BANGLADESH DELTA PLAN 2100

Baseline Studies : Volume 4

Agriculture Food Security and Nutrition

Editors
Dr. Shamsul Alam
Dr. Jaap de Heer
Giasuddin Choudhury

General Economics Division
Bangladesh Planning Commission, Ministry of Planning
Government of the People's Republic of Bangladesh

Kingdom of the Netherlands

BANGLADESH DELTA PLAN 2100

Baseline Studies on Agriculture Food Security and Nutrition

Volume 4

Baseline Study 15: Agriculture and Food Security
Baseline Study 16: Fisheries
Baseline Study 17: Livestock
Baseline Study 18: Forest and Biodiversity

Editors
Dr. Shamsul Alam
Dr. Jaap de Heer
Giasuddin Choudhury

General Economics Division
Bangladesh Planning Commission, Ministry of Planning
Government of the People's Republic of Bangladesh

June 2018

BDP 2100 Publication No. 04
Baseline Studies on Agriculture, Food Security and Nutrition

June 2018

Technical Assistance

BanDuDeltAS (Bangladesh-Dutch Delta Advisory Services) consisting of Twynstra Gudde (Lead Partner), Deltares, ECORYS, D.EFAC.TO, Euroconsult-Mott MacDonald, Wageningen University and Research Centre, Witteveen+Bos, UNESCO-IHE. Subcontractors are Climate Adaptation Services Foundation, Center for Environmental and Geographic Information Services (CEGIS), Institute of Water Modelling (IWM).

Editorial Associates

Md. Mafidul Islam, Joint Chief. GED, Bangladesh Planning Commission
Mohd. Enamul Haque, Deputy Chief and Project Director, GED, Bangladesh Planning Commission
Dr. Md. Taibur Rahman, Senior Assistant Chief, GED, Bangladesh Planning Commission
Murtuza Zulkar Nain Noman, Senior Assistant Chief and Asst. Project Director, GED, Bangladesh Planning Commission
Mohammad Asaduzzaman Sarker, Sr. Assistant Chief and Asst. Project Director, GED, Bangladesh Planning Commission
Mirza Md. Mohiuddin, Assistant Chief, GED, Bangladesh Planning Commission

Prepared and Published by
Bangladesh Delta Plan (BDP) 2100 Formulation Project
General Economics Division (GED)
Bangladesh Planning Commission
Government of the People's Republic of Bangladesh
Sher-e-Bangla Nagar, Dhaka 1207, Bangladesh
www.planncom.gov.bd

Disclaimer

Baseline studies were conducted to review past performances to generate information and knowledge, identify caveats and draw policy lessons and observe inter-sectoral impacts relating to water resources, land and agricultural practices and analyse climate change impacts. All these have been done to formulate delta action plan based on strategies developed through research by eminent scientists and professionals. Data, information and statements provided in the studies entirely belong to the authors, as such, GED bears no responsibility of inaccuracy, if any of data or statement.

Printed by
The Goodluck Printers
13, Naya Paltan Dhaka-1000

A H M Mustafa Kamal, FCA, MP
Minister
Ministry of Planning
Government of the People's Republic of Bangladesh

Message

I am happy to know that the General Economics Division (GED) of Bangladesh Planning Commission is publishing the Baseline Studies in six (6) volumes which were prepared for formulation of the Bangladesh Delta Plan (BDP) 2100.

Over the past 47 years since independence Bangladesh has secured tremendous gains in development. Bangladesh has achieved food self-sufficiency and the economy is gradually transforming from an agrarian base towards a modern manufacturing and services economy. Making this growth sustainable is even more challenging in the face of extreme adverse climate variability, with frequent storm and tidal surges, flooding, and droughts. I am confident that the BDP 2100 will amply guide us in realizing the vision that is aspired in the plan of being a prosperous country beyond 2041 and also contribute directly in making the growth sustainable by ensuring long term water and food security, economic growth and environmental sustainability while effectively reducing vulnerability to natural disasters and building resilience to climate change and other delta challenges. I hope BDP 2100 will also contribute to the making of 5 year plans as well as contribute to achieving SDG's and other national policy goals.

The Baseline Studies generated both quantitative and qualitative benchmark information for relevant subject areas of the plan and identified critical areas for future intervention. It also forms the basis for determining strategies and measures that have been suggested in BDP 2100 for different climatic Hotspots.

I am particularly pleased to note that BDP 2100 being a techno-economic plan, is the first attempt in our national planning history to formulate a real long term plan prepared by GED. The publication of the Baseline Studies in book form which served as basis for the preparation of the BDP 2100 has immense importance to keep the institutional memory preserved. These will be useful references to the policymakers, development partners, academics, researchers, students and professionals alike to further research endeavor and knowledge sharing.

In this instance, I would congratulate relevant officials of GED of Bangladesh Planning Commission for their hard work in compiling the Baseline Studies in book form. My sincere appreciation goes to the experts in their respective fields for completing the Background Studies for formulation of the BDP 2100.

(A H M Mustafa Kamal, FCA, MP)

M. A. Mannan, MP
State Minister
Ministry of Finance and Ministry of Planning
Government of the People's Republic of Bangladesh

Message

It gives me immense pleasure to learn that the General Economics Division (GED) of Bangladesh Planning Commission is going to publish 26 Baseline Studies in six (6) volumes which have been used as the inputs for preparing the country's first long term Plan i.e. Bangladesh Delta Plan (BDP) 2100. The Baseline Studies of BDP 2100 are the culmination of both quantitative and qualitative benchmark information for relevant subject areas of the plan and identified critical areas for future intervention. I believe, GED of Bangladesh Planning Commission has pursued with various eminent professionals, scientists, researchers, academia etc. at national and international levels for conducting these Baseline studies.

I know that BDP 2100 is the long term plan for the country to realize sustainable and a commonly agreed upon strategy with specific short, medium and long term interventions involving all relevant stakeholders for an optimum level of water safety and food security as well as sustained economic growth of Bangladesh and a framework for its implementation.

I congratulate the GED for taking up this bold initiative. I would like to thank the authors and also the reviewers who have contributed to prepare these Baseline Studies. Documented Baseline Studies will also be helpful for policy planners, development practitioners, researchers, academicians, professionals and even students as well. I also expect that the Baseline Studies will be useful for the officials of GED to prepare necessary policy briefs and write-ups they often prepare. I believe that not only GED but also other relevant officials will be immensely benefited with these Baseline Studies for upgrading and updating their knowledge and professional competences. Finally, I thank GED leadership for undertaking this endeavor for publishing Baseline Studies of the BDP 2100 for much wider use.

I wish all the best and all out success.

M. A. Mannan, MP

Shamsul Alam
Ph.D. (Newcastle), M.A. Econs. (Thammasat)
M.Sc. Ag. Econ. (BAU)
Member (Senior Secretary)
General Economics Division
Bangladesh Planning Commission

Prefatory Comments

Bangladesh is one of the largest delta's of the world and its rivers and floodplains support life, livelihood and economy. The country is defined by the delta, with almost a third of the country lying less than 5 (five) metres above sea level, on the contrary however, coastal zone, the low-lying area, is highly vulnerable, especially to cyclones and storm surges. In addition, salt-water intrusion, floods, sea level rise intensify the vulnerability of the community of the areas. These problems are likely to become even worse due to climate change adverse impact.

Many more challenges lie ahead for Bangladesh, the most important being pressure on land use, environmental protection, governance, globalization and macro-economic development. Given the ambition to be a developed country by 2041, addressing the expected impacts of climate change, there is a need for an integrated approach to future land and water management in relation to water safety, agricultural growth and food security. The recent and future anthropogenic changes in the hydrological cycle due to e.g. climate change, construction of dams and barrages in the upstream countries in combination with increasing water demand are expected to make future water governance and management even more challenging.

With a view to meeting the above challenges, the Government of Bangladesh (GoB) requested the Government of the Netherlands (GoN) to assist for formulation of adaptive, multi-sectoral, comprehensive and holistic Delta Plan taking lessons from Dutch experiences. The GoN agreed to provide the necessary support through its Embassy in Dhaka. In accordance with the decision of the Government, the General Economics Division (GED) of the Planning Commission, Ministry of Planning was assigned to lead the formulation of Bangladesh Delta Plan 2100, as the GED is mandated for medium and long term planning at the national level.

Bangladesh Delta Plan 2100 has been conceived as a techno-economic, long-term, holistic, water centric, strategic plan. As such, formulation of strategies in the short (budgeting), medium and long term is the most significant part in the planning process. The long term strategies will help to fulfil the Delta Vision, whereas the short and medium term strategies will help achieve benefits within the country's 5 year planning horizon as well as contribute to achieving SDG's and other national policy goals. An interactive planning process has been followed comprising three major steps: i) Conducting Baseline Studies; ii) Formulation of Adaptive strategies; and iii) Development of the Delta Management Framework. These steps were supported by country wide consultation processes which eventually led to the outcome of an Investment and Implementation Plan.

The project has prepared 26 Baseline Studies on known delta problems, reviewing existing policies and governance challenges in the sector of water resources, land, environment, disaster, agriculture, fisheries, livestock, transportation, finance, governance, knowledge generation etc. The studies followed the basic steps of reviewing the current policy situation, assessing the status of individual sectors, identification of drivers or pressures, conducting integrated analysis for the right interpretation of problems, challenges and knowledge gaps. For starting an integrated analysis with stakeholders it was essential to create an overview of already established and agreed-upon policies as well as to rank

priorities for further investigation, research and discussion. The key elements in the approach were (a) knowing the present state, problems, impacts, challenges and current responses or interventions; (b) consideration of uncertainties of social and natural systems and knowledge gaps; (c) the evaluation of drivers, trends or events in the interaction between the delta and society.

These Baseline Reports have been clustered into Six Volumes on the basis of thematic issues and topics.

Volume 1: Water Resources Management consists of seven Baseline Reports: 1. Sixty Years of Water Resources Development in Bangladesh: Lessons Learnt; 2. River System Management; 3. Water Resources; 4. Groundwater; 5. Coast and Polder Issues; 6. Water Supply and Sanitation; 7. Part A- Sediment Management and Part B- Meghna Estuary Study;

Volume 2: Disaster and Environmental Management consists of four Baseline Reports: 8. Climate Change; 9. Disaster Management; 10. Environmental Pollution; 11. Ecological Setting;

Volume 3: Land Use and Infrastructure Development consist of three Baseline Reports: 12. Land Resources Management; 13. Urbanization and Settlement; 14. Sustainable Transportation and Infrastructure;

Volume 4: Agriculture, Food Security and Nutrition consists of four Baseline Reports: 15. Agriculture and Food Security; 16. Fisheries; 17. Livestock; 18. Forests and Biodiversity;

Volume 5: Socio-Economic Aspects of the Bangladesh Delta consist of three Baseline Reports: 19. Population Growth and Management; 20. Socio-Economic and Demographic Condition; 21. Socio-Economic Characteristics of Chittagong Hill Tracts;

Volume 6: Governance and Institutional Development consists of five Baseline Reports: 22. Institutional Framework and Arrangements; 23. Information and Knowledge Management; 24. Regional Cooperation; 25. Financial Mechanisms & Arrangements in the Water Sector in Bangladesh; and 26. Private Sector Engagement in Deltas.

Volume 4: Agriculture, Food Security and Nutrition

The themes under the cluster "Food Security and Nutrition" are closely related and interdependent. Agricultural land is sometimes used for fisheries, especially for shrimp and prawn cultivation in the south west of the country. As a result, there are frequent conflicts between the farmers and fishermen. So a balance has to be made for the sake of harmony among the local people. Similarly, agriculture is closely related to the livestock sub-sector. Cattle are still used for tillage to about 50% of the croplands. Cattle also provides valuable fertilizer for vegetable and crop production. Livestock depends on crop residues and forage grown in the crop fields. Forest and biodiversity is also related to the other themes under the cluster, such as agriculture or fisheries and livestock. In Bangladesh, forest land is reducing due to human habitation and agricultural expansion. For a long term plan like the Bangladesh Delta Plan, it would be wise to consider the three sub-sectors in an integrated way, so that communities from all concerned are benefitted and the conflicts are avoided.

Agriculture sector, which is dynamic, changing with demand of people, availability of technology and change of management practices. Thus, it requires regular adjustment with different planning and development programmes. For a long time, planning a visionary exercise was needed in order to foster sustainable growth of this important sector, and it is expected that a comprehensive Bangladesh Delta Plan would meet this need for the development and sustainability of the sector, especially addressing the water and infrastructure related challenges. Ensuring food security for the poor is a fundamental strategic goal of the Government. It involves the physical availability of food at all times and its access to all at affordable prices.

Fisheries sector has been given due importance in preparing the Delta Plan 2100 with the objective of developing a comprehensive, participatory and doable 'Plan' for boosting up fisheries resources within environmental limits with expectation of ensuring protein based food security of increasing population. Under the vision, the government has targeted to achieve long term food security with safe fish products, surplus for export attaining strong economic growth

with maintaining environmental sustainability through robust, adaptive, integrated and innovative strategies and equitable resource management with good governance. Devising such plan requires a collaborative and participatory research within the sub sectors.

Bangladesh is endowed with vast marine, coastal and inland water resources having great fisheries production potential, contributing 3.69% to the Gross Domestic Product (GDP) of the country and almost one-fourth (22.60%) to the agricultural GDP. Fish supplements about 60% of our daily animal protein intake. More than 17 million people including about 1.4 million women depend on fisheries sector for their livelihoods by fishing, farming, fish handling, processing, etc. Different survey revealed that more than 80% of labours engaged in fish processing industries are women (gender aspect) and creating more employment opportunities to the rural people.

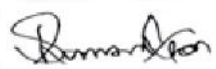
Livestock is a key component of the agricultural economy of Bangladesh. Despite its modest share of overall GDP (1.84% in 2014), livestock serves an essential role as a source of protein, employment generation, export earning, and provision of food security. Livestock resources play an important role in the sustenance of landless people, livelihood options for the rural poor families and are potentially important for poverty reduction. Agriculture, including livestock and fisheries, has emerged as a growth driver in the 21st century. The potential of the livestock sub-sector is much higher than generally estimated at present. Bangladesh has serious shortages of milk, as people want to consume it as nutrition for the whole family, not merely the children. Bangladesh, however, has to depend on imported milk products.

Commercial poultry is a fast growing sector. There are about 1.5 lakh commercial poultry farms all over the country. Besides, most rural families traditionally rear poultry birds in backyards, contributing significantly to the rural economy. It provides family nutrition and acts as a ready cash source. It is, therefore, an important option for poverty reduction.

Addressing climate change adaptation, innovation and knowledge gaps in appropriate technology development, technology diffusion and adoption to cope with the adverse effect of climate change is essential in Bangladesh in the context of integrated mixed farming system. It is very important particularly in the coastal region, in drought prone northern region and also floodplain areas including haor and other hydrological areas of the country.

Forest is an important renewable resource of the nature. It provides material like timber, pulp, pole, fuel wood, food and medicine, habitat for wildlife and primary base for biodiversity. The forest ecosystem also provides oxygen, controls or reduces the intensity of the cyclones and tidal surges in the coastal areas of Bangladesh, influences the rainfall, and sustained water yield in the river systems and other services. Besides, forest is a place for recreation and nature based tourism. Nowadays, eco-tourism is the preferred type of tourism, which is widely believed to be an alternative mechanism for environmentally sustainable development without depleting the forest resources, its habitats and biodiversity. Unfortunately, there has been great depletion of forests and biodiversity in recent years due to human pressure, agricultural expansion, over exploitation of forest resources and encroachment of forest land.

Goal of management for securing higher yield of wood per unit area from the forests led to establishment of mono-specific plantations through conversion of biodiversity rich natural forests. During the past one hundred years, considerable loss of natural forests and biodiversity occurred in Bangladesh. Many forest plants are greatly reduced in proportion, a good number of important animals have become extinct and many more are endangered. There has been shrinkage of forest areas primarily because of improper management, increasing human pressure and ruthless exploitation of resources. The overall productivity from the forest ecosystems has declined in recent years. The Baseline Study identified causes for the degradation of ecosystems, develop their proper management practices and prepare long-term planning for ensuring sustainable natural resources was felt essential.



(Shamsul Alam)

Acknowledgements

The Bangladesh Delta Plan 2100 has been prepared by the General Economics Division (GED) of the Bangladesh Planning Commission and is supported by the Government of the Netherlands. At the behest of the Hon'ble Prime Minister of the People's Republic of Bangladesh, Sheikh Hasina, a Memorandum of Understanding (MoU) was signed between Bangladesh and the Netherlands to cooperate on Bangladesh Delta Plan 2100. During a meeting in The Hague, Prime Minister Sheikh Hasina of the People's Republic of Bangladesh and Prime Minister Mark Rutte of the Netherlands renewed their support to the preparation and implementation of Bangladesh Delta Plan 2100.

Hon'ble Minister Mr. AHM Mustafa Kamal, M.P., Ministry of Planning, always encouraged the formulation of the project and contributed to the formulation of the plan passionately. Mr. Abdul Mannan, M.P., State Minister, Ministry of Planning and Ministry of Finance, gave valuable time and guidance.

We acknowledge the guidance and timely direction provided by the National Steering Committee (NSC) headed by Mr. Md Abul Kalam Azad, Principal Secretary of the Hon'ble Prime Minister and Dr. Kamal Abdul Naser Chowdhury, Principal Secretary of the Hon'ble Prime Minister and Mr. Md. Nojibur Rahman, Principal Secretary of the Hon'ble Prime Minister in consecutive terms for their contributions to successful completion of the Plan.

We are also grateful to the valuable contribution of the Panel of Experts headed by Dr Jamilur Reza Choudhury for their review of the Plan contents, and the important suggestions to improve those. The reviewers' contribution to the Baseline Reports are also acknowledged for their valuable comments and suggestions for improvement.

The International Economics Wing of the General Economics Division (GED), Bangladesh Planning Commission, coordinated all the reports under the broad and extensive guidance of Dr. Shamsul Alam, Member (Senior Secretary), GED, so that, the Plan could meet the quality standard. Mr. Naquib Bin Mahbub, Division Chief; Mr. Md. Mafidul Islam, Joint Chief; Dr. Md. Mizanur Rahman, Ex. Project Director; Mr. Mohd. Enamul Haque, Deputy Chief and Project Director, Dr. Md. Taibur Rahman, Senior Assistant Chief; Mr. Md. Murtuza Zulkar Nain Noman, Senior Assistant Chief, Mr. Mohammad Asaduzzaman Sarker, Senior Assistant Chief and Mirza Md. Mohiuddin, Assistant Chief provided constant support in the process of preparation of the plan.

The Embassy of the Kingdom of the Netherlands, in addition, regularly arranged funds and meetings. Ms. Martine van Hoogstraten, Head Development Cooperation, Mr. Carel de Groot, and Mr. Peter de Vries, First Secretary, Mr. ATM Khaleduzzaman, Senior Advisor, Water Management of EKN, always extended their valuable support to the activities related to the BDP 2100 project.

Prof. Dr. Jaap de Heer, Team Leader, Mr. Giasuddin Ahmed Choudhury, Deputy Team Leader of the project were always available to guide, advice and assist the studies. They extended impeccable efforts for coordination among the consultants, authors, reviewers and the GED. We thank the involved other experts from the consultancy teams: Mr. Stephan van den Biezen, Dr. Maminul Haq Sarker, Yeusuf Ahmed, Shaker Bin Shams, William John Oliemans, Anwar Zahid, Zahirul Haque Khan, Fred de Brujn, Ismat Ara Parvin and Tanvir Ahmed.

Last but not the least, many officials from the Ministry of Planning, Ministry of Water Resources and other ministries of the government graced with their presence to project-related meetings and discussions. Also many stakeholders attended the Delta Seminars/Workshops throughout the country.

We from GED gratefully acknowledge the efforts by all concerned.

June 2018

BDP 2100 Baseline Studies

Volume 4

Baseline Study 15
Agriculture and Food Security
Baseline Study 16
Fisheries
Baseline Study 17
Livestock
Baseline Study 18
Forest and Biodiversity

Table of Contents

List of Tables

List of Figures

List of Tables

List of Figures

List of Maps

List of Photos

List of Tables

List of Figures

Baseline Study 18: Forest and Biodiversity 333

List of Tables

List of Figures

Abbreviations

ANH	Agriculture for Nutrition and Health
APB	Actionable Policy Brief
ARI	Agriculture Research Institute
ARIMA	Autoregressive Integrated Moving Average
ADC	Additional District/ Divisional Commissioner
ADeC	Additional Deputy Commissioner
AIGAs	Alternative Income Generating Activities
ADB	Asian Development Bank
ADP	Annual Development Programme
AI	Artificial Insemination
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
BMCUL	Bangladesh Milk Producer's Cooperative Union Ltd
BLRI	Bangladesh Livestock Research Institute
BRAC	Bangladesh Rural Advancement Committee
BRDB	Bangladesh Rural Development Board
BSS	Bangladesh Sangbad Sangstha
BSTI	Bangladesh Standard Testing Institute
BQ	Black quarter
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BFDC	Bangladesh Fisheries Development Corporation
BFRI	Bangladesh Fisheries Research Institute
BOD	Biological Oxygen Demand
BSTI	Bangladesh Standards and Testing Institution
BWDB	Bangladesh Water Development Board
BADC	Bangladesh Agricultural Development Corporation
BARC	Bangladesh Agriculture Research Council
BBS	Bangladesh Bureau of Statistics
BCIC	Bangladesh Chemical Industry Corporation
BIHS	Bangladesh Integrated Household Survey
BR	Bangladesh Rice

BRAC	Bangladesh Rural Advancement Committee
BRRI	Bangladesh Rice Research Institute
BWDB	Bangladesh Water Development Board
CARE	Cooperative for American Relief Every Where
CHT	Chittagong Hill Tract
CHTDB	Chittagong Hill Tract Development Board
CIP	Country Investment Plan
CLDDP	Community Livestock and Dairy Development Project
CWU	Consumptive Water Use
CEGIS	Center for Environmental and Geographic Information Services
CIDA	Canadian International Development Agency
DAE	Department of Agricultural Extension
DLS	Department of Livestock Services
DC	District/Divisional Commissioner
DO	Dissolved Oxygen
DOE	Department of Environment
DoF	Department of Fisheries
DAE	Department of Agricultural Extension
DAP	Diammonium Phosphate
DFAT	Department of Foreign Affairs and Trade
DFID	Department of Foreign Affairs and International Development
DLR	Department of Land Record
DLS	Department of Livestock Services
DoF	Department of Fisheries
DTWs	Deep Tube-wells
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EP	Environment Policy
FAO	Food and Agriculture Organization
FAP	Flood Action Plan
FCD/I	Flood Control, Drainage and Irrigation
FGD	Focus Group Discussion
FRSS	Fisheries Resources Survey System
FY	Fiscal Year
FYP	Five Year Plan
FAO	Food and Agriculture Organization of the United Nations
FIAC	Farmers Information and Advice Centre
FMTW	Force Mode Tube-wells
FPMU	Food Planning and Monitoring Unit
FTF	Feed the Future
FY	Financial Year
FMD	Foot and Mouth Disease
GCA	Gross cropped Area
GDP	Gross Domestic Production
GIA	Gross Irrigated Area
GNP	Gross National Product
GoB	Government of Bangladesh

GO-NGO	Government and Non-Government Organization
GAP	Good Aquaculture Practice
GDP	Gross Domestic Product
GMP	Good Management Practice
GDP	Gross Domestic Product
HS	Hemorrhagic Septicemia
HACCP	Hazard Analysis and Critical Control Point
HH	Household
HYV	High Yielding Variety
HDC	Hill District Council
HNPSP	Health, Nutrition and Population Sector Programme
HYV	High Yielding Variety
ICT	Information Communication Technology
IFPRI	International Food Policy Research Institute
IR	International Rice
IRRI	International Research Institute
IUCN	International Union for Conservation of Nature
JMP	Jalmahal Management Policy
JICA	Japan International Cooperation Agency
Kcal	Kilo Calorie
LLP	Low Lift Pump
LPL	Lower Poverty Line
LDCs	Least Developed Countries
LGED	Local Government Engineering Department
LGRD	Local Government and Rural Development
LGRDC	Local Government, Rural Development and Cooperatives
MDG	Million Development Goal
MFI	Micro-finance Institutions
Mha	Million Hectare
MMt	Million Metric Ton
MOA	Ministry of Agriculture
MOCHTA	Ministry of Agriculture and Ministry of Chittagong Hill Tracts Affairs
MOF	Ministry of Food
MoP	Murat of Potash
MRA	Microfinance Regulatory Authority
MT	Metric Ton
MV	Modern Variety
MDG	Millennium Development Goal
MoA	Ministry of Agriculture
MOFL	Ministry of Fisheries and Livestock
MOLGRDC	Ministry of Local Government Rural Development and Cooperatives
MT	Metric Tones
MDGs	Millennium Development Goals
MFTS	Marine and Fisheries Technology Station
MOEF	Ministry of Environment and Forests
MoFL	Ministry of Fisheries and Livestock
MOL	Ministry of Land

MoWR	Ministry of Water Resources
MSY	Maximum Sustainable Yeild
NGO	Non-Governmental Organization
NLDP	National Livestock Development Policy
NLEP	National Livestock Extension Policy
NPDP	National Poultry Development Policy
ND	Newcastle Disease
NAPA	National Adaptation Programme of Action
NEMAP	National Environmental Management Action Plan
NFdP	National Food Policy
NFMP	New Fisheries Management Policy
NFP	National Fisheries Policy
NFS	National Fisheries Strategy
NGO	Non Governmental Organizations
NLUP	National Land Use Policy
NSAPR	National Strategy for Accelerated Poverty Reduction
NWP	National Water Policy
NWRD	National Water Resources Database
NWtP	National Wetland Policy
NAEP	New Agricultural Extension Policy
NAP	National Agriculture Policy
NARS	National Agricultural Research System
NFP	National Food Policy
NGO	Non-Government Organization
NHP	National Health Policy
N-P-K	Nitrogen-Phosphorous-Potash
NSB	National Seed Board
NSPS	National Social Protection Service
OIE	An Organization for world Animal Health
OPP	Outline Perspective Plan
PCR	Polymerase Chain Reaction
PL	Post Larvae
PPB	Perspective Plan for Bangladesh
PRSP	Poverty Reduction Strategy Paper
PKSF	Palli Karma Shahayok Foundation
PRAN	Program for Rural Advancement Nationally
PRSP	Poverty Reduction Strategy Paper
PSDP	Poultry Sector Development Project
PoA	Plan of Action
PSI	Private Sector Importer
SAAO	Sub-Assistant Agriculture Officer
SFYP	Sixth Five Year Plan
SME	Small and Medium Enterprise
SPARSO	Bangladesh Space Research & Remote Sensing Organization
SRDI	Soil Resource Development Institute
SRR	Seed Replacement Rate
SSP	Single Super Phosphate

STW	Shallow Tube-wells
SWAPNO	Strengthening Women's Ability for Productive New Opportunities
SIA	Social Impact Assessment
SIS	Small Indigenous Species
SFYP	Sixth Five Year Plan
SLDP	Smallholder Livestock Development Project
T. Aman	Transplanted Aman
TSP	Triple Super Phosphate
TV	Television
UNDP	United Nations Development Program
UP	Union Parishad
USD	US dollar
UGC	University Grants Commission
ULDC	Upazila Livestock Development Center
UP	Union Parishad
VGD	Vulnerable Group Developmet
VGF	Vulnerable Group Feeding
WMP	Waterbody Management Policy
WARPO	Water Resources Planning Organization
YGM	Yield Gap Minimization

Measuring Units

° C	Centigrade
ha	hectare
gm	gram
kg	kilogram
m	meter
mm	millimeter
mt	metric MT

BASELINE STUDY: 15

Agricultural and Food Security

Authors

Dr. Z Karim[1]

Dr. Fakhrul Islam[2]

[1] Dr. Z karim, Chairman, CASEED & Senior Adviser, FAO

[2] Dr. Fakhul Islam, Former Professor, Department of Agri. Economics, BSMRAU

Executive Summary: Study 15

Agriculture is the most important sector of Bangladesh economy due to its role in food security, employment and livelihood. Still more than 70% of the people in Bangladesh are directly or indirectly employed in this sector. The Bangladesh economy is transforming towards commercial agriculture with expansion of service sector. The agriculture of Bangladesh is dominated by crops which accounts about half of total agricultural GDP. Rice dominates Bangladesh agriculture covering more than 80% of the land area. Although food grain production has tripled over the last 40 year period, productivity of pulses, oilseeds, and fruits have not been increased much.

Agriculture sector is dynamic, changing with demand of people, availability of technology and change of management practices. Thus, it requires regular adjustment with different planning and development programmes. Country has much potential, yet it faces many challenges including vulnerability of climate change. For a long time planning a visionary exercise is needed in order to foster sustainable growth of this important sector. This necessitates a comprehensive Bangladesh Delta Plan (BDP) for development and sustainability of the sector harmonizing with the management of natural resources and addressing the challenges.

The overall objective of the base line study is to support preparation of Bangladesh Delta Plan to ensure long term sustainable production of crops for food security in Bangladesh. The specific objectives of the base study are: i) to identify gaps in relevant policy and planning documents; ii) to identify challenges and potentials of Bangladesh agriculture and food security; iii) assessment of current productivity status and to formulate development options for planning exercise; ix) outline an insight of long term Delta Plan ensuring food and nutrition security; and v) to develop a common and inclusive knowledge base.

Methodology of the base line study includes: i) review of relevant policy and planning documents, ii) collection of information from BBS, DAE, MOA, MOF, etc. and various on-line resources; ii) desk review, seminar/workshop, interactive meetings, consultation with line departments including other stakeholders; ix) analysis and synthesis; v) report preparation; and vi) consultation with relevant ministries, line departments, agencies, focal points experts, including other stakeholders on consensus building on findings of the base line report.

Much Progress has been made during the last decades in Bangladesh in formulation and adapting agricultural policies to the ever changing needs of modernizing agriculture. The governments in the past adapted different sets of policy to cater needs of the government line departments, private sectors and farmers to create an enabling environment for technology dissemination and enhancing agricultural productivity. Bangladesh experienced a continuous process of policy refinement.

Relevant policy and planning documents were reviewed and gaps were identified. The policy and planning documents reviewed were: New Agricultural Policy 2013 (NAP), National Agriculture Policy (NAP 1999), New Agricultural Extension Policy (NAEP, 1996), DAE-Strategic Plan, 1999-2002. Agricultural Extension Manual, 1999, Seed policy, 1993, Seed Rules 1998, Fertilizer distribution policy 2009, Plan of Action on National Agriculture Policy (NAP, 2003), Actionable Policy Brief (APB, 2004), National Jute Policy, 2002, Livestock Policy and Action Plan, 2005, National Fishery Policy, 1998, National Forest Policy 1994, National Land use policy, National Water Policy, 1998, Environment Policy 1992 and Implementation Programme, National Food Policy, 2006 and National Health Policy.

The gaps identified in National Agriculture Policy 2013 are: (1) The policy has addressed cereals and did not address adequately the non-cereals sector like jute, sugarcane, cotton etc. (2) There is absence of a framework to develop effective human resources for commercialized agriculture including unemployed rural youth and women. (3) It is necessary to formulate a strategic plan to encourage export of high value products. Existing land use plan may have to be modified for this purpose to enhance productivity of high value items including fruits, vegetables, medicinal plants, herbs, cut-flowers, foliage etc. and value added processed products. (4) Food safety and quality issues are not adequately covered or emphasized including the traceability of the product.

The public sector policies on seeds were stated in the National Seed Policy 1993, the Seeds (Amendment) Act 1997, the Seed Rules 1998, The Seeds Ordinance 1977 with amendments made in 1997 and 2005, the National Agricultural Policy 1999, the National Food Policy 2006 and National Food Policy Plan of Action 2007. The objectives and strategies for the seed sector are not narrated in these policy documents exactly in the same manner or language though the main thrust or message seems to be similar. It is narrated that the government would facilitate a balanced development of public and private sector roles in the production and distribution of quality seeds. What it actually means and how it would be achieved is not uniformly stated in these documents. Thus private and public sector interpret the intentions of these policies differently, causing some controversy.

The differences between private and public sector perspectives on the seed market are prompted by two factors: (i) lack of accurate data on the size and structure of the seed markets for different crops; and (ii) lack of sufficient clarity on the objectives and strategies of the national seed policy. These issues can be a hindrance to effective participation by private sector.

The fertilizer policy in Bangladesh evolved from adopting public fertilizer distribution system with subsidy to privatization. Existing GOB fertilizer distribution system and regulations often impedes the private dealers from effective operations and does not serve farmers in remote areas. The GoB fertilizer demand assessment is centrally determined and is not based on fertility level of soil. There is a monopoly system of import of urea fertilizer by BCIC. Beside this, BADC and private importers import the required quantity of TSP, MoP and DAP from different countries and sources. Import of fertilizers fully depends on MoA's allotment and permission.

There is no broad focus on the safety and quality of meat, poultry and their products. The Livestock Policy and Action Plan, 2005 fails to address hygienic slaughtering of cattle for safe meat and meat products. The National Fishery Policy, 1998 describes very little on the issue of managing safety and quality of fish for domestic consumption covering Good Aquaculture management. But some activities are in place in respect of export oriented fish and fish products where traceability is established following international requirements.

Ensuring food security for the poor is a fundamental strategic goal of the Government. It involves the physical availability of food at all times and its access to all at affordable prices. The interventions are currently made by MoA through 19 development projects. Some of the institutional problems and issues are also being addressed by MoA with own resources, and efforts are being made to address the others that will require external funding.

Policy developments & programmes of MoA are underway through the implementation of Country Investment Plan (CIP) and needs for further action**.** Under sub-programme 1.1 related to enhancing knowledge generation, CIP (2012/13) includes seven completed, 31 ongoing and seven pipeline projects with total financing at 192.9 million USD or 1.61% of total financed CIP. Of the 181.1 million USD for completed and ongoing projects, 137.2 million USD (76%) was financed by GoB and 43.9 million by DPs. Under sub-programme 1.2, related to improvement of agricultural extension service, there are 11 completed, 24 ongoing and four pipeline projects, amounting to 243.9 million USD. Of the total budget of 202.3 million USD for completed and online projects, 146.7 million USD i.e. 73% are financed by GoB and the rest 27% by DPs. This sub-programme accounts for 2.03% of total CIP budget. Sub-programme 1.3, which mainly focuses on research and extension for climate adaption, includes 11 ongoing and seven pipeline projects worth 366.9 million USD. DPs finance 170.9 million USD or 61% of the total 279.7 million USD of ongoing projects. Further actions are needed on following areas: (1) Improve agricultural extension services, (2) Strengthen management system of research institutes, (3) Focus technological development on efficiency, sustainability and resilience, (4) Improve research infrastructure and strengthen human resource and (5) Promote agricultural research for nutritional development and (6) Expand Farmers Information and Advice Centres.

The World Bank is actively considering assistance in strengthening the agro-technology system; and JICA is reviewing the need for strengthening the Central Extension Resources Development Institute through reorganization and

redefining its charter. The process of strengthening the Seed Wing of BADC and revitalizing the Seed Certification Agency is ongoing.

Achieving the MDG targets within the next decade will require Bangladesh to develop and implement more effective strategies by the MoF. Speeding up per capita income growth and pursuing targeted safety net programmes are needed for the expansion of household food intake.

UNDP has designed a project document for a Social Protection Policy Support Programme in partnership with GED, and in coordination with DFID and DFAT. The programme also includes a component of catalytic learning through a pilot delivery intervention called Strengthening Women's Ability for Productive New Opportunities (SWAPNO) that will provide a benchmark for innovative delivering systems, including micro-insurance and climate adaptive social protection.

Land use pattern of a country reflects its socio-economic stipulation. While land use changes are concerning topics in perspective of socio-economic changes of a country, the pattern of its changes in Bangladesh is to meet the dynamic demand of the society that creates pressure on natural environment. Decade-wise Land Utilization of Bangladesh has been analyzed. The shifting rate of agricultural land to non-agricultural use is said to be about 1% per year. Availability of agricultural land of Bangladesh is gradually declining. According to BBS statistics annual decline of agricultural land is about 0.38% during 1980 to 2007 (27 years average), 0.75% during 1983 to 1994 (10 years average) and 0.40% during 1993 to 2004(10 years average). Average shifting of agricultural to non-agricultural land is about 0.73% or 68,760 hectares annually during 2000 to 2010. Major agricultural land shifted to rural settlement. Considerable shifting also occurred to urbanization, industrialization and other structures. It is estimated that 10 percent of farmers in Bangladesh own 50 percent of the land (BBS 2009). About 60 percent of farmers are functionally landless and depend on sharecropping of land owned by the others. Average farm sizes are very small to support a family adequately. Apart from sharecroppers, approximately 20 percent of farmers are regarded as marginal. The sharecropping has good effect in terms of cultivation and agricultural production; however, it has adverse effect on soil productivity maintenance. Most share croppers do not use proper dose of fertilizer, appropriate crop rotation, or organic manure due to a seasonal or annual contract arrangement and wants to get as much benefit as possible from the land within the contract period.

There are thirty agro ecological regions and 88 sub regions which are relevant for land use and assessing agricultural potential. Fertility status of these regions varies. Upazila-wise prepared "land and Soil Resource Utilization Guide or Upazila Nirdeshika" is more for suitable crop selection and assessing agricultural potentials. Individual farmers have fragmented the land into small pieces causing wide variation in the management of each and every piece of land. This leads to the large variation in the fertility levels even between adjacent plots.

Although Bangladesh is a small country, it has a wide variety of soils. The fertility status of Bangladesh soils is extremely variable. Most of the soils are depleted and in urgent need of replenishment with organic matter and fertilizer in order to enhance crop productivity. It is estimated that more than 100 kg nutrients per ha year are mining out from the soil system. Organic matter status of about 3.67 million hectares of agricultural land is low to very low (1.76%). Status of phosphorus, potassium, sulphur zinc and boron is low in about 3.7, 2.72, 3.31, 2.76 and 2.49 million hectares of agricultural land and calcium and magnesium is reported low in about 1.43 million hectares. Balanced fertilization is the key to successful crop production and maintenance of good soil health. It is important to see how close nutrient addition and removal by crops match with each other. According to current statistics, the farmers of Bangladesh use 215 kg nutrients (N: 149 kg, P_2O_5: 37 kg, K_2O: 22 kg and S + Zn + B + others: 7) ha/year from chemical fertilizers, while the estimated removal is around 280 -350 kg/ha. From organic and natural sources about 50-70 kg nutrients are added to the soil system every year.

Bangladesh has virtually no possibility of increasing its cultivable land area. Therefore, food production of this country can be increased through increasing irrigation facilities together with expansion of HYVs and balanced use of fertilizer.

Besides, well-timely supply and availability of fertilizer should receive top priority to increase crop production in Bangladesh.

Total requirement of fertilizers like Urea, TSP, SSP, MP, Gypsum and mixed fertilizer for crop production in 20011-12 were 28, 5, 1.25, 1.5 and 3 lakh metric tonnes per year respectively. Among them 60 percent of Urea and 100 percent of mixed fertilizer were produced in the country. There was sharply increasing trend in use of fertilizer during 1981-2008 while TSP and MoP slightly increased. During 1963 to 1979, total fertilizer use increased dramatically with a growth rate of 16.5% per annum. Thereafter, the growth rate of urea declined. During 2004-12 growth rate of TSP and MoP sharply increased due to having government subsidy on these two fertilizers. It is evident that actual uses of all the fertilizers for rice production are below the recommended dose. The gap between the actual and recommended dose also exist for other crops.

Most of irrigation water is used for rice production with about 86% of the total irrigated area of Bangladesh. Irrigation is considered as a necessary precondition to enhancing agricultural production of Bangladesh. In this country the earliest approach to irrigation facilities was through constructing large scale multipurpose irrigation, flood control and drainage (FCD) projects during 1960 – 1970. Expansion of minor irrigation through groundwater using DTWs and STWs was the vital component of the GoB's strategy to facilitate irrigation for agricultural development. STWs under private ownership played significant role for irrigation development during 1980s and there had been recorded sharp increase in number of these equipment During Third Five Year Plan (1985-90) continued emphasis on irrigation facilities tremendously increased groundwater irrigation through the use of DTWs, STWs and manually operated HTWs. The agricultural growth in the country has been largely due to expansion of minor irrigation through the use of DTWs, STWs and LLPs. There is positive trend of irrigation growth in Bangladesh from 1982 to 2011.

The irrigation Consumptive Water Use (CWU) of rice production was 11.8 Bm^3 in 2000, has increased by 40% to 16.5 Bm^3 in 2010; the latter is estimated using the irrigation CWU per hectare of rice production is 265 mm in 2000. A projection has been made on irrigation CWU demand to 2020 and 2030 under two different scenarios: (1) Scenario of area expansion and surplus rice production. Under this scenario the irrigation CWU demand for rice will be 20.9 Bm3 and 24.5 Bm3 in 2020 and 2030, respectively, which are 27% and 48% increases from the 2010 level. (2) Scenario of Self - sufficiency in rice production, improving water productivity with no area expansion. According to this scenario, rice production will have to be 37.2 MMt by 2020 and 40.3 MMt by 2030, respectively. Even with no growth in water productivity (WP), irrigation CWU demand will decrease by 2.6 Bm^3 and 6.1 Bm^3 by 2020 and 2030, respectively, from the estimates in scenario 1, due to lower production requirement. With 5% growth in WP, irrigation CWU demand will decrease by 2.7 Bm^3 and 6.4 Bm^3 by 2020 and 2030, respectively; and with 10% growth in WP, irrigation CWU demand will decrease by 2.9 Bm^3 and 6.8 Bm^3, respectively. Importantly, the reduced irrigation CWU of rice in scenario 2 can meet most of the irrigation demand of other crops.

The implication of above water demand projection is that given the falling groundwater tables and water quality issues in Bangladesh, it will be extremely difficult to exploit groundwater resources sustainably under scenario 1. Without an increase in WP, it will be difficult to meet even the reduced demand under scenario 2. A few districts have already passed the sustainable thresholds of groundwater use in the Khulna region, Bogra and Pabna in the Rajshahi region, Barisal, Chittagong, Kishoreganj, Kushtia and Rajshah where irrigation CWU exceeds the usable groundwater recharge.

In Bangladesh the national requirement of quality seeds of all crops is estimated to be 932,250 metric tons. Against this national requirement, the supply of quality seeds was 186,450 metric tons. Seed system through quality seed replacement rate (SRR) against national requirement up to 2011-12 was 20 percent of which an about 80 percent seed is being fulfilled through the informal seed system of farmers' own saved seeds.

Increasing the speed of and sustaining agricultural growth are priorities for increasing food production and reducing poverty. The future challenge of increasing food production could be met through the introduction of modern

biotechnology and an increase in investment in agricultural technology generation and transfer. Varietal improvement and improvement of production practices are high priority of NARS research. Technologies developed by the NARS institutes are disseminated to the farmers through the extension department and NGOs. In meeting the demand for higher food production, thrust should be given to frontier research including genetic engineering, reduction of cultivation costs, problem soil management, strengthening of the technology-transfer linkage, and improvement of postharvest technology.

The average cropping intensity in Bangladesh is over 183% in 2011. It was found that cropping intensity has increased over the last fifty years by 60 percent. Rice is the staple food of about 156 million people of Bangladesh. It provides nearly 48% of rural employment, about two-third of total calorie supply and about one-half of the total protein intakes of an average person in the country. Rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh. Almost all of the 13 million farm families of the country grow rice. Rice is grown on about 10.5 million hectares which has remained almost stable over the past three decades. About 75% of the total cropped area and over 80% of the total irrigated area is planted to rice. Thus, rice plays a vital role in the livelihood of the people of Bangladesh.

Total rice production in Bangladesh was about 10.59 million tons in the year 1971 when the country's population was only about 70.88 millions. However, the country is now producing about 35.0 million tons to feed her 156 million people. This indicates that the growth of rice production was much faster than the growth of population. This increased rice production has been possible largely due to the adoption of modern rice varieties on around 66% of the rice land which contributes to about 73% of the country's total rice production.

Over the last 40 years, Bangladesh has experienced a "green" revolution' in rice production; with the production almost tripled from approximately 10 million metric tons in the mid-1970s to almost 34 million tons in 2013-14. It was largely based on the cultivation of high-yielding varieties (HYVs) under irrigation with use of chemical fertilizers.

Yield gaps between the potential yield in BRRI Research Station farm and Actual farmers' yield of different modern rice varieties by season. According to BRRI results of 2006-7 yield gap ranged 18-26%. This means that the farmers' actual yield is 18-26%. lower than the potentially attainable yield. During 2010-11 BRRI results showed that yield gaps ranged 22 to 32% and with an average of 20%. Some causes of rice yield gap are decreasing soil productivity, inefficient water and fertilizer use, inadequate supply of quality seeds, imbalanced use of fertilizer, low labour productivity, and higher input price. These factors are restricting realization of full yield potential of HYVs, resulting in lower yield of cereals in the farmers' field compared with much higher yield obtained in the research station. It was found some varieties of rice that productivity declined marginally, but rose sharply for wheat and maize**.** In 2012/13, rice productivity declined (-0.2%) for the first time since 2005/06.

In 2012/13, wheat and maize production grew sharply by 26% and 14%, respectively. Potato production rose by 5%, compared to a 1.8% reduction in the previous year, with the increase in yield (1.6%). Pulse and oilseed production rose faster in 2012/13, respectively by 11% and 5%. Fruit production accelerated, but vegetables exhibited mixed trend over the same period: brinjal and pumpkin maintained the upward trend while beans and lal shak production declined. Agricultural diversification is becoming increasingly important to tackle the rising food trade deficit due to changing consumption habits and for further promoting the diversification of diets, In turn, diversification toward higher value added on-farm activities, such as production of fruits, vegetables, legumes, fishery and livestock products can help accelerate agricultural income growth and poverty reduction, generate backward and forward linkages and promote growth of agro-based processing and marketing.

Bangladesh has made good progress since 1992 in reducing income poverty based on the national poverty line. The most recent estimates (Household Income Expenditure Survey – HIES, 2010) still 36.5% of the population has absolute poverty and are undernourished who fail to meet minimum level of caloric consumption needs of 2122 KCal/person/day and 17.6% of the total population are hard core poor who are unable to consume 1805

Kcal/person/day. Food security worsens with inter-year shortfall in food grain production caused by climatic variations and natural disaster such as floods, tidal surge and insect and pest attacks. Variations in food intake also exist between regions of the country, between adults and children and between men and women at the household level.

Availability of staple food has been increased largely and Bangladesh has become self-sufficient in rice staple food. The country produced 33.54 million tonnes for its 160 million people in FY 2010-11. Rice production increased by 2.91 times in 36 years, In 1971-72, the average rice yield was 1.05 tonnes per hectare, while in 2005-06 it was 2.52 tonnes. The per capita rice production has increased substantially over the level at independence.

Per capita availability of cereals (rice and wheat) has been found to increase from 374 g/day in 1994-95 to 647 g/day in 2010-11 (Table 6.3). Sharp increase in per capita availability of potato and vegetables is seen in the last four years, while the per capita availability of pulses and oilseeds has remained stagnant or declined. Availability of meat, milk and egg has also increased as shown in Table 4. Per capita fish availability increased from 27 g in 1994-95 to 56 g in 2010-11.

In 2011–12, 36.8 percent of households in the FTF zone and 35.3 percent of households in the rural national sample were food energy-deficient who could not afford an adequate diet. Furthermore, 17.5 percent of the households in the FTF zone and 16.5 percent of the households in entire rural Bangladesh were below the lower food energy threshold of 1,805 kcal/person/day and, therefore, remained severely food energy-deficient.

The acceleration in economic and agricultural growth has made a positive impact on the diversity of food intake away from the rice and vegetable based diet in favour of quality food. It may be noted that the per capita consumption of rice and wheat has been declining, while the consumption of vegetables, fruits and fish and meat has been growing.

In terms of minimum energy consumption Rajshahi and Barisal divisions are relatively worse off compared to other divisions (HIES 2005, HFSNA 2009). Malnutrition is also severe in the country. More than 90 percent of rural Bangladeshis are not getting enough vitamins A and iron deficiency— which can cause anaemia and the risk of death in childbirth—is also very high, especially for women of reproductive age (BIHS, 2011-2012).

It was found that that 40.5 percent of the population in the southern region lived below $1.25 per person per day in 2011–12. While 38.2 percent of the population in rural Bangladesh was living below the family welfare threshold, there are pronounced regional differences in the incidence. The rate varies widely across divisions, ranging from a low of 31.0 percent in Chittagong division to as high as 65.5 percent in Rangpur division. Although Rajshahi division ranks the second highest, the rate in this division is 23.1 percentage points lower than that in Rangpur division. Agricultural wages have increased quite sharply in recent years, enabling the rural poorest to improve their livelihoods significantly.

Coastal region, Haor and CHT have some special type of bio-physical constraints. These regions have been identified as disadvantaged regions in terms of poverty, food insecurity, environmental vulnerability and limited livelihood opportunities. Major Constraints of Coastal region are (1) Extreme environmental events and high vulnerability to climate change. (2) Low agricultural productivity, poor land use and low cropping intensity. (3) Low productivity of Rabi crops and little high value crops cultivation. (4) Predominance of small and landless farmers. (5) Limited availability of suitable irrigation water (6) Intrusion of saline water, water logging and occasional breaches of embankment. (6) Higher rates of poverty and malnutrition.

The CHT represents 9 percent of the landmass divided in three districts consisting of 25 Upazilas with one percent population of the country. Major constraints of CHT are (1) Natural resource degradation – soil erosion and siltation of water bodies; reduced soil fertility; and biodiversity loss. (2) scarcity of water in dry season (3) An under-developed sector for the provision of essential inputs and extension (seed, fertilizer, credit). (4) Scarcity of adaptive research, on-farm trials and demonstrations, leading to low knowledge of CHT-specific conditions and absence of innovative practices. (5) Limited access to markets, and opportunities for agro-processing. (6) Low productivity, and missed

opportunities for diversification (and associated benefits to nutrition), due in part to poor access to improved inputs, and/or to new adapted technologies. (7) Poor technical capacity of stakeholders and a lack of technical coordination. (8) Disjointed and/or overlapping programmes, without consistent guiding principles on the part of government and development partners.

Haors are located in the north-eastern region of Bangladesh. It has a total area of 8,000 km2. There are 373 Haor with a gross land area 1.99 million ha, net cultivated land 1.33 million, 16% of total rice land of Bangladesh in Haor area. People in the region are poorer than in any other part, More than 28% are below the Lower Poverty Line. Major Constraints of Haor are; (1) Degradation of natural resources and biodiversity. (2) Natural disasters are the main reason of poverty, lack of availability of basic infrastructure and social amenities, inequity in resources acquisition and poor access to natural resources. (3) Crop damage by flash flood. (4) Declining productivity of crops. (5) Poor Market linkage and value addition

The major challenges related to agriculture and food security in Bangladesh are: (1) Curse of poverty, food insecurity and malnutrition. (2) Degradation of natural recourses, (3) Low agricultural productivity and limited modernization and/or diversification, (4) Weak research extension linkage and technology delivery, (5) High post-harvest losses, (6) Problems of market linkages and value chains, (7) Scarcity of availability of agriculture labour, (8) Farm mechanization, (10) Food quality and safety problem, (11) Inadequate institutional credit, (12) Inadequate availability of quality seeds to the farmers, (12) Increased environmental shocks and livelihood risk.

Following knowledge gaps have been identified:

- Climate change induced climatic variability and likely impact on availability of water for agricultural production.
- Given the variation between the hydrological regions and expected impact of external factors, the demand needs to be quantified in detail at the level of each region for each of the key sectors
- Availability of mitigation technology and adaptations
- Socio-economic developments, reflected in changing water requirements
- There is considerable knowledge gaps on the farm level use of pesticides, food quality and safety in Bangladesh
- Post-harvest handling, processing and traceability of agri-food in the supply chains
- Climate resilient agro-technology and likely impact on food security
- Climate related shocks, vulnerability and volatility of food prices

1. Technology development and dissemination

i. **Enhance research and technology generation*:*** To increase agricultural productivity and diversity in a sustainable manner require research and technology development in support of increased productivity in varied ecosystems is required in the following areas: (i) for crops, varietals development (short maturing Aus and Aman rice, new HYVs, biotechnology) build on respective experiences of private and public sectors; management practices (fertilizer, cropping patterns, cultural practices for char land, hill and coastal areas); and water and soil conservation; (ii) Promote frontier technology development through enhanced investment in R&D for increasing productivity. This will include activities: (i) Develop new varieties, crops, improving food quality, nutrition, etc. (ii) Enhance agricultural productivity through diversification, sustainable management of natural resources (in flood plain and CHT) and inputs. (iii) Promote "agro-ecologically suitable" and "climate-smart" agriculture that are effective to feed the population sustainably in the long term, and (iv) Supporting transformation of agriculture by building innovative, action-oriented partnerships with different countries. Promoting innovation and best practice by bringing people together to share experience and expertise.

ii. **Improve research-extension-farmer linkages and extension services**. They are required in the areas of technology adoption & community-based learning (farmers skill training, soil health improvement, diversification of agriculture, cultivation of quick growing fruits and vegetables, cropping patterns, farm mechanization) and promotion of sustainable agriculture In order for interventions to be successful, human and infrastructure capacities of DAE, require strengthening.

2. Improved water resource management and irrigation

i. **Augmentation of surface water for irrigation through development of water reservoir, recharge ground water, reduce use of ground water to avoid hazard of arsenic contamination:** We have identified some key priority investment activities: (i) the development of small scale surface irrigation in the southern part of the country (iii) partially reduce reliance on deep well irrigation in the northern part of the country, reduce costs and mitigate the risk of Arsenic contamination; (iv) rehabilitate dikes and embankments particularly affected by previous cyclones to protect vulnerable households and production base against sea intrusion in the extreme south, (v) improved drainage, saline intrusion control and flood management; and (vi) increasing river water flow towards the south, in particular involving a major river dredging effort.

ii. **Use water saving technology for improving efficiency of water and install facilities to reduce distribution losses**: Activities include: (i) reduce water losses in existing schemes through improved water management, development of water saving techniques or rehabilitation of existing schemes.

iii. **Reduce impact of saline water intrusion in the South and enhance river water flow:** Activities include: rehabilitation of polders and their management; dredging of rivers; enhanced surface water irrigation; and improved brackish water resource management practices.

3. Crop diversification

Agricultural productivity enhancement through crop diversification, increased cropping intensity, farm mechanization, reducing post-harvest losses, and modelling of climate events. Following public interventions will be needed:

Facilitate agricultural credit to farmers: An agricultural credit is an important factor for diversification of agriculture. Farmers with access to credit facilities are found to be more diversified than others.

***Investment in transportation networks and improve market linkage*:** Access to market is found to be less important at the farmers' level but it is important for increasing diversity in agriculture regionally. This means, a district with better communication and transportation facilities are more diversified than other regions. Most of the non-cereal produces are perishable items and so means of transportation and access to the market is important for them. It is necessary to promote export of agricultural commodities, particularly vegetables and fruits.

***Training for farmers*:** Modern agricultural is much more challenging than before. There are elements of production, processing, storage and transportation and in all of them training is an important pre-condition for ensure higher profit to a farmer.

To promote non-cereal diversification in agriculture, DAE should organize itself to ensure farmers' level training programs.

Support research and extension for non-rice crops: To support research and extension for the promotion of pulse, oil crop, spices, roots and tubers, and vegetable crops.

4. Sustainable supply and use of improved quality of inputs

i. **Enhance availability of quality agricultural inputs:** The proposed priority interventions are: expansion of both seed multiplication and processing farms and preservation facilities of BADC, NARS, DAE, and contract

growers; capacity development of public laboratories and SCA for testing quality of inputs; strengthening participation of NGOs and private sector in seed distribution; capacity development of farmers for autonomous production of quality seeds; and establishment of mechanisms to ensure availability and reasonable prices of all quality and environmentally friendly agricultural inputs. Develop public private partnerships through capacity development.

ii. **Improve and increase sustainability of soil fertility management*:*** The proposed interventions are to promote fertilizer use efficiency and balanced use of fertilizer. The main purpose is to strengthen environmentally sound fertility management practices. This will be done through facilitating application of fertilizers on the basis of soil tests, as well as strengthening of soil testing laboratories and promotion of improved soil health management practices. Detail land resource inventory at union level and publication of user friendly guide will need to be done.

iii. **Facilitate access to credit and other financial services by smallholders and the rural poor**: There is a strong call for collateral-free bank loans at low interest rates for agricultural purposes.

5. Farm mechanization

Agricultural production and food security in the country is adversely affected owing to the insufficient use of farm power and inappropriate use of farm machinery thereby negatively impacting on environmental sustainability, labour productivity and/or labour scarcity. Some investment priorities are: (i) Increasing the availability of agricultural mechanization technology to the farmer. (ii) Develop and promote agricultural machinery that is resource and energy efficient and conserve natural resources. (iii) Applying appropriate machinery and equipment for agricultural production and (iv) Training and education for farmers for using suitable farm machinery.

6. Improving market linkages and development of value chains

i. **Improvement of infrastructure**: A number of priority investments have been identified: (i) Construction and adequate maintenance of rural roads to facilitate marketing of products and access to services in particular in remote areas. (ii) Construction or rehabilitation of rural markets including the supply of potable water, drainage, and storage facilities to improve conditions. (iii) Improvement and rehabilitation of wholesale markets in major cities; (iv) Private storage facilities to reduce losses and increase value added.

ii. **Capacity building of value chain actors and market promotion**: A number of **priority investments** have been identified: (i) Capacity building for group marketing at community level in the form of marketing groups, service cooperatives which capacities should be developed and training provided; (ii) Capacity development of farmers and market intermediaries through training in food quality and safety regulations and requirements, good agricultural practices so as to comply with market requirements; (iii) Improved post harvest management, value chain analysis and facilitation (iv) Promote agro-processing. (v) Facilitate coordinated, market-based action, harnessing the productive capacity of agriculture to drive food security, environmental sustainability and economic opportunity. (vi) Capacity building and strengthening Department of Agricultural Marketing (DAM).

iii. **Establishment of export processing zones**: Harness opportunities to expand market linkages and agribusiness with establishment of export processing zones.

iv. **Improving Food Safety and Quality for Consumer Health and Nutrition:** Food analytical labouratories at the central and regional level need to be established to facilitate support to food manufacturers, individuals and the enforcement of laws. An effective surveillance on food borne illnesses would be

necessary. It is necessary to strengthen capacities of the existing institutions, strengthen consumer protection and build on on-going insufficient food safety activities.

7. Livelihood improvement and food security

i. Development of programs of alternative income generation and food security, reduce malnutrition of women, children and distressed population.

ii. **Development of Community Based Nutrition Activities through Livelihood Approaches**: Home gardening, poultry raising and other community level nutrition-based agricultural activities need to be included as food based nutrition approach This strategy will include linking agriculture and food based nutrition to other nutrition efforts, including health.

iii. **Livelihoods improvement of population of char land, haor, coastal region and CHT**: All of these regions are not easily accessible and people are beset with lots of problems and sufferings. A large number of families, due to abject poverty and lack of alternatives, are often forced to relocate to such lands battling precarious weather and adverse living conditions. As the families are often hard to reach through mainstream anti-poverty programmes, it drastically reduces opportunities to promote social and economic development within these communities.

8. Climate change adaptation

An integrated approach which combines traditional knowledge with innovative strategies need to be adopted to address current vulnerability while building adaptive capacity to face new and dynamic challenges. The process involves four inter-related strategies: promotion of climate-resilient livelihoods strategies, disaster risk reduction strategies, capacity development for local civil society, and advocacy and social mobilization with particular focus on gender. Interventions should include: (i) Program to promote adaptive knowledge and technologies among communities/farmers. (ii) Enabling local preparedness and flood protection works and modelling under extreme climatic events.

9. Improved Land management

i. Promote Compact Township to reduce substitution of agricultural land for non-agricultural purposes.

ii. **Integrated char development and livelihood improvement**: The intervention activities include: (i) Prevent loss of life from natural disasters, (ii) Reduce loss of land, livestock and other assets due to flood and erosion, (iii) Promote sustainable agricultural development, (iv) Widen access to health and educational services, (v) Increase access to land rights for the landless, (vi) Improve access to development inputs and services.

iii. **Improvement of land information, land administration and management**: Land ownership record system is insufficient and incomplete in Bangladesh. As a result, it spills out jumbled and spontaneous land development throughout the country. Therefore, , it is important to establish a compatible land administration and management system for establishing a systematic approach for planned land development. Land Information System (LIS) should be accountable and feasible systematic approach and digitized for developing an up-to-date land administration and management. The improved LIS shall be related to various quantitative and qualitative aspects of land resource.

1 Introduction

1.1 Background and importance of the sector

Bangladesh has an area of about 14.76 million ha which about 8.52 million ha (58 percent of total land area) are cultivated land (BBS, 2010-11). Agriculture plays a dominant role in the growth and stability of the economy of Bangladesh. More than three quarters of the total population in rural areas derive their livelihood from the agricultural sector. About 48 percent of the labour forces are still employed in Agriculture.

During the recent decade overall GDP of Bangladesh has been considerably shown a positive trend. But the growth in agriculture GDP slightly declined with an average of about 3.4% during 1997 to 2013, present. Agriculture being the engine of growth of the economy, there is no other alternative but to develop agriculture sector for alleviation of poverty by attaining accelerated economic growth. Since achievement of food security, and generation of employment opportunities of the huge population of the country are directly linked to the development of agriculture, there have been continued efforts by the Government for the overall development of this sector.

There is continuous transformation of Bangladesh's economy as measured by changes in the sectoral shares of gross domestic product (GDP). This structural change clearly indicates a rapid movement away from an agriculture-dominated economy. Agriculture's share of GDP declined from 62 percent in 1975 to 19 percent in 2013, but agriculture's share of total employment has not declined as much. The declining share of agriculture in GDP should not be construed to reflect a diminishing role of agriculture in the overall growth of the economy or in poverty reduction. Notably, the service sector has expanded at a rapid pace at this stage of economic transformation. Much of the growth in the services sector relates to the marketing and processing of agricultural products resulting from rapid commercialization and diversification in agriculture.

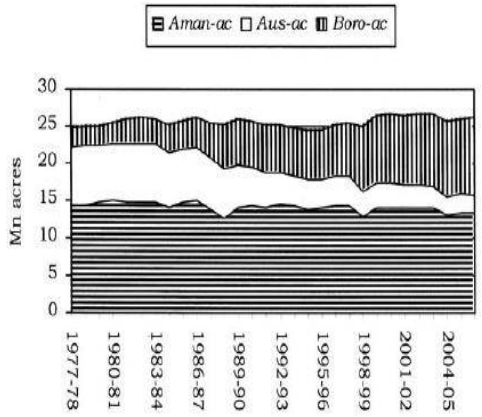
The agriculture of Bangladesh is dominated by crops which the accounts for now the half of total agricultural GDP (Table 1.1).

Table 1.1 Contribution of agriculture to GDP at constant price (Base: 1995-96=100 percentage)

Sector/ Sub-Sector	Year											
	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Agriculture	23.99	23.47	23.08	22.28	21.85	21.37	20.88	20.49	20.30	20.01	19.41	18.70
A. Crops	13.75	13.43	13.23	12.51	12.28	12	11.7	11.43	11.42	11.32	10.86	10.25
B. Livestock	2.96	2.93	2.91	2.95	2.92	2.88	2.79	2.73	2.65	2.58	2.51	2.45
C. Forestry	1.88	1.86	1.83	1.82	1.79	1.76	1.75	1.75	1.73	1.69	1.66	1.63
D. Fishing	5.40	5.25	5.11	5.00	4.86	4.73	4.64	4.58	4.49	4.43	4.39	4.37

Source: (1) For the period 2001-2007, Statistical Yearbook of Bangladesh 2007, and (2) beyond 2007, Bangladesh Economic Review 2013(Bengali).

Rice dominates Bangladesh agriculture covering more than 80% of the land area. The production of rice has shown a long term growth trend of 2.8 percent per annum over the time from 1981/82 to 2011/12 period. During 1997 to 2013, total rice acreage changed little, T. Aman acreage remained almost unchanged, while irrigated Boro acreage substantially increased with the reduction of rain-fed Aus which showed about 6.3 percent annual growth during the same period. Currently, Boro rice accounts for about 60 percent of total food grain production (Figure 1.1 and 1.2) in the country.



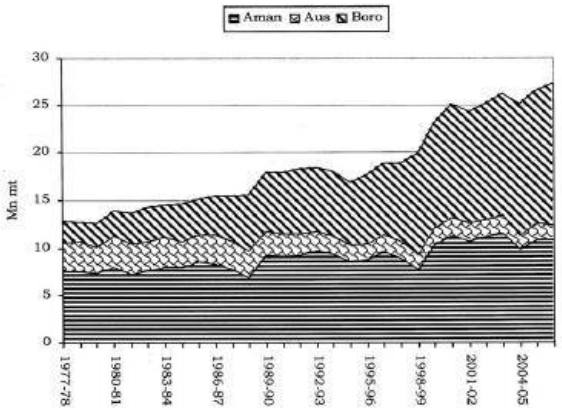


Figure 1.2 Rice acreage by season **Figure 1.1 Rice output by season**

The agriculture of Bangladesh is dominated by crops. Although food grain production has tripled over the last 40 year period, the production of other major food crops, such as pulses, oilseeds, and fruits remains low. The nutritional importance of such produce is therefore of concern. The average Bangladeshi diet contains a very high intake of cereals with too little contents of non-cereal food items. Hence, an average diet is deficient in energy vitamins and minerals.

1.2 Land use pattern

The term land use has been defined differently from various perspectives by different scholars. It has seen as a product of interactions between a society's cultural background, skill and its physical needs in one hand, and the natural potential of land on the other (Ram and Kolakar 1993. Land cover is the observed biophysical cover on the earth's surface. In other words, land use = land cover + land utilization (Di Gregorio and Jansen 1998). Further, land use is the arrangements, activities and inputs that people undertake on a certain land cover type (FAO 2000). According to these definitions land use reflects human activities such as the use of the land like industrial zones, residential zones, and agricultural fields and so on. The above definitions establish a direct link between land and the actions of people in this environment.

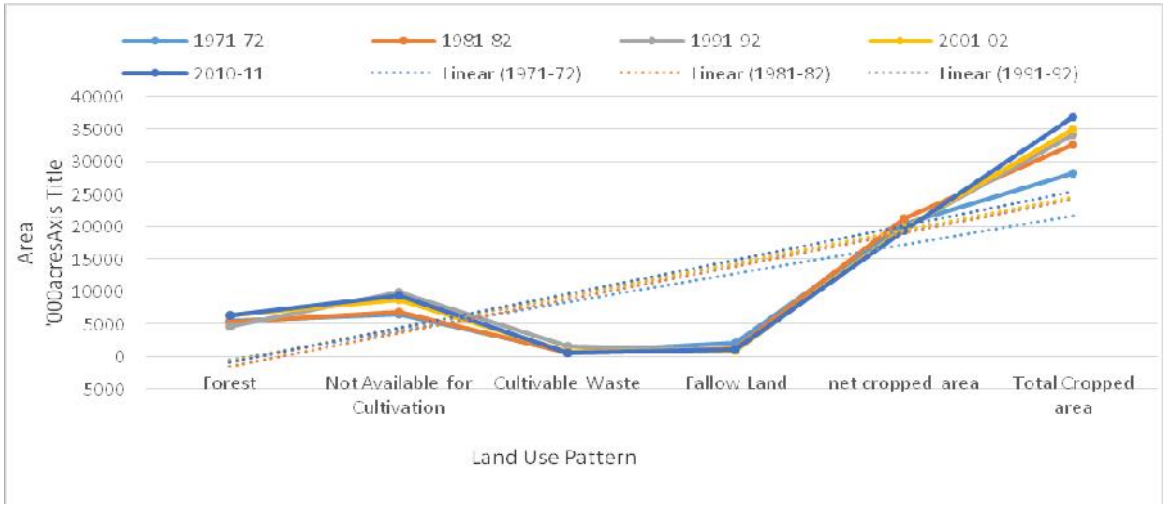


Figure 1.3 Decade-Wise Land Utilization of Bangladesh (1971-2011)

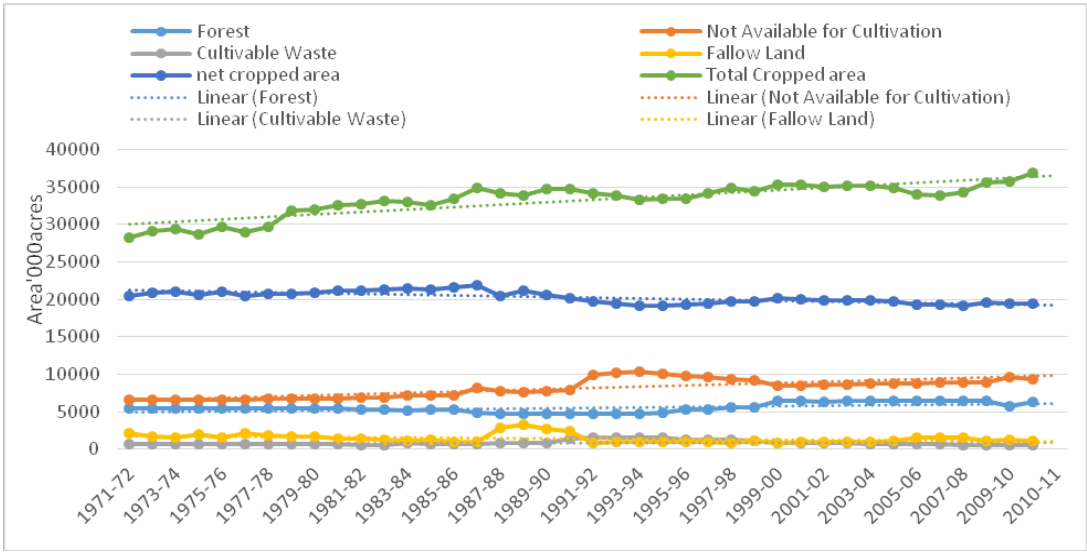


Figure 1.4 Trend of land use pattern of Bangladesh (1971-2011)

Land use pattern of a country reflects its socio-economic condition. The pattern of land use changes in Bangladesh is to meet the dynamic demand of the country that creates pressure on natural environment.

The shifting rate of agricultural land to non-agricultural use is said to be about 1% per year, which is alarming in respect to the total crop production in Bangladesh (Rahman and Hasan, 2003). This rate of change however does not seem to have a sound scientific basis. In fact, if this number were correct, at least one quarter of the country's agricultural land would have been lost since independence.

SRDI estimates land transfer from agriculture to non-agriculture sector using aerial photographs and Land sat imageries and has estimated approximately a 0.13% change per year during the period 1963 to 1983 (Rahman and Hasan, 2003). It is likely that the shifting rate will have been much faster during the 2000s till date, because of faster economic growth and the associated infrastructure development.

But according to BBS decline of agricultural land is about 0.383% annually from 1980-81 to 2006-07 (27 years average), 0.75% annually from 1983-84 to 1993-94 (10 years average) and 0.40% annually from 1993-94 to 2003-04(10 years average).

Despite the fact that agricultural growth has been higher than the rate of population growth concerns have been raised whether the land mass of Bangladesh is actually capable of supporting its ever expanding population. It is highly imperative that the twin problem of arable land loss and population growth are addressed simultaneously to ensure sustained means of production and thereby food security.

Land ownership and Sharecropping: It is estimated that 10 percent of farmers in Bangladesh own 50 percent of the land (BBS, 2009). About 60 percent of farmers are functionally landless and depend on sharecropping of land owned by the others. Average farm sizes are very small to support a family adequately. Apart from sharecroppers, approximately 20 percent of farmers are regarded as marginal and 20 percent are regarded as viable. The country's resource base, notably agricultural land, is stretched to the limit. While population is still growing at a rate of 1.6%, a slower pace than in the previous decades, however, is competing for land. Non-farm employment are creating opportunities but not being fast enough to ease pressure on the land. The sharecropping has good effect in terms of cultivation and agricultural production; however, it has adverse effect on soil productivity. Most sharecroppers do not use proper dose of fertilizer, appropriate crop rotation, or organic manure due to a seasonal or annual contract

arrangement and wants to get as much benefit as possible from the land within the contract period. As a result soil fertility has been declining with adverse impact on soil productivity.

Agriculture sector is dynamic, changing with demand of people, availability of technology and change of management practices. Thus, it requires regular adjustment with different planning and development programmes. The country has much potential, yet it faces many challenges including vulnerability of climate change. For a long term planning a visionary exercise is needed in order to foster sustainable growth of this important sector. This necessitates a comprehensive Bangladesh Delta Plan (BDP) for sustainable development and sustainability of the sector harmonizing with the management of natural resources and addressing the challenges.

1.3 Objectives of the base line study

The overall objective is to ensure long term and sustainable production of crops for achievement of food security in Bangladesh. The specific objectives of the base study are:

- To identify gaps in relevant policy and planning documents.
- To identify challenges and potentials of Bangladesh agriculture and food security.
- To assess current productivity status and to formulate development options for planning exercise.
- To develop an outline an insight of long term Delta Plan ensuring food and nutrition security; and
- To develop a common and inclusive knowledge base

1.4 Terms of Reference

Terms of Reference of The agriculture base line study will include the following major activities:

- Collection and review of relevant policy and planning documents to find out gaps. For example, Sixth Five Year Plan, Agriculture Policy, Food Policy, and Departmental Plans, sector plans, Food safety Guide Lines, Input Management Policy, Irrigation and Land Use Policy, etc.
- Conduct limited consultations in the hot spot area to assess field condition.
- Synthesis of the strategic document of the Ministry and Line Departments. Such as strategy of current food production, balanced fertilizer management, NARS research priorities and gapes etc.
- Analysis of food security status by regions and its implication in the long term planning.
- Identification of challenges of the sector and way forward. Like degradation of land and water recourses acidification, adulation of inputs, post-harvest losses, market linkages and value chains, etc.
- Recommendations on probable (alternative) strategies and implementable interventions that can address the challenges
- Assessment of the available technologies and technologies in the pipe line be-fitting to long term planning minimizing yield gaps.
- Project potentials of enhancing productivity and ensuring food security using advance technology from NARS and CGIAR centers.
- Formulate alternative development scenarios for planning exercise suggesting interventions.

1.5 Methodology

Methodology includes:

- Review of relevant policy and planning documents - Sixth Five Year Plan, Agriculture Policy, Food Policy, Food safety Guide Lines, Input Management Policy, Irrigation and Land Use Policy, etc.

- Collection of information from BBS, DAE, MOA, MOF, etc. and various on-line resources, etc.
- Desk review, seminar/workshop, interactive meeting,, consultation with line departments including other stakeholders
- Analysis and synthesis
- Report preparation

- Consultation with relevant ministries, line departments, agencies, focal points experts, including other stakeholders on consensus building on findings of the base line report.

2 Review of gaps in policy/planning documents and synthesis of recent strategies of the Government

2.1 Review of gaps in relevant policy and planning documents

Much Progress has been made during the last decades in Bangladesh in formulation and adapting agricultural policies to the ever changing needs of modernizing agriculture. The governments in the past have been adapted different sets of policy to cater its needs of the government line departments, private sectors and farmers to create an enabling environment for technology dissemination and enhancing agricultural productivity. Bangladesh experienced a continuous process of policy refinement. *A Positive Policy Reform Agenda had been framed and practiced during the green revolution and its post green revolution process* to reap the benefits of market orientation and open trade, while simultaneously addressing a broader range of domestic policy objectives. It was recognized that the stated objectives of agricultural policies generally fall into two categories. Either they address issues relating to equity and income distribution, or they relate to the correction of market failures and openness of the market economy. Market failures are often believed to be more frequent in agriculture than elsewhere in the economy due to agriculture's many functions having both positive and negative externalities, and public goods characteristics.

The positive reform agenda emphasized that issues relating to market failures should be addressed first, and only after that should remaining income distribution issues be tackled. Policies that address market failures also have an impact on farm incomes, sometimes positive and sometimes negative. The optimal level of intervention of each policy instrument should be considered together. For instance, reform of agricultural input markets in Bangladesh in the early 1980s, followed by liberalization of grain trading and the alteration of several longstanding programmes of public distribution of grains during the late 1980s and early 1990s. The subsequent sections presents our analysis of gaps in relevant policy documents of concerned ministries.

The National Agriculture Policy 2013

The new National Agriculture Policy (NAP) 2013, focuses on: sustainable and profitable agricultural production; development and dissemination of new technologies; increase in productivity, employment and income generation; competitive agriculture through commercialization; adaptation to climate change and sustainability of agricultural system; agricultural marketing to ensure better prices to both farmers and consumers; enhance production quality to meet export standards; opportunities for agro-processing industries; encouraging production of diversified and more nutritious crops.

Some downside risks and challenges identified for the implementation of the policy are: natural hazards; continued deterioration of soil health; continued reduction of arable land and water resources; increased use of agricultural land for non-agricultural purposes; and volatility of prices discouraging farmers to engage in crop production; loss of agricultural biodiversity; excessive use of pesticides; environmental degradation; and insufficient budget allocation for agricultural research. The implementation of the agriculture policy should also recognize and cope with the existing weaknesses of the agriculture sector, including an inadequately developed marketing system, excessive post-harvest

losses, limited availability of formal credit, and lack of suitable technologies, especially for unfavorable environment. In line with the objectives, constraints and challenges identified, the NAP (2013) defines the following main areas of intervention: research and development; agricultural extension; seed and plant; fertilizer; minor irrigation; agricultural mechanization; agricultural cooperatives; agricultural marketing; women in agriculture; management of natural resources; development of human resources; agricultural labour and non-farm activities.

Fertilizer Policy in Bangladesh

There has been a progressive shift in fertilizer policies in Bangladesh towards privatization, deregulation, and a reduction of subsidies, which began in the mid- 1980s and continued until mid-1990s. This was partially reversed following the severe fertilizer crisis in 1995. During global food price crisis in 2007-08 public sector roles were further strengthened towards market intervention and providing subsidy on fertilizers for achieving self-sufficiency and food security. Table 2.1 presented a brief description of evolution of fertilizer policy in Bangladesh till the first decade of the 21st century.

Table 2.1 Summary of Transformation Process of Fertilizer Policy/Regulation

Period	Policy, role of public and private sector
Post Green Revolution period (1960-1980s): Heavy subsidization and public sector role	
1960s–1970s	In response to inadequate supply and progress in the use of fertilizer, the public sector was given complete control over fertilizer procurement and distribution, with the responsibility of procuring fertilizer from both domestic and external sources and distributing it right to the level of the small administrative unit (*thana*) vested solely with the BADC. Under this "old marketing system" (OMS), the distribution of fertilizer was through Thana Sale Centers (TSCs) at subsidized prices. BADC-registered dealers were also allowed to lift fertilizer from TSCs and sell to farmers at regulated prices, for which a commission was paid to them.
1970s–1980s	The OMS was found to have a number of deficiencies, especially with regard to appointment of dealers, erratic supply, inadequate storage, and skewed incentives for dealers and farmers. Beginning in 1978, efforts were made to improve the system under a series of measures referred to as the "new marketing system" (NMS). Although the overall procurement operations remained a public sector monopoly, significant changes were introduced in the distribution chain, with the aim of improving efficiency and bringing in competitiveness and private participation. BADC withdrew from retail sales and instead concentrated only on maintaining wholesale centers at various strategic points in the country. Restrictions on fertilizer movement across the country and the cumbersome registration process for retailers were eased. Starting in 1983, fertilizer price at the retail level was also decontrolled.
1990s	Although the NMS had enjoyed major success in many aspects, various constraints remained and meeting farmer demand during peak season continued to be a problem. Thus, policy started to shift toward an open market system. By 1989, direct lifting of fertilizer from domestic production centers as well as ports was allowed in response to a urea crisis that occurred despite there being large stocks present. In 1992, the government excluded fertilizers from the list of restricted imports, paving the way for the private sector to import fertilizer. By December 1992, the subsidy on fertilizers was completely withdrawn and import and distribution of fertilizer were privatised.
Liberalization –reducing public sector roles (1990s-2000s)	
1990s–2000s	Fertilizer crises at various points in time (initially in 1995, followed by more recent setbacks in 2005, 2007, and 2008) resulted in partial restoration of government control over the fertilizer market. In recent years, following the promulgation of a new dealership policy in 2008 and 2009 in the wake of a fertilizer supply crisis and price spikes, the fertilizer distribution system was revamped and some amount of subsidy was also introduced (though the stated aim of the subsidy was more toward balancing the use of various fertilizers to maintain soil health). The fertilizer distribution network is once again composed of appointed/licensed dealers who are limited to selling in a particular designated area, with the objective of ensuring effective fertilizer distribution across the country. BADC is withdrawn from retail and whole sale markets at Primary Distribution Points (PDP). Licensing process for dealer was simplified and they can buy fertilizers from factory or import. They can sell non- urea fertilizers in their own price.

Period	Policy, role of public and private sector
Post Global Food Price Crisis (Post 2008 to current)	
Post 2008 to current	The prices of non-urea fertilizers were slashed to almost half per kilogram to help farmers during the *Boro* season. In order to mitigate crisis the government decided to bring the market under its direct control. The control measures were reintroduced on the marketing and distribution of urea in 2010 which again was withdrawn in 2011 and non-urea fertilizer prices are now available at a heavily subsidized price.

National Seed policy

A key element of production is a reliable supply of quality inputs that farmers can afford to purchase. The seed policy aims at balanced growth of both public and private sector seed production and distribution system. Bangladesh has been successful in switching over, largely, to high-yielding varieties (HYV) for rice production, the source of its impressive agricultural growth. Farmers can now manage 2-3 rice planting seasons per year. This has contributed for significant increases in production and food security.

National Food Policy, 2006

The National Food Policy 2006 (NFP) and the NFP Plan of Action (2008-2015) serve as a basis for identifying and prioritizing the options for investment and interventions for achieving food security in Bangladesh. The NFP provides strategic guidance for addressing the key challenges Bangladesh faces in achieving food security in all its dimensions, including public food supply and management.

The Plan of Action of the NFP (2008-2015) translates the provisions of the NFP into 26 areas of interventions and priority actions, providing a comprehensive framework for identifying investment and priorities for policy actions required to achieve food security. As such it provides a policy agenda, enabling the Government to undertake the right decisions, monitor progress toward the NFP objectives and highlights further policy changes to be undertaken. Food safety and quality control issues are not a major focus of the National Food Policy, although the importance of safe food is stated in Objective 1, but not reflected in the strategies suggested under it. Objective 3 addresses adequate nutrition, and in the Plan of Action (2008-2015) it is missing, Strategy 3.5: Safe, quality food supply briefly addresses food safety and proposes some limited actions. Food production, processing and marketing by the women and disabled does not include food safety and quality control issues. Although the policy includes the issues related to food safety and quality, implementation of action oriented activities are absent.

National Health Policy, 2007

The core goal of the National Health Policy (NHP) is to achieve sustainable improvement in health, nutrition, and family welfare status of the people, particularly of the poor and vulnerable groups, including women, children, and elderly people with ultimate aim of their economic and social emancipation and physical and mental well-being. In addition, for the first time the health policy also has put a strong emphasis on nutrition issues (FPMU et al. 2009). The Health, Nutrition and Population Sector Programme (HNPSP) includes facility-based treatment of acute malnutrition in children, iron-foliate supplementation for women, and antenatal care and counselling during pregnancy as well as delivery of basic health and nutrition services. And the National Policy for Arsenic Mitigation, and the corresponding 2004 Plan of Action was designed to address issues of arsenic poisoning. Food safety issues are not well elaborated in the NHP. The policy document includes only a single paragraph (No. 37) on food safety issues. But practically the implementation of the policy actions narrated in the document is very weak due to insufficient logistic support and shortage of skilled human resources and participation of stakeholders.

National Fisheries Policy, 1998

The policy describes very little on the issue of managing safety and quality of fish for domestic consumption covering Good Aquaculture management. But some activities are in place in respect of export oriented fish and fish products where traceability is established following international requirements.

National Livestock Development Policy, 2007

There is no broad focus on the safety and quality of meat, poultry and their products. The policy fails to address hygienic slaughtering of cattle for safe meat and meat products.

National Policy for Safe Water Supply and Sanitation, 1998

Although arsenic contamination of water is a serious issue in the rural areas, it is not reflected in the policy document. Food safety and quality issues are not at all reflected in the policy.

Perspective Plan 2010-2021

The government embarked on a Perspective Plan covering the 2010 to 2021 period. "Achieving food security" and "pursuing environmental friendly development" have been specially mentioned as broad development goals. This would be achieved through successive five year plans. Priority attention in planned crop intensification in the coastal zone is particularly emphasized in the document.

Sixth Five Year Plan (2011-2015) - Accelerating Growth and Reducing Poverty

The *Sixth Five Year Plan* (SFYP) is the first of two mid-term indicative plans aiming to "develop strategies, policies and institutions that allow Bangladesh to accelerate growth and reduce poverty" for the implementation of Vision 2021 adopted by the Government to elevate Bangladesh to a middle income country. The SFYP provides strategy, framework and guidelines for reducing regional disparities, developing human capacity, managing land constraints, using natural resources, increasing agricultural productivity, household income and employment and ensuring food security. "Ensuring food security" has been outlined as a key strategy in the SFYP. In case of food production, climate change adaptation strategy in the agriculture sector is also prioritized. Special emphasis is given to development of agro-processing and non-farm economic activities in the backward regions.

Country Investment Plan (CIP 2011) - A road map towards investment in agriculture food security and nutrition

The CIP was elaborated through an inclusive, participatory process in response to the L'Aquila Initiative and in line with the 5 Rome Principles. The CIP is a planning, fund mobilization and alignment tool. It was first approved on 14 June 2010 and revised in June 2011. It provides a coherent set of 12 strategic priority investment programmes under three components of food security: access, availability and utilization.

Master Plan for Agricultural Development in the Southern Region of Bangladesh (2012)

This Master Plan was developed by the Ministry of Agriculture with FAO's technical support. It provides a road map for the integrated development of Bangladesh's coastal region focusing on increasing agricultural productivity and sustainable food security.

Sustainable Agricultural Development Strategies for the Chittagong Hill Tracts (2013)

The Sustainable Agricultural Development Strategies were developed in 2013 by FAO under the guidance of Ministry of Agriculture and Ministry of Chittagong Hill Tracts Affairs (MOCHTA). They were motivated by concerns over environmental degradation and food insecurity in the region and define priorities in five areas: i) enhancing productivity, conservation and diversification, ii) more sustainable jum, iii) up-scaling technology and sustainable input supply, iv) market/value chain development, v) food security and nutrition.

Table 2.2 presents analysis of gaps of different policies related to Agriculture and food security.

Table 2.2 Analysis of gap of different policies related to Agriculture and food security

Agricultural Policies	Major goals and policy thrusts	Implementing ministry	Gaps
New Agricultural Policy 2013 (NAP)	Sustainable and profitable agricultural production; development and dissemination of new technologies; increase in productivity, employment and income generation; competitive agriculture through commercialization; adaptation to climate change and sustainability of agricultural system; agricultural marketing to ensure better prices to both farmers and consumers; enhance production quality to meet export standards; opportunities for agro-processing industries; encouraging production of more nutritious crops.	Ministry of Agriculture	1. The policy has addressed cereals and did not address adequately the non-cereals sector like jute, sugarcane, cotton etc. 2. Absence of a framework to develop effective human resources for commercialized agriculture including unemployed rural youth and women. 3. It is necessary to formulate a strategic plan to encourage export of high/value added products. Existing land use plan may have to be modified for this purpose to enhance productivity of high value items including fruits, vegetables, medicinal plants /herbs, cut-flowers/ foliage etc. and value added processed products. 4. Food safety and quality issues are not adequately covered or emphasized including the traceability of the product.
National Agriculture Policy (NAP), 1999	Food security, profitable and sustainable production, land productivity and income gains, IPM, smooth input supplies, fair output prices, improving credit, marketing and agro-based industries, protecting small farmers interest	Ministry of Agriculture	1. Crop diversification, efficiency of irrigation water use, women participation in agriculture were not adequately addressed. 2. Contract Farming as a concept to boost production of high value crops and improve market linkages of the smallholders briefly.
New Agricultural Extension Policy (NAEP), 1996	Provision of efficient decentralized & demand led extension services to all types of farmers, training extension workers, strengthening research-extension linkage, and helping environmental protection	Ministry of Agriculture	
DAE-Strategic Plan, 1999-2002	Adoption of Revised Extension Approach, assessment of farmers' information needs, supervision, use of low or no cost extension methods, promotion of food and non-food crops, and mainstream gender and social development issues into extension service delivery.	Ministry of Agriculture	
Agricultural Extension Manual, 1999	Annual crop planning, seasonal extension monitoring, participatory technology development and rural approval partnership, technical audit, attitude and practice surveys.	Ministry of Agriculture	

Agricultural Policies	Major goals and policy thrusts	Implementing ministry	Gaps
Seed policy, 1993	Breeding of crop varieties suitable for high-input and high output agriculture, multiplication of quality seeds, balanced development of public and private sector seed enterprises, simplification of seed important for research & commercial purposes, provision of training and technical supports in seed production, processing & storage monitor, control and regulate quality and quantity of seeds.	Ministry of Agriculture	The public sector policies on seeds are stated in the National Seed Policy 1993, the Seeds (Amendment) Act 1997, The Seed Rules 1998, The Seeds Ordinance 1977 with amendments made in 1997 and 2005, the National Agricultural Policy 1999, the National Food Policy 2006 and National Food Policy Plan of Action 2007. The objectives and strategies for the seed sector are not narrated in these policy documents exactly in the same manner or language though the main thrust or message seems to be similar. And that is that the government would facilitate a balanced development of public and private sector roles in the production and distribution of quality seeds. What it actually means and how it would be achieved is not uniformly stated in the various documents mentioned above. Thus private and public sector interpret the intentions of these policies differently, causing some controversy. Related to the supply of inputs are issues of private and public sector coordination. The differences between private and public sector perspectives on the seed market are prompted by two factors: (a) lack of accurate data on the size and structure of the seed markets for different crops; and (b) lack of sufficient clarity on the objectives and strategies of the national seed policy. These issues can be a hindrance to effective participation by private sector and should be addressed
Seed Rules 1998	Delineation of rules and regulations regarding changing functions and national seed board, registration of seed dealers, seed certification, marking truthful labels, and modalities of seed inspection.	Ministry of Agriculture	
Fertilizer distribution policy 2009	It governs the key issues of present marketing and distribution system. Under the present system, annual fertilizer demand is assessed by DAE and then MOA fixes the annual target centrally. Urea is imported by BCIC only.	Ministry of Agriculture	1. Existing GOB fertilizer distribution system and regulations often impedes the private dealers from effective operations and does not serve farmers in remote areas. 2. The GoB fertilizer demand assessment is centrally determined and is not based on fertility level of

Agricultural Policies	Major goals and policy thrusts	Implementing ministry	Gaps
			soil 3. Monopoly import of urea fertilizer by BCIC. BADC and private importers import the required quantity of TSP, MoP and DAP from different countries and sources. Import of fertilizers fully depends on MOA's allotment and permission.
Plan of Action on National Agriculture Policy (NAP, 2003)	Reviewing NAP and its implementation, setting out strategies and actions, and identifying institution and programme framework	Ministry of Agriculture	
Actionable Policy Brief (APB), 2004	Prioritize immediate medium-term and long-term policy measures with respect to seed, fertilizer, land, irrigation, mechanization, marketing, agricultural research and extension with a view to increasing labour & water productivity, investment in agriculture and improve risk management.	Ministry of Agriculture	
National Jute Policy, 2002	Keeping jute production at a desirable level, stabilizing supply and prices of jute, developing commercially viable jute industries, accelerating privatization of jute industries, and developing multiple uses of jute & jute goods.	Ministry of Jute	
Livestock Policy and Action Plan, 2005	Improvement of small scale poultry and dairy farming replicating CLDDP, reform of DLS, enforcement of law and regulations towards animal feeds, vaccines and privatization of veterinary services adoption of breeding policy, and establishment of livestock insurance development fund and livestock credit food.	Ministry of Fishery and Livestock	There is no broad focus on the safety and quality of meat, poultry and their products. The policy fails to address hygienic slaughtering of cattle for safe meat and meat products.
National Fishery Policy, 1998	Development of fishery resources, increasing fish production and self-employment, meeting demand for animal proteins accelerating fish exports, and improvement of public health.	Ministry of Fishery and Livestock	The policy describes very little on the issue of managing safety and quality of fish for domestic consumption covering Good Aquaculture management. But some activities are in place in respect of export oriented fish and fish products where traceability is established following international requirements.
National Forest	Bringing 20% area under	Ministry of	

Agricultural Policies	Major goals and policy thrusts	Implementing ministry	Gaps
Policy 1994	afforestation, enriching bio-diversity, extending assistance to forestry sector development through development of land and water resources, implementation of national and international efforts and agreements relating to global warming, desertification control of wild bird and animal trade, and prevention of illegal occupation of forest lords, felling of trees, encroachment and haunting of wild animals.	Environment and Forest, 1994	
National Land use policy	Minimizing loss of cropland, stopping indiscriminate use of land, preparing guidelines for land use for different regions, rationalizing land acquisition, and synchronization of land use with natural environment.	Ministry of Land	
National Water Policy, 1998	Development and management of surface and groundwater in an efficient manner ensuring access of the poor, women and children to water, accelerating development of sustainable public and private water delivery systems, development of a legal and regulatory framework for private sector investment in water development, and capacity building for designing future water resource management plans.	Ministry of Water Resource	Although arsenic contamination of water is a serious issue in the rural areas, it is not reflected in the policy document. Food safety and quality issues are not at all reflected in the policy.
Environment Policy 1992 and Implementation Programme	Protection of environment, identification and control of pollution, sustainable use of natural resources and participation in all international initiatives to protect environment	Ministry of Forests and Environment	
National Food Policy, 2006 and NFP Plan of Action (2008-2015)	The National Food Policy 2006 (NFP) and the NFP Plan of Action (2008-2015) serve as a basis for identifying and prioritizing the options for investment and interventions for achieving food security in Bangladesh. The NFP provides strategic guidance for addressing the key challenges Bangladesh faces in achieving food security in all its dimensions, including public food supply and management. The Plan of Action of the NFP (2008-2015) translates the provisions of the	Ministry of Food	1. It covers different aspects of food availability, access and utilizations. It did not rightly address the issue of food quality and safety which is now a burning issue in Bangladesh. Food safety and quality control issues are not a major focus of the National Food Policy, although the importance of safe food is stated in Objective 1, but not reflected in the strategies suggested under it. 2. The Bangladesh Pure Food Ordinance, 1959 and the Bangladesh Pure Food Rules, 1967, regulate

Agricultural Policies	Major goals and policy thrusts	Implementing ministry	Gaps
	NFP into 26 areas of interventions and priority actions, providing a comprehensive framework for identifying investment and priorities for policy actions required to achieve food security.		food safety in Bangladesh. The Pure Food Ordinance was amended in 2005 and established the National Food Safety Advisory Council (NFSAC). Current food safety laws and regulations in the country do not cover some of the important areas of food safety and that needs to be more science-based and modernized. The laws governing food safety are out-dated, do not cover food from farm to table and is not based on risk analysis with overlapping of legal provisions and responsibilities. 3. No specified coordinated governance design is available in the country. National standards and regulations have not been harmonized with Codex. Food safety issue is dealt not by one body, but around 15 ministries. There is no single authority on food safety.
National Health Policy	The core goal of the National Health Policy is to achieve sustainable improvement in health, nutrition, and family welfare status of the people, particularly of the poor and vulnerable groups, including women, children, and elderly people with ultimate aim of their economic and social emancipation and physical and mental well-being. The National Policy for Arsenic Mitigation, and the corresponding 2004 Plan of Action was designed to address issues of arsenic poisoning. The National Strategy for Infant and Young Child Feeding in Bangladesh is focused on direct interventions targeted to child nutrition.	Ministry of Health	Food safety issues are not well elaborated in the NHP. The policy document includes only a single paragraph (No. 37) on food safety issues. This paragraph includes causes of health problems due to unsafe water and low quality food, emphasizing the need for updating food safety laws, implementation of Pure Food Act, and the possibility of unification of Food and Drug Administration to safeguard the population against health hazards. But practically the implementation of the policy actions narrated in the document is very weak due to insufficient logistic support and shortage of skilled human resources and participation of stakeholders.

2.2 Synthesis of recent strategies of concerned Ministries and line Departments

2.2.1 Strategy of current food production and food security

Ensuring food security for the poor is a fundamental strategic goal of the Government. It involves the physical availability of food at all times and its access to all at affordable prices. Seventy per cent people of Bangladesh live in rural areas and draw their income and employment from agriculture and related activities.

The Ministry of Agriculture (MoA) has prepared a comprehensive agricultural policy in 2004 and started implementing the policy to address the problems of improving land, water and labour productivity by promoting balanced use of fertilizer, small scale mechanization, quality seed production, irrigation interventions in drought-prone areas, crop diversification, and improving water use efficiency and supply of agricultural inputs. These interventions are currently made through 19 development projects. Some of the institutional problems and issues are also being addressed by MOA with own resources, and efforts are being made to address the others that will require external funding. The World Bank is actively considering assistance in strengthening the agro-technology system; and JICA is reviewing the need for strengthening the Central Extension Resources Development Institute through reorganization and redefining its charter. The process of strengthening the Seed Wing of BADC and revitalizing the Seed Certification Agency is ongoing.

Policy developments &/programmes of MoA underway and needs for further action

Under sub-programme 1.1 related to enhancing knowledge generation, CIP 2014 (2012/13) includes seven completed, 31 ongoing and seven pipeline projects with total financing at 192.9 million USD or 1.61% of total financed CIP. Of the 181.1 million USD for completed and ongoing projects, 137.2 million USD (76%) are financed by GoB and 43.9 million by DPs. Under sub-programme 1.2, related to improvement of agricultural extension service, there are 11 completed, 24 ongoing and four pipeline projects, amounting to 243.9 million USD. Of the total budget of 202.3 million USD for completed and ongoing projects, 146.7 million USD i.e. 73% are financed by GoB and the rest 27% by DPs. This sub-programme accounts for 2.03% of total CIP budget. Sub-programme 1.3, which mainly focuses on research and extension for climate adaption, includes 11 ongoing and seven pipeline projects worth 366.9 million USD. DPs finance 170.9 million USD or 61% of the total 279.7 million USD of ongoing projects.

Enhance research and knowledge generation in a sustainable manner

The Government budget for the research institutes under NARS (including BARC) increased by 15%, up from 4.5 billion taka in 2012/13 to 5.2 billion taka in 2013/14, although its share in the National Budget remained unchanged at 0.23%, reflected in lower budget allocated to BRRI, but higher for other institutes. The SFYP stressed on avoiding fragmented and duplicated research; focusing research on farming system instead of individual crops; promoting problem solving research in different agro-ecological zones; and building linkage between research and extension.

Research priorities in Bangladesh agriculture published by BARC identified the following thematic areas: varietal development, management practices, diseases and pests, and processing and marketing. For instance, in the case of rice, the research priorities are: development of short duration, saline tolerant, submergence tolerant, drought tolerant, disease and pest resistant, aromatic, hybrid varieties and varieties with high iron, zinc and vitamin A, integrated crop management, yield gap minimization, intensification and diversification of rice based cropping system under different ecosystems, minimizing post-harvest losses, rice milling for high recovery, and diversified use of rice by products.

The National Agriculture Policy 2013 identified different strategies for research and development in the following areas: management system of research institutes, planning and financing of research, research topics and areas, technology transfer, equality in providing services, building information data base, public private partnership and protection of intellectual property right. These are discussed in further detail in the following sections.

Improve agricultural extension services

The DAE is the largest agency providing extension services to farmers with a total of 12,899 extension workers (SAAO) and 2,162 officers. Besides DAE, agricultural universities provide university-based extension training and activities. NGOs like BRAC, CARE Bangladesh, and World Vision as well as some private companies are also providing extension and advisory services. BRAC has 250 agriculturists and 8,903 agriculture extension workers working in 136,320 villages.

Priority issues identified in the NAP 2013 for improving extension services include: assisting farmers through coordinating extension endeavours of public, private sectors and NGOs; solving farmers' problems through building relationship among research institutes, extension department and universities under 'bottom-up' approach; adoption of modern information technologies in agricultural extension activities; encouraging partnership in extension activities between public and private organizations; raising productivity of agricultural crops; ensuring production of quality product; effort to be made to deliver appropriate technologies in hilly, drought-prone, Barind, char, *haor /baor* and water logging areas; increasing resilience to natural calamities by adopting short, medium and long run development programme, agricultural rehabilitation programme and crop insurance programme and creating 'agricultural rehabilitation encountering fund'; conservation of environment and natural resources through encouraging development of sustainable and environment friendly technologies, conservation of bio-diversity, adoption of integrated pest and crop management and controlling use of agricultural land for non-agricultural purposes; creating a coordinated data bank with the existing information on resources, inputs, technologies, production and marketing systems.

Further action in this area include:

Strengthen management system of research institutes: In line with NAP 2013, for scaling up quality of research, the coordination, planning, prioritization, monitoring and evaluation systems of research institutes should be strengthened. Coordination and integration is needed to avoid fragmentation and duplication of research efforts.

Coordinate research by public and private partners: Increased research focus is needed on farming systems or integrated production systems rather than individual commodities. Moreover, in line with NAP 2013, public-private partnership research and research in collaboration with international research organizations should be encouraged.

Focus technological development on efficiency, sustainability and resilience: Research needs to focus on development and improvement of stress tolerant and short duration varieties and farming practices; agricultural machineries and post-harvest technologies to enhance handling and marketing especially of high value crops; sustainable and efficient use of land and water resources; crop management in adverse environment and for climate change adaptation.

Develop an information bank: Lots of information obtained through research by different organizations is not openly accessible. So a central data warehouse may be developed under BARC through developing e-network. In line with NAP 2013 a data bank could be created with the existing information on resources, inputs, technologies, production and marketing systems, prices, etc.

Improve research infrastructure and strengthen human resources: The quality of research is constrained by the availability of modern instruments and other infrastructures due to availability of funding in public research organizations. Overall public spending in agricultural research is very low in Bangladesh compared to neighbouring country like India. Research funding needs to be up scaled in order to allow the required technological breakthrough.

Promote agricultural research for nutritional development: Agriculture has made remarkable progress, but progress in nutrition is lagging behind. To address this gap, emphasis should be given to carry out nutrition-oriented agricultural research. The starting point for 'Agriculture for Nutrition and Health' (ANH) is that agricultural practices, interventions, and policies can be better adapted and redesigned to maximize health and nutrition benefits and to

reduce health risks. In order to achieve this goal, ANH will bring together research and development professionals across the agriculture, nutrition, and health sectors to jointly tackle key challenges and design joint solutions.

Expand Farmers Information and Advice Centres: In line with NAP 2013, all field extension personnel of DAE, DLS, DoF, in collaboration with NGO and private companies need to provide integrated services for all farmers. The Farmers Information and Advice Centre (FIAC) housed in UP complex can work as the reference one stop service centre. For providing agricultural services (crops, fishery and livestock) round the clock, so far 727 "Farmers Information and Advice Centre" have been created under National Agricultural Technology project. For expansion of agricultural technologies so far 13,450 farmers' groups have been formed in 120 upazilas under this project. This Centre needs to be expanded throughout the country.

Strengthen agricultural information services through ICT in extension services: In line with NAP 2013, ICT can be used to facilitate farmers' participation and better linking marketing and production system through web and mobile based technologies. Digitized databases and management information systems may be set up at upazila, district and national levels. Mobile based text messages and voice messages may be utilized for early warning on pest and disease outbreak, natural disasters as well as to disseminate critical information. For expansion of ICT, 1,043 computers, 300 laptops and 1,043 printers, 300 multimedia projectors and 450 modems have been supplied in the field offices under DAE For using these instruments, skilled personnel need to be recruited or training needs to be provided to the existing staffs.

Strategies adopted in Sixth Five Year Plan crop sector:

- Sustainable achievement of self-sufficiency in the production of rice.
- Diversification of agricultural crops by adopting a system based on dissemination of information on agro ecological zoning to identify areas suitable for different crops.
- Priority attention in planned crop intensification in the coastal zone, the Sylhet region and the char areas in the northern poverty stricken region.
- Ecologically favourable, months November - February maybe devoted for growing high profit non-rice crops leaving the remaining eight months for growing two rice crops, Aman in particular.
- Motivate farmers to use recommended/balanced doses of chemical fertilizers, extensive production and use of organic fertilizer, and proper utilization of soil guide and soil testing facilities to enhance soil fertility.
- R&D for productivity increase yielding up to 20 per cent higher production of hybrid rice through technological progress, stress tolerant varieties (salt, submergence and drought tolerance for rice as well as heat tolerance for wheat) will be developed.
- Exploring reduction in yield gap for existing technologies and better seeds, efficient management of seed beds and adoption of the System of Rice Intensification (SRI), involving young seedlings, one seedling per hill, larger spacing, alternate wet and dry irrigation, use of compost/farm yard manure and direct seedling.
- Steps will be taken for distribution of khas land to the landless and the marginal farmers easing the rental system, computerized land records and transfer, safeguards against eviction of the *bargadars* and granting them the right of pre-emption in land transfer.
- ICT for extension will be widely used for regular weather forecasts through TV, community radio and cell phones.
- Services of SPARSO will be extensively used in forecasting.
- Increase of storage capacities by building additional capacities, 50,000 tonnes by 2015 and 1 million tons by 2021 and explored to facilitate safe storage of rice and perishables.

- Production and marketing cooperatives may be formed and concessional credit given to facilitate the growers purchase their own output during the harvest season and release to the market throughout the year; this will reduce the growers' dependence on the middlemen.

Livestock and fisheries

The Ministry of Fisheries and Livestock has also prepared fisheries and livestock policy. The National Livestock Policy is still in a draft form. It is expected to be finalized within this year. The major policies include: (a) promotion of smallholder dairy and poultry development; (b) development of goat, buffalo and duck in high potential areas through special projects; (c) institutional reform of DLS and enactment of laws and regulations for quality control of drugs, vaccines, feeds, chicks and breeding materials; (d) privatization of veterinary services of private good nature; and (e) explore all alternatives for producing fodder. In addition to routine activities of providing extension services, animal health service, supply of inputs, artificial insemination, and feed analysis, DLS has 9 on-going development programs/projects on production of vaccine, smallholder livestock development, artificial insemination and embryo transfer, breed up-gradation, modernization of Central Cattle Breeding Station and Dairy Farm, establishing regional duck breeding farm with hatchery, and training program for small scale dairy.

National Fisheries Policy was formulated in 1998, with the following objectives: (a) enhancing fisheries resources and production; (b) generating self-employment for poverty alleviation of fishers; (c) meeting the demand of animal protein; (d) increase foreign exchange earnings through export of fish and fisheries products; and (e) maintain ecological balance, conserve biodiversity and improve public health. The Ministry is thinking to revisit the policy of 1998. Fisheries Department has developed a strategy and action plan to implement the 1998 fisheries policy, taking into account the likely changes to occur over the next 10 years. The policies are being implemented through a range of revenue and development projects. Revenue projects include extension service to farmers, Fish Act implementation and Jatka protection. As many as 12 development projects supported by different donors are under implementation, covering aquaculture development, Brood Bank establishment, resource development and management, supporting coastal fishing community, fish inspection and quality control and development of Shrimp Seed Certification.

Strategies

- High priority given to closed water fisheries production.
- Increasing fresh water, (rather than brackish water) golda shrimp production in coastal areas.
- Potential use of cage culture in flood plains, with individual _ownership.
- Emphasis on supply of inputs and promotion of technical knowledge among the educated youth, in pond and other closed water bodies culture.
- Adoption and implementation of the concept of fishermen cooperatives towards 'Jaal jar jala taar' in government-owned water bodies.

The Ministry of Food: The Ministry has formulated a National Food Security Policy that includes access to and utilization of food, coordination, food policy analysis, short and long-run forecast of domestic and world supply and trade. In order to achieve these objectives, a multi-donor supported project, entitled "National Food Policy Capacity Strengthening Program" had been implemented. The broad objective of the project was to strengthen the capacity of FPMU for performing the new tasks of access to food, its utilization and nutrition, in addition to the current function of monitoring food availability and food assistance. The new functions also include improving inter-ministerial collaboration and coordination, food security related research and policy analysis, strengthening GO-NGO cooperation and encouraging dialogue and research capacity building of the civil society.

Achieving the MDG targets within the next decade will require Bangladesh to develop and implement more effective strategies. Accelerating per capita income growth and pursuing targeted safety net programmes are needed for the

expansion of household food intake. A comprehensive programme to address hunger would include interventions in the following areas:

- Promoting food security by sustaining strong growth of domestic food production and implementing a liberalized regime for food imports
- Designing and implementing interventions to promote food security
- Supporting safety nets for protection against natural disasters
- Promoting change in food habits for increasing nutritional intake of vulnerable
- Promoting improved infant feeding practices, including breast-feeding practices
- Supporting maternal schooling and hygienic practices
- Improving access to safe drinking water, especially by addressing the threat of arsenic contamination of underground water
- Improving access to sanitation
- Improving access to basic health facilities
- Promoting partnership among the Government, private sector and NGOs

Social Protection Policy Support Programme of General Economics Division (GED)

With the aim of supporting NSPS implementation, UNDP has designed a project document for a Social Protection Policy Support Programme in partnership with GED, and in coordination with DFID and DFAT (previously AusAID). Key outputs of this programme include: (i) the development of a better governance for social protection by strengthening coordination, monitoring and evaluation, as well as reporting functions; (ii) stronger research and analysis capacities to build a more effective evidence based policy development, parliamentary engagement and strengthening of social protection systems, by means of electronic payment platforms coordinated with field monitoring and evaluation.

The programme also includes a component of catalytic learning through a pilot delivery intervention called Strengthening Women's Ability for Productive New Opportunities (SWAPNO) that will provide a benchmark for innovative delivering systems, including micro-insurance and climate adaptive social protection. UNDP and the Local Government Division have in partnership planned the SWAPNO project, comprising public works employment of extreme poor women as the entry point, with a state-of-the-art graduation strategy aiming at beneficiaries' sustainable exit from extreme poverty.

3 Agricultural inputs

3.1 Present soil fertility status and fertilizer use

Thirty agro ecological zones and 88 sub zones have been identified by adding successive layers of information on the physical environment which are relevant for land use and assessing agricultural potential (BARC/GIS Data System 2000). These layers are:

- Physiographic (land forms and parent materials)
- Soils and their characteristics
- Depth and duration of seasonal flooding
- Length of the rained kharif and rabi growing periods
- Length of the pre-kharif period of unreliable rainfall

- Length of the cool winter period and frequency of occurrence of extremely low (below 0.40C) winter temperature.
- Frequency of occurrence of extremely high (> 400C) summer temperature.

Agro ecological zones and sub zones are very broad units. Fertility status of these regions varies considerably. Individual farmers have fragmented the land into small pieces causing wide variation in the management of each and every piece of land. This leads to the large variation in the fertility levels even between adjacent plots.

Although Bangladesh is a small country, it has a wide variety of soils. The fertility status of Bangladesh soils is extremely variable. Most of the soils are depleted and in urgent need of replenishment with manures and fertilizer if productivity has to be enhanced It is estimated that more than 100 kg nutrients per ha year are mining out from the soil system.

Although Bangladesh is a small country, it has wide variety and complexity of soils at short distances due to a diverse nature of physiographic condition, parent materials, lands, and hydrology and drainage conditions. Due to intensive cropping to grow more food, continuous changes are taking place in the soil fertility status due to organic matter depletion, nutrient deficiencies, drainage impedance/water logging followed by degradation of soil physical and chemical properties as well as soil salinity/acidity. The fertility status of Bangladesh soils is extremely variable. Most of the soils are depleted and are in urgent need of replenishment with organic matter and fertilizers in order to enhance crop productivity.

Nitrogen deficiency in soils: All the agricultural soils are critically deficient in soil nitrogen content and deficiency of micro nutrients are also limiting to crop production. But the extent of deficiency varies geographically depending on the extent of land use and nature of parent materials. The main reasons for such deficiency are due to:

- Intense decomposition of organic matter
- Rapid removal of mineralized products under high leaching conditions and crop removal.

Nitrogen being the most important nutrient element in soils plays the most vital role in crop production in Bangladesh. Responses of modern rice to applied nitrogen have been studied extensively throughout the country by a series of fertility trials. The average yield increase due to fertilizer N varies from 30 to 75%. In some cases, without application of nitrogen fertilizer modern rice showed almost complete failure, while application of 100 kg N/ha along with other nutrients resulted in a very successful crop yielding 6-7 t/ha.

Phosphorus deficiency in soils: Phosphorus is the second most important nutrient element limiting successful crop production. It becomes unavailable or fixed in the soils through a variety of ways. In acidic terrace and brown hill soils, phosphorus is largely fixed by iron and aluminium oxides at low pH, while in calcareous soils fixation occurs by calcium-magnesium carbonates. The net result of fixation is a decrease in the immediate availability of native and applied phosphorus.

Potassium deficiency in soils: Potassium is the third major plant nutrient recently identified as deficient in most Bangladesh soils. The previous idea about the sufficiency of potassium in Bangladesh soils might be true for local crop varieties with low yield potentials. One-ton wheat/ha or 2-ton rice/ha can be obtained from soils where K would be a limiting factor continuously without K fertilizers. The crop intensification with high yielding and hybrid varieties has shown widespread deficiency of potassium in Bangladesh soils. It has been recorded that a 5 ton/ha rice crop will remove more than 110 kg K which is to be made available to plants in less than 3 months' time and many of our old and highly weathered soils may not have potential to supply K at this rate.

Sulphur deficiency in soils: Sulphur has been recognized as the fourth major nutrient limiting crop production as early as 1980. In the past very little attention was paid to this nutrient until 1977 when sulphur deficiency in wetland rice was first detected at the Bangladesh Rice Research Institute (BRRI) farm and on nearby farmers' fields. Since then sulphur deficiency in Bangladesh soils is becoming widespread and acute. It has been reported that variable amount

of available S in soil ranging from as low as 2µg g-1 soil to as high as 75 mg g-1 is available. The use of high analysis fertilizers such as urea, triple super phosphate, muriate of potash and di-ammonium phosphate, cultivation of modern varieties, increasing cropping intensities and limited application of organic manure have all contributed to the intensification of the S deficiency problem in Bangladesh soils. The problem is more severe in wetland rice than in upland crops as anaerobic condition, under which rice is grown, reduces sulphate and makes it unavailable to plants.

Need to promote balanced fertilization: Balanced fertilization is the key to successful crop production and maintenance of good soil health. It is important to see how close nutrient addition and removal by crops match with each other. According to a study by Karim, 2010, the farmers of Bangladesh use 215 kg nutrients (N: 149 kg, P2O5: 37 kg, K2O: 22 kg and S + Zn + B + others: 7) ha/year from chemical fertilizers, against the estimated removal is around 300 -400 kg/ha. From organic and natural sources about 50-70 kg nutrients are added to the soil system every year. One nutrient balance study made by DAE-SFFP (2002) from a typical Boro- Fallow – T. Aman cropping pattern (10 t grain yield) is shown Table 3.1. It is quite evident from the study that severe mining of N and K are going on in the country's soil system. That's why the productivity of the soils is low and decline in crop yields has been recorded in many areas.

Table 3.1 Nutrient depletion due to rice cultivation

Nutrient dynamics	N (kg/ha)	P (kg/ha)	K (kg/ha)
Nutrient uptake cropping pattern	180	27	180
Leaching losses from: Soil Fertilizer	12 17	- -	6 -
Erosion	12	2	12
Gaseous losses: organic	24	-	-
N fertilizer	68		
Total Output	313	29	198
Fertilizer	170	25	75
Organic manure (5t/ha)	20	12	24
Incorporated crop residue	25	3	25
Nonsyymbiotic fixation	10	-	-
Atmospheric fixation	8	1	2
Sedimentation/weathering	-	2	10
Iriigation water	2	6	21
Total Input	235	49	157
Balance	-78	20	-41

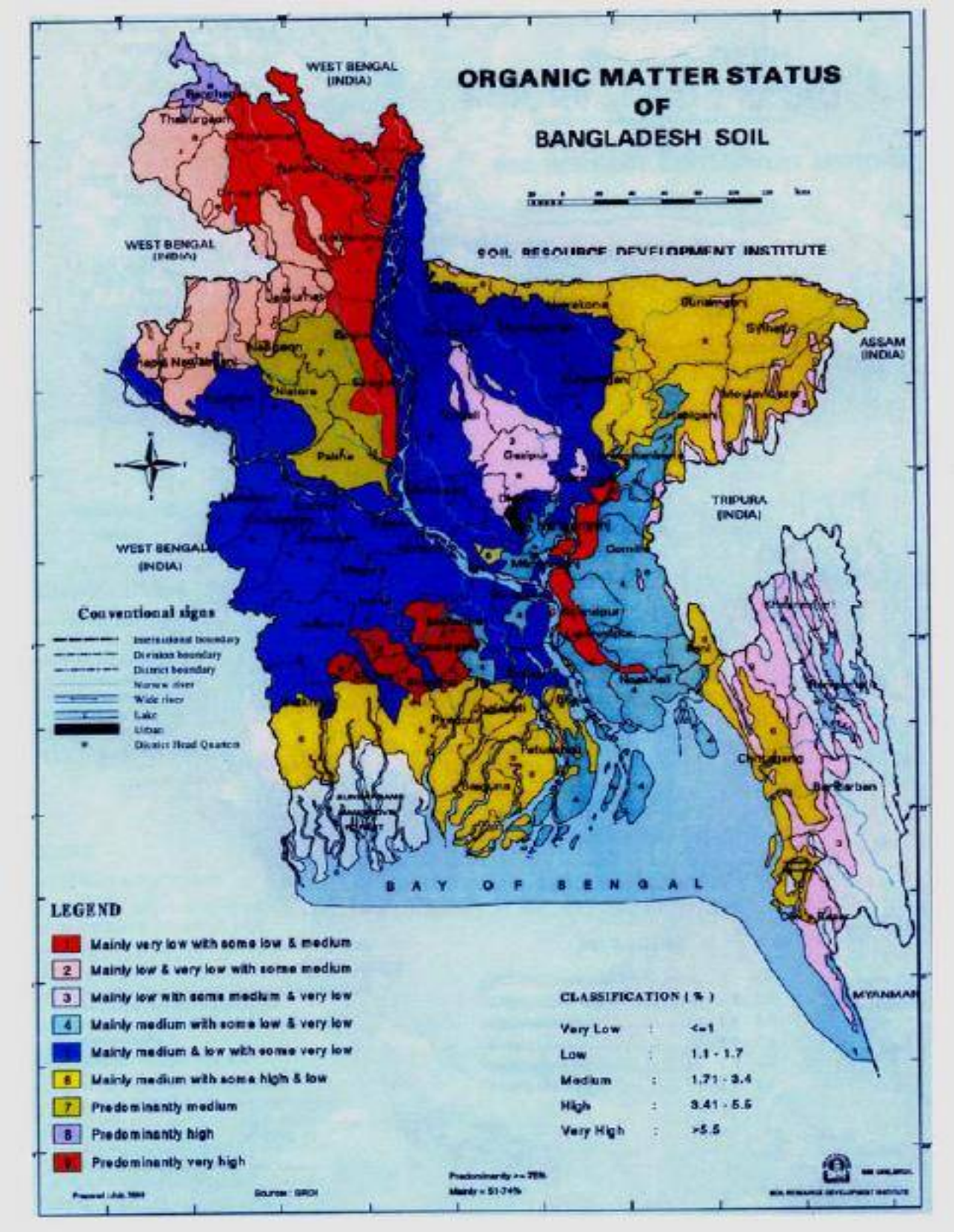


Figure 3.1 Organic Matter Status of Bangladesh Soil

Fertilizer recommendation for single crops and cropping patterns are usually made by following the guidelines clearly stated in "The National Fertilizer Recommendation Guide" which is revised and published from time to time by the Bangladesh Agricultural Research Council in consultation with NARS scientists engaged in soil fertility and fertilizer management research activities. Upazila Soil Use Guide published and updated by SRDI from time to time is also a useful guide for site-specific fertilizer recommendation. Each guide has at least 100-150 site-specific information on soils nutrient status, topography, hydrology, vegetation and drought. Fertilizer recommendations are usually made on the basis of soil fertility classes; yield goals and farmers' management ability. For high yield goal fertilizer recommendation, one should have site-specific information on nutrient status of soils as well as the crops. If the site-specific information on the soils is not available, moderate yield target may be fixed and the information available about agro ecological zone in the guide may be used to find out the fertilizer doses. Research on site-specific N management using leaf colour chart in Bangladesh is in progress at the Bangladesh Rice Research Institute.

Box 1.: A Case Study on Impact of soil fertility on rice productivity

Rahman (2006) examined the influence of selected soil fertility parameters on modern rice productivity utilizing a stochastic production frontier approach on a survey data from 21 villages in three agro-ecological regions of Bangladesh. Detailed crop input-output data were collected from 380 paddy rice farmers. The soil fertility status in each region was determined by analysis of soil organic carbon, available nitrogen, and phosphorus and potassium concentration. Results reveal that in addition to key production inputs, soil fertility also significantly affects the parameters of the production function. Available soil potassium and soil nitrogen significantly increase rice productivity whereas available soil phosphorus has an opposite effect. The soil organic carbon content also has a desirable positive effect but the influence is not significant. The mean technical efficiency of these modern rice farmers is estimated at 73%, implying that 37% [(100-73)/73] of the production can be increased by eliminating technical inefficiency alone. Results indicated that in policy terms technological initiatives should be targeted at measures to identify areas of lower soil fertility so that inherent soil-based productivity restrictions can be minimized. In part this will be facilitated by the transfer of indigenous knowledge from farmers in higher productivity areas, thus increasing rice production. Also, investment in rural infrastructure is suggested to improve technical efficiency.

Soil Salinity: Saline intrusion from sea water in coastal areas, compounded by tidal surges, adversely affects life, property, ecology and agricultural production in those areas. The problem is intensified with global climate change effect and degrading more area with salinity**.** Karim 2009b, mentioning SRDI data showed that over 103,000 ha of lands were saline in 2000, which is about 20% more than the saline area in 1973 (833,000 ha). This indicates that saline area has been increasing in the country over the three decades and will continue in the coming years with sea level rise due to climate change. During the monsoon, about 12% of the total area is under high salinity levels which increase to 29% during dry season. The increased salinity level would limit the cultivation of many crops in coastal areas.

3.2 The Trend of Fertilizer use in Bangladesh Agriculture

Increase in food production and attaining self-sufficiency in Bangladesh requires sustainable growth of agricultural sector in order to provide food for her increasing population. Fertilizer is considered to be one of the main inputs for increasing crop yields and farm profit. But balanced fertilization is the key to efficient fertilizer use for sustainable high yields. Bangladesh has virtually no possibility of increasing its cultivable land area. Therefore, food production of this country can be increased through increasing irrigation facilities together with expansion of HYVs and balanced use of fertilizer. Besides, well-timed supply and availability of fertilizer should receive top priority to sustain/increase rice production in Bangladesh.

The use of chemical fertilizer started in the country in 1951 with the import of 2,698 tons of ammonium sulphate, phosphates in 1957 and muriate of potash in 1960. Then, in 1965, the Government launched a 'Grow More Food' campaign and provided fertilizers and low lift pump (LLP) at a highly subsidized rate with pesticide at free of cost to popularize these inputs among the farmers and meet the country's food shortage. Thus, fertilizer consumption began to increase rapidly with the introduction of HYV rice (i.e. IR5 & IR8) and LLP use.

Total requirement of fertilizers like Urea, TSP, SSP, MP, Gypsum and mixed fertilizer for crop production in 20011-12 were 28.0, 5.0, 1.25, 1.5 and 3.0 lakh metric tonnes per year respectively. Among them 60 percent of Urea and 100 percent of mixed fertilizer were produced in the country. Fig 3.2 shows that annual consumption of chemical fertilizer is increasing at constant rate.

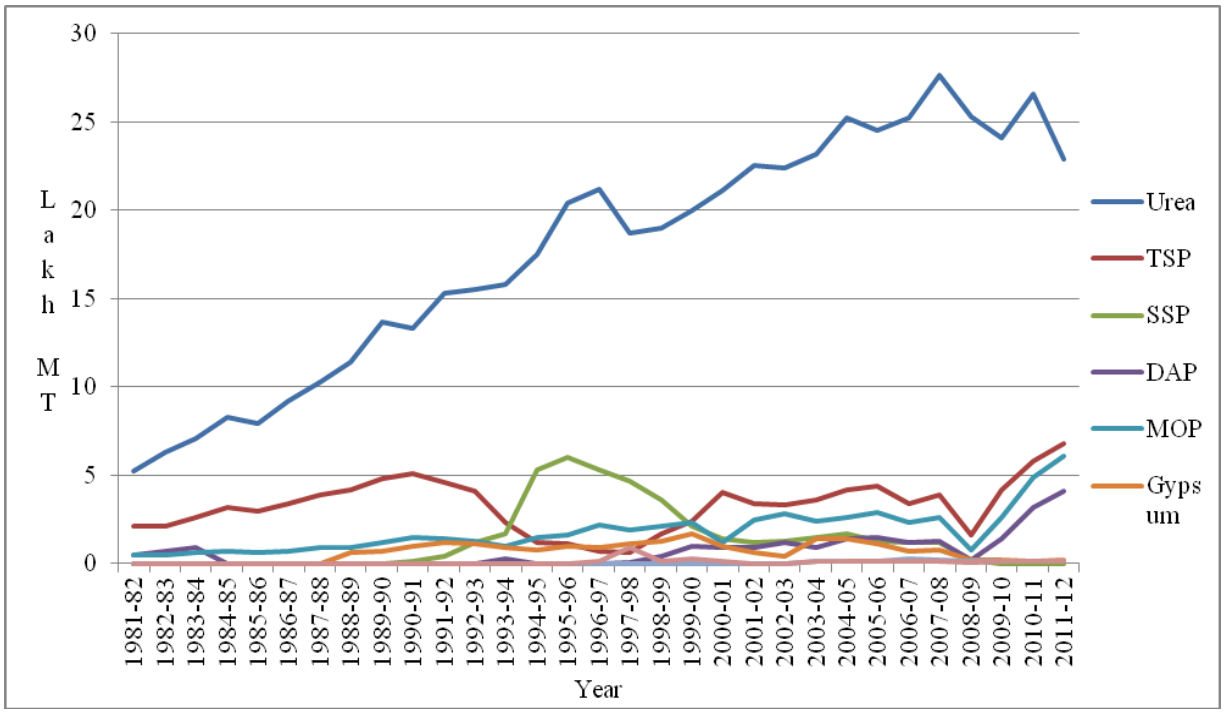


Figure 3.2 Fertilizer use by different types in Bangladesh: 1981-82 to 2011-12

During 1963-1964 to 1970-1979 period, total fertilizer use increased dramatically with a growth rate 16.5% per annum. Thereafter, the growth rate of urea declined. During 2004-12 growth rate of TSP and MP sharply increased due to government subsidy on these fertilizers (Table 3.2).

Table 3.2 Growth rates of fertilizer consumption over time (1984-85 to 2011-12) (Percentage)

Year	Total Consumption	Urea	TSP	MoP
1984/85-2011/12	4.17	4.24	1.80	7.12
1984/85-1989/90	8.05	8.31	5.46	8.97
1990/91-1994/95	3.65	5.57	-7.69	0.59
1995/96-1999/00	1.22	0.92	2.35	1.099
2000/01-2004/05	4.37	3.28	2.84	1.95
2005/06-2011/12	1.35	0.70	3.44	7.54

Source: Bangladesh Economic Review

3.3 Fertilizer Production and Imports

Bangladesh Chemical Industries Corporation (BCIC) is producing Urea, TSP and DAP which meets 41%, 10% and 12% of total consumption requirement **(**Table-3.3), respectively. Rest of the Urea is imported by BCIC. The TSP, DAP & MoP fertilizers are usually imported by the Bangladesh Agricultural Development Corporation (BADC) and the private sector importers (PSIs). The import requirement of fertilizers has been increasing over time with a declining trend in domestic production of fertilizer, especially Urea.

Table 3.3 Domestic fertilizer production and consumption (2005-06 to 2011-12)

Year	Urea		TSP		DAP		Total	
	Domestic Production (lac MT)	Percentage Consumed from production	Domestic Production (lac MT)	Percentage Consumed from production	Domestic Production (lac MT)	Percentage Consumed from production	Domestic Production (lac MT)	Percentage Consumed from production
2005-06	17.30	70.60	0.56	12.94	0.00	0.01	17.87	58.93
2006-07	18.17	72.25	0.50	14.82	0.80	69.74	19.48	65.58
2007-08	14.75	53.40	0.47	12.02	0.80	61.78	16.02	48.79
2008-09	12.80	50.56	0.24	15.45	0.29	160.00	13.33	49.27
2009-10	10.59	43.94	0.77	18.24	0.33	23.90	11.68	39.38
2010-11	9.09	34.27	0.63	11.24	0.40	12.95	10.12	28.73
2011-12	9.34	41.00	0.65	10.00	0.48	12.00	10.47	31.00

Source: BADC and BCIC

All fertilizer requirements of the country (such as Urea, TSP, DAP, and MoP etc) are met through domestic production and import. Different key actors are involved in the process of production, import and distribution. They include BCIC, BADC and PSIs. In addition, there are private traders, dealers and sub-dealers involved in the supply chain. BADC and private sector importers (PSIs) import the required quantity of TSP, DAP and MoP from different countries and sources depending on MoA's allotment and permission.

3.4 Fertilizes use in rice production

Rice is the staple food for the people of Bangladesh and will continue to remain so in future. Variations in management practices (irrigation and fertilizer application, crop management practices etc.), use of new high yielding varieties (HYV) and modern technologies play vital role for increasing rice production in this country.

Considering total cereal production (32.896 million ton), rice account for 95.20 percent (31.32 million tons) and other cereal crops only 4.80 percent (Bangladesh Economic Review, 2010 update). Zaman (1987) reported that 75 percent of total fertilizers are consumed for rice production and the rest of 25 percent for other crops.

Urea, TSP and MP are chemical fertilizers most commonly applied by rice farmers. The amounts of recommended and actual dose of fertilizers for rice production in Bangladesh are given in Table 3.4. Urea (nitrogen) is a major component of proteins, hormones, chlorophyll, vitamins and enzymes, essential for rice. Rice plants require a large amount of nitrogen at the early and mid-tillering stage to maximize the number of panicles (Datta, 1981). The recommended doses of other nutrients are also necessary for potential rice yield. Eliminate any one of these elements, and plants will display abnormalities of growth, deficiency symptoms, or may not reproduce normally.

Table 3.4 Use of fertilizers for Rice production in Bangladesh

Name of Crop (HYV)	Recommended dose (kg/ha)			Actual dose (kg/ha)			Use gap (%)		
	Urea	TSP	MP	Urea	TSP	MP	Urea	TSP	MP
T. Aus	141	101	69	135	28	17	4	72	75
T. Aman	166	101	69	135	30	24	19	70	65
Boro	269	131	121	192	47	37	29	64	69

Source: Islam, 2013

It is evident from the Table 4.10 that actual use of all the different fertilizers for rice production are below the recommended dose. The gap between the actual and recommended dose would be also true for other crops. The gap is significant for both TSP and MP fertilizers in Bangladesh. Non availability of fertilizers (availability of both fertilizers are fully depended on import process) and costs have lead to lower use of fertilizers against the recommended dose. But continuing rice production in a sustainable way, one of the important inputs required is the supply of balanced fertilizers consisting of N-P-K. Besides, it is also necessary for keeping soil fertility for a long period. Moreover, balanced fertilizers application is also essential for achieving higher level yield. Thus, there appears to be a large potential for raising fertilizer consumption through adoption of the recommend fertilizer practices by farmers.

3.5 Irrigation

3.5.1 Growth of irrigation in Bangladesh

Bangladesh is a lower riparian country in the flood plains of three great rivers—the Ganges, the Brahmaputra, and the Meghna—and their tributaries and distributaries. Fifty-three rivers drain 1.72 million square kilometers in Bangladesh, Bhutan, China, India, and Nepal. Only 8 percent of the catchment area is in Bangladesh. The country has about 25,000 kilometers of waterway stretching across 4.3 million hectares (MoL 2001), or almost 40 percent of the country's net cultivated area. This also includes wetlands and permanent water bodies that has a major impact on agricultural production and bio-diversity conservation in the country.

Rice (paddy) is the largest irrigation user with about 86% of the total irrigated area. In Bangladesh, irrigation is accomplished by: i) Major irrigation schemes using canal/gravity irrigation by surface water, ii) Minor irrigation schemes using groundwater by Deep Tube-wells (DTWs), Shallow Tube-wells (STWs), Force Mode Tube-wells (FMTWs) and also surface water using Low-Lift Pumps (LLPs). Irrigation is considered as necessary precondition to enhancing agricultural production of Bangladesh.

In this country the earliest approach to irrigation facilities was through constructing large scale multipurpose irrigation, flood control and drainage (FCD) projects during 1960 – 1970. Expansion of minor irrigation through groundwater using DTWs and STWs was the vital component of the GoB's strategy to facilitate irrigation for agricultural development. STWs under private ownership played significant role for irrigation development during 1980s and there had been recorded sharp increase in number of these equipment During Third Five Year Plan (1985-90) continued emphasis on irrigation facilities tremendously increased groundwater irrigation through the use of DTWs, STWs and manually operated HTWs.

The agricultural growth in the country has been largely due to expansion of minor irrigation through the use of DTWs, STWs and LLPs. The trend of irrigation growth in Bangladesh from 1982 to 2011 is shown below in Figure 3.3.

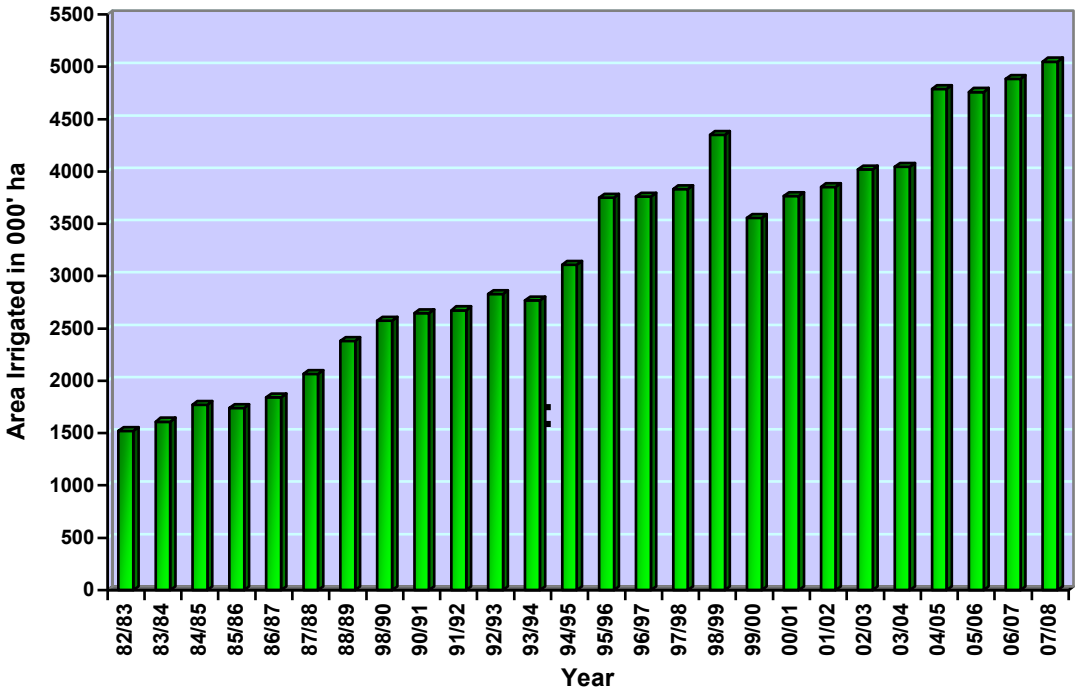


Figure 3.3 Trend in irrigation growth in Bangladesh

3.5.2 Demand for irrigation water

Rice occupies nearly 80% of the gross cropped area (GCA) and gross irrigated area (GIA), and accounted for 93% and 77% of the total increases in Gross Cropped Area (GCA) and GIA, respectively, between 1990 and 2010. Therefore, this analysis only projects the supply of rice and water demand, based on a study of International Water Management Institute (Upali *et al*, 2014). Among the rice crops:

- *Aus* rice area decreased rapidly and is only 9% of the GCA now;
- *Aman* rice area accounts for the largest portion of GCA (40% in 2010); and
- *Boro* rice expanded rapidly, mainly at the expense of *Aus* rice.

The ARIMA time series models (Box and Jenkins 1976) were used to project water demand to 2020 and 2030. The ARIMA (p, d, q) model has p and q autoregressive and moving average terms of the stationary time series of order d. (For details see Upali *et al*, 2014). Framework used for estimating future crop and water demand is presented in flow chart 3.1

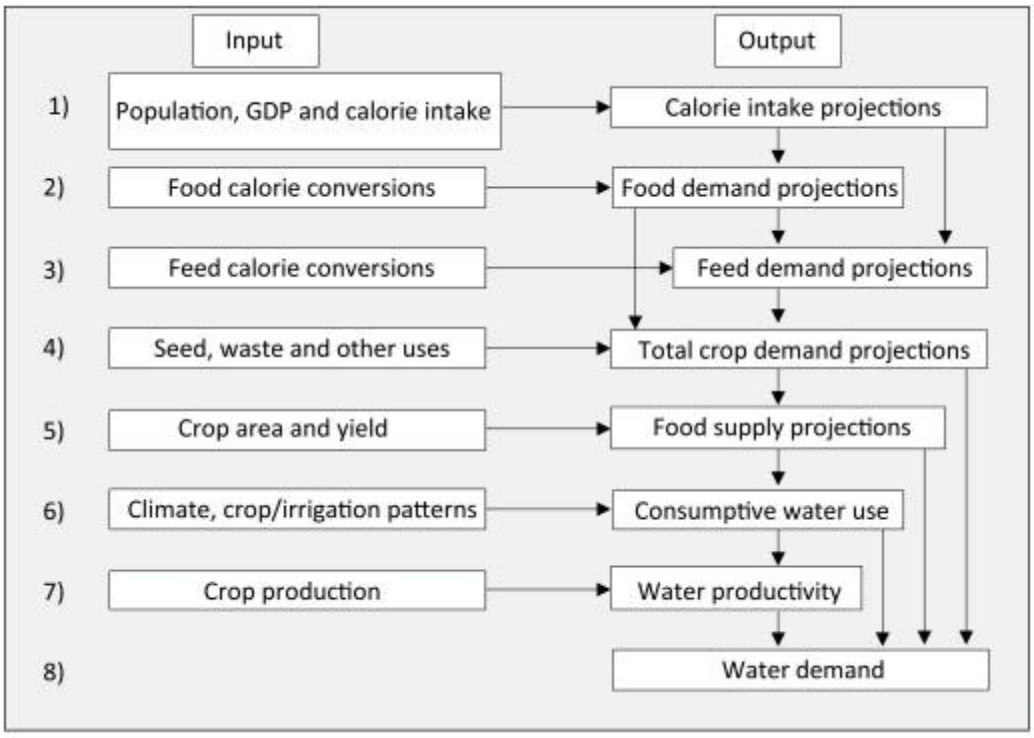


Figure 3.4 Framework used for estimating future crop and water demand

ARIMA models predict the following:

- A further decline in the *Aus* rice area (to 0.7 Mha by 2020 and 0.2 Mha by 2030).
- No significant changes in the *Aman* rice area. It is likely to stabilize between 5.7 to 6.1 Mha

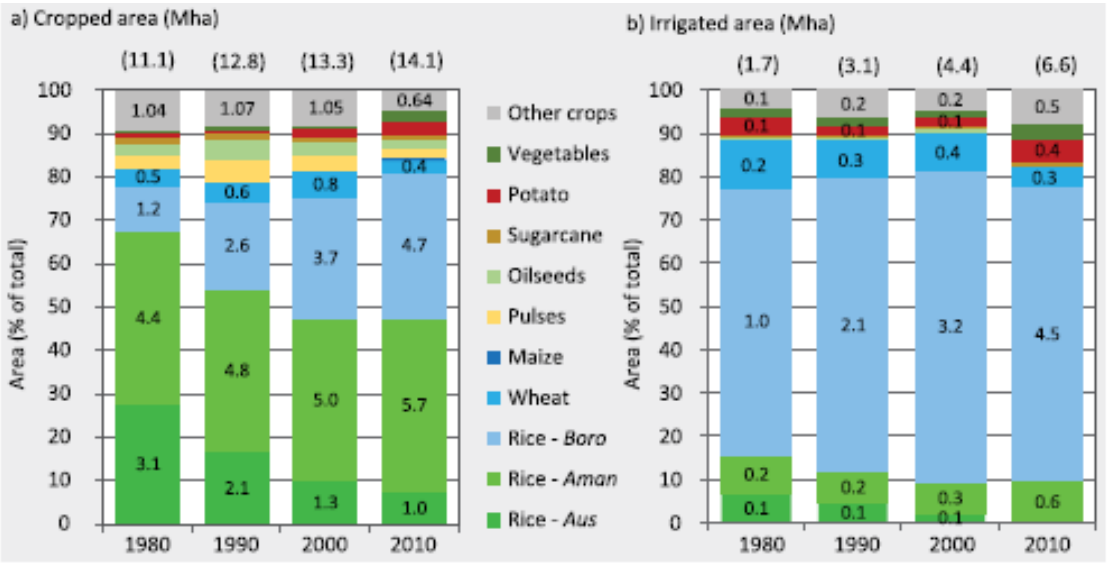


Figure 3.5 a) Cropped area (million ha) and b) irrigated area (million ha)

There will be a further increase in the *Boro* rice area (to 5.7 Mha by 2020 and another 1 Mha by 2030). The predicted increase in the *Boro* rice area will be significantly more than the decline in the *Aus* rice area (Figure 3.5 a). According

to the ARIMA forecasts, the total rice area will increase to 12.5 Mha by 2030; an additional 1.1 Mha from the present level and the *Boro* rice area (6.7 Mha) will contribute to almost all of this expansion.

Realistically, the increase in *Boro* rice acreage will not be possible due to increasing population, urbanization and land constraints. The Bangladesh Rice Research Institute (BRRI) projected that the total rice area will reduce to about 10.3 Mha by 2020 (BRRI 2013). The study carried out by the International Food Policy Research Institute (IFPRI) (Ganesh-Kumar et al. 2012) assumes that the *Boro* rice area can increase up to 6.5 Mha and the total rice area up to 12.6 Mha. While the extent of the projected expansion varies, all studies confirm that the main path to increasing rice production in the future is mainly through yield increases.

The ARIMA models predict:

- Yield of *Aus* rice to increase 2.0% annually between 2010 and 2020; 1.2% annually in the 2020s; and to reach 2.4 t/ha by 2030.
- Yield of *Aman* rice to increase 1.8% and 1.1% annually in the next two decades, respectively, and to reach 2.8 t/ha by 2030; and
- Yield of *Boro* rice to increase 1.2% and 1.0% annually in the next two decades, respectively, and to reach 4.8 t/ha by 2030. The projections of rice yield above assume that factors that contributed to growth in the past, such as advances in technology and high-yielding rice varieties, will continue to be developed and contribute to yield increases.

This analysis assesses future agricultural water demand under two scenarios of increases in WP:

(i) Area expansion and surplus rice production and (ii) self-sufficiency in rice production, improving water productivity with no area expansion. Rice production accounted for 93% of the total CWU and 90% of the total irrigation CWU.

The irrigation CWU of rice production, which was 11.8 Bm3 in 2000 (Table 3), has increased by 40% to 16.5 Bm3 in 2010 (Table 4); the latter is estimated using the irrigation CWU per hectare of 265 mm in 2000 (Table 3). This analysis estimates irrigation CWU demand to 2020 and 2030 under two different scenarios:

Scenario 1: Area expansion and surplus rice production: This scenario assumes that the area and yield of rice will increase as projected in the section, *Methodology and Data*. This means that the irrigated area will increase only in *Boro* rice: from 4.5 Mha in 2010 to 5.7 Mha in 2020 and 6.7 Mha in 2030. The irrigation CWU demand for rice will be 20.9 Bm3 and 24.5 Bm3 in 2020 and 2030, which are 27% and 48% increases from the 2010 level, respectively.

Scenario 2: Self-sufficiency in rice production, improving water productivity with no area expansion: According to this scenario, rice production will have to be 37.2 MMt by 2020 and 40.3 MMt by 2030, respectively, these estimates are 5% more than the projected consumption demand; and the additional 5% replenishes stocks. The assumption of self-sufficiency requires 3 MMt less production than in the "Business as Usual" scenario. This scenario analyses irrigation CWU under different WP growth scenarios of 0%, 5% and 10%. These are potentially feasible, since increases in WP are possible in both *Boro* and *Aman* rice. If the saving in production that is made from self-sufficiency is from *Boro* rice then the following will be true:

- Even with no growth in WP, irrigation CWU demand will decrease by 2.6 Bm3 and 6.1 Bm3 by 2020 and 2030, respectively, from the estimates in scenario 1, due to lower production requirement;
- With 5% growth in WP, irrigation CWU demand will decrease by 2.7 Bm3 and 6.4 Bm by 2020 and 2030, respectively; and
- With 10% growth in WP, irrigation CWU demand will decrease by 2.9 Bm3 and 6.8 Bm 3, respectively.

Importantly, the reduced irrigation CWU of rice in scenario 2 can meet most of the irrigation demand of other crops. The other three major irrigated crops are wheat, vegetables and potatoes: (a) the additional demand for these crops

would be 0.7 MMt, 11.1 MMt and 4.0 MMt, respectively; (b) the water productivity of these crops is 1.29 kg/m3, 1.96 kg/m3 and 3.98 kg/m3, respectively; and (c) the additional CWU demand (crop demand/water productivity) of these crops is 0.5 Bm3, 1.5 Bm3 and 5.7 Bm3, respectively. Since irrigation contributes to 19%, 74% and 62% of the total CWU, the total additional irrigation CWU of these three crops is 4.9 Bm3, which is less than the reduction in CWU of rice in scenario 2. Indeed, demand management taking into consideration food demand and production can substantially reduce the irrigation demand. However, there are still water supply constraints that need to be addressed.

Groundwater is the source for more than 75% of the irrigated area (BBS 2011). Thus, groundwater would have contributed to about 13 Bm3 of irrigation CWU in 2010. A large part of this CWU is from natural recharge, and the balance is from return flows of surface water irrigation. If the current share of groundwater irrigation was to continue, this would require at least 14-16 Bm3 by 2020 and 14-19 Bm3 by 2030. Besides this, domestic and industrial water demand will also increase. Therefore, a pertinent question is whether there are adequate renewable groundwater resources to meet the increasing demand.

Given the declining groundwater tables and water quality issues in Bangladesh, it will be extremely difficult to exploit groundwater resources sustainably under scenario 1. Without an increase in WP, it will be difficult to meet even the reduced demand under scenario 2. A few districts have already passed the sustainable thresholds of groundwater use in Khulna in the Khulna region, Bogra and Pabna in the Rajshahi region, Barisal, Chittagong, Kishoreganj, Kushtia and Rajshahi where irrigation CWU exceeds the usable groundwater recharge.

Table 3.5 Irrigation CWU demand under different scenarios of WP growth

Time	Season	Area (Mha)		CWU (Bm^3)		Total production	Water productivity	Savings of irrigation CWU (Bm^3) by only meeting the rice demand[1]		
		Total	Irrigated	Total	Irrigation	(MMt)	(Kg/m^3)	WP growth scenarios[2] 0%	5%	10%
2010	*Aus*	1.1	0.0	4.8	0.0	1.9	0.40	-	-	-
	Aman	5.6	0.6	30.7	0.0	12.5	0.41	-	-	-
	Boro	4.7	4.5	27.5	16.5	18.3	0.67	-	-	-
	Total	11.4	5.1	63.0	16.5	32.8	0.52	-	-	-
2020	*Aus*	0.7	0.0	3.2	0.0	1.5	0.47	-	-	-
	Aman	5.7	0.0	30.8	0.0	14.1	0.46	-	-	-
	Boro	5.7	5.7	33.9	20.9	24.6	0.73	2.60	2.74	2.89
	Total	12.1	5.7	67.9	20.9	40.2	0.59	-	-	-
2030	*Aus*	0.2	0.0	1.1	0.0	0.6	0.53	-	-	-
	Aman	5.7	0.0	30.8	0.0	15.9	0.52	-	-	-
	Boro	6.7	6.7	39.9	24.5	32.1	0.81	6.08	6.40	6.76
	Total	12.6	6.7	71.7	24.5	48.6	0.68	-	-	-

Sources: The area and total production data for 2010 are from the Bangladesh Bureau of Statistics; Water productivity and CWU for 2010, and projections for 2020 and 2030 are authors' estimates.

Notes: [1] Rice demand in 2010, 2020 and 2030 are 30.2 MMt, 37.2 MMt and 40.3 MMt, respectively.

[2] WP growth scenarios are only assumed for *Boro* rice.

3.6 Supply and demand for seeds

National seed system is mixed with three intercepting circles representing the main components (Figure-3.6). This diagram provides a conceptual overview of national system so that the relationship of the various sectors can be better understood. National Seed Systems vary greatly between countries. Some countries have quite strong national seed systems with well-developed agricultural research, national seed services and private sector seed companies.

Others countries have quite weak national seed systems with the community based seed system providing most of the seed used by farmers. In Bangladesh the National Agricultural Research (NARS) Institutes, Agricultural Universities, International Research Institutes and some private seed companies act as the source of modern varieties. The formal seed system (commercially oriented seed supply) involves both public and private sector seed enterprises, producing foundation and certified seeds. In the informal system the farmers produce, save and exchange seeds.

The first formal and organized seed system was introduced in Bangladesh with the establishment of the public sector agricultural inputs supply and service providing organization-the then East Pakistan Agricultural Development Corporation (EPADC) in 1961-62, later it was renamed as Bangladesh Agricultural Development Corporation (BADC) after the independence of Bangladesh in 1971. The BADC started its journey with the production of a meagre quantity of 13.8 tons of quality seeds. During 2011-12 it has increased its capacity to the extent that it could supply a large quantity of 1, 44, 200 tons of quality seeds of HYVs/MVs/Hybrids of four notified crops (rice, wheat, jute, and seed potato), and eight non-notified crops (maize, barley, kaon, cheena, pulses, oilseeds, spices, and vegetable seeds) .

In Bangladesh the national requirement of quality seeds of all crops is estimated to be 932,250 metric tons (Seed Wing, Ministry of Agriculture 2005-06). Against this national requirement, the supply of quality seeds was 186,450 metric tons (Seed Wing, Ministry of Agriculture 2011-12). Seed system through quality seed replacement rate (SRR) against national requirement up to 2011-12 was 20 percent of which about 80 percent seed is being fulfilled through the informal seed system of farmers' own saved seeds.

During 2011-2012, the seed replacement rate (SRR) of the quality rice seed of HYVs/MVs/Hybrids has increased to about 43 percent from 25% in 2005-2006,.The contribution of BADC alone is significant i.e. 39% against 10 percent in 2005-2006. This has made significant contribution to country's rice production to over 33.5 million tons in 2010-2011, and 33.9 million tons in 2011-12.

4 Technology generation and productivity of agriculture

4.1 Technology generation

The government of Bangladesh has given priority to the agricultural sector to boost agricultural production. Increasing the speed of and sustaining agricultural growth are priorities for increasing food production and reducing poverty. The future challenge of increasing food production could be met through the introduction of modern biotechnology and an increase in investment in agricultural technology generation and transfer. Table 4.1 presents information on technology generation and innovations in Bangladesh agriculture during 2004-14 and Table 4.2 presents information on number of cultivars registered for notified crops, 2000–14.

Varietal improvement and improvement of production practices are high priority of NARS research for rice, wheat, sugarcane, oil seeds, pulses, vegetables, fruits, fisheries and livestock. Also improvement of water resource for agricultural use, post-harvest management and farm mechanization are high priority of NARS research. NARS of Bangladesh has 12 ARIs, which are coordinated by BARC under MoA. The ARIs are mainly involved in doing agricultural research on crops, fisheries, livestock, and forestry. Technologies developed by the NARS institutes are disseminated to the farmers through the extension department and NGOs. In meeting the demand for higher food production, thrust should be given to frontier research including genetic engineering, reduction of cultivation costs, strengthening of the technology-transfer linkage, and improvement of postharvest technology.

Table 4.1 Technology generation and innovations in Bangladesh agriculture during 2004-14 period

Product type	Examples of innovations
Inputs	
Seed	Rice cultivars, hybrid rice, hybrid maize, Cultivars for potatoes, vegetables, and other crops
Fertilizer	Biofertilizer from coconut dust, earthworm compost, and green manure
Pesticide	Pheromones, parasitoids, and phostoxin
Machinery	Corn shellers, rippers, threshers, straw-bundle cutting machines, and seeders
Large-scale production	
Crop-based	Cultivars for gladiolas, strawberries, longum, grapes, guava, jujube, and durian
Processing	
Crop-based	Rubber rollers, colour sorters, and graders for rice processing; and solvent extraction for oil seeds and rice bran

Table 4.2 Number of cultivars registered for notified crops, 2000–14

Species, type of seed	Cultivars submitted by private companies or NGOs	Cultivars submitted by public agencies	Total
Rice			
Hybrid	76	5	81
Variety	0	13	13
Wheat	0	6	6
Maize	44	8	52
Jute	0	3	3
Potatoes	0	11	11
Sugarcane	0	8	8

For all non-notified crops, such as maize and vegetables, private companies have introduced hundreds of cultivars, but there is no centralized record of what has been introduced. For example, the Seed Certification Agency registered 52 maize cultivars during 2000–08, of which private organizations submitted 44.

4.2 Cropping intensity

The average cropping intensity in Bangladesh is over 183% (BBS 2011) and approaching to 200%. Cropping intensity in Bangladesh is limited by several factors. The primary factor is the flooding season, when land is constrained from cropping due to inundation. However, the duration of the rice season emerges as the primary factor in increasing cropping intensity. A significant portion of the land cultivated under rice stands fallow later in the dry season, with possibilities for non-rice cultivation given access to minor irrigation. No quantitative data seems to exist for the production limits through increased cropping intensity; this would be a complex exercise that would need to take account of local conditions. A study by Chowdhury *et al.* (1994) stated that cropping intensity has increased over the last fifty years by 60 percent. Between the mid-1970s and mid-1990s cropping intensity increased by 20 percent. Investment in irrigation appears to be the most important cause of increasing intensity of cropping with diversified high value crops. However, the influence of declining holding sizes with many short duration crops is also important in increasing cropping intensity. Continuous cultivation of flood free lands has deteriorated the land productivity. Appropriate crop rotation with legumes or deep rooted crop with fellow period may help to improve the soil health. Improvement of crop husbandry with proper extension program may improve soil fertility.

4.3 Present status of rice production and its potentiality

Rice is the staple food of about 156 million people of Bangladesh. It provides nearly 48% of rural employment, about two-third of total calorie supply and about one-half of the total protein intakes of an average person in the country.

Rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh. Almost all of the 13 million farm families of the country grow rice. Rice is grown on about 10.5 million hectares which has remained almost stable over the past three decades. About 75% of the total cropped area and over 80% of the total irrigated area is planted to rice. Thus, rice plays a vital role in the livelihood of the people of Bangladesh.

Total rice production in Bangladesh was about 10.59 million tons in the year 1971 when the country's population was only about 70.88 millions. However, the country is now producing about 35.0 million tons to feed her 156 million people. This indicates that the growth of rice production was much faster than the growth of population. This increased rice production has been possible largely due to the adoption of modern rice varieties on around 66% of the rice land which contributes to about 73% of the country's total rice production. However, there is no reason to be complacent. The population of Bangladesh is still growing by two million every year and may increase by another 30 million over the next 20 years. Thus, Bangladesh will require about 27.26 million tons of rice for the year 2020. During this time total rice area will also shrink to 10.28 million hectares. Rice yield therefore, needs to be increased from the present 2.74 to 3.74 t/ha.

4.3.1 Rice productivity

Rice is grown in all over Bangladesh. Figure 4.1 presents top 11 rice producing districts in terms of highest contribution to country's total rice production. In this regard Comilla stood first followed by Patuakhali and Bhola.

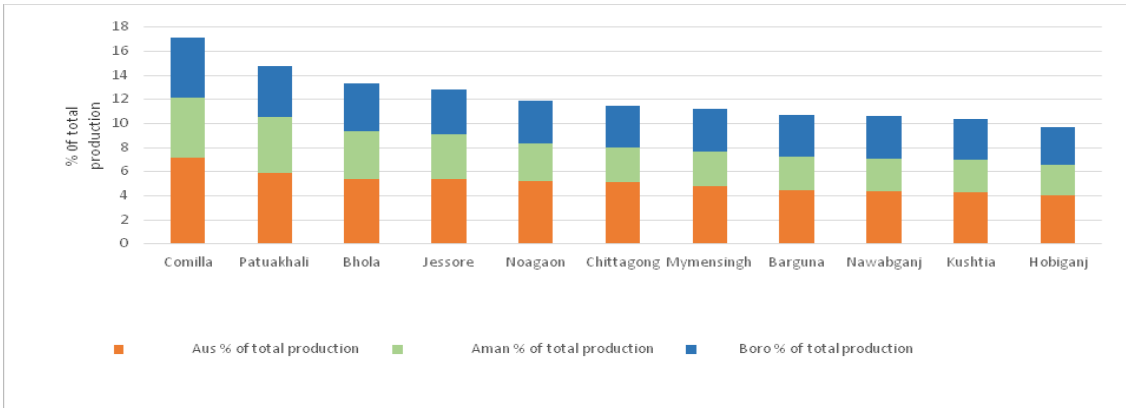


Figure 4.1 Top eleven rice producing districts of Bangladesh

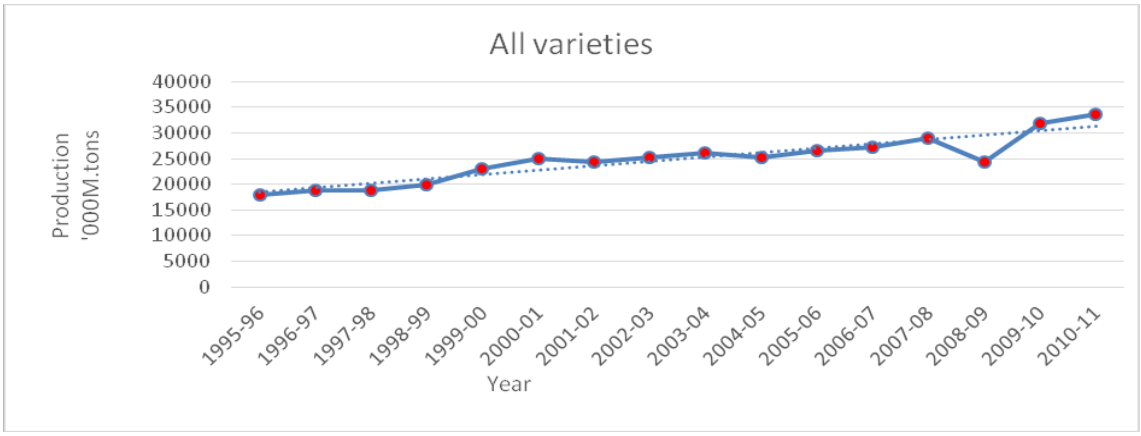


Figure 4.2 Trends of rice production during 1995-2011 period

Figure 4.2 illustrates the trends of rice production over the past three and a half decades. Over the last 30 years, Bangladesh has experienced a "green" revolution in rice production, with a tripling of production from approximately

10 million metric tons in the mid-1970s to almost 34 million tons in 2013/14. It was largely based on the cultivation of high-yielding varieties (HYVs) under irrigation with use of chemical fertilizers This 'Green Revolution' has enabled Bangladesh to increase food availability to meet the demands of a rapidly growing population. Fig 5.3 presents trends in rice production in Bangladesh by season. It is found that during 1970-2010 growth in Aus rice production was almost stagnant while both Boro and Aman Rice production had increasing trends. The main rice producing season in the Boro and Aman (Figure 4.3)

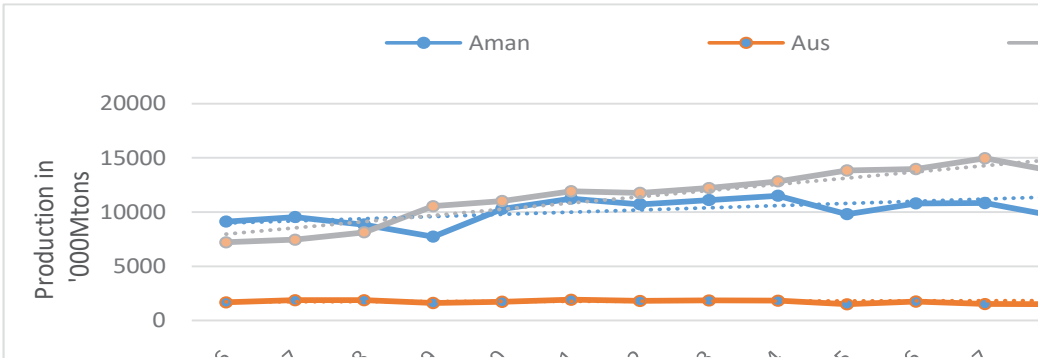


Figure 4.3 Trends of rice production by season during 1995-2011 period

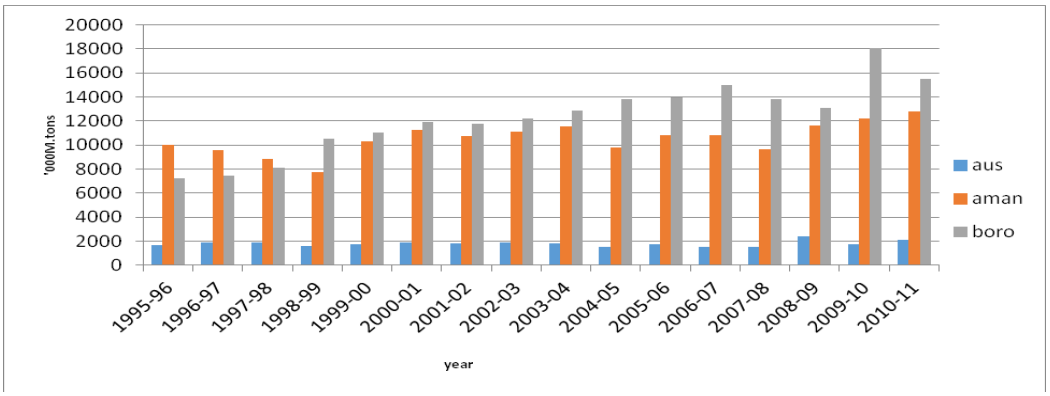


Figure 4.4 Production of rice by season during 1995-2011 period

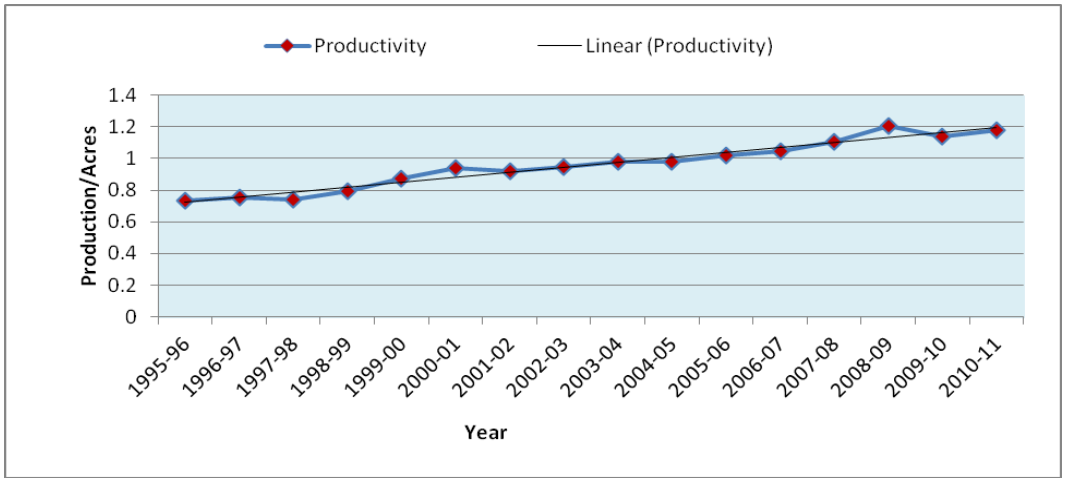


Figure 4.5 Productivity of all varieties of rice during 1995-2011 period

4.3.2 The potential of new rice varieties in Bangladesh

Since 1973, BRRI in partnership with IRRI has been engaged in adaptive research for evaluating elite lines under the IRRI managed International Network for Genetic Evaluation of Rice (INGER) and released varieties that suited Bangladesh agro-ecological conditions under the brand name BR and later Brridhan. Many of the elite lines that came to Bangladesh were suited for the boro and aus seasons. The most popular of them are BR1, BR3, BR14, BR14, and more recently BRRI dhan 28 and BRRI dhan 29. Yield gap between the potential farm yield in BRRI farm and Actual farm yield of different modern rice varieties are shown in Table 4.3.

Table 4.3 Maximum Possible Rice output considering new modern rice varieties in Bangladesh

Season	No. of Rice Varieties	On-station Potential Farm Yield (t/ha)	BRRI on-farm Yield (t/ha)	Yield Gap (t/ha)
T. Aman	22 BRRI rice varieties	5.03	3.45	1.58
Boro	16 BRRI rice varieties	5.59	4.35	1.24
Aus	Average 15 BRRI rice varieties	5.1	3.51	1.59
Average of all variety		5.22	3.74	1.48

Data source: Household survey of BRRI in 9 regions of Bangladesh, Annual report of BRRI 2010-11 and 2011-12.

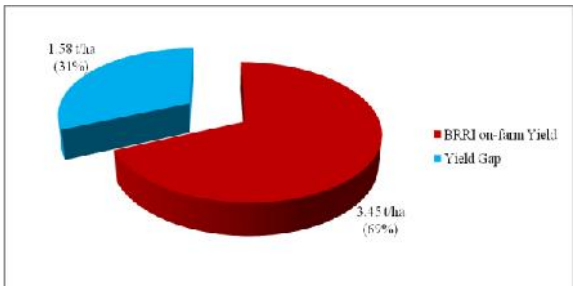


Figure 4.7.Yield Gap of Modern T. Aman Rice in 2010-11

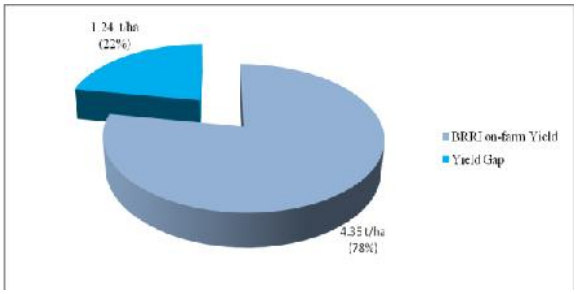


Figure 4.6 Yield Gap of modern Boro Rice in 2010-11

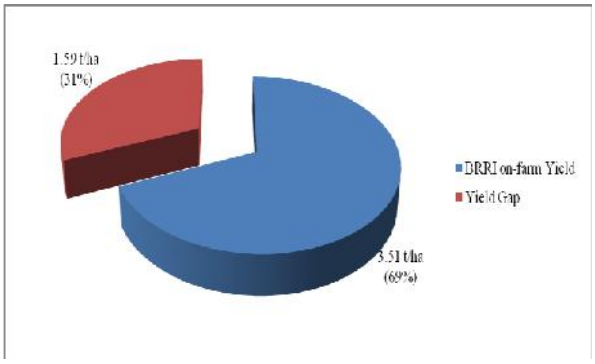


Figure 4.9 Yield Gap of Modern Aus Rice in 2010-11

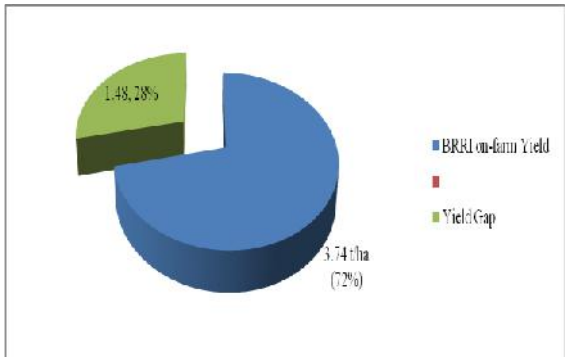


Figure 4.8 Yield Gap of all Modern Rice Varieties in 2010-11

4.3.3 Potentials of enhancing rice productions

For increasing rice production in the country following interventions could be considered:

- Bridging the yield gap
- Scaling up of good farmer's management practices (GFMP) under favourable Agro-Ecological Zones (AEZ)
- Greater thrust of agricultural intensification in the southern and Sylhet regions.
- Replacement of local varieties by modern varieties in T. aman season where possible.
- Limited increase in modern variety Boro area.
- Replacement of the present varieties by superior inbred, hybrid and super high yielding varieties.
- Increment of irrigation areas in both Boro and T. Aman season.
- Application of superior management technologies.
- The use of quality seeds.
- Mechanization of rice cultivation particularly minimization of post-harvest losses.

Bridging the yield gap

Since 1973, BRRI in partnership with IRRI has been engaged in adaptive research for evaluating elite lines under the IRRI managed International Network for Genetic Evaluation of Rice (INGER) and released varieties that suited Bangladesh agro-ecological conditions under the brand name BR and later Brridhan. Many of the elite lines that came to Bangladesh were suited for the boro and aus seasons. The most popular of them are BR1, BR3, BR14, BR14, and more recently BRRI dhan 28 and BRRI dhan 29, BRRI dhan 58. We have used 4 data sets for analysis of yield gaps of modern rice varieties. We have analysed yield gaps by growing seasons- Aus, Aman and Boro. We have used one data set of BRRI based on a field survey during 2006-7 and another data set based on a survey in 2010-11. We have used also BBS and DAE data sets. Yield gaps between the potential yield in BRRI Research Station farm and Actual farmers' yield of different modern rice varieties by season are presented in Table 4.3 and also in Figures 4.6 to 4.9. Less yield gap was observed for Modern Boro rice. Comparing results of different data sets it was found that BRRI survey results indicated less yield gaps compared to BBS and DAE results. According to BRRI results of 2006-7 yield gap ranged 18-26%. This means that the farmers' actual yield is 18-26%. lower than the potentially attainable yield. While BRRI results of 2010-11 showed that yield gaps ranged 22 to 32% and with an average of 20%. But if we compare yield gaps estimated using farmer's actual yield from BBS survey and BRRI's technically attainable yields than the yield gap is much higher (30-62%). Results of Karim (2009) based on DAE and BBS data also indicated that higher yield gaps exist.

Causes of yield gaps: Some of the persisting problems of increasing crop production, particularly cereal production using the available HYVs are decreasing soil productivity, inefficient water and fertilizer use, inadequate supply of quality seeds, imbalanced use of fertilizer, low labour productivity, and higher input price. These factors are restricting realization of full yield potential of HYVs, resulting in lower yield of cereals in the farmers' field compared with much higher yield obtained in the research station. The major concern is how to reduce this yield gap by improving soil, water and labour productivity, optimizing fertilizer use and reducing input price. Declining land resources and competing demand for limited land is a major concern for future agriculture. New technological breakthrough, appropriate development interventions and a robust land use policy will be needed to address the problems.

Agricultural land in Bangladesh is shrinking fast. The option left for increasing productivity is through minimizing yield gap. The average yield of rice was taken from BBS data base and the attainable yield by the farmers was computed from a large number of research and demonstrations, on farm trials and farming system sites, farmers participatory and pilot demonstration (Table 4.4). Only attainable but sustainable yield is considered as the maximum yield ceiling by farmers

Table 4.4 Attainable yield of rice and yield of good Farmers' management practices (GFMP)

Rice	Average Yield (ton/ha)		
	National	Attainable	GFMP
Aus Rice			
Local	1.14		
HYV	1.96	3	2.5
Aman Rice			
Broadcast	0.93		
Local	1.24		
HYV	2.27	4	3.65
Boro Rice			
Local	1.79		
HYV	3.9	5.5	4.5
Total			

It is considered that 30% and 60% of yield gap may be reduced by 2021. Table 5.5 provides the projected production of rice. There is some opportunity of increasing HYV coverage during the Aman season. This will add some increased production of HYV in Aus and Aman areas by replacing local varieties. It is reasonable to consider 20% and 15% increase, respectively in HYV of Aus and Aman seasons. It is enhanced production over the production by bridging the yield gap situation. There could be 37.6 million ton of rice production by the year 2021 from the existing rice area (Table 4.5).

Table 4.5 Projection of rice production in 2021 based on 60% and 30% yield gap minimization (YGM)

Rice	Projection of milled rice production in 2020-2021 (000 mt)			
	2020		2021	
	30% YGM	60% YGM	30% YGM	60% YGM
Aus Rice				
Local	408	408	408	408
HYV	1262	1425	1275	1450
Aman Rice				
Broadcast	287	287	287	287
Local	1660	1660	1660	1660
HYV	9359	10998	9485	11251
Boro Rice				
Local	226	226	226	226
HYV	19482	21479	19631	21783
Total	**32683**	**36483**	**32972**	**37064**

4.4 Productivity of other crops and agricultural diversification

It was found that production declined marginally for rice, but rose sharply for wheat and maize**.** In 2012/13, rice production declined (-0.2%) for the first time since 2005/06. Wheat and maize production grew sharply by 26% and 14%, respectively, during the same period, mainly due to favourable weather condition and timely supply of seeds and fertilizers by GoB and private companies. Moreover, higher prices before planting encouraged farmers to bring

more land under these crops. Potato production rose by 5%, compared to a 1.8% reduction in the previous year, with the increase in yield (1.6%) accounting for about one third to the observed growth. As a result, potato prices declined significantly at harvest time, causing protests by the growers, then the prices rose as a result of increasing export and stocking in cold storages. Pulse and oilseed production rose faster in 2012/13, respectively by 11% and 5%, compared to 5% and 3% in the previous year. Fruit production accelerated, but vegetables exhibited mixed trend over the same period: brinjal and pumpkin maintained the upward trend while beans and lal shak production declined.

Table 4.6 depicts the production growth rates of selected crops pre- and post- Plan of Action (PoA) period. Growth of rice, wheat, pulses, brinjal and edible oilseeds accelerated after the start of implementation of the PoA, which coincided with the post food price crisis period, while it decelerated for other crops. Wheat, pulses and brinjal production growth rebounded from declining trends.

Table 4.6 Crop production growth rate (%)

Crops	**Pre-PoA (2000/01-2006/07)**	**Post-PQA (2007/08-2012/13)**
Rice	1.62*	3.16*
Wheat	-14.73*	7.43*
Maize	95.77*	7.04
Potato	9.07*	7.93*
Pulses	-5.45*	5.71*
Brinjal	-2.50*	1.64*
Pumpkin	8.68*	1.96
Beans	9.11*	2.40*
Lal Shak	5.77*	1.06
Edible Oil	2.20*	4.44*
Banana	9.26*	-2.90*
Guava	24.65*	6.00*
Mango	31.51*	3.93*
Pineapple	10.01*	-3.81
Jackfruit	30.62*	-0.83

Source: BBS; *Significant at 10% level

Agricultural diversification is becoming increasingly important to tackle the rising food trade deficit due to changing consumption habits and for further promoting the diversification of diets, especially in rural areas, where production and consumption patterns tend to be more closely linked. IFPRI studies show that agricultural diversification is positively correlated with household and child dietary diversification, and that it is promoted through access to irrigation, credit, input subsidy, extension services and women's empowerment. In turn, diversification toward higher value added on-farm activities, such as production of fruits, vegetables, legumes, fishery and livestock products can help accelerate agricultural income growth and poverty reduction, generate backward and forward linkages and promote growth of agro-based processing and marketing. A more diversified production requires a more diversified set of inputs, public and private services and infrastructures. A number of programmes have been undertaken to promote diversification through appropriate technologies. While these need to continue, greater emphasis is required to adopt public interventions and to promote the engagement of private actors, for example in providing diversified extension services for the different.

After the food price crisis crop diversification had been hampered by the increasing use of land to produce rice and other key staples such as wheat and oilseeds, whose areas – beside the one occupied by pulses-rebounded from their previous negative trends (Table 4.7). Maize, spices, potato, and vegetables continued expanding, albeit at a slower pace in the same period. Sugarcane and fruit area declined. It is particularly noticeable that the rice area in total cropped area dropped year-on-year in 2012/13, giving space for the increase in share of all other crops, but jute and fruits.90 Indeed, it provides a first sign of a renewed focus on diversification. A similar trend is observed in terms of overall agricultural diversification, which seems to have improved, in the last fiscal year, as the share of rice on total agricultural value year-on-year fell by 0.8% with rising shares of fishery and livestock sectors by 0.7% and 0.2%, respectively, in 2012/13.

Table 4.7 Acreage growth rate of selected non-rice crops

Crops	Pre-PoA (2000/01-2006/07)	Post-PQA (2007/08-2012/13)
Rice	-0.44	1.34*
Wheat	-10.43*	0.17
Maize	68.46*	3.30
Oilseeds	-3.90*	2.14*
Spices	5.93*	4.94
Pulses	-6.07*	4.90*
Potato	6.41*	2.34*
Sugarcane	-1.89*	-3.75*
Fruits	-6.69*	-2.68*
Vegetables	4.11*	1.37
Jute	-2.02*	13.67*

Source: BBS *Significant at 10% level

Crop sub-sector growth has been highly unstable varying from 5.23% in 2005-06 to 4.82% (estimated) in 2010-11(Bangladesh Economic Review, 2011). This shows that it is possible to enhance growth of crop agriculture with appropriate use of production inputs under favourable climatic conditions. On the other hand, growth instability in certain years indicates that crop agriculture is highly vulnerable to natural disasters and unpredictable climate behaviour. Growth of crop agriculture also depends on input availability, input quality and input-out price.

4.5 Export Potentials of Agricultural Commodities

Bangladesh produces a large number of diversified High Value Agricultural Crops (HVACs) in different agro ecological regions. Marginal and small farmers are the key players in production, value chain and marketing of the agro products. At present a number of fresh and processed agro-commodities are exported from Bangladesh to different ethnic markets.

Besides the above commodities some of the private sector agencies are currently exporting a good quantity of Jute leaves, Barley, Sesame, Cashew nut, Baby pineapple, Baby corn, French bean, Black pepper some indigenous fruits and vegetables. Barley is the most saline tolerant crop and it has potential of production for export from about one million hectares of coastal saline land. Halal meat market exists in some countries, which Bangladesh can explore it.

Table 4.8 Agro-commodities from Bangladesh in the Export Market

Fruits	Vegetables		Others
Lemons	Teasel gourd	Green chili	Betel leaf
Jackfruits	Yard long bean	Coriander leaves	Betel nut
Mango	Bottle gourd	Garlic	Flowers
Pineapple	Okra, egg plant	Ginger	
Papaya	Taro stolon	Turmeric	
Guava	Leafy vegetables		
Banana	Radish, beans		
Melon,	Cabbage		
Litchi	Cauliflower		
Jujubi	Bitter gourd		
Hog plum	Potato, tomato		

Export Projection of Agro-commodities

Karim and Islam (2014) stated Bangladesh could earn more than $1800 million in about 18 years (Fig 4.7 and Table 4.9). Export potentials of fruits and vegetables are about 160 thousand metric tons (Fig 3) and potatoes would be around 200 thousand metric tons (Fig 4). The potentials of exporting fresh & frozen horticultural crops and processed food would exceed 600 thousand metric tons. Bangladesh exports shrimp and fishes of around $ 530 million in 2012-13(Bangladesh Economic Review, 2014).

The export potentials of Bangladeshi agro-commodities are constrained by low productivity, poor hygiene and non-compliance of sanitary & phytosanitary standards and HACCP practices. The export will increase manifolds by overcoming hindrances described below.

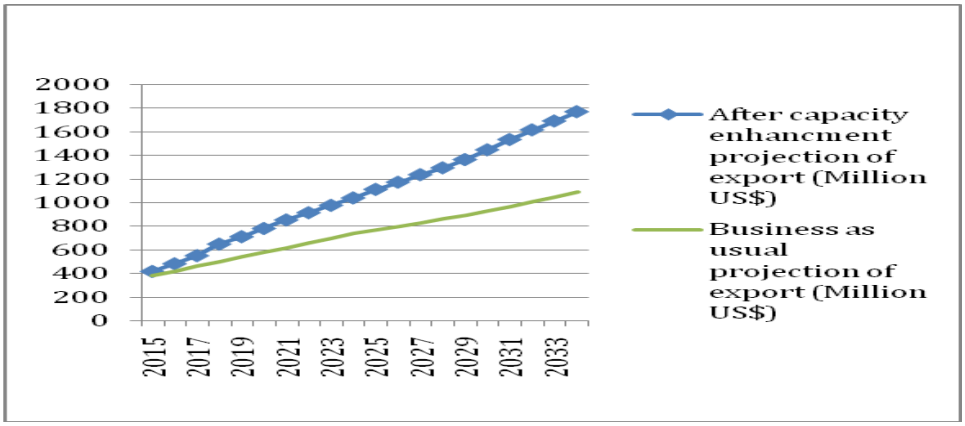


Figure 4.10 Projection of export of fresh, frozen horticultural crops and processed food (million US$) under business as usual and enhanced capacity

Box-2: Projection of export of fresh, frozen horticultural crops and processed food
A Time series data of exports of horticultural crops and food was used for the period 2008-13. The database of Hortex Foundation and Export Promotion Bureau was used. A Statistical Forecasting soft ware is used for generation of projections for 20 years using simple linear regression techniques. Two alternative scenarios have been assumed: (1) Business as usual scenario and (2) Capacity enhancement of concerned actors: For example Strengthening Hortex Foundation, Food Quality Certification capacity of concerned agency, Capacity of compliance of SPS and traceability of produces, improving capacity of farmers and exporters, etc. It is assumed that during a 10 year periods (2014-24) 50% capacity has been improved and during later 10 years (2024-34) Bangladesh is fully capable of operating in the international food markets.

Table 4.9 Projection of Export of Fresh, Frozen Horticultural Crops and Processed Food

(Million US$) Under Business As Usual and Enhanced Capacity

Year	Business as usual projection of export (Million US$)	After capacity enhancement projection of export (Million US$)	Incremental benefits due to capacity enhancement (Million US$)	Year	Business as usual projection of export (Million US$)	After capacity enhancement projection of export (Million US$)	Incremental benefits due to capacity enhancement (Million US$)
2015	380	418	38	2026	796	1171	374
2016	420	482	63	2027	828	1234	406
2017	459	551	92	2028	861	1292	431
2018	499	648	150	2029	896	1361	466
2019	538	711	172	2030	932	1444	512
2020	578	780	202	2031	969	1531	562
2021	617	852	235	2032	1008	1612	605
2022	657	913	256	2033	1048	1687	639
2023	697	975	279	2034	1090	1765	676
2024	736	1038	302	Total	14773	21576	6803
2025	766	1110	345	GDP % (2013	21.7	14.9	6.9

During 2015-2034 total export under business as usual scenario is US $ 14773 million and under improved scenario is US $21556 million and additional benefit due to improvement is US $ 6803 million.

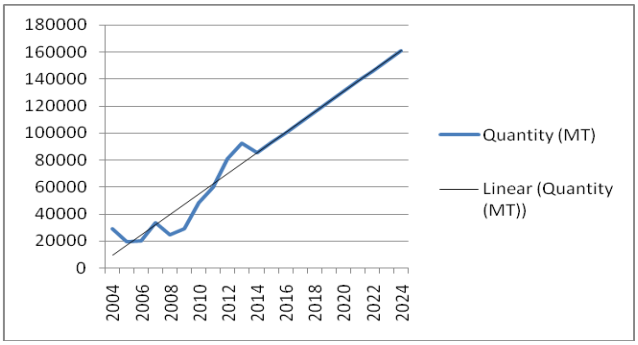


Figure 4.11 Projection of export of fresh fruits and vegetables (MT)

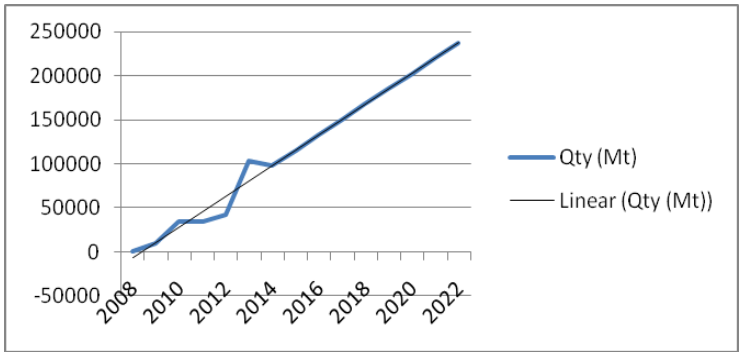


Figure 4.12 Projection of potato export quantity (Mt)

Main Hindrances to Export

Non-compliance of Sanitary and Phyto-sanitary Standards (SPS)

In recent years, sanitary and phyto-sanitary (SPS) measures have become an increasingly prominent issue for global trade in agricultural. These concerns are typically greatest for Bangladesh that tends to have weak SPS management capacities that can thwart efforts towards export-led horticultural diversification and rural development. The arbitrary imposition of SPS measures especially for horticultural and fisheries products is a ploy developed countries have been able to use in the guise of environmental concerns to further protect their agriculture by restricting imports from developing countries.

The European Union (EU) requirement for example on the levels of Maximum Residue Level (MRL) allowed on horticultural export is a major challenge. Implementation of the zero analytical level means that farmers have to reduce the levels of pesticides used or uses those pesticides, which have very low residual levels. Other SPS measures imposed include Pest Risk Analysis and Environmental Protection Requirement by export market. Small-scale farmers in particular find it difficult to meet these standards. There is therefore need for the government and all concerned to provide technical support on the benefits of SPS adhering to the regulations and local markets.

In general, the level of awareness of the role that SPS management capacity plays is limited among small holder horticultural farmers and hence there is need for concerted information, campaigns and training at all levels of stakeholders. For high value horticultural products, international regulations and standards related to food safety and quality will determine trade opportunities but must also safeguard health of the populations. Therefore, corresponding national regulations should be developed and enforced for commodities both for local and/or regional consumption as well as for the exports that constitute about 1% of the total horticultural production in Bangladesh.

Poor HACCP System

Bangladesh is member of Codex Alimentarius Commission (CAC). It deals with standards for food safety including food standards for commodities; codes of hygienic or technological practice, and pesticide residue in foods for export of HVACs, Codex standard of HACCP must be followed. BSTI is trying for some items but still problem remains mostly with the frozen shrimps, fish and vegetables, which restrict expansion of export market.

Non-traceability of Production and Packaging Processes of HVACs

Hortex in its initial period in collaboration with BRAC did wonderful job of exporting French bean in the mainstream market maintaining traceability, SPS and standard packaging. Unfortunately the export of French bean discontinued although potentiality of its export still exists. For traceability, supervised contract farming is a pre requisite. In the NATP- 2 contract farming should be organized in production, processing and marketing, organizing groups of marginal and small farmers in the CIG and non-CIG areas and Hortex Foundation should build the capacity of organizing contract farming system.

Lack of Farmers' Access into Supermarket

Besides, it is also important to realize that the process of super-marketization has initiated a series of restructuring waves across the world's food retail industry leading towards a tighter "knitting together" or integration of the national and regional food markets. They have also caused numerous spillovers to occur with and across surrounding sectors and marketing channels.

Super-marketization offers a massive market opportunity for those producers who are willing and able to suitably organize themselves to respond international market demand through meeting the requirements of the specified standards. However, recent research shows that for farmers, to effectively respond to these new market opportunities, must make substantial on and off farm investments in technology and adjustment of the production system, quality assurance, processing, and food safety standards consistent to global market. Such conditions often limit market access options for small and limited resource farmers.

It is clear that the changes in agri-food systems caused by the combination of increasing globalization, market liberalization, and super-marketization present significant challenges for small-scale producers in developing and transition countries and unless development programs actively and continually facilitate farmers access to newly emerging global marketing channels, farmers will be forever excluded and they will remain in continued poverty. Hortex Foundation should bear this great challenge in mind and prepare itself to continuously undertake rigorous program of capacity building including market access training of all stakeholders operating in export. Nation should also built required infrastructure for testing, HACCP and SPS.

Limitations of SPS Services in Bangladesh

In Bangladesh there is no organized contract farming for HVACs for which no traceability system is yet established. This is a serious weakness of our commodities. Country's position of SPS and HACCP is poor. From consultations and visits of Plant Quarantine Wing of DAE and Testing Laboratory located in the Port Custom House at Chittagong, we observed that they have almost no facilities for doing required SPS and HACCP services for HVACs (Appendix-3). The Plant Quarantine Wing is newly created with all the officers and staff seconded from DAE. Many of them do not have required background for plant quarantine service; moreover they are subject to transfer at any moment. Government is trying to make it an Independent Directorate. However, it should be fully independent with facilities and well trained staff positions.

Now a days to cope with the international requirement many countries have established independent accredited laboratories for performing the SPS services following the WTO's and FAO's Codex and HACCP standards. The system of analysis of residuals of pesticides and chemicals must be established following environmental protection regulations and health safeguard standards.

In the Port Laboratory there is no facilities exists for analysis of agro-products. About two years back they have received three expensive equipment, i) UV-VS Spectrophotometer, ii) Gas Chromatograph and iii) High Performance Liquid Chromatograph. These equipment are still unpacked and concerned chemists informed that they could not install those because of some missing parts (Appendix-4). This is really disappointing. The laboratory has three qualified Chemists only, but they have to do analysis inspection for certification of a lot of diversified items both for export and import in the country.

4.6 Agricultural marketing

The Bangladesh agriculture is transforming towards commercialization with production of high value produces. But there are a number of problems facing the small and marginal farmers:

- Limited market access due to small volume of production,
- High post-harvest loss,

- Inadequate storage and transpiration facilities,
- Lack of cool chain,
- Food quality and safety problems,
- Inadequate credit facilities,
- Lack of processing facilities and
- Low output prices, etc.
- Poor road, link road and market infrastructure.

In Bangladesh, small farms account for 96 percent of operational holdings with a share of 69 per cent of cultivated area. Most poor farmers are not linked to markets for a variety of reasons: remoteness, low production, low farm-gate prices, and lack of information, to name a few. Most of these smallholders practice either subsistence farming or operate largely in local markets due to lack of connectivity to more lucrative markets at regional, national or global levels. As a result, incentives remain weak, investments remain low, and so does the level of technology adoption and productivity, resulting into a low level equilibrium poverty trap. Identifying and linking poor primary producers to productive opportunities in the agriculture and fish sub-sectors can significantly increase incomes as they access high-value markets and sell value added produce. Specifically, commercial production of vegetables, pulse and oils, fish, poultry and rice all represent expanding, profitable sub-sectors within which smallholder producers can engage and generate the productivity and increases income necessary to elevate themselves out of poverty.

There is a strong demand for investment in the sector for development of market and value chains, speed up dissemination of technology and enhancing institutional capabilities to deliver essential services to the small farmers, traders and various supply chain actors for developing demand led value chains and enhancing market linkages of the small and marginal farmers. Successful Marketing requires learning new skills, new techniques and new ways of obtaining information.

Hortex implemented an innovative, market-driven value chain development approach through Supply Chain Development Component (SCDC) of National Agriculture Technology Project (NATP). This approach is linking consistently with the agricultural innovation systems, especially within a rapidly changing globalized economy of Bangladesh. In short, with a stable economic growth of the country, there are changes in consumption patterns that are creating emerging markets for new high-value products of crops, livestock and fisheries. Under this emerging value chain development approach, it is the growing market for high-value products that controls specific innovations that can be successfully taken up by different farm households within local communities to improve their farm household income. In the process, each farm household must consider its own resources (e.g., land, labour, access to water) and access to different markets (e.g., transportation infrastructure; distance to different local, regional, and even global markets). Then, it must determine which enterprises would be most feasible and whether appropriate technologies are easily available for them to successfully produce and market these different crops, livestock, fisheries, or other agricultural products (Fakhrul, 2014).

Also, important is the number of other farm households within each local community who share common interests (CIGs) and who are willing to work together, especially in creating producer organizations (POS) in the post-harvest handling and marketing of these products to urban or export markets. The increasing demand for different high value food products (e.g., fruits, vegetables, fish, animal products, etc.) creates new market opportunities for products that can be produced by small-scale farm households who have the necessary labour resources to produce and market these high-value, labour-intensive crops and other products.

This transformation require a longer time, because most extension personnel are trained in technical fields associated with the major food crops as well as animal production. Most extension workers have little or no training in farm management, agricultural marketing, value chain analysis and the newly emerging, high-value crops and products;

nor about various micro-finance options and agribusiness management. In this regard, Hortex Foundation developed some important supply chain model for high value crops. During 2008-14, SCDC has developed an approach/business model and piloted value chain development activities in 20 upazilas through a collaborative approach between, Hortex and line extension agencies- Department of Agricultural Extension (DAE), Department of Livestock Services (DLS) and Department of Fisheries (DOF) (Fig . 4.10)

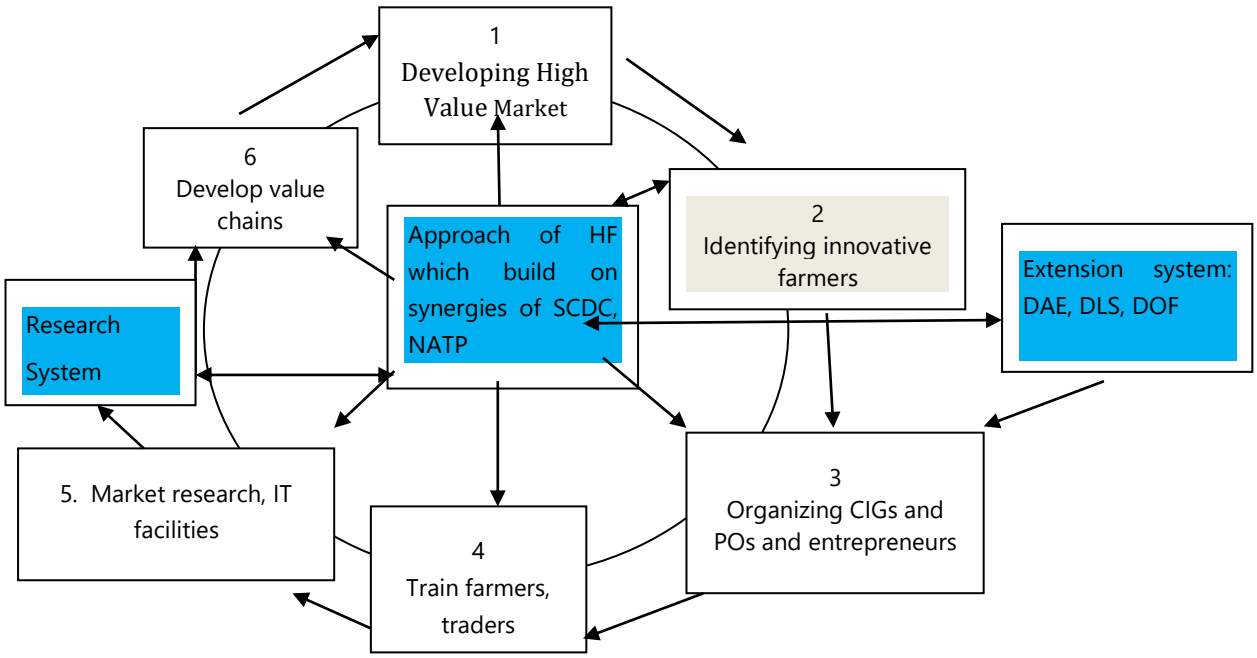


Figure 4.13 Innovative approach of Hortex for developing value chains of high value produces

Hortex has piloted and established a network 25 Commodity Collection and Marketing Centers (CCMCs) and shortened 2 segments (*faria* and collector) of the value chain. The SCDC of Hortex has developed 62 high potential value chains in 20 upazilas in 13 districts across the country and provided supports for post-harvest management, improvement of market linkages and enterprise development activities. Twenty four technologies were demonstrated and training of CIG farmers were organized through CCMCs in project sites for development of market linkage of the farmers. It is necessary to scaled up value chain development activities of NATP for improving market linkages, minimizing post-harvest loss, entrepreneurship development and value chain development.

4.7 Supply and demand of rice in Bangladesh

Bangladesh achieved a major milestone at the end of the 1990s by approaching the critical point of demand-supply balance with regard to rice (Deb 2002; Hossain and Deb 2009). There is no denying that Bangladesh has achieved an impressive success in terms of rice production. On an average, during the last decade, production of rice experienced a growth of about 4 per cent per annum. The growth in rice production was attributed mainly to adoption of HYVs of rice. At present, almost three-fourths of the cultivated rice varieties are high-yield. Indeed, currently the farmers from the deep-flooded areas of depressed basins and the salinity-affected coastal areas only grow low-yield traditional rice varieties. Since independence, almost 90 per cent of the growth in rice production attributed to increases in yield. The dry season-irrigated Boro rice alone contributed to over 80 per cent of the increased production which now accounts for over 55 per cent of the total rice production in Bangladesh (Hossain *et al*. 2009). However, to meet demand and replenish the food stock, Bangladesh needs to import food grains, in varying amounts. On average, over 8 per cent of

the total food grains supply in the domestic market of Bangladesh has been secured from imports during the recent decade. In FY2007-08, the share of imports in available food grains (rice and wheat) was only 9.7 percent (Table 4.10).

Table 4.10 Share of Food grain supply sources (%)

Year	Domestic Production	Imports	Food Aid
FY2000	92.0	4.6	3.2
FY2001	94.6	3.8	1.7
FY2002	93.5	4.7	1.8
FY2003	89.3	9.9	0.8
FY2004	90.8	8.3	0.9
FY2005	88.6	10.4	1.0
FY2006	91.4	7.9	0.7
FY2007	92.1	7.6	0.3
FY2008	89.6	9.7	0.8
FY2009	91.4	8.2	0.4
FY 2010	91.7	8.3	0
FY2011	86.9	13.1	0

Source: Authors' calculation based on the Bangladesh Bureau of Statistics (BBS) data.

In 2011 the government of Bangladesh decided to export rice to boost prices for growers. At present, the average retail price of coarse rice is Tk 25 a kg, while the production cost per kg is said to be Tk 26.50. The government stock currently stands at 1.3 million tonnes, 488,000 tonnes of which have so far been acquired since the last boro harvesting season and it intends to continue with the procurement, at Tk 28 a kg, until September.(Year 2013) The idea of rice exports is not new, In 1981 the government exported 10,000 tonnes of rice. Part of the reason for rice export is space constraint in public warehouses. The available space in government-owned warehouses can store 350,000 tonnes of rice, but the capacity is expected to increase once the government embarks on the VGF (vulnerable group feeding) programs. As the rice stock is getting stale so it is necessary to think of ways to offload it from the warehouses. The total rice output recorded by the Bangladesh Bureau of Statistics for fiscal 2011-12 was 33.73 million tons, nearly 1 percent rise from the previous fiscal year's 33.54 million tons In 2015, Bangladesh exported 50 tons of rice to Sri Lanka. Table 2.8 presents projections of rice export potential of Bangladesh. Bangladesh could export around 5.2 million ton milled rice per year after meeting domestic needs during 2015 to 2021.

Table 4.11 Export potentials of rice from Bangladesh

Year	Population Million	Milled rice requirement (Million ton)	Production (Million ton)	Surplus/Potentials of exports (Million ton)
2015	156.7	25.9	33.6	5.6
2021	166.9	27.6	37.8	5.2

Source: Islam (2014)

A projection has been made on supply and demand for rice in Bangladesh over the period from 2015 to 2030 and assessed the possible surplus or deficit that Bangladesh could face in the future (Ganesh-Kumar, 2012). Both supply and demand projections are made under various scenarios. Hence, we compute the surplus/deficit by taking the maximum and minimum of all supply and demand forecasts. The maximum and minimum values of the supply forecasts correspond to the optimistic scenario (OS) and pessimistic scenario (PS) projections. The maximum (minimum) demand forecasts correspond to the case of high (low) population growth with high (low) income growth. The range of surplus/deficit estimates is estimated across all possible combinations of the supply and demand forecasts. These estimates, done separately under the two possible assumptions on the indirect demand requirements, are reported in Table 4.12.

Table 4.12 Projected demand, supply, and deficit/surplus of rice in Bangladesh, in million tons

Year	Supply projections		Demand projections		Surplus (+) / deficit (-)	
	OS	PS	Max	Min	Max	Min
Intermediate demand coefficient = 10%						
2015	35.2	31.2	32.4	29.8	5.4	-1.2
2020	39.3	33.8	36.9	31.7	7.6	-3.0
2025	39.2	36.4	41.6	33.3	5.9	-5.3
2030	39.0	38.8	46.6	34.8	4.2	-7.8
Intermediate demand coefficient = 20%						
2015	35.2	31.2	36.5	33.5	1.7	-5.3
2020	39.3	33.8	41.5	35.7	3.7	-7.6
2025	39.2	36.4	46.8	37.5	1.7	-10.5
2030	39.0	38.8	52.5	39.1	-0.1	-13.7

Above projections of the future supply and demand show that Bangladesh can face either a surplus or a deficit in rice, depending upon the prevailing supply and demand scenario. The country could face a surplus situation if supply growth occurs as per our optimistic scenario specification and demand growth is relatively slow, driven primarily by slow growth in population and to a lesser extent by slow growth in per capita incomes. When the reverse happens, then deficits are likely to happen. The above estimates of surplus/deficits also reveal a certain pattern over time irrespective of the assumptions on the intermediate demand requirements. The projections of surpluses increase until 2020, after which the surpluses become smaller. In fact, if the intermediate demand requirement is assumed to be 20 percent of total demand, then by 2030 the country is likely to face a deficit in the range of 0.1 to 13.7 million tons. This pattern in the surplus projections can be attributed to our supply scenario specifications, wherein constraints on land availability will increasingly begin to affect production growth under current technologies. The deficit projections show a steady rise over time, reflecting the sharp rise in demand under the high population growth scenario.

5 Analysis of current food security status

Food security exists when all people, at all times, have access to sufficient, safe and nutritious food to maintain healthy and productive lives. The key elements of food security are: a) availability of enough food from domestic production and/or imports to meet the demand, b) access of the food to all people at all times through enough incomes and affordable prices, c) proper hygiene and sanitary practices and safe water for utilisation of food to have optimum impact on health and nutrition, and d) a regulatory framework in place and its proper implementation for controlling contamination to ensure food safety.

Bangladesh has made good progress since 1992 in reducing income poverty based on the national poverty line. The country was able to lower the overall incidence of poverty from 58.8 percent in 1991-92 to about 48.9 percent in 2000, with an annual rate of decrease of 1.8% about the percentage point per year. It further declined to 40% in 2005 with a decreasing rate of 3.9% about the percentage point per annum and further to 31.5% in 2010 (Fig. 5.1). In spite of the advancement, about 57.7 million people are poor with one-third caught in hard-core or extreme poverty. Bangladesh past efforts towards improving food security have resulted in a 5.0 percentage decrease in the proportion of undernourished between 1990-1992 and 2002-2004 when it came down to 30%. However, mainly due to population growth, the number of undernourished actually increased from 39.3 million to 44 million (POA, 2008-15). The most recent estimates (Household Income Expenditure Survey– HIES, 2010) indicate that still 31.5% of the population has absolute poverty and are undernourished who fail to meet minimum level of caloric consumption

needs of 2122 KCal/person/day and 17.6% of the total population are hard core poor who are unable to consume 1805 Kcal/person/day.

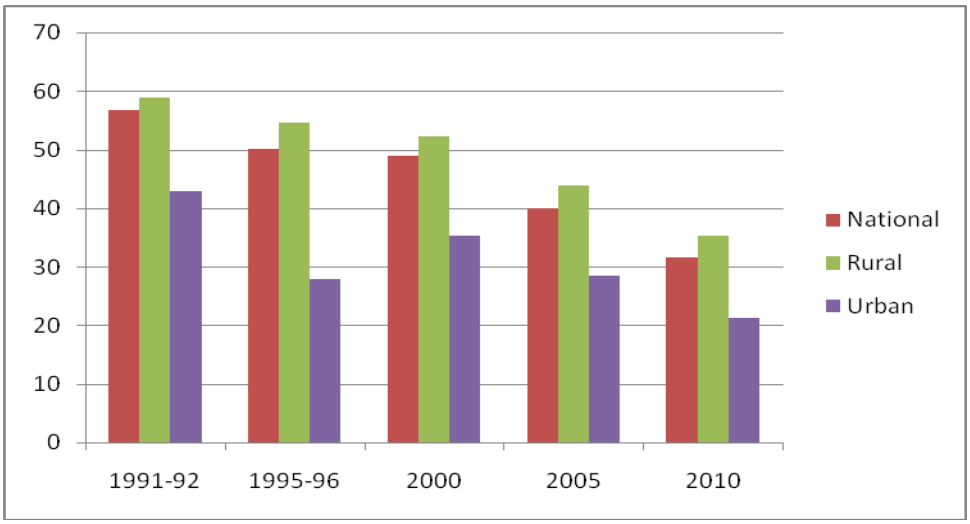


Figure 5.1 Incidence of poverty in Bangladesh during 1991-92 to 2010

Food security worsens with inter-year shortfall in food grain production caused by climatic variations and natural disaster such as floods, tidal surge and insect and pest attacks. Variations in food intake also exist between regions of the country, between adults and children and between men and women at the household level.

5.1 Availability of food

In view of repeated experience of severe hunger and famine, food security in Bangladesh has long been synonymous with achieving self-sufficiency in rice, the dominant staple food. The Bangladesh economy has made remarkable progress in rice, tripling production from 11 million tonnes in 1971 to 33 million tonnes in 2012. In the fiscal year (FY) 1974-75, when the population of Bangladesh was only 79.9 million, the total rice production was 11.1 million tonnes. The country produced 33.54 million tonnes for its 160 million people in FY 2010-11. Rice production increased by 3.02 times in 36 years, In 1971-72, the average rice yield was 1.05 tonnes per hectare, while in 2005-06 it was 2.52 tonnes.

Per capita rice production has increased substantially over the level at the time of independence. The growth of production was achieved by fast adoption by farmers of higher yielding crop varieties developed by scientists, supported by rapid expansion of irrigation infrastructure through private investment in tube wells.

Rice production continues to increase, but wheat production is showing a declining trend in recent years. Wheat production decreased from 1.6 million tons in 2001-02 to 0.97 million tons in 2010-11. Production of vegetables and fruits has increased, but at a slow pace from 1.59 million tons and 1.47 million tons in 2001-02 to 11.19 million tons and 3.56 million tons in 2010-11 respectively. Spectacular success has been achieved in the production of potato. It has increased significantly from 2.90 million tons in 2001-02 to 8.30 million tons in 2010-1 (Table 5.1). Production of non-cereals such as pulses, oilseeds, vegetables and fruits, which are the chief sources of protein, mineral and vitamin, still remains far below the actual requirements, making it difficult to provide balanced diet for all. The production of pulses and oilseeds has picked up in recent years due to favourable prices, some progress in the development of higher yielding varieties, and identification of favourable agro-ecological niche. The dependence of Bangladesh on the world market for the availability of pulses, edible oil and sugar and milk has been growing, along with wheat.

Table 5.1 Trend in domestic production of food crops: 2001-02 to 2010-11 period (Million MT)

Year	Food grain		Potato	Pulses	Oilseeds	Vegetables	Fruits
	Rice	Wheat					
2001-02	24.30	1.61	2.90	0.35	0.39	1.59	1.47
2010-11	33.54	0.97	8.30	0.72	0.84	11.19	3.56

Around 90 per cent of the rural population of Bangladesh is directly involved in agriculture and around 43.6 per cent of the total labour force is engaged in agricultural activities. For increasing food production and attaining food sufficiency a sustainable growth of the agricultural production is required.

Bangladesh used to receive substantial amount of wheat, the secondary staple food as food aid from developed countries. Commercial import of wheat has however increased despite growth in domestic production till the 1990s, mainly due to the discontinuation of food aid and stagnation of domestic production after a rapid growth in the 1980s. The import has recently exceeded three million tonnes. It appears that even if Bangladesh achieves self-sufficiency in rice production or becomes a rice exporting country, the import of wheat will continue.

Bangladesh has rich biological resource base for fish production. In terms of nutrition, fish occupies a significant position in the dietary habits of the people. The growth in fish production was sluggish in the 1970s, it picked up in the 1980s, and was very rapid (7 percent per year) in recent years due to the expansion of pond aquaculture. Entrepreneurs have started converting low-lying lands into fish ponds and engaging in highly productive and profitable pond aquaculture. The prices of cultured fish such as tilapia, koi, and pangash have declined compared to other fish, and have been within the reach of low income consumers.

Fish production increased from 1.89 million tons in 2001-02 to 3.41 million tons in 2012-13 (Table 5.2). Meat, milk and egg production has also increased significantly over the last ten years. But the shortage is still there. According to the Bangladesh Economic Review, 2014 the livestock growth rate in 2012-13 was 2.74% and was 6.10% for fisheries sub-sector..

Table 5.2 Trend in Fish, meat, milk and egg production, 1001-02 to 2012-13 period

Year	Fish (Million MT)	Meat (Million MT)	Milk (Million MT)	Egg (Million piece)
2001-02	1.89	0.78	1.78	4424
2012-13	3.41	3.62	5.07	7617

Source: Bangladesh Economic Review, 2004 and 2014

Per capita availability

Per capita availability of cereals (rice and wheat) has been found to increase from 374 gm/day in 1994-95 to level gm/day in 2004-05 with further to 647 gm/day in 2010-11 (Table 5.3). Sharp increase in per capita availability of potato and vegetables is observed during the last 15 years, while the per capita availability of pulses and oilseeds has remained stagnant or declined. Availability of meat, milk and egg has also increased as shown in Table 5.3. Per capita availability of fish increased from 27 gm in 1994-95 to 53 gm in 2010-11, while those of meat and milk increased from 11 gm and 35 gm in 1994-95 to 35 gm and 55 gm, respectively in 2010-11(Table 5.3).

Table 5.3 Production and availability of major food items: 1994-95 to 2010-11 period

Food Items	**Production (million tons)**			**Availability (gm/capita/day)**		
	1994-95	**2004-05**	**2010-11**	**1994-95**	**2004-05**	**2010-11**
Cereals	18.08	26.13	35.0	374	464	647
Potato	1.50	5.95	8.30	32	108	153
Pulses	0.53	0.31	0.72	11	10	13
Oilseed	0.48	0.56	0.84	10	10	15

Food Items	Production (million tons)			Availability (gm/capita/day)		
	1994-95	2004-05	2010-11	1994-95	2004-05	2010-11
Vegetable	1.21	6.50	11.19	21	108	207
Fruits	1.41	4.60	3.56	24	68	65
Fish	1.17	2.10	2.89	27	41	53
Meat	0.48	1.06	1.90	11	21	35
Milk	1.52	2.14	2.95	35	42	55
Egg (Million) number	2400	5623	6078	19	41	41

5.2 Access to food

In a market economy, the access to food depends on four elements: a) production-based element that depends on ownership of land, b) trade-based entitlement that depends on market prices of food, c) labour-based entitlement that depends on the employment and wages, and d) transfer-based entitlement that includes gifts, remittances from relatives, and relief and subsidies obtained from the government. The ability of the household and the people to access food is the outcome of the complex operation and interactions of all these elements.

In Bangladesh, 70 percent of the people live in rural areas where agriculture is the major occupation. Almost 60 percent of the rural households are engaged in farming. The farming household can access their food from self-production and/or trading the surplus with other foods available in the local market. But the landownership is unequally distributed, and so is the access to food from self-production. Almost 30 percent of the households do not own any land and another 30 percent own only up to half an acre. Such tiny landownership is insufficient to meet the food needs of four to five-member households, whatever advanced technology the farmer use. A tenancy market is in operation, which provides access to land to landless and marginal landowners for farming. A large proportion of marginal farmers go the market to access food as their own production (after payment of rent and interest for loans) is inadequate to meet the household needs.

An analysis of the BIHS data (2011-12) has been carried out to estimate the percentages of households that could not afford to acquire 2,122 kcal/person/day and 1,805 kcal/person/day. The results are illustrated in Figure 5.2. In 2011–12, 36.8 percent of households in the FTF (Government's Feed the Future) zone and 35.3 percent of households in the rural national sample were food energy-deficient who could not afford an adequate diet. Furthermore, 17.5 percent of the households in the FTF zone and 16.5 percent of the households in entire rural Bangladesh were below the lower food energy threshold of 1,805 kcal/person/day and, therefore, remained severely food energy-deficient.

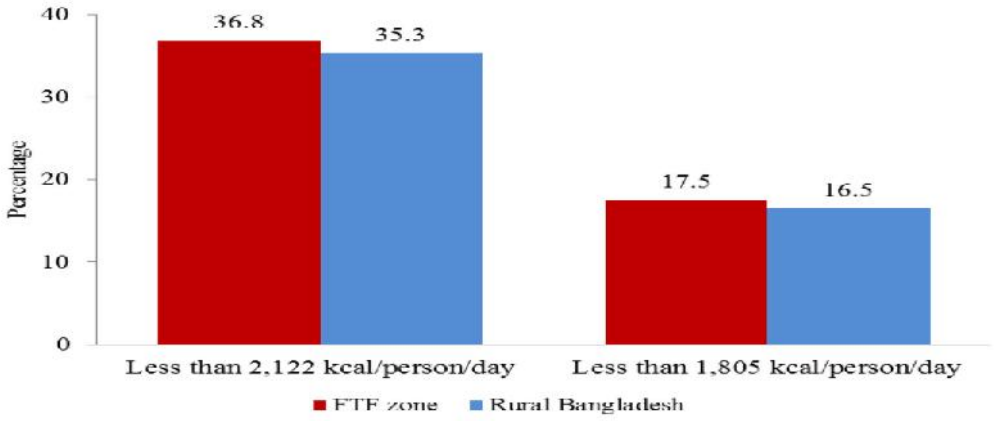


Figure 5.2 Percentage of households below food energy thresholds

The dominant determinant of access to food is obviously the level and the growth of income. In Bangladesh, the per capita income remained almost stagnant till the end of 1980s due to slow growth of GNP and high population growth. The income growth per year has accelerated since 1990, reaching 6.5 percent in recent years. Bangladesh has also achieved remarkable progress in population control. But, the income is highly unequally distributed and the disparity has been growing. As a result nearly one-fourth of the people still live below the poverty line, with inadequate income to access food from the market.

An indicator often used to assess the capacity of the poor to access food from the market is the level and trend in real wages. This indicator shows that since the mid-1990s there has been a favourable trend in the income of the households who depend on selling labour in the market, such as agricultural wage labourers, transport operators and construction workers. The Land Reform in 1984 stipulated a minimum wage equivalent to 3.5 kg of rice at the prevalent market price. The rice equivalent wage had increased from about three kg in 1990 to nearly 8 kg in 2011. The only low income group who have not been able to increase their real income are industrial labourers, particularly the unskilled workers in the garment industry and the fixed wage earners in the public sector.

The hike in food prices after the food crisis in 2007 has had a negative impact on the real wages and access to food. Sharp increase in food grain prices significantly lowers the real income of poor households who spend over half of their income on staple food. At the same time the instability in producer prices increases risks and uncertainty, and discourages the subsistence farmer to invest in agriculture. The volatility in food prices remains an issue for achieving seasonal and temporal stability in food security.

Safety net programmes: Bangladesh is often at the mercy of natural calamities such as floods, droughts and cyclones. Riverine Bangladesh also witnesses frequent land erosion causing thousands of people to lose their land every year. Despite the gains achieved by Bangladesh in augmenting availability of staple food, a safety net programme is essential to insulate the poverty stricken population from chronic as well as temporary food insecurity that results from external shocks. A number of food safety net programmes are in operation in Bangladesh, each with its own specific objectives and target population. These include test relief, Vulnerable Group Feeding, Vulnerable Group Development, Food for Work, Employment Guarantee Scheme, etc. A number of social protection programmes such as vulnerable group feeding, allowance for destitute women, and old age pensions have also been introduced to support food security of the extremely needy people.

The present government has given high priority to the safety nets for ensuring food security. Currently nearly 2.2 percent of the GDP are allocated for safety nets and social protection. The evaluation of the programmes however revealed several limitations; a) large overheads due to operation of a large number of small programmes by different ministries often with the same objectives, b) improper targeting of beneficiary households, and c) leakages in implementation.

5.3 Utilisation of food and nutrition security

The acceleration in economic and agricultural growth has made a positive impact on the diversity of food intake away from the rice and vegetable based diet in favour of quality food. The change in per capita consumption of different items in the food basket for the rural and urban people, as estimated by the Household Income and expenditure surveys (HIES) of the BBS, are reported in Table 5.4. It may be noted that the per capita consumption of rice and wheat has been declining, while the consumption of vegetables, fruits and fish and meat has been growing. For rural areas the consumption of rice has declined from 175 kg per person per year in 2000 to 161 kg in 2010, a decline of about 1.4 kg per year. For urban areas, the consumption of rice and wheat together has declined from 144 kg per person per year in 2000 to 140 kg in 2010, a decline 1.5 kg per year. During 2000 to 2010, the consumption of meat and egg has increased by one-third for rural areas and by 35% in urban areas.

Table 5.4 Consumption of different food items (gm/person/day)

Food item	Normal for balanced nutrition	Rural area				Urban area			
		1984	2000	2005	2010	1984	2000	2005	2010
Rice	500	421	479	477	442	351	377	389	343
Wheat	100	65	24	12	38	79	17	28	51
Vegetable	225	140	196	218	221	179	196	228	241
Pulses	30	26	15	13	13	22	19	19	17
Fruits	50	17	26	33	43	21	27	33	50
Fish	45	29	38	40	46	39	41	50	60
Meat & egg	34	10	15	18	20	22	31	31	42
Milk	50	22	29	31	32	34	33	37	39
Total	934	741	899	986	1005	761	841	999	983

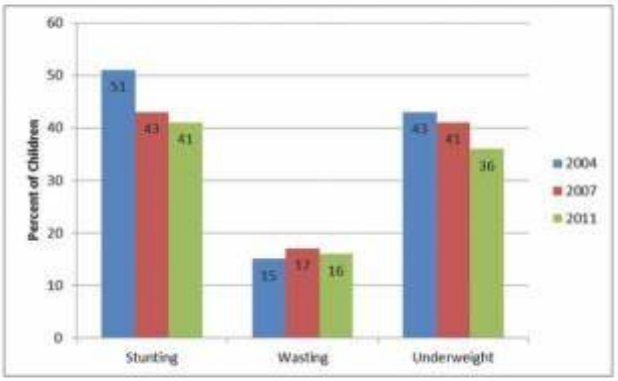
Source: Household Income and Expenditure Survey report of various years, Bangladesh National Nutrition Council for minimum food intake requirement

However, the level of consumption of other food items, hardly meets the requirement for balance diet as specified by the National Nutrition Council and FAO. The numbers in Table 6.4 shows the average level of consumption has reached the adequacy level for rice and vegetable, and about to be reached for fruits and fish, but serious deficiency persists for food such as pulses, oil, and livestock products.

The average numbers also masks serious inequality in the distribution of consumption across the income scale. While the richer sections of the society are being able to gradually reduce their cereal intake and diversify their diet, the poor still have an unmet demand for rice. For all the other food items, consumption for all income groups have increased, marginally for the bottom 40 percent but substantially for the top 20 percent. A recent IFPRI study shows that nearly 20 percent of the population is still calorie deficient and the gender disparity in calorie intake still persists. The 2011 report of the Food Security and Nutrition Surveillance project implemented by the Helen Keller International (HKI) and BRAC University shows that a quarter of the households has to go without a meal a day or to reduce the intake of food a number of days during a month.

Bangladesh has made significant progress in reducing under-nutrition for the children (Figure 5.3). The prevalence on underweight children for their age declined from 60 percent in 1990 to 36 percent in 2011, and is on track for achieving the target set by the Millennium Development Goals (MDGs). However, progress in reducing stunting, the indicator of chronic malnutrition, shows a less encouraging picture. The level is still about 41 percent, much higher than countries in sub-Saharan Africa. Over 2007 to 2011, the stunting declined by only two per cent points. Stunting affects the cognitive ability and the immunity of the children from diseases. The prevalence of wasting, an indicator of current nutritional status, remains at an alarming level of 15 to 17 percent, with very little improvement over time.

Figure 1. Undernutrition in under-5 children in Bangladesh, 2004 to 2007



Source: Bangladesh Demographic and Health Surveys 2011

Figure 5.3 Under-nutrition in under-6 children in Bangladesh, 2004-7

Low birth weight among Bangladeshi infants is among the highest in the world, ranging between 20 and 22 percent. The nutritional status of women shows a better trend. The proportion of women with chronic energy deficiency has declined from 52 percent in 1997 to 25 percent in 2011. But the prevalence of obesity among women is also emerging as a public health issue. The hidden hunger, the insufficiency of vitamin A, iron and zinc in the diet that causes major diseases such diarrhoea and anaemia and poor eye sight is still a major health problem.

Despite tremendous accomplishments in the past, in 2009 nearly half of the Under-5 children were underweight (nearly 8.0 million children). Given the current trend it is unlikely that Bangladesh will reach the MDG (Millennium Development Goals) target of reducing prevalence of the underweight in children by 2015. Based on data from 1990 to 2009, the number of underweight children reduced at the annual rate of 1.0 per cent. To reach MDG target, the number of the underweight children has to reduce at the annual rate of 2.0 per cent from 2009 and onwards.

The underweight rates were more pronounced in rural areas compared to urban areas (BDHS 2007 & HFSNA 2009). By 2005, 40 per cent of the population (60 million) were not obtaining the minimum level of dietary energy of 2122 Kcal. In terms of minimum energy consumption Rajshahi and Barisal divisions are relatively worse off compared to other divisions (HIES 2005, HFSNA 2009). Malnutrition is also severe in the country. More than 90 percent of rural Bangladeshis are not getting enough vitamins A and iron deficiency— which can cause anaemia and the risk of death in childbirth—is also very high, especially for women of reproductive age (BIHS, 2011-2012).

5.4 Analysis of food security by region

Poverty and food insecurity are interlinked. The most startling consequence of widespread poverty in Bangladesh is that about one-fifth of the country's 160 million people cannot afford an adequate diet. The poor do not have sufficient purchasing power to secure their access to food, even when food is available in local markets. Chronically underfed and highly vulnerable, this segment of the population remains largely without assets (other than its own labour power) to cushion lean-season hunger or the crushing blows of illness, flooding, and other calamities. The poor are highly vulnerable to shocks (such as natural disasters or crop failures) that cause sudden losses of real income and, hence, transitory food insecurity. Sudden increases in food prices, such as the surge in 2007–08 and again in 2010–11 also result in transitory food insecurity, particularly for low-income households, by reducing their real income. Family coping strategies (such as the consumption of less food, the withdrawal of children from schools, and the distress sale of productive assets) often aggravate the risks of destitution.

The economic setting presented in this section is the fundamental basis for access to food at the household level. Various factors that can affect a household's access to food in terms of its purchasing capacity are analyzed from the Bangladesh Integrated Household Survey (BIHS) data carried out by IFPRI under PRSSP supported by USAID.

The Figure 5.4 shows that 40.5 percent of the population in the Feed the Future (FTF) zone lived below PPP $1.25 per person per day in 2011–12. While 38.2 percent of the population in rural Bangladesh was living below the poverty threshold, there are pronounced regional differences in the incidence of poverty. The rate varies widely across divisions, ranging from a low of 31.0 percent in Chittagong division to as high as 65.5 percent in Rangpur division. Although Rajshahi division ranks second highest, the poverty incidence in this division is 23.1 percentage points lower than that in Rangpur division.

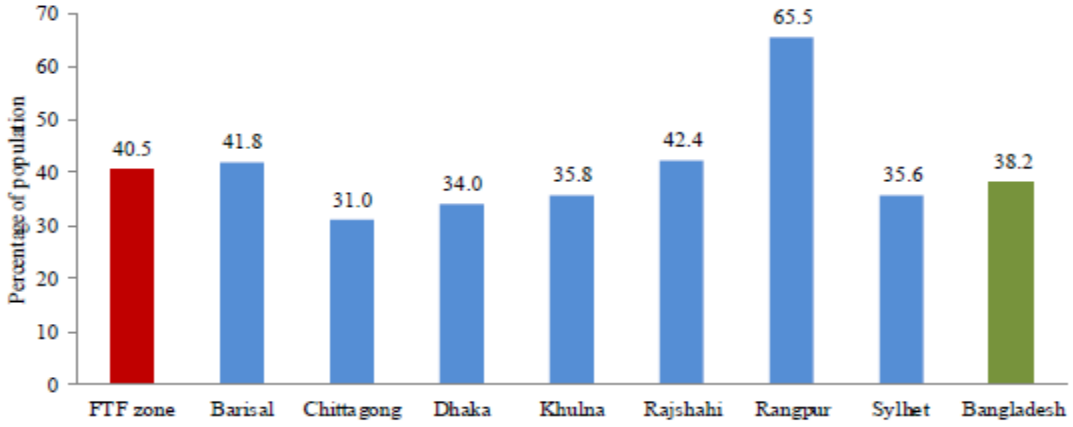


Figure 5.4 Percentage of people living on less than PPP $1.25/day

Figure 5.5 provides the estimates of consumption expenditures per person per month. At the rural level across all districts, average monthly per capita expenditure was Tk 2,692 at 2011–12 current prices, which was only 1.2 percent higher than the estimate for the FTF sample of households at Tk 2,660 per person per month.

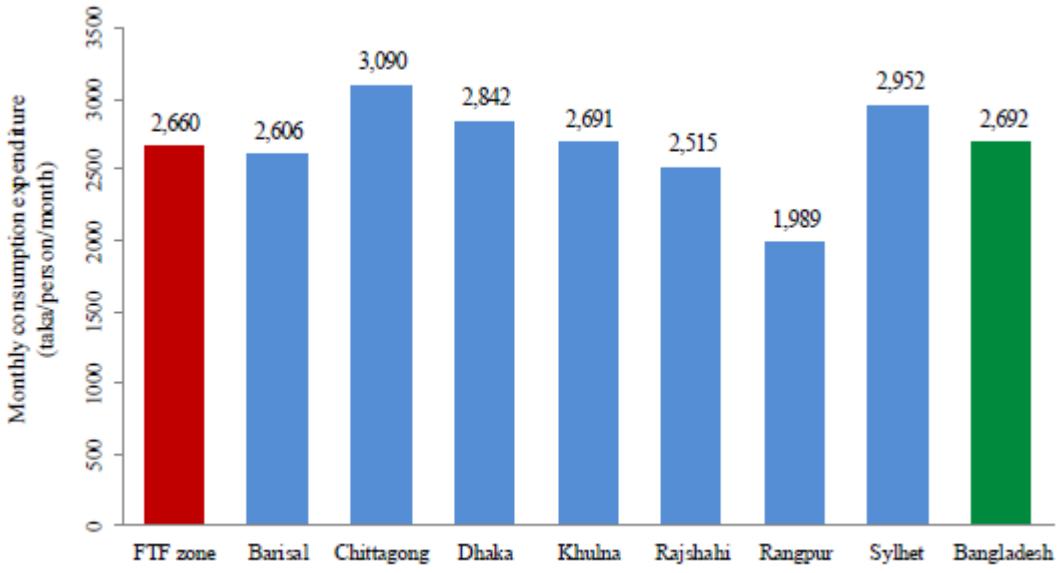


Figure 5.5 Monthly per capita consumption expenditures

The highest average monthly per capita expenditure was Tk 3,090 in Chittagong division, followed by Tk 2,952 in Sylhet division. The lowest average monthly per capita expenditure was Tk 1,989 in Rangpur division, which was about 26 percent lower than the rural average across all districts.

Tables 5.5 and 5.6 present the patterns of income distribution in the FTF zone and in entire rural Bangladesh, respectively. The figures in Table 5.1 indicate that while the richest 10 percent of the population in the FTF zone earned 22.7 percent of all income, the poorest 10 percent earned only 4.3 percent of the total income. The distribution of income at the rural level across all districts shows a similar pattern: the poorest 10 percent of the population earned 4.2 percent of total income in rural Bangladesh, while the richest 10 percent earned 23.2 percent of all income (Table 5.6).

Table 5.5 Distribution of per capita income: Feed the Future zone

Per capita expenditure group	Average per capita expenditure	Share of total expenditure in each group
(taka/month)	(percent)	
1 (poorest)	1,019	1.91
2	1,275	2.39
3	1,411	2.65
4	1,536	2.88
5	1,650	3.10
6	1,747	3.28
7	1,863	3.50
8	1,975	3.71
9	2,096	3.93
10	2,212	4.15
11	2,349	4.41
12	2,484	4.66
13	2,641	4.96
14	2,834	5.32
15	3,049	5.72
16	3,303	6.20
17	3,626	6.81
18	4,123	7.74
19	4,805	9.02
20 (richest)	7,283	13.67
All households	2,660	100.00

Table 5.6 Distribution of per capita income: Rural Bangladesh

Per capita expenditure group	Average per capita expenditure	Share of total expenditure in each group
(taka/month)	(percent)	
1 (poorest)	1,015	1.85
2	1,275	2.32
3	1,440	2.62
4	1,566	2.85
5	1,671	3.04
6	1,781	3.24
7	1,893	3.45
8	2,016	3.67
9	2,140	3.89
10	2,268	4.12
11	2,412	4.39

Per capita expenditure group	Average per capita expenditure	Share of total expenditure in each group
12	2,566	4.66
13	2,734	4.97
14	2,916	5.32
15	3,137	5.70
16	3,386	6.16
17	3,749	6.82
18	4,263	7.75
19	5,062	9.20
20 (richest)	7,675	13.96
All households	2,692	100.00

Source: BIHS

The most widely used summary measure of inequality is the Gini coefficient. The estimated Gini coefficients for income distribution are 0.284 for the FTF zone and 0.307 for rural Bangladesh (Figure 5.6). The inequality in income distribution is the highest in Sylhet division (0.319) and the lowest in Rangpur division (0.273).

Comparisons among estimates presented in Figures 5.4, 5.5, and 5.6 indicate that the incidence of poverty (termed as the family welfare indicator) and inequality in income distribution are negatively correlated across regions, whereas there is a positive relationship between average income and income inequality.

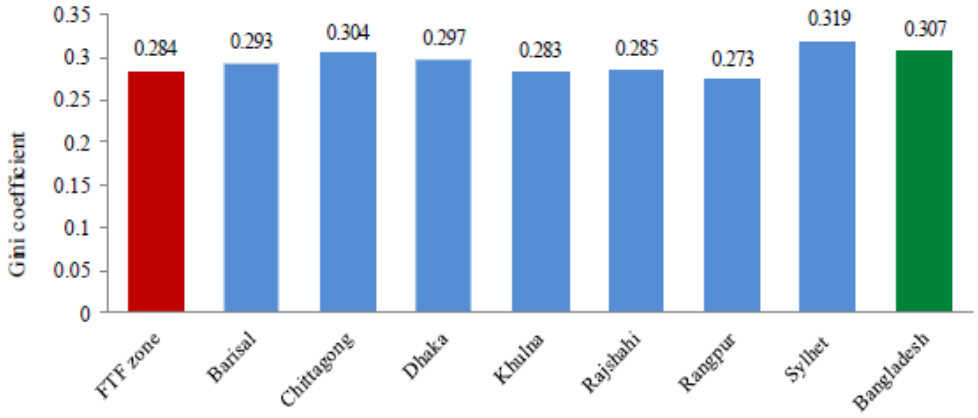


Figure 5.6 Gini coefficients for income inequality, by region

The **labour force participation rate** for all household members age 15 and above is about 73 percent both in the FTF zone and in rural Bangladesh. However, there are considerable differences in labour force participation rates in terms of males and females. In the FTF zone, the overall labour force participation rate for males is 86 percent, while for females, it is 61 percent. The rates are 87 percent for males and 60 percent for females in rural Bangladesh as a whole. The labour force participation rate is the highest for the poorest income group, the rate declines as household income increases, and this relationship is more pronounced for males.

Rural Bangladesh is predominantly an agrarian society with low rates of employment in the nonfarm sector. Farming is by far the main source of employment, with 71 percent of the total labour force in the FTF zone and 66 percent in entire rural Bangladesh engaged in farming. Wage labour (agricultural and non-agricultural) is negatively correlated with household income—12 percent of the labour force in the FTF zone and at the rural level belong to the lowest income quintile, and only 1.5 percent and 1 percent of the labour force in the FTF zone and in rural Bangladesh,

respectively, are in the highest income quintile. In contrast, business and trade and salaried work are positively correlated with income.

Agricultural Wage: The level of agricultural wage has a large bearing on the incidence of poverty and food insecurity. Agricultural wages have increased quite sharply in recent years, enabling the rural poorest to improve their livelihoods significantly (Zhang et al. 2013).

Figure 6.7 shows the pattern of daily agricultural wages in the FTF zone and across divisions in rural Bangladesh. Wages represent average wage received by a worker in seven days prior to the survey date. The wages were estimated by adding cash wages to the value of in-kind (usually food) wage, if any. The average daily wage was Tk 220.3 for males and Tk 199.9 for females in the FTF zone. The daily wage rate at the rural level for males (Tk 222.5) was 16.0 percent higher than the rate for females (Tk 191.8). The gender gap in wage rates was biggest in Barisal division—the male wage was 31.4 percent higher than the female wage, and smallest in Rangpur division—the male wage was only 3.8 percent higher than the female wage. The agricultural wages for both males and females were the highest in Chittagong division. The lowest wage for males was recorded in Rangpur division, and for females in Rajshahi division.

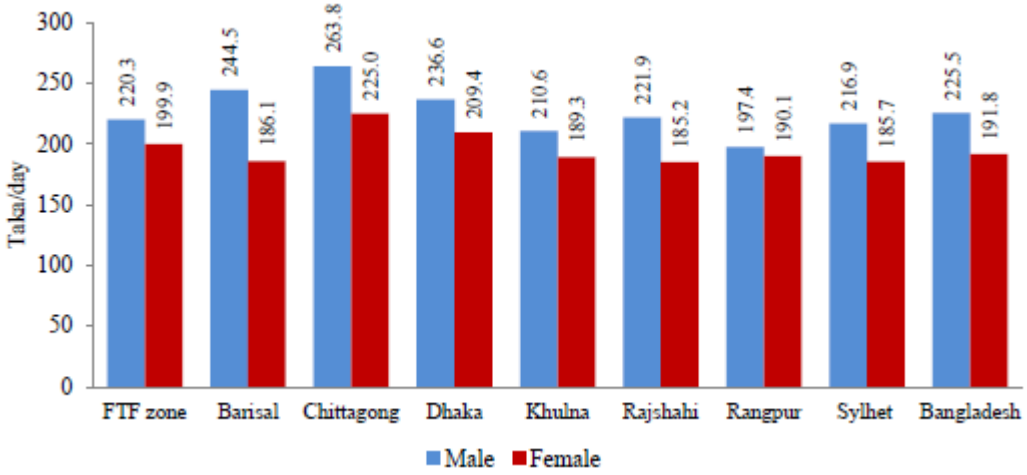


Figure 5.7 Average daily wage rates of agricultural labourers, by region

Figure 5.8 shows the amount of rice (in kilograms) that could be purchased by one day's wage for males and females across regions. The BIHS data suggest that on average, a rural household with 4.7 members consumes 2.33 kilograms of rice per day (average daily per capita rice consumption is 495.5 grams). The average daily agricultural wage for a male worker in rural Bangladesh during the survey could buy 7.6 kilograms of rice, which is 3.3 times higher than the rice consumption of an average rural household.

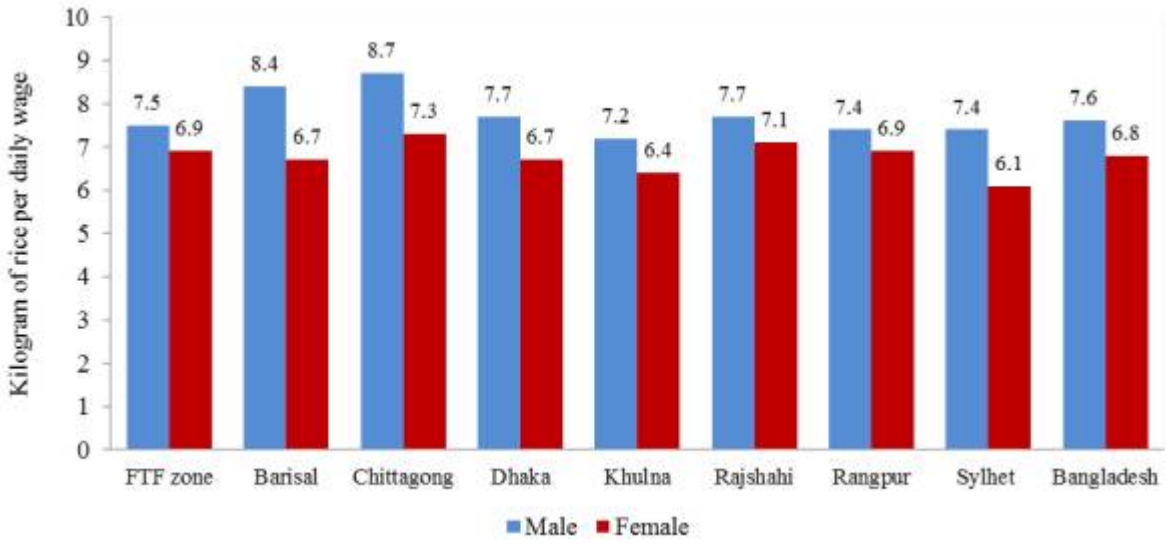


Figure 5.8 Kilograms of rice that could be bought by daily agricultural wage, by region

5.5 Food security implications in the long term planning

Around 90 per cent of the rural population of Bangladesh is directly involved in agriculture and around 43.6 per cent of the total labour force is engaged in agricultural activities. For increasing food production and attaining food sufficiency a sustainable growth of the agricultural sector is required. However, it would be a great challenge to attain food security while maintaining sustainable agriculture practices. Moreover, decreasing arable agricultural land, together with increasing population and changing climatic conditions, make this challenge more formidable.

The recent global food price inflation illustrates the critical importance of ensuring food security for a large poor country like Bangladesh. Past progress in rice production suggests that Bangladesh has the capacity to achieve food security through domestic production. Indeed, with proper incentives, there is scope for food exports also.

The emphasis on productivity improvements will be particularly helpful in reconciling food security objectives with farmer incentives. In case of food production, climate change adaptation strategy in the agriculture sector needs to be prioritised to address the global food insecurity susceptibility due to climate change.

6 Development impediments in the agro-ecologically depressed regions

6.1 Coastal region

Coastal region, Haor and CHT have some special type of bio-physical constraints. These regions have been identified as disadvantaged regions in terms of poverty, food insecurity, environmental vulnerability and limited livelihood opportunities. Table 6.1 presents salient features of coastal zone of Bangladesh.

Table 6.1 Salient features of coastal zone of Bangladesh

Coastal Zone: Salient features*	
Area	47,201 Sq km (32% of country total)
Number of districts	19 (in parts or in full) 12 in exposed coastal zone that meets the coast;
Number of upazilas	147 (48 in exposed coastal zone)
Population (S-SW)	36.8 million (2001); 41.3 million (2010); 60.8 million (2050)
Main AEZ regions	13 (GTF): Satkhira, Khulna, Bagerhat, Barisal, Pirojpur, Jhalakati; Patuakhali, Barguna; 18 (YMEF): Bhola, Lakshmipur, Noakhali, Feni, part of Barisal; (AEZ region 23 (CCP) – Chittagong, Cox's Bazar – is excluded; but additionally Gopalganj, Kushtia, Jessore and other adjacent areas are considered as relevant and interlinked)
Embankments	5017 km

In the southern region, 15 percent of total cultivable land is either fallow and/or not under productive use. Major physical factors responsible for land being not used intensively are soil salinity, water salinity, subsidence and water logging.

Polders are major interventions in the southern region with protective structures that provide benefits to the production systems and livelihoods. The polders of the southern region are edge-old and facing following problems:

- ***Siltation***: Due to empoldering, natural inundation outside the polders has been obstructed by embankments resulting in higher elevation of land outside the polder and no siltation inside.
- ***Drainage***: Because of siltation of outfall channels, channels within polders have significantly lost drainage capability resulting in water logging. The problem has been compounded by siltation of internal drainage channels.
- ***Water logging***: Because of land accretion, particularly in the Meghna estuary, many rivers and *khals* (drainage canals) have been silted up. Onrush of upstream flow and prolonged rainfall often cause water logging. This problem has been aggravated by empoldering.
- ***Salinity***: Though soil salinity declines in the long run because of empoldering, problem recurs because of erosion and embankment failure (breaches or overtopping by storm surge).
- ***Land use conflict***: Shrimp farmers bring saline water inside the polder by cutting embankment or using LLP. This affects salinity balance inside the polder and causes damage to crops in surrounding fields. Competing land use often results in confrontation and violence and thereby affects the social fabric. Polders have not been

designed for the multi-functional land use and the BWDB has no mechanism how to deal with land use conflicts.

Vulnerability of polders

- Many polders are in dilapidated conditions in terms of breach and slip in the embankment, erosion, neglect in repair works, drainage congestion because of siltation and encroachment of canals and, above all, location in the risk zone.
- Water control structures in many places are damaged or non-functional.
- BWDB has categorized that out of 158 polders 51 are "most vulnerable" and another 55 polders as "medium vulnerable". To cope with vulnerability, it is necessary to rehabilitate damaged infrastructures of the polders

Major Constraints of Coastal region

- Extreme environmental events and high vulnerability to climate change
- Low agricultural productivity, poor land use and low cropping intensity
- Low productivity of Rabi crops and little high value crops cultivation
- Predominance of small and landless farmers
- Intrusion of saline water, water logging and occasional breaches of embankment
- Higher rates of poverty and malnutrition

Strategies for development of agriculture and livelihoods of Coastal region

The Master Plan included a set of strategic programs and activities for development of agriculture and livelihoods of coastal region. Based on field study, regional consultations and interaction with various stakeholders, a list of interventions have been identified under 26 programs across 10 thematic areas as follows:

- Crops, horticulture & agro-forestry
- Fisheries
- Livestock
- Nutrition
- Water management
- Polder management
- Drainage improvement
- Agri-business
- Agricultural credit
- Capacity building

Total investment need is estimated at 578,026 million taka (57,802.6 crore taka), which is equivalent to about US$ 7,225 million. Component wise investment need has been presented in Figure 6.1.

Among the interventions, 24 have been marked as 'Top' priority, which account for 258,673 million BDT while 37 are identified as 'High' priority that would require 265,955 million BDT

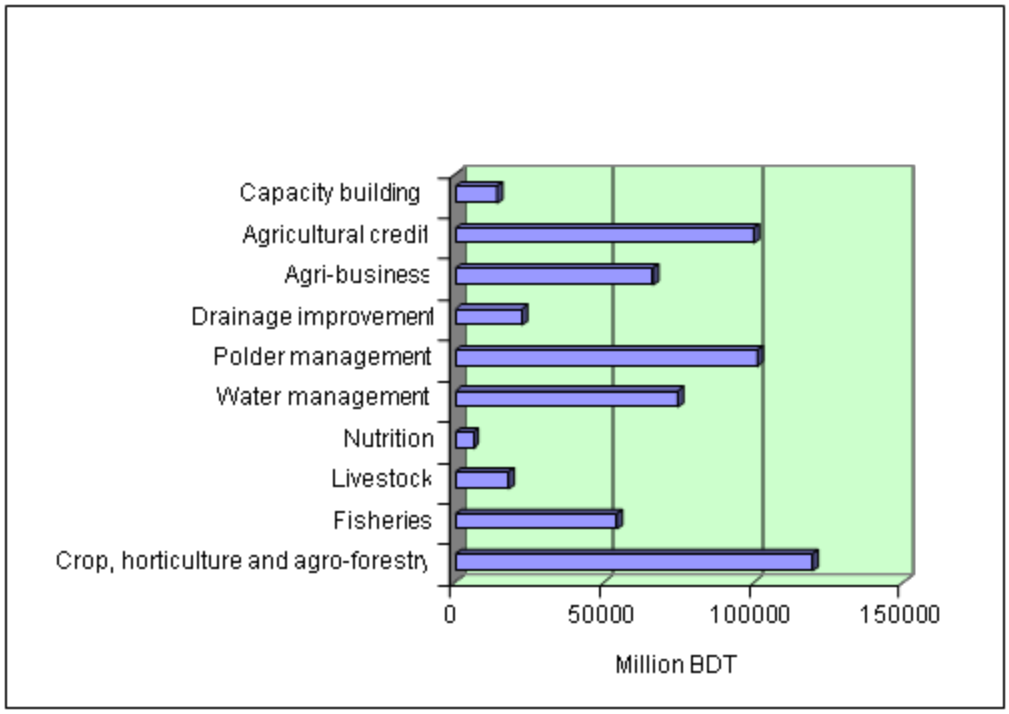


Figure 6.1 Investment need for implementation of master plan

6.2 Chittagong Hill Tract (CHT)

The CHT represents 9 percent of the landmass divided in three districts consisting of 25 Upazillas with one percent population of the country. According to the Population and Housing Census 2011, the CHT region has a total area of 13,295 km^2, 342,390 households and about 1.7 million people. Population density per km^2 is lower in the CHT (120) compared to Bangladesh (1015). CHT is the home of a large number of small ethnic communities.

Land has been a common access resource for local communities. They operate on land for agricultural purposes with customary rights obtained through an ages-old traditional system. Majority of farms are of small size, less than one hectare each. Only seven percent of holdings are 'large' (being three hectares or above). Small farms are more concentrated in Khagrachhari district, while medium and large farms are more prevalent in Bandarban and Rangamati.

The incidence of poverty is high in the CHT. About half of the population or more are poor. The income per household member in the CHT is about two thirds the income of rural Bangladesh and the percentage of main income earners that rely on manual labour, 43%, is almost twice as high as rural Bangladesh.

Land and Water are the two critical resources for sustaining agriculture productivity. In the CHT lands are at different elevations, Rangamati and Khagracchari are relatively low-lying. Land in Bandarban covers a wide range of elevation. Elevation is a key factor in determining crop suitability and seasonality based on agro-ecological considerations. Because of the predominance of hilly terrains with steep slopes, most of the land is not suitable for 'plough agriculture'.

Large number of Watersheds exist in the region. The main source of surface water is rainfall and accumulated waters in streams, *chharas*, and lakes. Khagrachhari district has been delineated into 119 watersheds. Rangamati has 273 watersheds, while Bandarban has 267 watersheds. Total length of *chharas* connected to the rivers and spreading

over the CHT region is more than 7,200 km. These *chharas* are steep and so they cannot hold water for long. About 862 km of *khals* connected to *chharas* and rivers flow during the wet season.

Most of the rivers, *chharas* and *khals* dry up in the winter due to deforestation, non-scientific crop cultivation in the upland areas causing soil erosion and consequent siltation of the rivers, *chharas* and *khals*. The *Kaptai Lake* is also endangered due to siltation problem. The deforestation in all three districts is taking place at a very fast rate. Dense forest coverage has reduced by 61% in the last five years and the rate is also high for medium dense forests. In total 659 watersheds have been delineated in the CHT, 119 in Khagrachhari district, 273 in Rangamati district and 267 in Bandarban district. Very limited surface water level stations are available in the CHT.

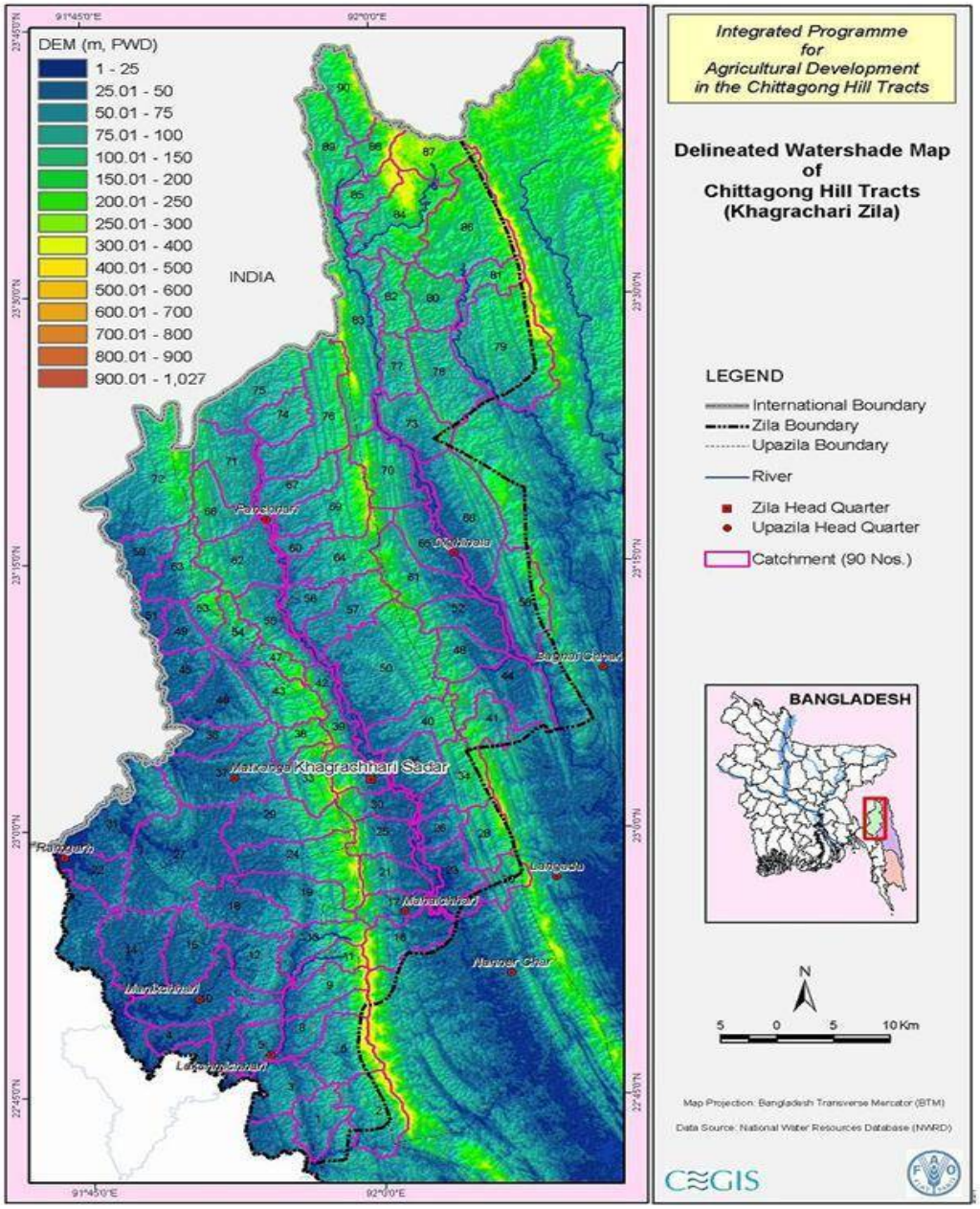


Figure 6.2 Watershed of CHT

Major Livelihoods Practices are farming, fishing, livestock rearing and trading. Less than one-fifth of the total valley land area (270,812 ha) is currently under irrigation. Rice is the main crop grown in this land area. Some HYV rice varieties are grown in the floodplains. Besides rice, maize, mustard, chili, winter vegetables and potato are also grown. Jum is a prominent indigenous farming practice and 6.5% of the farmers depend on jum farming system. The number of *jum* farmers was 7,832 in 1980; it is now estimated at 22,413, although numbers have fallen recently. An average *jum* cycle was 12-15 years to allow sufficient regeneration of natural resources during the interval. In 1961, after the construction of the *Kaptai Dam*, the *jum* cycle was shortened to 3-5 years. At present the average is 2-3 years.

Main crops grown in the *jum* are rice, maize, millet, sesame, cucumber, pumpkin, ash gourd, melon, chili cowpea, turmeric, flowers and medicinal herbs. Sugarcane, cotton and tobacco are important cash crops in the CHT. However, cotton cultivation has declined in comparison to the past. Sugarcane cultivation has slowly increased because of market demand and the advent of HYV species of chewing variety. Tobacco cultivation is increasing and has made inroads in some of the remote areas.

Commercial fruit gardens are mainly concentrated on banana, papaya, lemon, pineapple, mango, orange, cashew nut and jackfruit But a number of other fruit crops are grown in scattered areas. Farmers hardly follow recommendations on plant spacing, proper application of different fertilizers and other cultural practices. As a result, yields are relatively low and much of the potential remains unexploited.

Major constraints of CHT

- Natural resource degradation – soil erosion and siltation of water bodies; reduced soil fertility; and biodiversity loss
- An under-developed sector for the provision of essential inputs and extension (seed, fertilizer, credit)
- Scarcity of adaptive research, on-farm trials and demonstrations, leading to low knowledge of CHT-specific conditions and absence of innovative practices.
- Limited access to markets, and opportunities for agro-processing
- Low productivity, and missed opportunities for diversification (and associated benefits to nutrition), due in part to poor access to improved inputs, and/or to new adapted technologies
- Poor technical capacity of stakeholders and a lack of technical coordination
- Disjointed and/or overlapping programmes, without consistent guiding principles on the part of government and development partners.

Strategies for development of agriculture and livelihoods of CHT (prepared by MoA and FAO in 2013)

Enhancing productivity

Improved access to low lift pumps (LLP) for irrigation and the utilization of surface water should be the subject of a major investment programme, as it is in other areas of the country (cf Country Investment Plan for Agriculture, Food Security and Nutrition, Ministry of Food, 2010).

A centre under the CHT Regional Council should be established for both in situ and ex-situ conservation of genetic resources – this will require at least 100 ha of land with necessary laboratory and other physical facilities.

More sustainable adapted and improved *jum* practices

Adopting such measures on a large scale will require local strategies, a major awareness raising campaign, and targeted skills development programmes such as specialist farmer field schools

Up-scaling of technology and sustainable input supply

A programme of local adaptive research is needed, to build better bridges between research and local initiatives such as farmers' field schools, supported by a network of extension staff, locally-based scientists and farmer field school facilitators. Programmes and incentives are needed to develop the agro-inputs sector.

Marketing and value chain development

HDC, LGED, DAM and AIS need to promote development of market infrastructure (market sheds, storage infrastructure, sanitary facilities, etc) construction of link roads, improvement of transportation and market information systems. SME and household based agro-processing need to be promoted by CHTDB, HDC and BSCIC and line departments.

6.3 Haor region

Haors are located in the north-eastern region of Bangladesh. It has a total area of 8,000 km^2. There are 373 Haors with a gross land area of 1.99 million ha, net cultivated land 1.33 million ha, 16% of total rice land of Bangladesh. Total population of Haor area is 20 million with rich ecosystems and bio-diversity. People in the region are poorer than in any other part of the country, More than 28% of the people are below the Lower Poverty Line (LPL).

Major Constraints of Haor

- Degradation of natural resources and biodiversity
- Natural disasters are the main reason of poverty, lack of availability of basic infrastructure and social amenities, inequity in resources acquisition and poor access to natural resources.
- Crop damage by flash flood
- Declining productivity of crops
- Poor Market linkage and value addition

Strategies for development of agriculture and livelihoods of Haor

The master plan strategy for development of Haor region includes the following (Master Plan for Development of Haor Region, 2012):

1, Improved water and disaster management

2. Agricultural development for food security

3. Biodiversity enhancement and wet land management

4. Social safety nets and improvement of living

5. Improved physical infrastructure and

6. Enterprise and technology development

7 Challenges

The following section outlines the major challenges related to agriculture and food security in Bangladesh.

7.1 Curse of poverty, food insecurity and malnutrition

Despite its transformation from a country of chronic food shortages to one of food self-sufficiency, Bangladesh still faces food-security challenges. Almost 40 percent of people in rural Bangladesh live on less than $1.25 per day and 60 percent of that income is spent on food. In rural Bangladesh, 66 percent of the labour force makes their living in farming, and the vast majority of the farmers (81 percent) farm less than one and a half acres (Bangladesh Integrated Household Survey (2011-12)

Bangladesh has a population of approximately 165 million and is growing at a rate of 1.6%. The Bangladesh economy faces much pressure to feed increased numbers of people. Despite poverty reduction over the last two decades, absolute number are still high. About 50 million people, or 31.5% of total population, are still poor, with one-fourth caught in hard-core or extreme poverty. Regional and gender-based differences are also a grave concern, as are time-bound vulnerabilities caused by fluctuations in weather throughout the year. Certain section of people also tend to suffer more from poverty, malnutrition and food insecurity, including women, children, elderly, the disabled and remote rural dwellers.

7.2 Degradation of natural recourses

The growing population places stress on limited natural resources. Cropped land is declining at the rate of about 1% per year. On average, Bangladesh is losing good quality agricultural land by approximately 80,000 ha annually due to urbanization, building of new infrastructure such as roads and implementation of other development projects. In addition, degradation is due to soil erosion, river erosion, soil fertility decline, depletion of soil organic matter, water logging, soil salinity, pan formation, acidification and deforestation.

Water erosion accounts for about 40 percent of land degradation due to washing away of topsoil and depositing sand on the croplands from upstream. Riverbank erosion and siltation are chronic concerns for Bangladesh. About 1,200 kilometers of riverbank are eroding and more than 5000 kilometers river banks face erosion-related problems in the country. The major rivers such as the Jamuna, Ganges and Padma consume several thousand hectares of floodplain making thousands of people landless and homeless every year. During the last three decades the Jamuna, Ganges and Padma rivers have consumed about 180,000 ha. (BWDB 2009). This amount excludes the annual erosion along the other major rivers and also in the Meghna estuary where the amount of erosion is very high. From the 1970s to early the 1990s, the extent of mean annual erosion was about 3,300 hectares along both banks of the Jamuna River only. The Flood Action Plan, Bangladesh predicts a net erosion loss in the Brahmaputra-Jamuna basin of 34,120 hectares of "mainland" acreage for the period 1992-2011, an area similar to what had eroded in the 12 years previous to that time (MPO 1987). Similar rates of net loss in land due to erosion are expected in the other three main rivers. The river bank erosion is expected to increase further with the rise of water flow in the rivers due to global temperature rise and increased ice melting in the Himalayas. Given the geo-morphological development of the rivers and the prevailing socio-economic context of Bangladesh, it would not be feasible to protect the riverbank erosion fully. Non-structural measures, such as prediction of erosion when and where applicable and educating people how to mitigate could be alternatives to minimize the suffering of the people.

In the last three decades, for instance, 170,000 ha area of agriculture land has been affected by increased salinity. Soil fertility decline is occurring in Bangladesh due to unbalanced use of fertilizer, intensification of crop cultivation without appropriate techniques for sustainable natural resources management, and the advance of mono-culture rice without rotation. Cultivation practices in CHT have led to top soil loss.

The major rivers passing through Bangladesh deposit sediment on the flood plains, gradually changing their topography and creating the phenomenon of *Charlands,* which tend to have lower agricultural productivity due to soil quality, and are subject to further erosion and frequent flood damage. Linked to the high levels of siltation affect irrigation and drainage systems; water logging can also be a severe problem. Over exploitation of groundwater has also led to arsenic contamination of tube wells and groundwater sources. Within 59 districts of the country where about 1.44 million tube wells have been affected and people are exposed to arsenic toxicity.[3]

[3] FAO, UNICEF, WB & WHO, *Towards an Arsenic-Safe Environment in Bangladesh* (Dhaka, Bangladesh, March 2010), http://www.unicef.org/bangladesh/Towards_an_arsenic_safe_environ_report_22Mar2010.pdf.

Forest area amounts to about 11% of the total land area, but barely half of that is actual tree covered. High degradation of forested land is occurring in Bangladesh, largely due to population encroachment and crop/horticultural farming; illegal logging practices are also to blame (particularly in the CHT). In addition, the output of forests in Bangladesh is one of the lowest in the world. Productivity is low due poor management practices, low initial survival, incompatible species composition, low soil efficiency, etc. Better management practices, even at community level, are necessary in this regard.

7.3 Low agricultural productivity and limited modernization and/or diversification

The agriculture sector in Bangladesh is characterized by a fragmentation of farm structure: 80% of farmers are marginal and small (0.02 to 1.0 ha of land). Decreasing farm sizes, inefficient use of limited water resources, degradation of soil quality and failure to adopt known modern technologies and practices are behind the phenomenon of low productivity. Indeed, there is a wide gap between farm yields and experimental stations. This is true across all sub-sectors. The yield gaps even in the favourable agri-ecological regions often exceed 40% of the farmer's achievable yields with good practices.

7.4 Weak research extension linkage and technology delivery

While many improvements in management practices are theoretically possible, the National Mainstream Extension Approach of DAE, DLS and DOF does not have the capacity to cope with the emerging challenges in each sector on the scale needed. Equally, research scientists are only slowly adjusting the research agenda to meet the needs of farmers and producers. Despite a long history of Farmer Field Schools in the country there is a very limited amount of "action" or "adaptive" research being practiced

7.5 High post-harvest losses

There is large post-harvest loss around 20% in rice and 30% in vegetables and fruits (Table 7.1). There is also a substantial scope to increase agricultural production by reducing post-harvest losses, by increasing the shelf life of perishable commodities and by adding value through agro-processing of agricultural commodities into finished or semi-finished products, packaging in appropriate containers, proper storage and exports. The food processing industry in Bangladesh is growing. The policy, institutional and infrastructure barriers to agribusiness, agro-processing and supply chain need to be removed in order to provide a "big push" to agriculture and rural development. The production and processing of these products is also labour intensive and, therefore, is likely to have a significant favourable impact for generating additional employment in the rural areas.

Table 7.1 Post-harvest losses of major corps in Bangladesh

Sl No.	Food crops	Production (million tons)	Loss (%)	Total losses (million tons)	Cost (Tk/kg)	Total loss (million Tk)
1	Rice	29.75	12	3.57	8.00	28560
2	Wheat	0.77	13	0.10	8.00	8000
3	Maize	0.78	13	0.05	5.00	475
4	Pulse	0.56	15	0.08	25.0	2075
5	Oil seeds	0.55	15	0.082	20.0	1640
6	Spices	1.46	15	0.22	10.0	2200
7	Vegetables	8.75	30	2.62	4.00	10492
8	Fruits	7.88	25	1.97	9.00	17721
9	Potato	5.37	20	1.07	8.00	8592
10	Sweet potato	0.72	20	0.15	3.00	435
11	Sugarcane	3.51	20	0.70	2.00	1404
	Total	60.1		10.61		81594

Source: NMTPF, 2010.

7.6 Problems of market linkages and value chains

The lack of organized markets for selling farm produce is a significant problem for Bangladesh. The salient features of agricultural product markets are poor infrastructure, with lack of storage and processing facilities, poor roads and communication system, unfair practices of middlemen, etc. The marginal and small farmers are often facing problem of marketing their products and are not getting fair price due to existence of trade syndicates. Additionally, in some localities such as coastal areas and CHT, the limitations of infrastructure make access to markets difficult. The rate of post-harvest loss is quite high in such cases, estimated country-wide at around 12% in rice and 25% in vegetables and fruits.

Furthermore, agri-business and agro-processing activities are extremely restricted, which severely impedes the country's post-production potential. Value addition and supply chain investments including processing, packaging, storage and transportation at the local and national levels are a priority. In addition, efforts need to be made to ensure that products abide by certain quality attributes. Several issues including policy environment, such as product standardization, food safety, sanitary and phyto-sanitary measures need greater investment to increase the quality of produce and potentially the volume of exports.

In Bangladesh, small, medium, and even large farmers are vulnerable to the exercise and influence of market power by rural traders, wholesalers, retailers, and processors. These petty traders are poorly rewarded for their efforts and the risks they take in an environment of inadequate quality control, gross returns as well as increasing product wastage. Formation of farmers' groups is one possible way to create better market linkages and ensure fairer competition in prices and curb exploitation of middlemen.

7.7 Scarcity of availability of agriculture labour

The share of agricultural sector in informal economic activity in Bangladesh however, is very high (Sixth Five Year Plan, 2011). The contribution of labour in agricultural sector is decreasing over the years (Figure 8.1). The participation rate of labour force in agricultural sector increased between 1999-2000 and 2002-2003 with a rate of 0.4 percent but since then it has decreased.

Household panel data collected from 62 villages showed that adult male participation in agriculture has sharply declined from 83% in 1988 to 56% in 2000, a decrease by 27%; this has however, increased to some extent to a level of 65% in 2008. Participation of women in agriculture on the other hand remained almost the same in 1988 and 2000

(59% and 58% respectively); but compared to 2000, in 2008 women participation has increased by about 8%. Findings indicated that decrease in agricultural activities by adult male was due to less involvement in crop cultivation in recent years. About 79% adult males were engaged in crop cultivation in 1988 which has dropped to only about 42% in the year 2000; however, there had been some increase in male participation in crop cultivation in 2008 (53%).

This transformation of agricultural labour is found due to productive and well paid job situation mainly in the organized manufacturing and services sector. As a result scarcity of agricultural labour during peak season is increasing. The government made a commitment to reduce the percentage of labour force engaged in agricultural sector to 30 percent by 2021. Based upon historical trend the labour force engaged in agriculture has decreased to 47.3 percent in 2010 from 51.3 percent in 1999-2000. If this trend continues, the contribution of labour in agriculture might decrease to 39.55 percent by 2021, which is higher by 9.55 percent compared to the target of the government.

In Bangladesh, being a traditional Muslim society, women's participation in economic activities in general and in agriculture in particular has remained low. But recent Labour Force Surveys conducted by the Bangladesh Bureau of Statistics show rapidly increasing participation of women in economic activities. The progress is attributed to poverty, empowerment of women by NGOs, and migration of male members from agriculture to non-farm occupation. With the absence of male members, women's role is changing from unpaid family worker to farm managers.

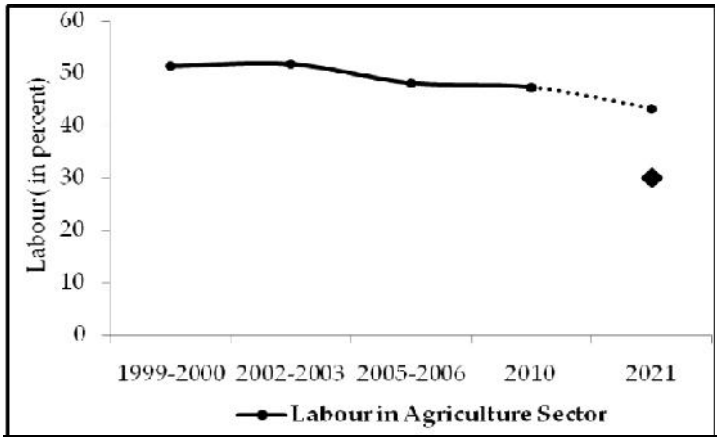


Figure 7.1 Labour employed in agriculture sector

Source: Labour Force Survey (1999-2000, 2002-2003, 2005-2006 and 2010),

Bangladesh Bureau of Statistics (2002, 2004, 2008 and 2011a)

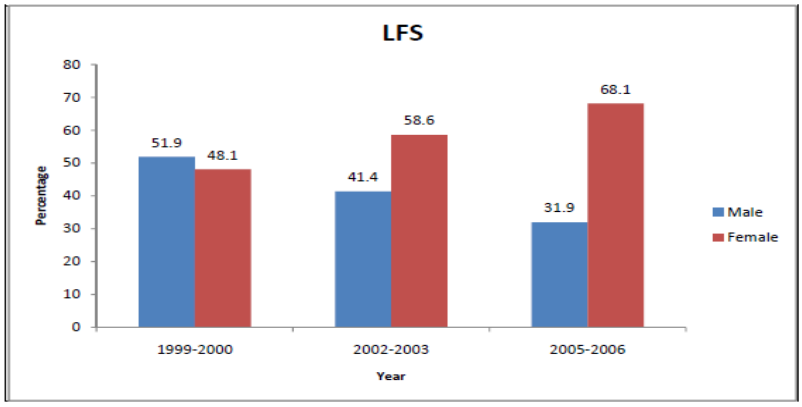


Figure 7.2 Percentage of adult male and female participation in Bangladesh agriculture overtime

Source: Labour Force Survey (LFS) 1999-2000, 2002-2003 and 2005-2006.

7.8 Farm mechanization

Modernization in Bangladesh agricultural sector is going on with the increased use of power tillers, irrigation equipment's, threshers, drum seeders, maize shellers, rice milling machine, improved storage, cool-chain and transportation, etc. Farm machinery, such as, weeders, threshers, winnowers, centrifugal pumps etc. are developed and manufactured locally with locally available materials. Manually operated weeders and sprayers are used widely. A few hundred pedal and power operated winnowers are also being used in the country (Roy and Singh, 2008). It was found that farm mechanization promoted commercial farming and helped in reducing post-harvest losses. Post-harvest loss in agriculture amounts to over US$ 4000 million a year. Proper grading, packing, pre-cooling, refrigerated storage and transportation can reduce these losses and maintain the quality. Mechanization in the country is associated with some inherent drawbacks like, fragmented lands, poor buying capacity of farmers, lack of quality machines for farm operation, inadequate knowledge of the users about machines and insufficient awareness building activities. For the modernization of the agricultural sector, support is needed on skill development of researchers, capacity building of manufacturers, formulation of agricultural mechanization policies, support to the formation of farmers' groups, review and rationalization of current tariff rates and expand credit facilities for farm mechanization.

7.9 Food quality and safety problem

Bangladesh faces significant problems with food contamination through poor handling practices, and deliberate adulteration for purpose of fraud (extension of shelf life, passing off cheaper ingredients as expensive ones, etc.). Not only does this impact the health of the population, but it also affects the exportability of Bangladeshi agricultural produce. The challenge is how to create a satisfactory food control system backed by inspections and improved practices among food producers and handlers, as well as building awareness of consumers.

7.10 Inadequate institutional credit

While demand for credit is increasing with the advent of new technologies and high value crops, the supply side has remained less vibrant. Volume of institutional credit is conspicuously low and the proportion of the public sector in the total volume of institutional credit is even smaller. According to data of Bangladesh Bank, around 25 percent total disbursement of rural credit is delivered by the public sector.

The remaining 75% has been delivered by micro-finance institutions (MFI) including NGOs and the Grameen Bank. However, the demand for credit is much more than what is met by non-institutional sources. In a case study conducted under the preparation of the Master Plan for agricultural development of the Southern region it is roughly estimated that around 80 percent of the volume of credit comes from various non-institutional sources largely dominated by mohajans and dadanders (Figure 7.3). They charge interest on loan at exorbitant rates, generally 10 percent per month.

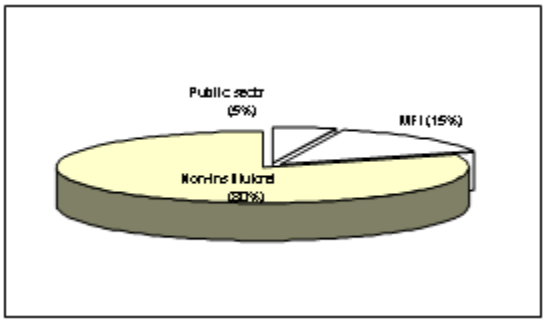


Figure 7.3 Supply of rural credit in the Southern region

Loan conditionality of *dadanders* is quite stringent, as they lend money with the guarantee of repayment in the form of products whose price is fixed unilaterally by them in advance. Advance sale of labour in crop fields in exchange of loan (cash or rice) is also common.

Specialized banks, like the *Krishi Bank*, are a major source of agricultural credit. Two-thirds of the credit from public sector agencies is from specialized banks (Planning Commission, 2011). As of July 2010, there were 527 NGOs registered by the Microfinance Regulatory Authority (MRA). The *Grameen Bank*, however, operates as a quasi-NGO specialized bank outside the orbit of the MRA. They usually cover the landless and poor women who are categorized as "non-farm" households (defined as those who own less than 0.05 acre of land). Average amount of microcredit from MFI sources has been Tk 7,144 (Planning Commission, 2011). Amount of credit received per person would be higher as people borrow from multiple sources.

Despite fast growing microfinance sector and its better recovery performance, there has hardly been any attempt by public sector institutions, particularly specialized banks, to reform their mode of operation and make them user-friendly. Besides few government projects with credit component, public sector credit agencies are characterized by the following phenomena.

- Access to credit is impeded by procedural complexities, such as, provision of collateral, filling up forms and delay in approval.
- Farmers often find it difficult to understand procedures.
- Hidden and real costs of credit are high in terms of travel, time and obscure payments that discourage farmers to go to the banks for credit.
- Poor farmers do not receive satisfactory clientele service from banks.
- Women are excluded from the banking service as they can hardly offer any collateral (land).

As total demand for credit far outweighs its supply, private moneylenders dominate the credit market. Poor farmers have little choice.

7.11 Inadequate availability of quality seeds to the farmers

The first and foremost challenge in the seed sector of Bangladesh is how to make available sufficient quantity of quality seeds to the farmers. The NSB has estimated national requirement of quality seeds to be 932,250 tons for the year 2011-12. The seed replacement rate of quality seed against national requirement was 12.61% in 2005-2006 which has increased to 20% (average of quality seed replacement rate of all agricultural crops) in 2011-2012 against target (22%). For improving total crop production, seed replacement rate must be enhanced and the private sector has a major role to play in this endeavour.

7.12 Increased environmental shocks and livelihood risk

The prevailing high incidence of poverty and population density makes Bangladesh extremely vulnerable to climate change and natural disasters (flooding, tropical cyclones and storm surges). Indeed, in the Climate Change Vulnerability Index 2011, Bangladesh is rated 'extreme.' It is the sixth most cyclone-prone country in the world, and first rated flood prone country in terms of human exposure (annually, 30 to 50% of the country is flooded).

Climate change and variability have already been creating adverse impact on livelihoods, particularly those who are living in the coastal areas and in the arid and semi-arid regions of the country. Poorer groups are even more vulnerable to climate-induced emergencies, in particular women and children. In addition to affecting lives and livelihoods directly, it also puts a strain on agricultural production and limits investments due to preoccupation with high risk. The most vulnerable regions in Bangladesh are 14 coastal districts in the south and 6 districts of haor basins areas in the north east.

8 Knowledge gaps

Following knowledge gaps have been identified:

- Climate change induced climatic variability and likely impact on availability of water for agricultural production.
- Given the variation between the hydrological regions and expected impact of external factors, the demand needs to be quantified in detail at the level of each region for each of the key sectors
- Availability of mitigation technology and adaptations
- Socio-economic developments, reflected in changing water requirements
- There is considerable knowledge gaps on the farm level use of pesticides, food quality and safety in Bangladesh
- Post-harvest handling, processing and traceability of agri-food in the supply chains
- Climate resilient agro-technology and likely impact on food security
- Climate related shocks, vulnerability and volatility of food prices

9 Development Options/Interventions

Following interventions are suggested for inclusion in the Bangladesh Delta Plan for development of agriculture and achievement of food security:

Technology development and dissemination

1) **Enhance research and technology generation*:*** To increase agricultural productivity and diversity in a sustainable manner require research and technology development in support of increased productivity in varied ecosystems in the following areas: (i) for crops, varietals development (short maturing Aus and Aman rice, new HYVs, biotechnology) build on respective experiences of private and public sectors; management practices (fertilizer, cropping patterns, cultural practices for char land, hill and coastal areas); and water and soil conservation; (ii) Promote frontier technology development through enhanced investment in R&D for increasing productivity. This will include activities: (i) Develop new varieties, crops, improving food quality, nutrition, etc. (ii) Enhance agricultural productivity through diversification, sustainable management of natural resources (in flood plain and CHT) and inputs. (iii) Promote "agro-ecologically suitable" and "climate-smart" agriculture that are effective to feed the population sustainably in the long term, and (iv) Supporting transformation of agriculture by building innovative, action-oriented partnerships with different countries. Promoting innovation and best practice by bringing people together to share experience and expertise.

2) **Improve research-extension-farmer linkages and extension services:** Interventions should be based on existing programmes (such as the National Agricultural Technology Project) and aim to put in practice the agricultural extension policy. They are required in the areas of technology adoption, reducing yield gap, crop zoning & community-based learning (farmers skill training, soil health improvement, diversification of agriculture, cultivation of quick growing fruits and vegetables, cropping patterns, farm mechanization) and promotion of sustainable agriculture (including implementation of the Southern Delta Master Plan).. In order for interventions to be successful, human and infrastructure capacities of DAE, require strengthening.

Improved water resource management including irrigation

1) **Augmentation of surface water for irrigation through development of water reservoir, recharge ground water, reduce use of ground water to avoid hazard of arsenic contamination:** We have identified some key priority investment activities: (i) the development of small scale surface irrigation in the southern part of the

country requiring new infrastructure and capacity building possibly building on the projects implemented by the Ministry of Local Governments; (iii) partially reduce reliance on deep tube well irrigation in the northern part of the country, reduce costs and mitigate the risk of Arsenic contamination; (iv) rehabilitate dikes and embankments particularly affected by previous cyclones to protect vulnerable households and production base against sea intrusion in the extreme south, (v) improved drainage, saline intrusion control and flood management; and (vi) increasing river water flow towards the south, in particular involving a major river dredging effort.

2) **Use water saving technology for improving efficiency of water and install facilities to reduce distribution losses**: Activities include: (i) reduce water losses in existing schemes through improved water management (capacity building of water management cooperatives), development of water saving techniques or rehabilitation of existing schemes.

3) **Reduce impact of saline water intrusion in the South and enhance river water flow:** The focused activities that emerged from the consultations are: rehabilitation of polders and their management; dredging of rivers; enhanced surface water irrigation; and improved brackish water resource management practices.

Crop diversification

Agricultural productivity enhancement through crop diversification, increased cropping intensity, farm mechanization, reducing post-harvest losses, and modeling of climate events. Following public interventions will be needed:

Facilitate agricultural credit to farmers: An agricultural credit is an important factor for diversification of agriculture. Farmers with access to credit facilities are found to be more diversified than others.

***Investment in transportation networks and improve market linkage*:** Access to market is found to be less important at the farmers' level but it is important for increasing diversity in agriculture regionally. This means, a district with better communication and transportation facilities are more diversified than other regions. Most of the non-cereal produces are perishable items and so means of transportation and access to the market is important for them. It is necessary to promote export of agricultural commodities, particularly vegetables and fruits.

***Training for farmers*:** Modern agricultural is much more challenging than before. There are elements of production, processing, storage and transportation and in all of them training is an important pre-condition for ensure higher profit to a farmer.

To promote non-cereal diversification in agriculture, DAE should organize itself to ensure farmers' level training programs.

Support research and extension for non-rice crops: To support research and extension for the promotion of pulse, oil crop, spices, roots and tubers, and vegetable crops.

Sustainable supply and use of improved quality of inputs

1) **Enhance availability of quality agricultural inputs:** The proposed priority interventions are: expansion of both seed multiplication and processing farms and preservation facilities of BADC, NARS, DAE, and contract growers; capacity development of public laboratories and SCA for testing quality of inputs; strengthening participation of NGOs and private sector in seed distribution as the role of private sector in the provision of quality seeds and other inputs has increased over past years; capacity development of farmers for autonomous production of quality seeds; and establishment of mechanisms to ensure availability and reasonable prices of all quality and environmentally friendly agricultural inputs (i.e. seeds, planting materials, fertilizers, pesticides). Develop public private partnerships through capacity development. Public private partnerships are needed in order to strengthen capacities for the production of agricultural inputs, laboratories and the establishment of

marketing networks in the country. It is necessary to establish an effective and strong monitoring system to protect the infected and low quality seeds from neighbouring countries.

2) **Improve and increase sustainability of soil fertility management*:*** Restoring soil fertility is an important issue for the Bangladesh government**.** The proposed interventions are to promote fertilizer use efficiency and balanced use of fertilizer. The main purpose is to strengthen environmentally sound fertility management practices. This will be done through facilitating application of fertilizers on the basis of soil tests, as well as strengthening of soil testing laboratories and promotion of improved soil health management practices. Additionally, awareness of Upazila Nirdeshika (land and soil use guide) for location specific prescription of fertilizers by the grass root level extension workers should be strengthened.

3) **Facilitate access to credit and other financial services by smallholders and the rural poor**: There is a strong call for collateral-free bank loans/credit at low interest rates for crops, livestock and fishery production for smallholders and the rural poor. The need to create specialized financial institutions for these sectors was also iterated.

Farm mechanization

Agricultural production in the country is adversely affected owing to the insufficient use of farm power and inappropriate use of farm machinery thereby adversely impacting on environmental sustainability, labour productivity and/or labour scarcity. It is important of moving toward sustainable agricultural practices, by increasing access to environmental friendly agricultural machinery that contributes to the enhancement of rural livelihoods and reduces pressure on natural recourses that are the lifeblood for producing food. Some investment priorities are: (i) Increasing the availability of agricultural mechanization technology to the farmer. (ii) Develop and promote agricultural machinery that is resource and energy efficient and conserve natural resources. (iii) Applying appropriate machinery and equipment for agricultural production (iv) Promote research for development of cost-effective farm machineries for the farmers (v) Training and education for farmers for using suitable farm machinery.

Improving market linkages and development of value chains

1) **Improvement of infrastructure**: A number of **priority investments** have been identified that could form the programme, including (i) Construction and adequate maintenance of rural roads to facilitate marketing of products and access to services in particular in remote areas. (ii) Construction or rehabilitation of rural markets including the supply of potable water, drainage, and storage facilities. (iii) Improvement and rehabilitation of wholesale markets in major cities; (iv) Private storage facilities to reduce losses and increase value added.

2) **Capacity building of value chain actors and market promotion**: A number of **priority investments** have been identified that could form the programme, including (i) Capacity building for group marketing at community level in the form of marketing groups, service cooperatives whose capacities should be developed and training provided; (ii) Capacity development of farmers and market intermediaries through training in food quality and safety regulations and requirements, good agricultural practices so as to comply with market requirements; (iii) Improved post-harvest management, value chain analysis and facilitation (iv) Promote agro-processing. (v) Facilitate coordinated, market-based action, harnessing the productive capacity of agriculture to promote food security, and environmental sustainability.

3) **Establishment of export processing zones**: Harness opportunities to expand market linkages and agribusiness with establishment of export processing zones.

4) **Improving Food Safety and Quality for Consumer Health and Nutrition:** Food analytical labouratories at the central and regional level need to be established to facilitate support to food manufacturers,

individuals and the enforcement of laws. There is no reliable surveillance data on food borne illnesses, impeding the understanding of the extent of disease burden and health and nutritional implications. An effective surveillance on food borne illnesses would therefore be necessary. These would include among others, strengthen capacities of the existing institutions, strengthening consumer protection and improving insufficient food safety activities.

Livelihood improvement and food security

1) Development of programs of alternative income generation and food security, reduce malnutrition of women, children and distressed population.

2) **Development of Community Based Nutrition Activities through Livelihood Approaches**: Home gardening, poultry raising and other community level nutrition-based agricultural activities need to be included as food based nutrition approach and also complemented by integrated horticultural development, fish ponds, behaviour change communication or any other activities. This strategy will include linking agriculture and food based nutrition to other nutrition efforts, including health. The proposed programme under the Delta Plan would aim to restore a process to assist the rural communities, based on their local conditions and priorities, to undertake these activities through a livelihood approach aimed to build local capacities and provide technical and financial support in and where required.

3) **Livelihoods improvement of population of char land, haor, coastal region and CHT**: All of those *chars* regions are not easily accessible and people are beset with lots of problems and sufferings. Despite appalling conditions, a large number of families, due to abject poverty and lack of alternatives, are often forced to relocate to such lands struggling with precarious weather and adverse living conditions. As the families are often hard to reach through mainstream anti-poverty programmes, it drastically reduces opportunities to promote social and economic development within these communities. In consequence, to achieve the millennium development goals (MDGs) and accelerated economic growth and nationwide poverty reduction policies of the Government are hindered.

Climate change adaptation

Bangladesh, due to its geo-physical position and socio-economic context, is highly prone to regular natural hazards and the impacts of climate change. Riverine *char* lands, coastal region and haor areas are considered as hotspots for climatic hazards. An integrated approach which combines traditional knowledge with innovative strategies need to be adopted to address current vulnerability while building adaptive capacity to face emerging challenges. The process involves four inter-related strategies: promotion of climate-resilient livelihoods strategies, disaster risk reduction strategies, capacity development for local civil society, and advocacy and social mobilization with particular focus on gender. Interventions should include: (i) Program to promote adaptive knowledge and technologies among communities/farmers. (ii) Enabling local preparedness and flood protection works and modelling adaptations under extreme climatic events.

Improved Land management

1) Promote Compact Township to reduce substitution of agricultural land for non-agricultural purposes.

2) **Integrated char development and livelihood improvement**: The intervention activities included: (i) Prevent loss of life from natural disasters, (ii) Reduce loss of land, livestock and other assets due to flood and erosion, (iii) Promote sustainable agricultural development, (iv) Widen access to health and educational services, (v) Increase access to land rights for the landless, (vi) Improve access to development inputs and services.

3) **Improvement of land information, land administration and management**: Bangladesh has a very high population density. Scarce land and the rapid increase of population of the country are creating high pressure

over land-man ratio. Land ownership record system is old, paper based and incomplete in Bangladesh. Therefore, it is important to establish a compatible land administration and management system for establishing a systematic approach for planned land development. Land Information System (LIS) should be accountable and feasible systematic approach for developing an up-to-date land administration and management. The improved LIS shall be digitized and related to various quantitative and qualitative aspects of land resource. Holding different cartographic information, the improved LIS shall facilitate capturing, retrieval, and querying of information and provides tools to perform different analyses using digital information.

10 References

Bangladesh Economic Review 2014, 2011, Ministry of Finance. Dhaka,

BBS, 2011. Statistical Year Book of Bangladesh 2011, Bangladesh Bureau of Statistics, Dhaka.

BBS, 2009. Statistical Year Book of Bangladesh 2009, Bangladesh Bureau of Statistics, Dhaka.

BBS 2008b. Statistical Year Book Bangladesh, BBS, Dhaka

BIHS, 2011-2012, The Status of Food Security in the Feed the Future Zone and Other Regions of Bangladesh: Results from the 2011–2012 Bangladesh Integrated Household Survey, International Food Policy Institute.

BRRI (Bangladesh Rice Research Institute). 2013. Bangladesh rice knowledge bank. Available at http://www.knowledgebank-brri.org/ (accessed on April 27, 2014).

Chowdhury, N.T. 2010. Water management in Bangladesh: An analytical review. *Water Policy* 12(1): 32-51.

Deb, U.K. 2002. "Has Bangladesh Really Achieved Self-sufficiency in Food Grain? A Review of the Evidence." In Bangladesh Facing the Challenges of Globalisation: A Review of Bangladesh's Development 2001. Dhaka: Centre for Policy Dialogue (CPD) and The University Press Limited (UPL).

Deb, U.K., Hossain, M. and Jones, S. 2009. Rethinking Food Security Strategy: Self-sufficiency or Self-reliance. Dhaka: UK Department for International Development (DFID).

HIES, 2005, 2010. Households Income and Expenditure Survey, 2005 and 2010, Bangladesh Bureau of Statistics, Dhaka.

Hossain, M., M. Asaduzzaman, M. A. S. Mandal, U. K. Deb and S. Jones. 2009. Rice Technologies: Strategic Choices and Policy Options, BIDS Policy Brief prepared for the National conference on 'Market Volatility, Vulnerability and Food Security: Strategic Issues and Policy Options', organized by BIDS and DFID, Dhaka, April 9, 2009.

Ganesh-Kumar, A.; Prasad, S.K.; Pullabhotla, H. 2012. *Supply and demand for cereals in Bangladesh, 2010-2030*. IFPRI Discussion Paper 01186. New Delhi, India: International Food Policy Research Institute (IFPRI).

Karim, Z. 2009. Climate Change Impacts on Bangladesh Agriculture and Food Security – Policy, Strategy and Management interventions, Keynote paper, Presented at the Consultative Workshop on Climate Change Impacts on Agriculture and Food Security, Ministry of Agriculture, GOB and FAO, Dhaka.

Ganesh-Kumar, A, Sanjay K. Prasad and Hemant Pullabhotla, 2012. Supply and Demand for Cereals in Bangladesh, 2010–2030 IFPRI Discussion Paper 01186, June 2012 .

Fakhrul Islam, S.M. 2014. Assessing potentiality of exporting rice from Bangladesh and its impact on food security and rural prosperity, Research Paper, University Of Illinois at Urbana-Champaign and CASEED, 2014

Fakhrul Islam, S.M. 2014, Transforming Hortex as a center of excellence, Hortex Foundation, Dhaka
Karim and Islam, 2014, Report on Institutional capacity assessment of Hortex Foundation, MATP/MoA, Dhaka.
Karim, Z. 2009. Background paper on food and agriculture: Crops, forestry, fisheries and livestock, Planning Commission, Ministry of Planning, Government of Bangladesh.
Karim, Z, 2010. Soil fertility review for agro-economic zoning, CASEED/DAE/KATALYST.

Karim, Z. and A. Iqbal. 2001. Impact of Land Degradation in Bangladesh (Changing Scenario in Agricultural land use). Bangladesh Agricultural Research Farmgate, Dhaka 1215, Bangladesh. pp. 106.
MOA, 1995, Fertilizer control order/GoB fertilizer policy, Ministry of Agriculture, Government of Bangladesh.

Rahman, A & A. Hasan, 2003. Assessment of shifting of agricultural land to non-agricultural land in Bangladesh, Soil Resource Development Institute, Dhaka.

MOA, 1996, New Agricultural Extension Policy, Ministry of Agriculture, Government of Bangladesh.

MOA, 1997, National Seed Rules, Ministry of Agriculture, Government of Bangladesh.

MOA, 1999, National Agricultural Policy, Ministry of Agriculture, Government of Bangladesh.

MOA, 2008. 'National Agriculture Policy (Draft 3)'. Ministry of Agriculture, Government of Bangladesh.

Master Plan 2014, Master Plan for Agricultural Development of the Southern Region of Bangladesh, Ministry of Agriculture, Government of Bangladesh and FAO

NMTPF, 2010, Towards a Food Secure Bangladesh: Country Programming Framework 2010-2015, Ministry of Agriculture, Government of Bangladesh and FAO

Upali A. Amarasinghe, Bharat R. Sharma, Lal Muthuwatta and Zahirul Haque Khan, 2014. Water for Food in Bangladesh: Outlook to 2030, International Water Management Institute.

BASELINE STUDY: 16

Fisheries

Author

Mohammed Mukteruzzaman[1]

[1] Mohammed Mukteruzzaman, Associate Specialist, Agricultural & Fisharies Division, CEGIS

Executive Summary : Study 16

Bangladesh is endowed with vast marine, coastal and inland water resources having great fisheries production potential, contributing 3.69% to the Gross Domestic Product (GDP) of the country and almost one-fourth (22.60%) to the agricultural GDP. Fish supplements about 60% of our daily animal protein intake. More than 17 million people including about 1.4 milion women depend on fisheries sector for their livelihoods by fishing, farming, fish handling, processing, etc. Different survey revealed that more than 80% of labours engaged in fish processing industries are women and creating more employment opportunities to the country people.

Fisheries sector has been given due importance in preparing Delta Plan 2100 with the objective of developing a comprehensive, participatory and doable 'Plan' for boosting up fisheries resources within environmental limits with expectation of ensuring protein based food security of increasing population. Under the vision, the government has targeted to achieve long term food security with safe fish products, surplus for export attaining strong economic growth with maintaining environmental sustainability through robust, adaptive, integrated and innovative strategies and equitable resource management with good governance.

Devising such 'Plan' requires a collaborative and participatory research within which the sub sector based visionary issues are outlined as below:

- vision for aquaculture includes development of sustainable, socially acceptable, economically viable and environment friendly technology;
- vision for inland capture fisheries includes generation of most effective management tools, biodiversity conservation, and sustainable fishing technology;
- vision for coastal fisheries includes development of sustainable coastal aquaculture technologies, guidelines for estuaries fishing methods and biodiversity conservation for coastal ecosystems; and
- vision for marine fisheries to develop appropriate guidelines for sustainable marine fish harvest and technology for entrepreneurs for mariculture of commercial important species for sustainable fisheries management.

The fisheries sector in Bangladesh is broadly divided into three sub-sectors such as inland capture, inland culture and marine fisheries. The inland fishery sub-sector is formed with 11 types of habitat containing an area of about 4.7 million ha while the marine fishery is formed with two types of habitat based on depth having an area of about 11.9 million ha. The inland fishery is further divided into two sub sectors, such as inland capture fishery which is formed with five types of habitat containing an area of about 3.91 million ha while the inland culture fishery which is formed with six types of habitat containing an area of 0.79 million ha. Analysis of time series data for 12 years (2003-2014) reveals the declining trend of capture fishery habitat area and it decreased by 0.16 million ha while the trend of culture fishery habitat area is increasing and it increased by 0.35 million ha.

The estimated country total fish production in 2013-14 fiscal year is about 3.55 million MT in which the inland aquaculture contributed the most, over 57% followed by inland capture fishery, over 28% and marine fishery , about 17%. The production growth rate over the last 10 years is almost steady and varying from 4.04 to 7.32% with an average of 5.38% whereas average growth rate is 5.61% in the last five years. Its contribution to the national export earning is 2.01%.

Production opportunities in different sectors of fisheries in next 10^{th} year identified tentatively as about 5% growth rate in hatchery based seed supply of fish; about 4% in shrimp post larvae; about 4.75% growth in all inland aquaculture sectors; about 4% growth in coastal/shrimp aquaculture and continuing decline in inland capture fisheries at about 0.5%. An increase is anticipated in the marine fishery by about 2.1% subject to utilization of marine resources within the scope new maritime boundary. The other prospective areas of fisheries sector are small scale pond aquaculture, commercial/intensive culture, stocked beels and oxbow lakes, rice-fish culture, rice-prawn culture, cage culture, pen culture, etc.

A total of 260 species of freshwater fish is known to inhabit in Bangladesh, 12 exotic fish species, 24 freshwater prawn species, 475 marine fish species and 36 marine shrimp species. Hilsa is dominating the species composition as a single fishery by over 10%. A total of 54 species have been identified as threatened freshwater species of fishes in Bangladesh (IUCN, 2000).

Fctors responsible for fish decline are siltation, water pollution, FCD/I projects, channelization of river, unplanned construction of embankment, dams and roads, and diversion of waterflow in the major river in the neighbouring country. Moreover, the water quality in the inland water has been degraded due to water pollution caused by discharge of untreated industrial effluents, domestic organic waste and agro-chemicals.

Climate change is another factor affecting fisheries. The drivers of climate change usually affect fisheries differently include temperature, precipitation, evaporation, humidity, hydrology, wind direction and speed, incidence of extreme events, etc. These variables vary with region and season and can affect the productivity or distribution of fisheries resources in a variety of ways through altering hydrology. Alteration of different climatic parameters associated with water environment has been keeping deleterious impacts on fisheries resources substantially and has the potential to be acute in future. Adaptation measures currently practicing by the fish farmers for combating the climate change insuced impacts on fisheries include covering water-body with water hyacinth by 15-20%, deepening of pond bottom, irrigation to pond, release bigger sized-fish fry, well fish culture in the coastal area, application of bio fertilizer, culturing of harsh environment and salt tolerant variety of fish, rice-fish culture, etc.

The estimated human nutrition based fish requirements of the country for 2015 is around 3.48 million MT and total estimated requirement is 3.96 million MT considering the requirements for export, diverted for fish meal and poultry feed, and fish wastage. Similarly, for 2016 it is 3.52 million MT and 4.05 million MT respectively.

Various management initiatives have already been made, some are continued and some are proposed to be executed country wide. Most prominent management practices are reserve and pile fisheries, fish sanctuaries, Beel nursery, spill way fisheries, net-pen fish culture, seasonal cultured water body (Floodplain) under the community enterprise approach, floating cage culture, etc.

1. Introduction

1.1. Background

Bangladesh is endowed with vast marine, coastal and inland water resources having great fisheries production potential. The fisheries sector plays a very important role in the national economy by contributing 3.69% to the Gross Domestic Product (GDP) of the country and almost one-fourth (22.60%) to the agricultural GDP. Over the last 10 years (2004-05 to 2013-14 FY), the fisheries growth is almost steady and on an average it is 5.38 percent. This sector experienced more or less consistent in growth, varying from 7.32% growth in 2009-10 to 4.04% growth in 2013-14 (Bangladesh Economic Review, 2014). More than 2% of export earning of the country comes from fisheries sector. Given proper government support, besides increasing fish production for food security, fisheries sector has ample potential of creating various types of ancillary industries in rural areas with very high rate of economic return. It can create more employment opportunities to the country people, mainly for the rural poor people, which would also prevent their migration to urban areas. Fish supplements about 60% of our daily animal protein intake. More than 17 million people including about 1.4 milion women depend on fisheries sector for their livelihoods by fishing, farming, fish handling, processing, etc. Different survey revealed that more than 80% of labours engaged in fish processing industries are women (National Fish Week, 2015).

The country is one of the biggest and active Deltas governed by upstream flow of three mighty rivers such as the Padma, the Meghna and the Jamuna having high potential of fresh and brackish water capture and culture fisheries along with vast marine resources. The fisheries sector is broadly divided into four sub-sectors, such as inland capture, inland culture, coastal and marine industrial fisheries. Bangladesh is one of the world's leading inland fisheries producers and has a huge water resources all over the country in the form of seasonal and perennial water bodies like rivers, estuaries, canals, Sundarbans (mangroves), depressiopn (*Beels*), reservoir (Kaptai lake), floodplains, ponds, seasonal cultured water bodies, oxbow lakes (*Baor*) and shrimp/prawn farms covering about 4.70 million ha. The total area of perennial inland water is generally estimated at 1.86 million ha while the area of inundated paddy fields and other low-lying places which retain monsoon waters for about six months allowing seasonal fishing and culture is estimated at 2.83 million ha.

The coastal and marine zone of Bangladesh is one of the world's richest ecosystems having high biological diversity and characterized by higher productivity and unique mangrove influences. The marine fisheries resources of Bangladesh keep crucial role in the economy of the country contributing about 17% of the total fisheries production of 3.55 million MT during 2013-14 (DoF, 2015[2]). The newly settled maritime boundary with neighboring states Myanmar and India up to 200 nautical miles from the coastline comprising of 11.88 million hectares of maritime waters (MoFA, 2014[3]), which has huge potential for marine fisheries in artisanal, industrial and coastal sub-sectors. A large part of the coastal area is suitable for shrimp farming particularly of black tiger shrimp (*Penaeus monodon*) identified by the government as a priority area. The production in 2013-14 (about 0.22 million MT) increased by a factor of 1.7 over 2005-06 (about 0.13 million MT). This increase was largely due to an expansion in the area of coastal shrimp farming, from only about 0.22 million ha of brackish water ponds in 2006, to an area of about 0.28 million ha in 2014 and improvement of technology.

[2] FRSS, 2013-14

[3] Bay of Bengal Maritime Boundary Arbitration between Bangladesh and India

One of the major objectives of the Delta Plan 2100 is to enhancing fisheries production utilizing vast water resources within environmental limits to ensure protein based food security of the increased population. The Vision 2021 is thus considered as a building block component of a step-up approach of the Delta Plan. Under the vision, the government has targeted to achieve self-sufficiency in food and its security. This requires achieving multiple objectives of enhancing productivity, livelihoods security and equitable distribution of benefits side by side with the conservation and management of potential fisheries resources. In this context, a socio-eco-friendly development strategies and action plans are needed to address environment/climate change issues on the one hand and the interests of the poor, including marginal fishers and other disadvantaged groups, such as women.

1.2. Objectives

The main and broad objective of the study is to develop a comprehensive, participatory and doable Fisheries Sector Plan for the country including Investment Program for the integrated development and sustainable management of fisheries.

Specific objectives are:

- To investigate the proximity of related policies, acts, rules and regulations, vision, mission, strategies, goals, targets and strategic plans to the vision of Bangladesh Delta Plan 2100 and address the gaps, opportunities and threats to maintain conformity with future plans;
- To assess current resource base, productivity status and future scenarios of aquaculture and fisheries production in need of formulating development options for planning exercise;
- To analyze fish production trend and the regulatory drivers for the change of trend over the years;
- To identify present Strengths, Weaknesses, Opportunities and Threats in the fisheries sector;
- To provide information on fisheries related institutional frameworks;
- To identify the potentiality, opportunities and major challenges of women participation in different fisheries management options and formal documents;
- To synthesize present management system of different water bodies and wetlands;
- To formulate a strategic direction for achieving the goal of protein based food security by 2100;
- To outline an insight of long term Delta Plan integrating fisheries with other productive sectors including land and water resources; and
- To prepare Investment Plans for the sustainability of fisheries development of the country.

1.3. Fisheries Vision

Fisheries production is escalating over the years but the productivity per hectare water area is not yet attained at its optimum. Nevertheless, in 2008-09 fish production was 27.01 lakh MT which was increased to about 35.5 lakh MT in 2013-14. As per the Vision 2021, fish production target in 2013-14 was 34.00 lakh MT whereas the production has been achieved about 35.5 lakh MT. It is 31.36 percent increased growth than the production of 2008-09. As a result of this increased production, Bangladesh has attained 4th position in inland open water fisheries production and 5th position in inland closed water fisheries production (FAO, 2014).

Fisheries Vision for 2100 along with corresponding strategies for achieving the desired goal is needed to foster future water and food security by ensuring "**Safe and secured animal protein for all"**. The Ministry of Fisheries and Livestock (MoFL) is leading the development of a long-term vision and action plan for the fisheries sector of Bangladesh with the cooperation of the Department of Fisheries (DoF), Bangladesh Fisheries Research Institute (BFRI),

Bangladesh Fisheries Development Corporation (BFDC), etc. This vision will guide approaches to fisheries management and help stakeholders make decisions about investments and activities. Legislative reform may stand as a pre-requisite to support its implementation. The comprehensive Fisheries Delta Vision is defined as:

"Ensure long term food security with safe fish products, surplus for export attaining strong economic growth with maintaining environmental sustainability through robust, adaptive, integrated and innovative strategies and equitable resource management with good governance."

An incremental and phased approach will be needed to move forward to achieve the vision. This means identifying the actions that need to be taken over the next five years and agreeing on the order in which these actions would be taken.

For the stakeholders a short, memorable vision statement would be useful for capturing the spirit and intent of fisheries by 2100. The study suggests the following conceptual framework that has the vision in the centre as shown in Figure 1-1.

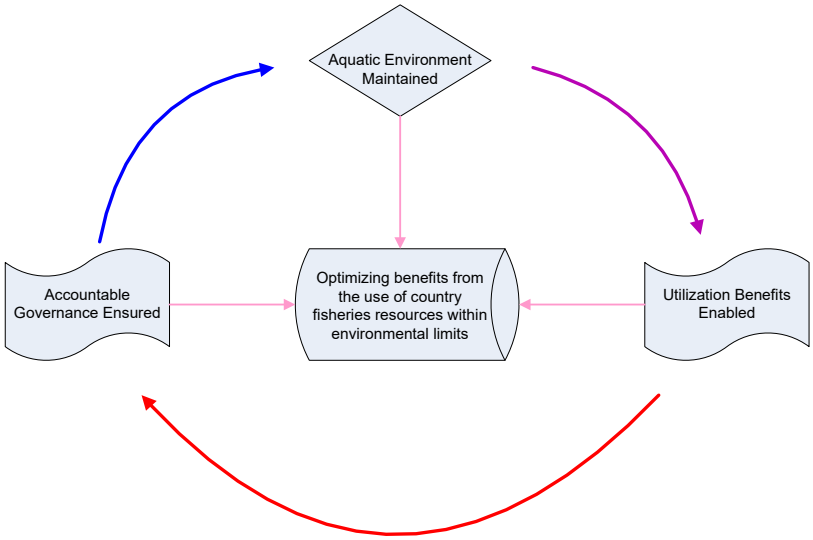


Figure 1-1: A conceptual framework of achieving country fisheries vision

The points shown in the outer circles reflect the three key result areas[4] which are required to achieve the vision. These are outlined as (i) utilization benefits enabled; (ii) accountable governance ensured and (iii) aquatic environment maintained. These three distinct result areas and actions are inter-dependent.

Capture fishery oriented country fisheries management is very traditional with some recent applications of community based fisheries management following a co-management approach. Therefore, there is further significant potential to create economic, cultural, social and environmental value through the development of new management tools. This potential will help to drive a primary sector-led strengthening of the country economy.

The Ministry of Fisheries and Livestock (MoFL) is leading the development of a long-term vision and action plan for the fisheries sector of Bangladesh with the cooperation of the Department of Fisheries (DoF), Bangladesh Fisheries Research Institute (BFRI), Bangladesh Fisheries Development Corporation (BFDC), etc. This vision will guide

[4] [4] *Source:http://www.fish.govt.nz/NR/rdonlyres/E094D5AB-F1F1-4645-A2BF-FB79F564849E/0/MFishFisheries2030Report Revised_Final_19Feb.pdf (Modified)*

approaches to fisheries management and help stakeholders make decisions about investments and activities. Legislative reform may stand as a pre-requisite to support its implementation.

Collaborative and participatory research is needed for introducing knowledge based fundamental research and technology generation. As such, emphasis should be given on development of improved genetic varieties of major culture fishes, heat and cool shock tolerance varieties, breeding and controlled propagation and culture-management of highly migratory riverine engendered species, mariculture of commercially important marine fin fishes and non conventional marine species. The sub sector based visionary issues are outlined as below:

Vision for Aquaculture:

Develop sustainable, socially acceptable, economically viable and environment friendly technology to support the continued development of aquaculture as the key supplier of animal protein and opportunity for resource development.

Vision for Inland Capture Fisheries:

Generate most effective management tools, biodiversity conservation, and sustainable fishing technology combating environmental effect and comprehensive data and information necessary for guideline formulation.

Vision for Coastal Fisheries:

Develop sustainable coastal aquaculture technologies, guidelines for estuaries fishing methods and biodiversity conservation for coastal ecosystems.

Vision for Marine Fisheries:

Develop appropriate guidelines for sustainable marine fish harvest and technology for entrepreneurs for mariculture of commercial important species for sustainable fisheries management.

To achieve the vision, a draft action plan has to be developed through a series of workshops and discussions with a range of stakeholders and staffs of the DoF, BFRI and other national and international NGOs who work on fisheries. The vision for 2100 is important to arrive at answers as to 'how' over the next five or more years and to outline an action plan for achieving the goal of "Optimising benefits from the use of country fisheries resources within environmental limits".

1.4. Approach and Methodology

The Fisheries Sector Planning has been carried out by following a systematic approach which includes (i) a review of literatures including plans, policies, strategies and papers/documents, (ii) challenges and problem identification, (iii) data collection, processing and analysis, (iv) setting of baseline situation and future projection, (v) development of strategy, (vi) development of project portfolios, (vii) sharing the draft report with relevant agencies and (viii) finalisation of the report. The flow diagram of the planning approach is presented in Figure 1-2 and a brief description of the different parts of the approach is given below:

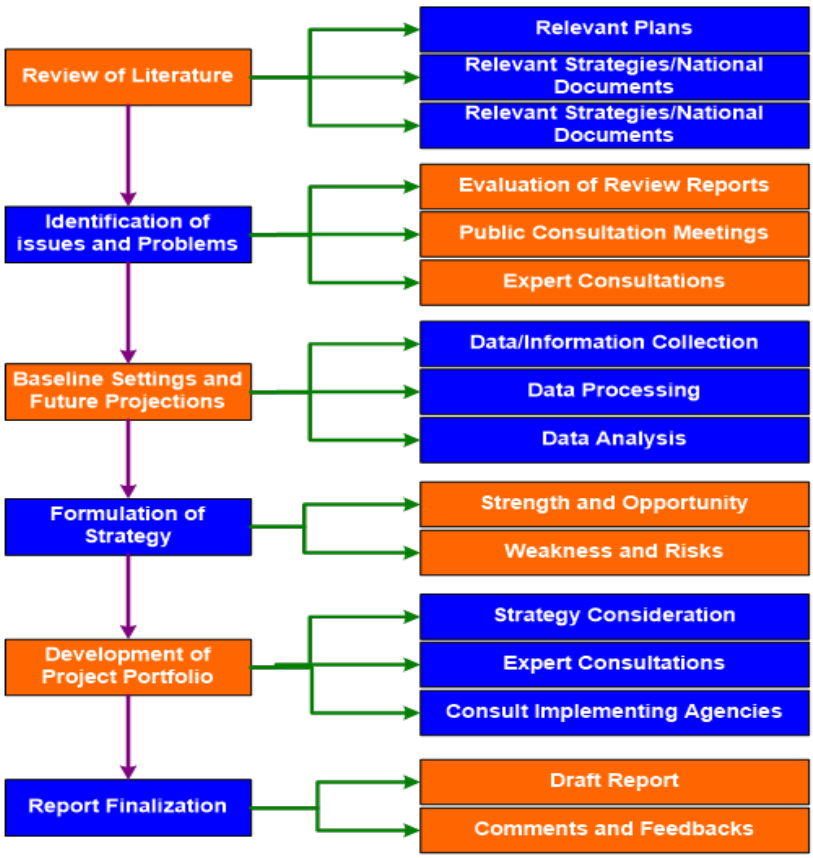


Figure 1-2: Flow diagram of Fisheries Planning Approach

Review of literature: Fisheries Sector Planning under the Delta Plan will play an important role in the sustainable and integrated development of the country. It has been carried out based on existing documents and literatures which include (i) relevant plans and strategies such as the 1st to 7th Five Year Plans (Draft), the Outline Perspective Plan (OPP), the National Environmental Management Action Plan (NEMAP), the National Fisheries Strategy (NFS), etc. (ii) relevant acts and rules, (iii) relevant national documents/reports such as the Fisheries Road Map, Vision 2020-21, the Millennium Development Goals (MDGs), the Poverty Reduction Strategy Paper (PRSP), the National Strategy for Accelerated Poverty Reduction II (NSAPR), the Bangladesh Climate Change Strategy and Action Plan (BCCSAP), the National Adaptation Plan for Action (NAPA) etc. (iv) relevant projects such as the MPO, FAP and NWMP and (v) relevant policies such as the National Fisheries Policy (NFP), the Jalmahal Management Policy (JMP), the Waterbody Management Policy (WMP), the New Fisheries Management Policy (NFMP), the National Water Policy (NWP), the National Land Use Policy (NLUP), the National Wetland Policy (NWtP), Environment Policy (EP), the National Food Policy (NFdP), etc.

Challenge and Problem identification: Identification of issues and problems and challenges for fisheries resource planning is one of the important tasks. This has been done through evaluation of reviewed reports/journals/documents and consultation with expert professionals of different organisations, departments and research institutes. Based on the identified challenges and problems, baseline settings, future projections and strategy of the project portfolios have been prepared.

Baseline settings and future projection: The baseline scenario has been developed based on the fiscal year 2013-14; fisheries production systems of different secondary sources such as the Fisheries Resources Survey System (FRSS), Internet, etc.

Time series FRSS data of the Department of Fisheries (DoF) stored in NWRD (1983-2013) of WARPO, different literatures and Internet sources have been used for the assessment of open and closed water fisheries and their trends. Marine fisheries has been assessed considering new maritime boundary dealt in the draft 7th Five year Plan. Fish species diversity and composition status have been analysed based on FRSS and literatures. Species of conservation significance have been collected from the IUCN Red List of Threatened Fish Species.

Fisheries projection has been done based on the projection system of the Fisheries Road Map prepared by the Ministry of Fisheries and Livestock (MoFL and Vision 2020-21 up to year 2030). Protein based fisheries demand has been estimated based on the criteria considered under the Fisheries Road Map. Climate change issue has been considered in assessing fisheries.

The status of the forward and backward linkages of aquaculture has been assessed based on literatures. The mandates, responsibilities and activities of different government and non government organisations and universities have been jot down and described in this report. It will help in implementing the proposed investment plans as well as in assessing the impacts of the interventions.

Formulation of strategy: Future development strategies and corresponding project portfolios have been devised based on local demand, habitat suitability and keeping harmony with the plan of the implementing agencies. During strategy formulation the strengths, weaknesses, opportunities and threats/risks of the fisheries sector have been considered. The strategy has been fixed to utilise the strengths and opportunities optimally and to eliminate weaknesses and minimise threats.

Development of project portfolio: Findings of opinions of the experts, Department of Fisheries (DoF) and the Bangladesh Fisheries Research Institute (BFRI) have been used in developing the project portfolios. A number of project portfolios have been developed for fulfilling the strategic thrust. These investment plans have been prioritised in consultation and through opinion sharing at the Department of Fisheries with participation of relevant agencies and universities.

1.5. Structure of Report

The Fisheries Sector Plan for supporting the preparation of the Delta Plan, 2100 consists of the following chapters:

Chapter 1 contains the background, objectives, vision and approach and methodology of the task.

Chapter 2 presents review of fisheries relevant plans, strategy and policies to give an understanding of the policy directives on country fisheries.

Chapter 3 contains the institutional settings for fisheries to give an idea about the human resources involved in the fisheries sector.

Chapter 4 presents the challenges and opportunities of fisheries sector.

Chapter 5 contains the country fisheries consumption and expenditures.

Chapter 6 describes the fish biodiversity, habitats, productions, fish demand, etc of the country.

Chapter 7 describes climate change induced fisheries risk, impact and adaptations.

Chapter 8 describes blue economy.

Chapter 9 describes different fishing practices and fisheries management.

Chapter 10 describes the constraints to fish and fisheries including the environmental and anthropogenic impacts on the fisheries sector.

2. Review of Plan, Strategy and Policy

2.1. Context

Over the last several decades, various globally applicable lessons have been learned about fisheries policies and their effect on fisheries development. Some of the promoted policies and their implementation in the country have not resulted in the desirable and expected results. Development policies have given impetus mainly on expansion, production and technology based approaches. Most of the policies missed to address the needs of small scale fisheries. The following issues and experiences are relevant for guiding the future investment and interventions, particularly for the small-scale fisheries sector development. They include:

- Fisheries development policy have ignored addressing the needs of small-scale fisheries;
- Despite a large global investment in fisheries development programmes, most of the fishers live in poverty and fisheries resources are increasingly overexploited;
- There is a lack of information and understanding of small-scale fisheries; government and policy-makers remain remote and unaware of their problems;
- Inadequate linkage with the water management projects implemented by various agencies like BWDB, LGED etc.;
- There is a lack of integration between agriculture and fisheries on water issue; between land and fisheries departments on land issue.

While the above observations register some of the major negative effect of policies the followings identify some of the challenges:

- Existence of multiple goals in a single policy complicates management of the resources; management systems which have ignored the wealth-producing (rent) function of a fishery in pursuit of other goals (e.g. employment; poverty alleviation; conservation) have tended to perform badly;
- Fisheries development and resource management need to be seen as complementary aspects of the same process; however, an unmanaged fishery is an inappropriate vehicle to manage economic growth and development;
- The successful management and development of small-scale fisheries is difficult to achieve using Western scientific-based approaches; the use of technical assessment models and regulations based on well-defined institutions are difficult to apply in the Least Development Countries (LDCs).

Finally, it should be noted that lessons learned have resulted in the formulation of more comprehensive and cohesive strategies which may require policy changes. These include:

- The problems of fisheries development and management are increasingly being viewed from a broader perspective; adopting a purely sectoral approach to fisheries analysis denies the fact that many households and communities integrate fishing into a diverse livelihood strategy based on different activities and resources; crucially the issue of poverty in fisheries requires a multi-disciplinary and multi-sectoral approach;
- New attitudes to fisheries management and development in LDCs are emerging; these include principally community-based and co-management approaches as strategies to attempt to include all stakeholders in the management process;
- Despite the neglect of small-scale fishers, many do thrive and there is increasing recognition of their role in livelihoods (socio-economic safety-net) and the economy.

The role of government has been increasingly scrutinised in the light of the poor performance of many fisheries development initiatives; the need for government to provide an enabling environment in LDCs for resource users to participate in management and development has been recognised.

The vision 2020-21 of the Government targeted to achieve self-sufficiency in food and thus increased food security. This requires achieving multi objectives of enhancing productivity, livelihoods security and equitable distribution of benefits side by side with the conservation of fisheries resources. This is not an easy task since increased productivity through intensification of production system might lead to increased stress on natural water bodies and aquatic biodiversity. Hence, careful policy interventions are needed to protect environment on the one hand and the interests of the poor, including marginal fishers and other disadvantaged groups including women on the other hand. In line with 20-21 vision, the Government is going to devise Delta Plan, 2100 where policy issues should be given more impetus.

2.2. Fisheries in National Plans

Understanding fisheries sector as a vibrant sector, different national plans have given utmost importance for promoting fisheries production, so that fish demand of increased population is met. Followings are the plans how fisheries sub-sector is considered.

Seventh Five Year Plan

The Seventh Five Year Plan (7FYP) has been devised for the period of 2016-20 and considered fisheries sector as one of the important sectors. A review of 7FYP is done for identifying and prioritizing the potential areas for developing portfolios and programs in the Delta Plan, 2100.

As per Article 15 of the constitution, the country is obligated with fundamental responsibility of securing citizens in following ways:

(a) Provision of the basic necessities of life, including food

(b) Right to work or right to guaranteed employment at a reasonable wage

In view of (a) noted above, it is a fundamental responsibility of the state to ensure availability of required quality and quantity of fish for the citizen and the fisheries sector contributes to (b) through creation of employment opportunities.

The Goal and Objective of 7FYP for Fisheries Sub-sector

In compliance with the National Document of Vision 2020-21, following goals are set in the 7FYP for fisheries sub-sector.

Goal

- Attaining self sufficiency in production of fish and shrimp and generate surplus for export;
- Improving livelihoods security and income of fishers and fish farmers with priority to the poor, landless, women and other disadvantaged groups with equitable distribution of benefits and thus contribute to reduced poverty;
- Improving food safety standard of fish and fish products for both export and domestic consumption; and
- Improving conservation of aquatic biodiversity of rivers, beels, haors, baors, floodplains and other water bodies.

Objectives/Targets

Following objectives have been set for achieving the above mentioned goals:

- Increase fish production to 3.7 million MT annually by 2015 from the benchmark of 2.7 million MT in 2007-08;
- Increase fish and shrimp export to 130,000 MT in 2015 from 75,000 MT in 2007-08. Increase employment opportunity in the sub sector by 20% in five years;
- Increase employment opportunity in the sub sector by 20% in five years;
- Increase participation of women in pond aquaculture from 25% to 30% in five years;
- Enhance the role of GoB Quality Control System for integrating, networking and facilitating an industry lead public private partnership and accreditation by internationally reputed quality assurance and compliance system for both export and local consumption; and
- Establish and maintain sanctuaries in selected segments of rivers, estuaries, the whole of Sundarbans, important beels, haors, and the breeding grounds of hilsha, and shrimp etc.

Sectoral / sub-sectoral development strategies and policies for 7FYP

a. Open water fisheries management

The availability of fish in the rivers, canals, beel, haor, baor and floodplains is decreasing because of over-fishing and contaminating the environment with pollutants like agro-chemicals, industrial wastes and urban sewers. The massive infrastructure of roads and embankments, urbanization and housing projects has blocked many water bodies. This has adversely affected breeding and spawning of many indigenous fish species. Therefore, in many areas, previously rich in fisheries, fish became scanty. Particularly the rivers like Buriganga, Turag, Balu and part of Shitalakhya have become biologically dead.

Therefore, main strategies in this regard should be as follows:

- Control of pollution of the rivers in which the main actor will be the Ministry of Environment in collaboration with other concerned agencies.
- Prevent further deterioration of water-logging, blockade of water-flows and shrinkage of water-bodies by infrastructures like embankment, roads, urban hosing projects and industrialization. Such projects must follow the environmental rules and regulations (including EIA, SIA, etc.) and incorporate adequate mitigation measures in consultation with the MoFL.
- In the case of such problems created by existing infrastructure, projects and programmes will be implemented to construct and maintain fish-passes, fish-friendly regulators, re-excavate canals and rivers restoring and conserving productivity as much as possible.
- Establish and maintain fish and wetland sanctuaries which will comprise complete ban on fishing in certain eco-sensitive areas like Sundarbans, parts of Kaptai Lake, and several sections of the river Halda, selected beels in haor areas and certain sections of the Bay of Bengal etc. Similarly, along the major rivers having parallel channels, selected ones will be preserved.
- The conservation strategy will specially include seasonal ban, gear restriction, identifying genuine fishers by providing ID Cards, species restriction, and alike.
- Besides strict implementation of the Fish Act, 1950; GOB will assist the fisher folk accessing Social Safety Nets like VGD and VGF and alternative livelihoods support.
- The fishers will be organized in sustainable community based organizations and such organizations will be given management responsibility of khas jolmohal on long term basis so that they conserve rather than just exploit resources. Present short term leasing system, often benefiting the influential elite and the leaseholder

not taking any effort to conserve, will gradually be replaced by the long term lease to organizations of genuine fisher who will be trained in sustainable management and provided other support.

- Daudkandi model of floodplain aquaculture will be further promoted to expand all over the country but with added emphasis to combine maintaining sanctuaries in the important beel and haor areas; keeping enough opportunities to free flow of water between rivers and beels; rearing fries of various indigenous species in nurseries and supplementing natural stock.

b. Inland aquaculture

Inland aquaculture production is constrained mainly by three problems- seed, feed and extension service. Therefore, the strategies in this segment should be as follows:

- Maintain purity of brood stock of indigenous carp and other indigenous fish species conserving the natural breeding, spawning, nursery and grow-out areas to complete the whole lifecycle and natural reproduction process.
- Purebred brood fish of commercially important indigenous fish species will be maintained in the selected Fish Seed Multiplication Farms of the DOF, research stations of the BFRI, other GOB establishments and important private and NGO hatcheries with facilitation and monitoring support by the DOF and BFRI.
- Brood fish from the above source will be distributed to the GOB hatcheries and selected private and NGO hatcheries to produce good quality fish seed and fries of commercially important and endangered species.
- Operation of hatcheries, nurseries and supply of spawn and fry, in which private sector is the key player, will be constantly monitored by GO-NGO collaboration and public private partnership. Compliant hatcheries will be awarded quality certification. Advertising in the printed and electronic media must contain such reference of quality certification. Gradually, marketing of fish fry and spawn without holding quality certificate will be banned, initially in the selected districts and then all over the country.
- Production, import and marketing of fish and shrimp feed, feed ingredients, minerals and vitamin premix, and other inputs, in which private sector is the key player, will be constantly monitored by GO-NGO. Compliant feed mills and other enterprises will be awarded quality certification. Advertising in the printed and electronic media must contain such reference of quality certification. Gradually, marketing of fish fry and spawn without holding quality certificate will be banned, initially in the selected districts and then all over the country.
- Aquaculture and conservation will be restructured to reinforce the strengths of each other, sustainable and community based flood plain aquaculture will be combined with maintaining sanctuaries and restocking of indigenous species
- Pen culture and Cage culture will be further promoted but guided and monitored for species selection, location, target group identification, and feed and input use etc. Special care will be taken to restrict pen and cage culture of exotic carnivorous species like piranha. Species promoted for cage and pen culture will include all indigenous carp species, mono-sex tilapia, shorputi, shrimp, prawn, and selected exotic carps etc.

c. Shrimp and coastal aquaculture

Main constraints to the expansion of sustainable shrimp farming and coastal aquaculture are: (a) inadequacy of proper water management infrastructure, (b) scarcity of good quality/ virus-free shrimp and prawn post larvae, (c) inadequate technology support, (d) social conflicts on competing water and land uses and the benefits and cost sharing, and (e) failure to maintain quality between harvest to processing and tracing the sources of contamination.

Addressing the above problems will include:

- Government will define shrimp farming zones in the coastal region based on natural advantages of shrimp and prawn farming and rehabilitate water management infrastructure in each zone to optimize production and environmental sustainability. Different methods of aquaculture and farming system will be promoted in different zones depending on suitability- such as shrimp with salt limited to south eastern Cox's Bazar district, shrimp with paddy in Khulna and Satkhira districts, mono-crop improved extensive shrimp farming in limited areas of both southeast and southwest regions, improved traditional golda farming in areas like Bagerhat, northern Khulna and banning extensive shrimp farming in low-saline and non-saline areas.
- Introduction of SPF shrimp by private sector, which is duly facilitated by the government.
- Production of virus-free shrimp PL requires availability of virus free mother shrimp which is becoming scarce. Conservation of shrimp and prawn parent stock and their harvest by stress-free trawling, transportation and rearing in the hatcheries will be facilitated. To ensure supply of virus-free shrimp PL, all hatcheries will ensure PCR test of both mother shrimp and shrimp PL and DoF will provide certification of PL quality of both golda and bagda hatcheries.
- Import of both golda and bagda PL will be controlled, including illegal border trading.
- Extension support and research extension linkage will be strengthened.
- Community originations of shrimp farmers and other primary stakeholders will be supported with technology, input, financing and market linkage by contract growing system run by the processing plants and monitored by the DOF and partner NGOs.
- Traceability of supply source will be ensured by contract growing and marketing system which will also ensure supply of virus-free PL, good quality and contamination-free feed and other inputs at reasonable price.
- Trail of **e-Traceability** and subsequently screening throughout the supply chain.
- Premium price will be provided for quality output.

d. Marine fisheries

Constraint to the sustainable exploitation of marine fishery resources include (a) lack of knowledge of the species wise current stock, location of the breeding ground and the grow out areas, and the potential maximum sustainable yields by species, season and location; (b) alleged over-fishing; and (c) encroachment by trawlers of neighboring countries.

Strategies to overcome these will comprise:

- A comprehensive survey of marine fisheries resources followed by regular updating of data and monitoring
- Rapid assessment of fisheries stocks by species in recently resolved South-West waters of EEZ
- Determine/ re-estimate maximum sustainable yield by species, location and season
- Formulation of National Marine Fisheries Policy
- Moratorium on entry of new trawlers/fishing boats to the existing fishing fleet
- Registration of all mechanized fishing boats and providing fishing license
- Restrict and control pouching of resources and illegal entry of foreign trawlers
- Identify conservation needs and methods that can be effectively administered and regularly monitored
- Cooperate with the Coast Guard and Navy on the control of encroachment and breach of regulation, also by local vessels.
- Institutional capacity building of the concerned agencies.
- Strengthening of Monitoring, Control and Surveillance System (MCS) in the Bay of Bengal

- Promote development of technology for production of seed for culturing marine fish, mollucs and sea weed.
- Joint research programmes to address confronting issues- biodiversity, climate change impacts.
- Strict surveillance should be continued for fishing complying all relevant Acts, Rules and Regulations
- Impose seasonal ban to exploit fish and shrimp to protect spawn and juveniles.
- Equipping VTMS/AIS to all industrial fishing vessels
- NPOA to eliminate IUU fishing in maritime boundary in response/compliance to FAO-CCRF
- Marine Fisheries Surveillance Check posts at strategic locations in coastal/estuarine rivers
- Collaborative effort for distant water fishing (beyond 200m of EEZ and ABNJ) to explore and exploit tuna and large pelagic fishes.

The Five Year Plans (FYPs) of GoB have guided sectoral policy processes. Each FYP sets a total target for fisheries production, and fisheries policy is, in principle, expected to deliver these targets (Table 2-1).

Table 2-1: Production target and achievement in national fishery plans

FYP Year	Target (Lakh MT)	Achievement (Lakh MT)
1st 1973-1978	10.20	6.43
2 year plan (1978-1980)	8.08	6.46
2rd 1980-1985	10.00	7.74
	Tk 1,743M fisheries development budget	Tk 1,583M spent
3rd 1985-1990	10.00	8.47 (estd)
4th 1990-1995	Tk 7,490 M fisheries development budget	Tk 300M spent
5th 1997-2002	20.75	18.50 (estd)
6th 2011-2015	35.8 (2014)	35.5 (2014)
7th (Draft)	37.0	-

Outline Perspective Plan (OPP)

About 2.8 million ha of land remains inundated for more than four months. This vast floodplain currently remains under-utilized for fish production. Fish production has been increasing since 1990s through (a) pond aquaculture (fish raised in ponds) using hatchery-reared fish fingerlings; and (b) conversion of fish ponds by raising embankments around low-lying lands. However, production under capture fisheries has stagnated because of underinvestment in fisheries sectors of the floodplains. The fish habitat in rivers, creeks, and canals has been reduced steadily by siltation and drying of the perennial water bodies. Fish hatcheries in coastal areas have expanded to suboptimal levels. Fisheries meet nutritional needs, generate employment and earn foreign currency. For achieving the projected fish production of 36.7 and 41.4 lakh MT and corresponding demand of 35.4 and 39.1 lakh MT respectively for 2015 and 2021 set under OPP, 2010 by following the strategies mentioned below:

- High priority given to closed water fisheries production;
- Increasing fresh water, (rather than brackish water) golda production in coastal areas;
- Potential use of cage culture in floodplains with individual ownership;
- Emphasis on supply of inputs and promotion of technical knowledge among the educated youth, in pond and other closed water bodies; and
- Adoption and implementation of the concept of fishermen cooperatives towards 'Jaal jar jala taar' in government-owned water bodies.

National Environmental Management Action Plan (NEMAP)

The NEMAP has the concern about wetlands and the sustainable use of their resources. In its section entitled "Wetland Issues" discusses solely on freshwater resources. There is however a section on Coastal and Marine Resource Management Issues, and Fisheries and Livestock Issues both of which deal with specific areas of concern.

The section on "Fisheries and Livestock Issues" identified the following key Issues regarding fisheries.

- Ecosystem alterations due to unplanned Flood Control, Drainage and Irrigation (FCD/I) projects can be considered as a major constraint to the viability of open water capture fisheries;
- Construction of coastal embankments, closures of tidal streams and channels have reduced the fisheries productivity. It has also damaged traditional "gher" fish culture and replaced it with modified brackish water aquaculture;
- Water abstraction from permanent water bodies, like beels and haors, during the dry season reduces the suitable habitat for fisheries;
- Inadequate regulation of shrimp culture in the coastal belt has contributed to increased soil salinity and damage to sensitive ecosystems like mangrove forests apart from the socio-economic impacts;
- The auction of freshwater bodies on a lease basis has lead to over-exploitation of fish resources to maximise short term profits; and
- Over-fishing and harvesting of fish fries are contributing significantly to depletion of fisheries resources.

In the "Wetland Issues" section NEMAP emphatically pointed out that "the reduction of wetlands is one of the marked features of environmental degradation in Bangladesh". The following key issues were identified:

- Reduction of wetland areas due to increased agricultural practices;
- Loss of wetland biodiversity;
- Unplanned infrastructure construction leading to increased flooding and drainage problem;
- Mineralization of perennial waterbody during dry season from residual fertilizer leading to eutrophication and retard growth of fish;
- Poisoning of wetlands for some aquaculture project intervention in the open water environment (Haor area); and
- Absence of integrated management of wetlands.

2.3. Fisheries in National Strategy

The National Fisheries Strategy (2006) reflects a shift from the way the sub-sector is currently managed. The sector was controlled by the Government through its agents mostly the Department of Fisheries. Their activities largely included the management and control with direct involvement in supplying some of the inputs such as fingerling. The strategy stipulates that their activities moves to one of fostering participation with local communities, the private sector and NGOs; the provision of advice; and establishing a regulatory framework in which the sub-sector can function properly. This strategy emphasizes collaboration linkages and partnerships throughout. The strategy also reflects current government concern for poverty alleviation through more targeted activities by all. Some of the strategies as outlined in the National Fisheries Strategy (2006) are pointed out below:

- Developing long term objective planning and ensuring People's Participation;
- Coordination, collaboration and support from relevant other Ministries/Departments for fisheries sub-sector;

- Developing a regulatory framework for the sub-sector;
- Having pro-poor management strategy;
- Ensuring gender equality;
- Providing Alternative Income Generating Activities (AIGAs); and
- Managing the environment properly.

2.4. Acts and Rules on Fisheries

Formal fisheries management in Bengal (part of which is now Bangladesh) has a long history. As early as 1793, the British rulers had given large tracks of lands to the landlords who were supposed to collect tax from the assigned estates. Since then many acts, rules, ordinances have been formulated. The effort culminated by the formulation of the National Fisheries Policy in 1998. Following is a brief summary of this historical development along with the key features of the individual events. A list of events is shown in Table 2-2.

Table 2-2: Implications of fisheries with different Act and Rules

Sl. No.	Important Acts, Rules and Policies related to Fisheries	How Implicate Fisheries
1	Permanent Settlement Regulation 1, 1793	Large water estates (Jalmohals) belong to direct control and management of the Zaminders. Despite this provision, ownership of many wetlands remained as private or common property.
2	The Private Fisheries Protection Act, 1889	This Act protects the interest of private fisheries (Fishponds & Jalmohals) through legal provision but it does not directly address the issue of fisheries management.
3	State Acquisition and Tenancy Act, 1950	Lease system was introduced to generate revenue from the Jalmohals, which is still being managed by the Additional Deputy Commissioner (ADC, Revenue). The lease is granted through a bidding system to a registered fishermen cooperative participating in the bid. In case of a seasonal Beel, the lease term is for one year only, whereas the permanent water bodies and Baors are leased for a three-year period. Most of the fish producing wetlands are owned and managed by the Ministry of Land and its sole objective has been to maximize revenue generation through leasing out the wetlands
4	The Protection and Conservation of Fish Act, 1950	This Act covers all types of aquatic species including fish, prawn, shrimp, amphibians, tortoises, turtles, crustaceans, mollusks, echinoderms and frogs at all stages in their life cycle and all types of water bodies. The Act specifies a number of useful fisheries management rules for sustainable fish culture and conservation in the country. These are: use of appropriate fishing gear (net, cage, trap, explosives) and building water management structures (dams, weirs, bunds and embankments). It also specifies the fishing and non-fishing seasons and the size of fish below which any prohibited species cannot be killed or sold. This policy is revised and included the

Sl. No.	Important Acts, Rules and Policies related to Fisheries	How Implicate Fisheries
		banning of 'jatka' of hilsa and use of kerrent jal.
5	Bangladesh Fisheries Development Corporation Act, 1973	Under this Act the Bangladesh Fisheries Development Corporation (BFDC) was established with the provision of developing fishing industry; establishing units for preservation, processing, distribution and marketing of fish products; encouraging formation of fishermen's cooperatives; taking stock of the fisheries resources and establishing institutes for training and research on modern fisheries management.
6	The Fish and Fish Products (Inspection and Quality Control) Ordinance, 1983	The Ordinance gives the Government the power to set grades, quality and standard of fish and fish products for ensuring nutrition security. Penalties for violations have also been specified.
7	The Fisheries Research Institute Ordinance, 1984	As per this Ordinance, the Fisheries Research Institute has been set up at Mymensingh to carry out and coordinate fisheries research in Bangladesh.
8	The Protection and Conservation of Fish Rules, 1985	Under the Rules, installation of fixed nets, cage, trap, etc has been prohibited for controlling harmful and unlawful fishing activities. Moreover, construction of bund, weir, embankment, etc has been banned except for the purposes of irrigation, flood control and drainage. Use of explosives, poison and small meshes is banned. Also, catching certain fish during the breeding season from April 1 to August 31 has been banned. It has also been made illegal to dredge and extract sand and gravel, and discharge waste or any other polluting matter that disturb, alter or destroy natural habitats of fish in marine reserves.
9	The Fish Hatchery Act, 2010	Under this Act, it is proposed to mitigate the inbreeding and cross breeding problems in many hatcheries. It will also encourage the hatchery and nursery owners in producing quality fish seeds.
10	The Fish hatchery Rule, 2011	Under this rule, the hatchery owner is to declare best health management and pollution control in producing fish seed or shrimp PL to give certificate of quality fish seed mentioning traceability of brood fish.
11	The Fish Feed and Animal Feed Rule, 2011	Under this Rule, it is proposed to maintain recommended dose of additives, feed binder and ingredients, and to take approval of BSTI for country production but for imported feed it needs to take approval of the DoE.
12	The Marine Fisheries Ordinance, 1983	An Ordinance to make provisions for the management, conservation and development of marine fisheries of Bangladesh. The Director shall be responsible for issuing licences in respect of all marine fishing in the Bangladesh fisheries waters • Local fishing vessels to be registered • Local fishing vessels to hold valid certificate of inspection

Sl. No.	Important Acts, Rules and Policies related to Fisheries	How Implicate Fisheries
		• Grounds for refusing to issue licences, etc, to local fishing vessels • No entry for foreign fishing vessels in Bangladesh fisheries waters except with licence • Entry by unlicensed foreign fishing vessels into Bangladesh Fisheries waters • Foreign fishing vessels liable to fine and forfeiture if found in Bangladesh fisheries waters illegally • Foreign fishing vessels to observe navigation, customs laws, etc • Grounds for refusing to issue licence, etc, to foreign fishing vessels • Scope of appeal for any kind of refusal • Use of explosives, etc are prohibited • Small meshes, etc are prohibited • Government may declare marine reserves • Fishing, dredging, etc prohibited in marine reserves • Government may permit scientific research • For the purpose of enforcing the provisions of this Ordinance and the rules, an authorised officer may stop, examine, etc, any fishing vessel • Authorised officer may enter premises, seize vessels, etc, without warrant • Power to stop vessels • Persons arrested without warrant to be taken to police station Etc.
13	Marine Fisheries Rules, 1983	These rules are made under the Marine Fisheries Ordinance (No. XXXV of 1983). They regulate the issuance and conditions of fishing licences for national and foreign fishing vessels, determining licence conditions, allowed fishing gear, mesh size, etc. Licences, unless determined otherwise in an individual licence, shall expire on 31 December of the year of issuance. Allowed fishing areas are determined according to type of fishing gear used, for example, for fishing with set bag nets, upto 40 meters depth in marine waters at high tide.

2.5. Fisheries Perspective in National Documents/Reports

Vision 2020-21

The vision 2020-21 is composed of eight inter-related goals wherein section 7.4 of goal demonstrates the importance of wetlands as "*Conservation of designated wetlands to maintain ecosystem balance*". Elaboration of this statement clearly mentions how to conserve fisheries resources. On-going siltation and flood control interventions (e.g. embankments, sluice gates, etc.) have endangered wetlands as well as their associated fisheries. Systematic conservation and judicious use of wetlands will thus be crucial over the coming years. To this effect, pond aquaculture will continue to expand along with environmentally sound management of open water and marine fisheries. Appropriate zoning of land under agriculture and aquaculture will be carried out to address the attendant concerns. It is also important to enforce laws to stop continuous conversion of wetlands into agricultural, industrial and residential uses. This Vision prepared in 2010 constitutes the fisheries sub-sector related following directives:

- Ensure fish based food for all and make Bangladesh self-sufficient in food by 2013;
- Attain self-sufficiency in the production of fish;
- Export surplus products after meeting domestic requirement;
- Ensure lease of khas ponds/haors to genuine fishermen;
- GDP growth raised to 8% by 2013 and 10% by 2017 to 2021 which will be sustained thereafter;
- MDG targets to be achieved (such as halving percentage of people in poverty) by 2017;
- Make Bangladesh an ecologically attractive place through retention of forests and water bodies;
- Unemployment rate reduced to 15% by 2021 from present 40 percent; and
- 85% of the people have standard nutritional food by 2021.

Millennium Development Goal (MDG)

Trends in Target 7.2 interprets integrating the principles of sustainable development into country policies and programs reverse the loss of environmental resources and reduce biodiversity. For achieving the desired goal of MDG prepared in 2009 set an indicator for enriching the fish species diversity. The indicator mentions that proportion of fish stocks should be maintained within safe biological limits.

Poverty Reduction Strategy Paper (PRSP)

To scale up the poverty stricken community through fisheries sector under the strategy of "Caring for Environment and Sustainable Development" following issues are being addressed in PRSP, 2005.

- Currently, in the public sector, there are 35,285 Jalmahal, both open and closed;
- There is a provision for leasing out the water bodies which makes it difficult for the poor fishermen to have access to those bodies;
- The Government has adopted a Jalmahal Policy to establish the right of the poor fishermen; and
- In the new 'Land Use Policy', introduction of the proposed 'Certificate of Land Ownership' will provide access to the fishing community for fishing in the floodplain.

Following recommendation could be put forward regarding the fisheries sector discussion under PRSP:

Increasing productivity of the inland capture fishery; the current system of short-term leasing of waterbodies is neither sustainable from a resource management perspective nor propoor as there is frequent capture of benefits by local elites. So, it is recommended to go for long term leases of waterbodies. A second major issue is that many leases are currently overvalued in relation to the production potential.

National Strategy for Accelerated Poverty Reduction II (NSAPR)

The overall strategy of fisheries sub-sector development envisages intensification of aquaculture by species and ecosystems, addition of export-oriented species, ensuring biodiversity and preserving natural breeding grounds, product diversification, value addition, and development of appropriate marketing infrastructure. For increasing fish production, emphasis will be given on:

- Making people more conscious about conservation for increasing natural fish stock and protecting fish habitats;
- Protecting breeding and nursery grounds of major fishes through establishment of sanctuary and re-excavation of canals, beels and baors under different programs;
- Encouraging alternate income generating activities for fishermen;
- Protecting beels and haors from the use of pesticides;
- Encouraging rice-cum-fish culture and aquaculture by intensifying poly culture;
- Emphasizing management of aquaculture in floodplains involving local community;
- Ensuring disease and quality control of fry and fingerlings; and
- Prioritizing research and development to meet new changes in the sector.

Bangladesh Climate Change Strategy and Action Plan (BCCSAP)

Adaptation in fisheries sector is highly required to combat the climate change induced damage. Therefore, following actions are recommended under BCCSAP:

- Assess potential threats to fish spawning and growth of freshwater, and coastal and brackish water fisheries sector and develop adaptive measures, including pond fisheries, river-based cage aquaculture, etc.;
- Assess potential threats to the marine fish sector and develop adaptive measures;
- Assess potential impacts on the shrimp sector and develop appropriate adaptive measures and cultural practices; and
- Assess potential impacts on the migratory fish

Box 1: Dilemmas in the NFP

For shrimp production the aim is to increase production – but this may be difficult without impinging on coastal areas protected by the Ministry for Environment and Forest. Further, the socio-economic and ecosystem impacts would need to be further addressed. There is a policy objective to expand production in the marine sector against recognition that some stocks may already be exploited at the maximum sustainable level. To implement policy there is a strong need to gain better knowledge of where there is scope for expansion, and where change can be made without threat to the livelihoods of dependent communities.

The NFP recognises the need to carry out research and training in support of major objectives, but a human resource development strategy is not considered and there is no clear statement of the priorities and responsibilities for research (eg the roles of DoF vis a vis the BFRI). Inter-institutional coordination is a clear intention of the policy but the mechanisms and priorities are not spelled out.

Contributing to poverty alleviation is a stated objective of the NFP. This is an important element in a sector where property rights regimes and the potential social and economic consequences of improved management (eg control of access) are highly significant to the poor. The Policy implies a relationship between increased production and poverty alleviation, and suggests the formation of cooperatives as part of this process. It does not, however, mention co-management or the participation of the poor in sustainable exploitation of resources. The strategy by which fisheries will

including Hilsa and develop appropriate adaptive measures.

National Adaptation Plan for Action (NAPA)

NAPA recommended the following adaptive measure for coping and building resilience to the climate change impact on fisheries sector:

- Adaptation to fisheries in areas prone to enhanced flooding in North East and Central Region through adaptive and diversified fish culture practices.

2.6. Policy concept for fish, fishery and fishers

The general concept for management of a renewable aquatic living resource like fish, which has a life cycle, is that:

Firstly, fish should be given a chance to reproduce at least once in life. In other words- this concept implies that (i) an appropriate number of spawners are necessary to sustain the population (ii) young fish should be protected to grow to maturity and the spawner be protected during breeding season.

Secondly, the fish be given suitable habitat with sufficient productivity and ecological requirements including facilities for spawning, migration etc. and free from any contamination of water and soil.

Thirdly, users rights to the resource should be ensured equitably and the socio-economic condition of the poor users group need to be improved.

Box 2: Performance of the NFMP

The performance of the NFMP has been limited by local level power relations. The National Fishermen's Association (NFA) was mandated to draw up a list of genuine fishers; this was then approved by a thana NFMP committee and subsequently the district committee. However, middlemen were known to have extracted 'fees' for putting fisher's names on the district approved lists and fisher cooperatives that were set up to apply for licenses were co-opted by wealthy influential elites.

It has been argued that the NFMP simply reflected unfair power relations already present in the fishery. Others have highlighted its positive impacts on poor fishers. A study of its performance suggested that i) NFMP eliminated exploitation by middlemen leaseholders, ii) License fees charged for fishing units were reasonably low, and iii) the fishermen obtained economic benefits. The current status of the NFMP is unclear given the revision of policy for leasing open water jalmohals In 1995, the GoB declared all rivers and open water bodies open access, thus technically rendering the NFMP licensing system defunct. However some NGOs are attempting to apply the NFMP's principles, and the DoF has recently established new projects that build on NFMP activities and assume continuation In 1998, the Ministry of Land was reported to have placed some 31 Jalmohals under the NFMP and recently another 10. The DoF is supporting management and organising the fishing community of those Jalmohals under a GOB financed development project.

2.7. Fisheries Relevant Policy

The National Fisheries Policy, 1998

The NFP aims at developing and increasing production of fish resources and create self-employment to improve the socio-economic condition of the fishermen. It commits to ensure the lease of unutilised *khas* ponds, *dighis* and other fisheries to the trained youth groups. The Policy emphasizes the nutritional value of fish in the improvement of public health and also attaches importance to maintaining ecological balance and biodiversity. It seeks to ban the import, distribution and sale of any alien species of fish or fry without prior approval of the Government.

The Policy calls for precautionary measures to minimise adverse impacts of agriculture, industry, transportation, urbanisation, flood control and irrigation. It proposes transferring fish sanctuaries or parts thereof to the DoF and commits for measures to prevent industrial pollution and limit unrestricted use of harmful pesticides. The policy also has statements on use of prohibited methods of fishing and emphasises the proper application of law for protecting endangered fish species. In leasing out government *khas* water bodies, it seeks to ensure priority for the genuine fisher folk. It also considers the control of fish quality and marketing and export.

Poverty alleviation is a stated objective of the NFP but related strategies are not discussed. The role of property rights regimes in poverty and livelihoods has been widely discussed by national NGOs, donors and researchers but these are

not taken up. However, the NFP refers to an assumed link between increased production and poverty alleviation. It suggests the formation of fisher co-operatives but does not propose how this might be achieved, or acknowledge the apparent limitations of the specially-designed fisher groups within NFMP and elsewhere.

The NFP addresses all aspects of fisheries: inland and coastal policies (fish and shrimp culture); education, research and extension policies; organisational policies (credit etc); commercial policies (export, transportation, marketing, processing and quality control); management policies (inland - open and closed; marine). Those parts relating to the marine sector are comparatively detailed and predominantly concerned with increasing the quality of product. The implicit aim is to return Bangladesh to the global marketplace for marine products (particularly shrimp. Policy statements relating to inland fisheries predominantly concern production, culture and enhancement but both the inland and marine sub-sectors emphasise ecological balance and the maintenance of biodiversity.

There appears to be lacking co-operation, coherence and co-ordination with other interested sectors and ministries within the NFP. The MoFL asserts that it will 'control all aspects of the fisheries sector' but makes no reference to linkage with the numerous agencies and ministries that currently manage aspects of fisheries. The policy states that coordination 'will be established' but the mechanism by which this might occur is not made explicit.

The NFP addresses the development of the sector through activities and inputs such as the provision of credit and the establishment of a Fisheries Bank. It states that tax laws will be changed to boost fisheries production, but it is unclear which stakeholders would benefit and how this would be implemented.

The NFP aims to increase exports through increased production of raw product. Given the lack of data on stocks, the need to maintain extraction at current MSY, the problems with enforcement of existing law (see Legal and Regulatory Frameworks) and the need to protect the coastal environment there are obvious limits to pursuing this objective.

With increased production as its leitmotiv, the NFP states that it will implement the policies listed by bringing all closed water bodies into production, promoting aquaculture on open water bodies (again, without acknowledgement of local level issues and institutional sustainability), increasing hilsa production and redrafting Fish Acts to ensure implementation of policy.

Finally, the NFP proposes the setting up of a National Fisheries Council to implement the policy, to encourage more coordination and recognises that new laws need to be formulated in this regard. As such, the implementation plan is weakened by its failure to prioritise activities in terms of capacity and needs.

Box 3 An Action Plan for the NFP

This was to be addressed within the GoB/WB/DFID Fourth Fisheries Project; where it was recommended that the DoF establish a Fisheries Planning Team to prepare a draft strategic Action Plan by September 2002. The TOR of the Planning Team includes the following:

- Review and define the core functions of the DoF in the context of the National Fisheries Policy, current sector needs and the roles of other stakeholder institutions
- Identify priority areas where DoF must take the lead, and other areas which might be better addressed through partnership with other institutions and from this analysis prepare an outline mission statement for the DoF
- Design a time bound strategy for the development and implementation of a coherent plan to address the priority areas over a five year (detailed) and ten year (indicative) timescale by 30 November 2002
- Develop an outline National Fisheries Development Plan, identify the necessary resources and capacities to deliver the plan and recommend a coherent and integrated institutional framework for implementation
- Identify current and future constraints to implementation of the plan and propose an integrated program for national and external support

The core Planning Team was recommended to include members from other institutions (eg NGOs, WARPO and LGED), and to co-opt members from other key institutions (eg Environment/Forests, community based organizations and the private sectors). The suggested deadline was revised to

In broad terms, the NFP reflects the character of the previous and current FYPs in stating ambitious goals but failing to develop plans for implementation. Although the Policy specifically identifies thirteen priority areas for action, twelve of these relate to increased production and export while only one relates to the 'socio-economic condition' of fishers.

Current overview

Table 2-3 provides a simplified SWOT analysis of the policy context for the fishery sector. Identifying where developments could be positive, where constraints and threats lie and where opportunities can be identified for the sector. Any policy approach would have to take these into account, and to identify ways to control threats and develop opportunities. To date, the national response, to the extent that these factors have been recognised, has been variable. This study has suggested that over the last 43 years in Bangladesh:

- A large number of policies have been produced covering both national (overarching) and sectoral agendas, but there has been considerable overlap and lack of coherence between policies.
- Policymaking has tended to be rather top-down, originating from central government and favouring the priorities and interests of influential elite.

Table 2-3: A strategic overview of fishery policy options

Strengths	**Weaknesses**
Fisheries resources may be resilient; Resource biodiversity Rural producers are dynamic, innovative; Rural producers could manage fisheries; Indigenous skills adapt to new technologies; Rural producers can organise themselves; Government is amenable to international collaboration; Good level of scientific fisheries knowledge in some areas (aquaculture) Some capacity in fisheries management in government; Role of fisheries in economy (& livelihoods) recognised by policy-makers	Poor understanding of policy process; Policies lack coverage; Limited policy formulation capacity; Policy narratives are inappropriate; Policy implementation is weak; Fishers lack access to resources; Fishers lack access to inputs; Fishers lack access to education/information; Fishers lack access to infrastructure; Fishers lack experience of constituency form; Rural economy is constrained; Institutions favour elites; Property rights not well-established; Regulatory framework is weak; GoB extensively involved in service provision
Opportunities	**Threats**
Encourage greater recognition of good governance and economic management to enable fisheries development; Build appropriate policy-making capacity in GoB (new training); Build new narratives/ideas which foster effective fisheries management (sectoral); Build new narratives which focus on rural livelihoods (cross-sectoral); Facilitate process of fisheries development (inductive action research/development) through more NGO/donor/GoB projects; Encourage public-private sector initiatives	Overexploitation of fisheries resources; Increasing human population; Environmental degradation; Policy incoherence Bureaucratic politics Political instability; Weak governance; Limited policy space; Weak economic management; Resistance to institutional change; Resistance to political change

Policy Framework

Key Points:

- The sector policies are disconnected from macro-level goals and local level needs and constraints
- The policy process and wider stakeholder engagement is little developed and

- Policy implementation strategies and monitoring capabilities are weak or lacking

Priority Areas:

- Develop the National Fisheries Policy within the cross-sectoral forum and in the context of the PRSP to address the wider development goals
- Create the implementation strategy and develop modalities for policy implementation and monitoring

Recommendations:

- Policies and strategies pertaining to the sustainable use of renewable natural resources, poverty reduction and economic growth should be rationalized and enacted through appropriate action plans to be developed by the NRMC and FDEC
- Existing policies should be harmonized to ensure there are no overlaps or contradictions in relation to the Fishery sub-sector. Within this process an action plan for the NFP should be developed
- Ensure that policymaking, which has tended to be rather top-down originating from central government favouring the priorities and interests of influential elite, is more participatory and in line with the recommendations for decentralized government as outlined in the IPRSP document.

Policy has been developed specifically for the sector, but should also be seen in the broader context described in natural resource and related policy areas (Box 3). Two GoB policies have had a major impact on environmental issues in general, and fisheries in particular:

- The Twenty Year Perspective Plan (1990 – 2010) which sets out policy on economic growth, poverty alleviation, employment generation and increased self-reliance
- The National Environmental Plan (1995) which focuses on achieving environmentally sound development and the sustainable use of all natural resources.

New Fisheries Management Policy (NFMP), 1986

The NFMP was a major policy departure by the MoFL in 1986; an initiative to overcome problems of exploitation of resources. Its objectives were to divert maximum benefits to genuine fishers through harvesting, and to adopt conservation measures to ensure sustainability of resources. The approach was developed on the basis of the slogan – 'Jal Jar Jala Tar' (He who possesses fishing net should have access to fishing in water bodies).

Whereas policy before had focused chiefly on production and revenue, the NFMP placed the needs of "genuine fishermen" as central and aimed to move the development of national fisheries forwards by relieving exploitation of the poor. The NFMP acknowledged that ownership of Jalmohals by the MoL severely restricted the ability of the MoFL to 'carry out its mandate to manage, protect and conserve the inland fisheries of the country' and set out to protect fishers from influential middlemen and limit the number of fishers to protect stocks.

The policy was to be implemented by i) identifying so-called "genuine fishers" and organising them into groups, ii) providing licenses for well-defined waters together with the gradual phasing out of the yearly lease system and iv) the provision of technical inputs to these groups. These inputs included integrated pest management and stocking – both of which met with limited success. Subsequently this policy has been modified as named Jalmahal Management Policy, 2009.

Public Water Body (Jalmahal) Management Policy (PWBMP), 2009

The Government under the responsibility of the Ministry of Land has formulated the "*Public Water Body (Jalmahal) Management Policy, 2009*" for privileging the genuine fishermen community in getting lease the khas water body and

'Jalmahal' and revenue based fisheries management for conserving fisheries resources in turn to increase fish production and biodiversity.

- Based on MoU, the jalmahals, those handed over and to be handed over to the Ministry of Fisheries and Livestock (MoFL), Ministry of LGRD, Ministry of Environment and Forests (MoEF) will be managed by them through adopting planned project;
- The concern ministry/department will arrange necessary steps and measures so that genuine fishers or fishers' cooperatives could participate duly in managing the handed over 'jalmahals';
- The Upazilla and District water body management committee will consist of representatives from the private sector, civil society, department of agriculture and law enforcement agency;
- The District Commissioner (DC) will annually update the list of public water body and notify in the notice board, local dailies and websites for the stakeholders;
- Jalmahal Management Committee is given responsibility to evaluate the performance of jalmahal management under different projects based on the indicators including poverty reduction of the concerned fishermen community, improvement of socio-economic condition and role of jalmahal in increasing fish production. Evaluation report will submit to MoL by 30 *Chaitra* every year.
- Government owned closed water bodies (up to 20 acres) which are leased out to the youth society for creating self-employment would not be continued further. In this case, registered youth fisheries (age limit within 18 to 35) cooperative will get priority in getting lease of jalmahal;
- Over 20 acres of closed water bodies will be managed by District Jalmahal Management Committee under the principle of "*jal jar jola tar*" biased towards the genuine fishermen;
- The fishermen committee or cooperatives adjacent to or on the banks of the jalmahal are registered by the Department of Cooperative who can apply for the management of respective jalmahal;
- Any fishermen community /group/samity living adjacent to a water body is registered by the Department of Cooperative will be the beneficiary of that particular water body;
- In case of jalmahals over 20 acres, the District Jalmahal Management Committee (DJMC) in favour of MoL is mandated to issue lease the jalmahal to the locally registered genuine fishers organization/club for three years based on negotiation;
- The lease-holders are not allowed to sub-lease the water bodies and must use it only for fish production;
- While the Upazilla fisheries officer will recommend whether the samity members are actually fishermen or not, the Upazilla Water Body Management Committee will prepare and finalize the fishermen group living adjacent to a particular water body;
- The commercial banks and financial institutions will provide loan to the fishermen or their community in order to scientifically manage the leased water bodies;
- A database will be prepared and updated with information regarding the public water bodies of the country; and
- The lease value of each jalmahal will be fixed at 5% increment on the average of the last three years leased value.

National Water Policy (NWP), 1997

Realizing the harmful effect of FCD/I projects on capture fisheries habitat and production system including obstacles to the migration routes of fishes, Government in its National Water Policy (1999) gave due consideration to fisheries and environment. Availability of water is essential for sustenance and growth of fisheries sector. Accordingly the following provisions have been made on the Policy:

- Fisheries will receive due emphasis in water resource planning in areas where the anticipated social impact is high;
- Measures will be taken to minimize disruption to the natural aquatic habitat and water channels;
- Drainage schemes, to the extent possible, will avoid state-owned swamps and marshes that have primary value for fish, waterfowl or other wildlife;
- Water bodies such as haor, baor, beel, roadside ditch/borrow pit, etc. will be reserved for fish production and development to the extent possible;
- Perennial links of the water bodies to the rivers will be properly maintained;
- Water resources projects will not interrupt fish movement and adequate provisions in controlled structures will be made to allow fish migration and breeding; and
- Brackish aquaculture will be confined to specific zones designated by the Government for this purpose.

National Wetland Policy (NWtP- Draft/prepared by IUCN)

The Principal Objective of the Wetland Policy will be to promote the conservation of wetlands in Bangladesh, in order to sustain their ecological and socio-economic functions and thereby further the aims of sustainable resource development. In order to achieve this Objective the Government of the Peoples Republic of Bangladesh will take the actions outlined below.

- Establish the key principles by which Wetland resources can be sustainably used;
- Ending the existing unsustainable practices in wetlands so as to stop and reverse the decline in their productivity;
- Ensure that measures are taken to maintain existing levels of biological diversity in Wetlands;
- Maintain the functions and values derived from Wetlands throughout Bangladesh; and
- Actively promote the recognition and integration of wetland functions in resources management and economic development decision- making, with particular regard to sectoral policies and programmes in the water, fisheries, agriculture, industries tourism and infrastructure sectors.

Key Principles of Wetland Policy

In pursuance of the above actions the Wetlands Policy will be based on the following 'key Principles:

- Wetland resources form a very important part of the environment in Bangladesh and therefore their conservation must be ensured;
- Wetland conservation will not exclude development of resources, provided that this development is ecologically sustainable and economically beneficial to the people of the locality; and
- Wetland conservation and development must involve the local communities and therefore people's participation must be ensured.

Many issues have been incorporated in the wetland policy. In the section augmentation of fisheries resources, Beels and Haor fisheries along with pond/tank fisheries have been discussed. The main issues regarding beels and haors are as follows:

- Conversion of wetland into rice fields during the boro season, thus destroying the wetland habitat;
- Encouragement to over fishing by leasing to the highest bidder; and
- Lack of enforcement of existing laws, rules and regulations.

Policy Recommendations on Augmenting Fisheries

- All identified Beels, Baors and Haors will be notified in the Bangladesh Gazette, and in all of them except those earmarked solely for conservation of biodiversity, the primary development aim will be the augmentation of fisheries;
- In pursuance of the above objective a land and water sharing scheme will be worked out for each Beel, Baor and Haor. This will enable optimum development of fisheries but also allow some use for grazing and crops;
- All rivers, which are defined as including hills, streams and khals, will also be classified according to various different needs for their water and their land area (which includes chars). Fisheries needs will be given primary except where irrigation or navigation considerations are deemed more important;
- A Panel of Experts will be formed, under the Ministry of Planning, to carry out the above-mentioned classification and to recommend proper land and water use. This Panel will contain experts recommended by the Ministries of Water Resources, Land, Environmental and Forest, Industries and Communications;
- Halda River will be placed under a Standing Committee nominated by the Ministry of Fisheries, Water Resources and Environment and Forest, so that it's Carp Spawning Areas are adequately protected. Similarly all brood fisheries will be protected on recommendation of District Wetlands Conservation Committee (DWCC);
- The MoFL will take adequate measures to develop all khas ponds (tanks) for their fishery potential. Ownership of all types of khas ponds/tanks will be placed under MoFL, so that MoFL can take adequate measures to develop all khas ponds/tanks to optimize their fishery potential;
- NGOs will be encouraged by the MoFL to manage derelict ponds (tanks) so that their fishery potential can be realized; and
- A Land Use survey will be undertaken of all coastal aquaculture with a view recommend measures to restrict their damaging effect and increase their productivity potential. The report issuing from this survey will also consider optimum energy use, so that these wetlands are fully utilized.

National Food Policy (NFdP), 2006

Food is a basic human need and plays a crucial role in the agro-based economy of Bangladesh, where a large proportion of the income of the population is allocated to food. The first and foremost responsibility of the State is to ensure an uninterrupted supply of food to all people at all time. To achieve "adequate and stable supply of safe and nutritious food" the government will take initiatives for agricultural development and extension, the best and most efficient use of available land, agricultural inputs and efficient use of water resources for irrigation and for production of livestock, fish and other non-crop items including fruits.

Development of Non-Crop Agriculture (Fisheries)

Increasing production in the fisheries sub-sector can be considered as one of the important frontiers towards augmenting overall food production in the country. Considering the importance of this sub-sector in the country's food security and foreign exchange earnings, the government will encourage increased production and development through undertaking the following activities:

- Improvement of quality and productivity of fisheries by strengthening research, training and extension services;
- Ensure development of animal health care services, particularly for the control of parasitic and infectious diseases through wider coverage of vaccination of poultry and cattle heads and take necessary measures for conservation of indigenous species;
- Support to development of feed industry for fisheries;
- Investment assistance for expansion of marketing network for production technologies, input supply, improved technology for preservation and marketing of fisheries products;
- Support development and expansion of technologies for the resource-less and poor by involving non-governmental organizations at a larger scale; and
- Ensure expansion of integrated rice plus fish production system in the rice fields.

For achieving the targets a number of Investment Plans or Portfolios will be proposed in the Fisheries Sector Plan under the Delta Plan of the country.

2.8. Code of Conduct for Various Segments of Aquaculture-based Industry in Bangladesh

Due to natural and man-made changes, the open water fish production from the inland waters is now declining. Aquaculture has been receiving more and more attention for increasing fish production. Despite its significant contribution to the global food production and economy, aquaculture is not beyond criticism, often for valid reasons. The main points of concern related to:

Environmental issues related to (i) Mangrove destruction, (ii) Bio-diversity destruction by mass collection of shrimp post-larvae along with myriad of miscellaneous non-target aquatic organisms from the sea-shore and brackish water rivers; the latter are just wasted, (iii) Effluent discharge often with heavy loads of silts and organic matter offsetting the balance of the aquatic environment, (iv) Releasing prohibited or harmful chemicals used in the shrimp or fish farms, (v) Releasing diseased farm animals or exotic species from the farm into the open environment.

Social issues and resource use conflicts mainly include (i) Obstruction of common property wetlands and flowing rivers and canals for aquaculture, (ii) Salt water intrusion in agricultural lands affecting agricultural crops, (iii) Unauthorized use of others' land, (iv) Using child labour.

Food safety issues chiefly related to (i) Use of agricultural pesticides that may access to aquaculture areas

(ii) Prohibited or restricted drugs and chemicals often used as preventive, curative or growth promoting agents in the farm feed or water, eventually gain access into the shrimp and fish and ultimately into human consumers.

Code of Conduct of DoF

A Code in the field of aquaculture industry is a set of prescribed rules and practices that one or all individuals of an organization or facility must properly comply to achieve a certain desired goal. The code of conduct for various segments of the shrimp aquaculture industry in Bangladesh to help ensure (i) food safety by minimizing biological and chemical risks and hazards that are likely to affect human health, (ii) traceability of the food, (iii) environmental

sustainability and bio-diversity, (iv) labour standard and (v) social harmony at each step of the value chain. All these issues are very important for sound and sustainable development of the industry providing safe, environmentally sustainable, and socially acceptable shrimp and other fisheries products for domestic consumption as well as export.

The DoF has prepared Codes of Conduct for the following segments of the shrimp industry:

1. Black tiger or Bagda shrimp (*Penaeus monodon*) hatchery
2. Galda (*Macrobrachium*) shrimp hatchery
3. Black tiger or Bagda shrimp (*Penaeus monodon*) farm
4. Galda shrimp (*Macrobrachium*) farm
5. Shrimp / Fish feed mill
6. Shrimp collection and service centre or depot
7. Ice plants
8. Fishing boats
9. Shrimp or fish carrier transport van / vessel

Following issues are considered in maintaining code of conduct in aquaculture:

i. Legal ownership and right to the use of the hatchery land and infrastructure;

ii. Harmony with the community

iii. Environmental protection and sustainability:

a. Site selection saving mangrove and public wetlands,

b. Layout, design, construction and operation,

c. Water conservation,

d. PL source,

e. Brood-stock origin,

f. Brood-stock health,

g. Safe discharge of waste liquids and solids (Effluent Management),

h. Sediment management and

i. Storage and Disposal of Hatchery/Farm Supplies.

iv. Food safety

a. Drug and Chemical Management,

b. Avoidance of pesticide contamination,

c. Microbial sanitation,

d. Feed and feed management,

e. Shed and shrimp dumping facilities at harvesting points,

f. Water supply,

g. Ice supply,

h. Synchronizing farm harvesting and shrimp transportation to depot/processing factory at the earliest to ensure freshness of the shrimp, and

i. Daily cleaning and sanitation.

v. Registration with and license from an appropriate organization

vi. Selling and transportation of pl

a. Minimum age for sale of PL

b. Techniques to be used

vii. Workers' health and hygiene issues

viii. Labour standard compliance: Labou Law

ix. Traceability records

a. Farm shall systematically record data in the DoF prescribed Record Book

FAO Code of Conduct for Responsible Fisheries

This Code sets out principles and international standards of behaviour for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity. The Code recognises the nutritional, economic, social, environmental and cultural importance of fisheries, and the interests of all those concerned with the fishery sector. The Code takes into account the biological characteristics of the resources and their environment and the interests of consumers and other users. States and all those involved in fisheries are encouraged to apply the Code and give effect to it.

The objectives of the Code are to:

a) establish principles, in accordance with the relevant rules of international law, for responsible fishing and fisheries activities, taking into account all their relevant biological, technological, economic, social, environmental and commercial aspects;

b) establish principles and criteria for the elaboration and implementation of national policies for responsible conservation of fisheries resources and fisheries management and development;

c) serve as an instrument of reference to help States to establish or to improve the legal and institutional framework required for the exercise of responsible fisheries and in the formulation and implementation of appropriate measures;

d) provide guidance which may be used where appropriate in the formulation and implementation of international agreements and other legal instruments, both binding and voluntary;

e) facilitate and promote technical, financial and other cooperation in conservation of fisheries resources and fisheries management and development;

f) promote the contribution of fisheries to food security and food quality, giving priority to the nutritional needs of local communities;

g) promote protection of living aquatic resources and their environments and coastal areas;

h) promote the trade of fish and fishery products in conformity with relevant international rules and avoid the use of measures that constitute hidden barriers to such trade;

i) promote research on fisheries as well as on associated ecosystems and relevant environmental factors; and

j) provide standards of conduct for all persons involved in the fisheries sector.

3. Institutional Setting

3.1. Introduction

Development and growth in the aquaculture sector are sustainable only if complemented with adequate support services. Training, extension, credit, skilled human resources and market infrastructure lay the groundwork for increasing productivity and competitiveness. As in other countries, support services in Bangladesh traditionally focused on capture fisheries. In recent years, they have been shifting to aquaculture.

3.2. Fisheries Organizations and Institutions

Several organizations and institutions are involved in fisheries development and management in Bangladesh (Organogram in Figure 3-1). Ministry of Fisheries and Livestock (MOFL), Government of Bangladesh is the main and lead administrative agency responsible for formulating fisheries policy and development strategies. Under MOFL there are four agencies namely (i) Department of Fisheries (DoF), (ii) Bangladesh Fisheries Research Institute (BFRI), (iii) Bangladesh Fisheries Development Corporation (BFDC) and (iv) Marine Fisheries Academy, each with specific functions and responsibilities for development and management of the fisheries sector.

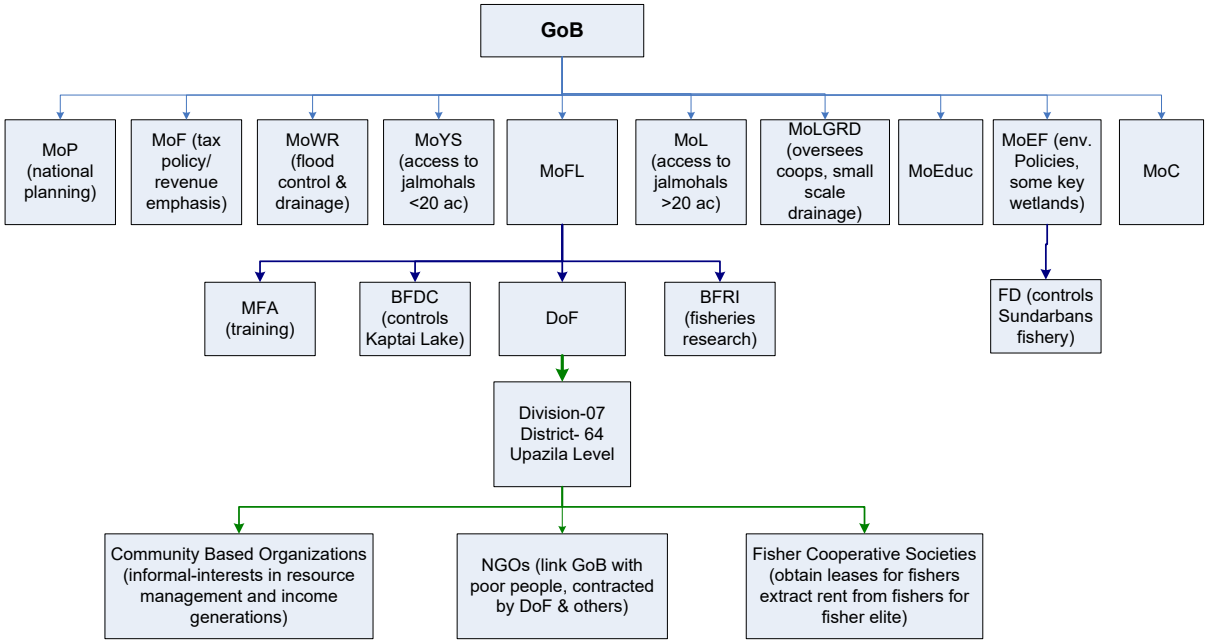


Figure 3-1: Government and non-Government agency roles in fisheries in Bangladesh

3.2.1. Department of Fisheries

The Department of Fisheries (DoF) is the largest of the state owned fisheries organisations responsible for fisheries development and management both in the inland and marine waters of Bangladesh. It is presently functioning under the Ministry of Fisheries and Livestock. The mission statement reflects the overall goal for the DoF and incorporates the objectives for the sector as a whole including all stakeholders.

Mandate of DoF

Fisheries Extension Services

In the recent past, several development projects of the DoF have been launched with strong extension and institutional strengthening components for both carp and shrimp culture. Different approaches and strategies of aquaculture have been adopted under different projects. The DoF has engaged a number of NGO's in extension/common management activities under some of its projects. The extension efforts of the DoF both in revenue as well as development set-up are still inadequate. Extension services include technical advice on all sorts of aquaculture and related activities, central demonstration of farming, publication and distribution (free of cost) of booklets, posters, leaflets, etc. Following are the main extension related activities:

- Provide technical know-how to the farmers through training and advice on aquaculture and management;
- Disseminate modern and improved technologies on aquaculture, fisheries management and hatchery operation, etc.;
- To facilitate arrangement for institutional credit for fish and shrimp farmers, fishers and fish traders;
- Undertake surveys and investigation for fisheries resources; and
- Implement development projects to support farmers and fishers.

Conservation of Fisheries Resources

- Enhance fisheries through conservation and management of fisheries resources; and
- Enforce Fisheries Acts, Rules, Regulations, etc.

Quality Control of Fish and Fisheries Products

- Ensure quality of fish and fishery products and issuance of health certificate of exportable fish products; and
- Enforce of fish and fishery products (Inspection and Quality Control) Rules.

Policy Framework

- Advising the Government in formulating policies related to aquaculture and aquatic resource management;
- Collection of data on fisheries and its compilation, editing and publications; and
- Planning, formulation, implementation, monitoring and evaluation of Fisheries Development Projects.

Health and Socio-economic Development

- Socio-economic development of fisher-folk by facilitating alternative income generating activities;
- To formulate and implement development projects towards sustainable utilization of fisheries resources to ensure food security.and
- Poverty alleviation through aquaculture and aquatic resource management.

Human Resource Development

- Train DoF officials to make them competent in catering to the needs of the farmers/fishers and enable them to pursue sustainable management of aquatic resources.

Organizational Setup of the DoF

For rendering above services to achieve the mission and vision of the DoF, it has following wings: (i) Inland Fisheries, (ii) Marine Fisheries, (iii) Fisheries Resources Survey System (FRSS), (iv) Fish Inspection and Quality Control (FIQC), and (v) Training. A total of 5,786 manpowers[5] from different tiers are involved in DoF for providing its mandated services (Figure 3-2). Among the posted manpower 4,314 are under revenue budget and 1,472 are under development projects.

3.2.2. Bangladesh Fisheries Research Institute

The Bangladesh Fisheries Research Institute (BFRI) usually conducts different types of research institutionally on inland and marine fisheries. The BFRI is responsible for undertaking basic and field need-based research for technology development in the field of aquaculture, fisheries management, and post-harvest technology for transfer to the private sector through DoF. The following roles are observed by the BFRI:

- Research Division: This division comprises two units-
  - A programme section which takes care of planning and monitoring of research and statistics and socio-economic studies.
  - An operation unit which takes care of the operation of five research stations, namely, the Freshwater Station (FS) at Mymensinghm, the Riverine Station (RS) at Chandpur, the Brackish water Station (BS) at Paickgacha of Khulna and at Bagerhat and the Marine and Fisheries Technology Station (MFTS) at Cox's Bazaar.
- There are two sub-stations:
  - Reservoir Fisheries Management Sub-station at Rangamati; and
    - Floodplain Ecosystem Management Sub-station at Santahar, Bogra

Two more fisheries research stations are being planned to be established by the BFRI with financial assistance of the government by 2015: one at Mulshatal mouza of Bowlai union of Kishoreganj Sadar under Kishoreganj district called the "Haor Fisheries Research Station" and another at Kushli mouza of Kushli union of Tungipara upazila under Gopalganj district called the "Beel Fisheries Research Station". The objectives of establishing these two stations are as follows:

a) for sustainable development and conservation of the haor and beel fisheries resources of Bangladesh respectively;

b) for carrying out demand driven research for development of appropriate technologies for increasing production, diagnosis and controlling fish diseases and conserving haor and beel fisheries resources; and

c) for creating modern training and demonstration facilities and provide training for dissemination of new aquaculture and inland open water fisheries management technologies to fishermen, farmers and entrepreneurs.

- Training and Co-ordination

This division provides short-term training programmes on different aspects of fish culture and technology to field level extension workers, fish farmers and relevant staff engaged in various non-government and government organisations. Besides, arrangements are periodically made for holding seminars, workshops, symposia and academicians and conferences for the exchange of ideas among planners, academicians and researchers of the

[5] Compilation, National Fish Week, 2015, DoF, MoFL

country. Co-ordination of similar programmes undertaken by the headquarters and research stations is the responsibility of this division.

- Support Service Division

This division has two units:

d) A technical division with the responsibilities of engineering and procurement activities; and

e) An administration and finance section for the administrative and financial activities of the Institute.

3.2.3. Bangladesh Fisheries Development Corporation

Bangladesh Fisheries Development Corporation (BFDC) is a public sector organisation under the Ministry of Fisheries & Livestock dedicated to the development of fisheries in Bangladesh especially in the field of marine fisheries. The facilities of the BFDC include: one fish harbour, seven fish landing and wholesale fish market, 15 ice plants each with 235 MT/day, four fish processing center, 12 cold storages having capacity of 1630 MT each, 12 freezing plant each with 48.50 MT/day, nine frozen storage having capacity of 1100 MT, six insulated fish van, nine (2 shrimp & 7 white fish) fishing trawler, one marine workshop, one dockyard having two slipways, and one slipway for mechanized boats.

The main function of the Corporation is to help in developing the fisheries sector of the country by carrying out the following roles and responsibilities:

- Taking all measures for the development of fisheries and fishing industries;
- Establishing fishing industries;
- Establishing units for capture of fish and promote better organisation for exploitation of fish wealth;
- Acquiring, holding or disposing of fishing boats, fish carriers, road and river transports and all equipments and accessories necessary in connection with the development of fishing industry;
- Establishing units for preservation, processing, distribution and marketing of fish and fishery products;
- Undertaking survey and investigation of the fishery resources;
- Establishing institute or make arrangement for the training and research in the methods of catching, processing, transportation, preservation and marketing of fish;
- Setting-up organisation for export of fish and fishery products;
- Establishing fish catching unit to build up organised body for exploitation of fisheries;
- Forming fisheries industry and fishermen co-operative society;
- Formulating scheme or schemes for carrying out all or any of the functions specified above.

BFDC is presently responsible for marketing of formalin free fish including creating marketing and fish landing facilities, while Marine Fisheries Academy is responsible for training of cadets for marine fishing vessels.

However, in practice, policy and its application in inland fisheries is determined more by the Ministry of Land and finance requirements from fisheries than from MOFL and Department of Fisheries. The fisheries sector has focused on production and more recently on sustainability and access for fishers and the poor, while the central government focus in fisheries is still to collect revenue and exert patronage over fisheries irrespective of the income level of the fishers who actually depend on the fisheries.

Amongst other agencies involved in the Fisheries Sector, Ministry of Land (MOL) is very much related to fisheries management as it controls all the public water bodies in rivers, beels, ox-bow lakes, Government owned ponds etc. In

the private sector fisher cooperative societies and NGOs are also involved in fisheries sector. Other organizations and institutions[6] involved in fisheries are listed in Table 3-1 below:

Table 3-1: Government agencies involved in fisheries management and conservation

Ministries	Institutions	Activities
Ministry of Fisheries and Livestock (MoFL)	Department of Fisheries (DoF)	Extension, management, project implementation, training and human resource development, enforcement of laws and regulations, conservation, quality control, registration & certification, fishing licenses, fisheries awareness building and motivation, support to policy formulation, administration, etc.
	Bangladesh Fisheries Development Corporation (BFDC)	Marketing, production, training, etc.
	Bangladesh Fisheries Research Institute (BFRI)	Fisheries and other aquatic animal related research and training
	Fisheries and Livestock Information Department (FLID)	Fisheries and livestock related information dissemination
Local Government, Rural Development and Co-operatives	Upazila Administration	Management of water bodies less than 20 ha, field level supervision and management of fisheries resources, etc.
	Rural Development Board	Fisheries components of integrated rural development
	Directorate of Co-operatives	Registration and Supervision of fishermen co-operatives
	Bangladesh Jatiya Matshyajibi Samabay Samiti (BJMSS)	Development of fishermen co-operatives and facilitate of procuring ice plants and import of gears
	Bangladesh Samabay Bank Ltd.	Financing fishermen's co-operatives
Ministry of Land (MoL)	Land Administration and Land Reform Division	Leasing of public water bodies
Ministry of Water Resources	Bangladesh Water Development Board (BWDB)	Leasing of reservoirs and irrigation canals and implement fisheries projects
Ministry of Commerce	Department of Commerce	Promotion of fish and fishery products, registration and regulation of fish processing plants
Ministry of Shipping	Mercantile Marine Department	Registration of fishing vessels/boats/crafts
Ministry of Education	Universities, colleges and training institutes	Higher fisheries education and diploma
Ministry of Sports and Youth Development	Youth Development and Training Center	Training, motivation and credit support to fish culture practice to youths
Ministry of Finance	External Resource Division	Administration of external aid on fisheries
	Commercial Banks	Credits or loan for fish culture
		Budget for the fisheries sector and projects
Ministry of Planning	Fisheries Section	Planning and approval of fisheries sector projects and monitoring and evaluation of different projects
Ministry of Foreign Affairs	-	Fish export related functions and expansion of fish and fishery products export. All fisheries related international policies and issues.

[6] *Source: www.bangladeshgov.org/www.MoFLgov.bd*

The key features are:

a) the division of interests in fisheries (e.g. between land administration, Department of Fisheries and Forest Department),

b) overlaps in policy between land, water (two different ministries and agencies build water control structures), environment and fisheries which are yet to be harmonised; and

c) overall dominance by short term revenue interests and leasing systems supported by the Ministry of Finance and Ministry of Land which are at odds with sustainable harvesting (and sustainable tax revenue) and with poverty reduction.

Fish production and harvesting systems are almost entirely in the hand of the private sector, with the exception of some production-oriented activities required for demonstration and field testing of technology and training and extension undertaken by the DoF. Exploratory/ experimental fishing required for stock or impact assessment of any management intervention is carried out by the Govt. Agencies. BFDC of course undertakes commercial fishing in the Bay of Bengal by trawlers.

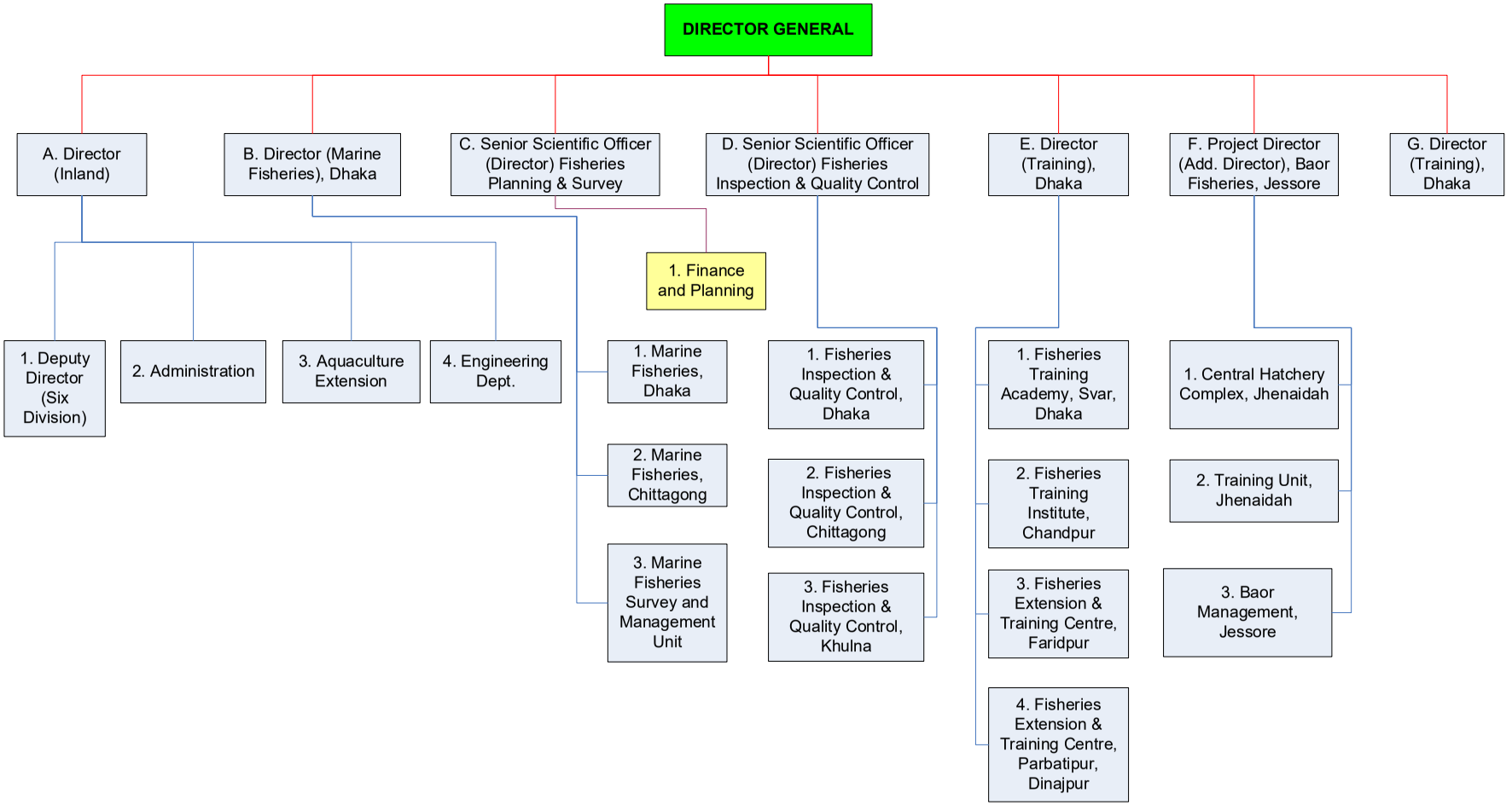


Figure 3-2: Organogram of the DoF

3.3. Fisheries Academy

There are five fisheries academies in Bangladesh and these have a substantial role to play in developing the fisheries sector. The following Table 3-2 attributes the locations of individual academies along with their roles and responsibilities[7].

Table 3-2: List of fisheries academies, their locations and roles

Academy	Location	Roles
Marine Fisheries Academy	Chittagong, BFDC	Degree on Marine Fisheries including Navigation, Marine Engineering, Electrical Engineering, Refrigeration Engineering, Radio Engineering and Operation, Trawler Operation, Fish Processing and Boatmen Training, etc.
Fisheries Training Academy		
Fisheries Training Academy	Savar, Dhaka	Provides administrative and technological training to DoF officials
Demonstration Farm and Training Center	Teknaf, Cox's Bazar	
Fisheries Training Center, ADB Hatchery	Charpara, Cox's Bazar	
Fish Breeding & Training Center	Raipur, Lakshmipur	
Fish Breeding & Training Center	Parbatipur, Dinajpur	
Fisheries Training & Extension Center	Purba Gangabardi, Faridpur	
Fisheries Training Center	Nator Sadar, Nator	
	Kotchandpur, Jhenaidah	
Fisheries Training Institute	Chandpur Sadar, Chandpur	
Fisheries Training and Extension Center	Maskanda, Mymensingh	
Fisheries Extension and Training Center	Faridpur	Fish culture and fisheries management training to farmers and officers
Fisheries Training Institute	Chandpur	In-service training on fish culture, management and administration for fisheries officers; 4 years Diploma on Fishery
Fish Hatchery and Training Center	Raipur	Fish culture and hatchery technology to farming and in service training

[7] *Source: www.bangladeshgov.org/www.MoFLgov.bd*

3.4. Vision and Mission of Fisheries Sub-sectors

The key features of the vision and mission of the fisheries sector are as follows:

Vision of DoF: The Department of Fisheries (DoF) has envisioned some important programs and targets to achieve the goal of Vision 2021. Initiation of good practices in environment friendly fish/shrimp farming for promotion of export, biological management of jalmohals, establishing of easy access of real fishers to the open water capture fisheries, creation of employment opportunities and other various pragmatic programs have been taken by the DoF to facilitate achievement of 'Vision-2021'. It is expected that all these programs will contribute to reduce present poverty from 6.5 crores to 2.2 crores by the year 2021.

Mission of DoF: The mission of the Department is "*to support sustainable growth in fish and shrimp production with other aquatic resources as well, for domestic consumption and exports, and management of open water fisheries resources through community participation leading to equitable distribution of the benefits generated, for optimal economic and social growth in Bangladesh*".

Vision of BFRI: The vision of BFRI is to become a Center of Excellence on Fisheries Research to evolve aquaculture technologies, and management guidelines for open water fisheries to optimize sustainable harvest from national aquatic resources in consonance with environment, economics and equity and to assist the country in all matters relating to its fisheries R&D.

Mission of BFRI: Interfacing fisheries science and education to bridge between demands and capacity of potential aquatic resources and assuring the role in global fisheries through sustainable growth of the sub-sector.

4. Challenge and Opportunity

4.1. Strength, Weakness, Opportunity and Threat

Strength, Weakness, Opportunities and Threats (SWOT) is a widely used tool for analyzing internal and external environments in order to attain a systematic understanding of a strategic management situation (Wheelen and Hunger, 1995; Kotler, 1988). The philosophy behind the SWOT analysis is that the strategies an organization adopts should match the environmental threats and opportunities with the organization's weaknesses and especially its strengths (Weisheng Lu, 2010). The SWOT analysis provides a framework for identifying critical issues and helps in isolating key issues in order to facilitate a strategic planning to resolve the fisheries related problems. Under fisheries sector analysis, strengths and weaknesses are concentrated mostly on issues while threats and potentials are mainly concentrated on driving forces. Table 4-1 attributes the list of strength, weakness, threat/limitation and potential/opportunity in fisheries sector of the country.

It tries to establish a strategic fit between an organization's internal strengths and weaknesses and the opportunities and threats posed by its external environment. This thinking has widely been accepted as a fundamental principle underlying modern strategic management (Beer et al., 2005). Therefore, SWOT analysis has been conducted to analyze the potentiality of the fisheries sector in Bangladesh to formulate the strategic action plans in response to the future challenges of fisheries sector.

Table 4-1: Strength, weakness, opportunity and threat

Strength	Weakness	Opportunities	Threat
Natural Resources			
Inland open water bodies/wetlands Mother fishery and breeding grounds Extended marine fisheries area under new maritime boundary Swamp forest and marsh vegetation High quality native brood fish SIS dominant floodplain fisheries Inland fisheries genetic resources Brackish water fish breeding ground (Mangrove forest) Anadromous and Catadromous fish dominant coastal fisheries Marine Genetic Resources Others (Specify)	Increasing trend in habitat degradation Obstructed fish migration Indiscriminate fishing Aerial and vertical overlap of fishing Seasonal water pollution Scattered and unorganized fish aquaculture ponds Flooding inundation of fish ponds Genetic erosion of fish species Inadequate organized floodplain aquaculture Lack of zoning for shrimp aquaculture in coastal areas Poor management of fishing grounds Poor understanding of policy process Property rights not well-established Others (Specify)	Restoration of fish habitats and seasonal refuge areas Establishment of fish sanctuary in depressions (Beels) and pools (Duars/Kums) of rivers Diversified approaches for revival of fish biodiversity Utilization of floodplains Preservation of gene pool/supply of quality fish seed 'Jalmahal' leasing to fishing communities under co-management arrangement Surplus fish production for export Hilsa and other estuarine fish migration Surplus production for export from prawn, shrimp and mud crab culture Involvement of small and medium entrepreneurs in culture fisheries Encourage public-private sector initiatives Identification and utilization of fishing grounds in the new maritime boundary Others (Specify)	River flooding to culture fisheries Over-exploitation of fisheries resources Unplanned urbanization Unplanned industrial development and effluent discharge Habitat destruction Suppression of natural regeneration of swamp plants Effect of cannibalistic species Deforestation Increasing dam on the trans-boundary rivers Withdrawal of upstream freshwater flow Influence of climate change extremity Recurrences of natural disasters including flooding Weak governance Aquaculture induced environmental pollution Climate change Others (Specify)
Human Resources			
Highly experienced traditional fisherman community Fish farming know-how Competencies in fisheries officers and	Rising of opportunistic part-time fishermen Lack of awareness of environmental sustainability Land ownership belongs to land ministry	Empowering local fishers/farmers with technological know-how Land tenure wide fishermen participation in fisheries and other natural resource	Spread of invasive or exotic cannibalistic fish species Proposal for funding Traditional management systems are being

Strength	Weakness	Opportunities	Threat
scientists Increasing small and medium entrepreneurs Existence of local level organizations (GOs & NGOs) for coordinating interests of fisheries Fisheries based studies Others (Specify)	Indiscriminate fishing Inadequacy in fish conservation measures and fisheries campaign Lack of capacity for integrated fisheries management Conflicts between fishers-farmers & within community Lack of adequate DoF staffs and professionals Lack of fish based recreational facilities Others (Specify)	management Women participation and empowerment in fisheries management Rising economic capital of small and medium entrepreneurs in fish culture and fishing management Foster beneficial rural-urban link Others (Specify)	challenged by powerful interests Changing spectacle on fisheries employment Others (Specify)
Economical Resources and Fisheries Marketing			
High cost-benefit ratio in fish production Loan/micro-credit program by NGOs and banks Government's good will in fostering fisheries Stabilized fish market Others (Specify)	Unstable value chain system Inadequacy in fisheries forward and backward linkages Improper combination of species and ration of area-individual number in polyculture practice Insufficient investment in fisheries research & study Post-harvest losses Indiscriminately distributed fish products Others (Specify)	Establishment of adequate and quality forward and backward linkages Increasing agro-tourism services Spread out of agro-based industries Increasing chain shops and departmental stores in urban and semi-urban areas Financial support to entrepreneurs Rising national economy through involving small and medium entrepreneurs in fish culture and fishing management Others (Specify)	Presence of relatively more mediocre from producer to consumer Livestock commodity (cow, goat, sheep, etc) barrier in shrimp farming area Indiscriminate marketing system Less interest in abiding by the code of conduct in preparation and using of fish feed Others (Specify)
Social Resources			
Strong social norms, values, ethics, etc. Strong social bonding among fishers and farmers (Trust) Strong social networking Fisher's Associations Social fair	Deficit in trust between local fishermen/farmers and staffs of DoF and other NGOs Social conflict between fishermen and agriculture farmers Leasing of 'Jalmohal' to influential persons rather than the fishers community	Community based fisheries co-management approach for developing the sector Promoting long-term and mid-term integrated fisheries development programs under Participatory Fisheries Management (PFM) approach	Anthropogenic security issue like robbery, killing of fishers in marine fishing Natural calamity Mortgage/*Dadan* Equity issue i.e. social conflict for sharing benefits

Strength	Weakness	Opportunities	Threat
Others (Specify)	Inefficient signaling system in weather forecast in marine condition Inadequate awareness in coping mechanism against the adversity in marine condition Others (Specify)	Development of a robust, integrated and adaptive fisheries management strategies Community enterprise approach in floodplain aquaculture Others (Specify)	Biasness in selecting proper fishermen in leasing 'Jalmohal' Enmity predominantly in aquaculture sector Others (Specify)
Technological Resources			
Multidimensional traditional gears Gears are mostly species specific Multidimensional crafts: traditional and mechanized crafts Others (Specify)	Lack of developed ICT system in local level of fisheries management and fish farming system Lack of digitalized financial mechanism at local and regional fisheries management Lack of digital information-help activities Inadequate tools and trawls for industrial fishing in respect of new maritime boundary Others (Specify)	Digitalization in maintaining fisheries information and sharing its benefits Quick information and credit support system for local fishermen community Extension of Fisheries Information Service Center (FISC) all over the country up to Union Improvement of signaling system in weather forecast in marine condition Others (Specify)	Improper use of ICT Local adoption of ICT systems ICT mobilizations Others (Specify)
Research			
Govt. and foreign donor funded University-level academic research on fisheries resource management, hatchery system, aquaculture, reproductive potentiality, proximate biochemical composition, histological, genetic engineering, etc. Research on induced breeding Research on Hilsha migration, breeding, etc. Others (Specify)	Lack of integrated fisheries research like Flood Action Plan-17, -20, etc. Lack of knowledge sharing of the findings of conducted research Lack of research in finding out fishing grounds in new maritime boundary Others (Specify)	Integrated research for Fisheries Master Plan for Bangladesh Research on Suitable Fisheries Zoning Plan for Bangladesh based on the identified Fisheries Hot Spot Research on possible barriers and potentiality to establish ICT system and digitalized and innovative financial mechanism Expansion of genetic engineering research for adaptive fish variety Others (Specify)	Funding Mainstreaming the research findings to national fisheries policy Others (Specify)
Strategic Direction			
National Fisheries Policy, 1998	Maximum ordinance, rules and acts are old	Integrated Fisheries management	Influence of musclemen in the rightful

Strength	Weakness	Opportunities	Threat
Protection and Conservation of Fish Act, 2015 Fish Act, 2015 National Shrimp Policy, 2014 Fish Feed Rules, 2011 Fisheries Hatchery Rules, 2011 Code of Conduct for selected segments of the Aquaculture Industry in Bangladesh, 2011 Fisheries Hatchery Act, 2010 Fish Feed and Animal Feed Act, 2010 National Jalmohal Policy, 2009 Natural Water Body Conservation Act, 2000 The Chingri Mohal Management Policy, 1992 The Protection and Conservation of Fish Act, 1950 The Bangladesh Fisheries Development Coordination Act, 1973 Bangladesh Civil Service (Agriculture: Fisheries) Composition and Cadre Rules, 1980 The Fish and Fish Products (Inspection and Quality Control) Ordinance, 1983) The Marine Fisheries Ordinance, 1983 The Marine Fisheries Rules, 1983 The Fisheries Research Institute Ordinance, 1984 The Protection and Conservation of Fish Rules, 1985 The Private Fisheries Protection Act, 1889	Poor enforcement of rules and regulations Others (Specify)	Food security Surplus production for export Others (Specify)	implementation of these acts is the major hindrance Political willingness Others (Specify)

Strength	Weakness	Opportunities	Threat
Shrimp Culture Tax Rules, 1993 Shrimp Culture Tax Act, 1992			
Management Organizations and Their Roles and Practices			
Fisheries management and development organizations (like Govt Agencies: DoF, BFDC, BFRI, Others (Specify); NGOs: BRAC, ASA, Caritas, Grameen Bank, World Vision; Research organizations: IUCN, CEGIS, CNRS, etc. Fisher/fish farmer organizations Ecologically Critical Area (ECA) Fish biodiversity conservation measures Others (Specify)	Insufficient implementation of management activities Insufficient monitoring and evaluation Inadequacy in accountability Inadequacy in transparency Others (Specify)	Restoration of fish habitats and seasonal refuge areas Establishment of fish sanctuary in deep Beels and river deep pools (Duars) Revival of fish biodiversity Utilization of floodplains Preservation of gene pool/supply of quality fish seed Rising economic capital of small and medium entrepreneurs in fish culture and fishing management Long-term and mid-term integrated fisheries development programs incorporating Participatory Fisheries Management (PFM) approach Development of a robust, integrated and adaptive fisheries management strategies Digitalization in maintaining fisheries information and sharing its benefits Quick information and credit support system for local fishermen community Integrated Fisheries management Establishment of FISC in Unions Food security Surplus for export Others (Specify)	Taxation Funding Influence of musclemen in the rightful implementation of the programs is the major hindrance Others (Specify)

4.2. Strategic Action Plan

4.2.1. Strategy considerations

Wetland management system should be given impetus for improving fisheries sector of the country through retrieving degraded fish habitats, and involving the local communities, relevant government and non-government stakeholders. Additionally, for supplementing the fisheries demand of the poor and huge country-wide need, given less important aquaculture sector has utmost scope to boost up through improving the floodplain aquaculture infrastructure and fish culture technology and its dissemination to the farmer level. Thus to improve the fisheries sector holistically and its productivity as an expected level so as to reach at the saturated state of population-fish demand fulfillment countrywide, fixing up the fisheries sector strategy needs to emphasize on the vast wetland resources and stakeholders management.

Since the country fishery sector is substantially contributing to export earning, it has great potential to play role in achieving the overall export target 22% in GDP by 2014-15 while it was projected 18% for 2009-10 and 26% by 2020-21 set in the Perspective Plan for Bangladesh (PPB) 2020-21. Owing to its great potential, improvement of this sector was expected to keep significant role in the attainment of overall fish production target 36.7 lakh MT by 2014-15 while it was 27.0 lakh MT in 2008-09 and 39.0 lakh MT by 2020-21 (PPB, 2010). Identifying the development initiatives for fisheries sector of the country that might in turn contribute to food and nutrition self-sufficiency, increase employment opportunities and human well-being and maintaining ecosystem equilibrium is the integral part of the wetland management oriented fisheries sector strategy.

In order to meet the projected demand for fish during the 7FYP, the government would need to invest more resources in this sub-sector in order to achieve higher growth of fish production during the planned period. There is a huge scope of producing more fish through which national supply-demand gap could be minimized. Moreover, it has a great potential of exporting more fish.

The wetland management oriented fisheries development strategy must take into account:

- The current strengths and weakness of the wetlands and wetland management systems, different approaches for improving capture fishery, aquaculture practices and also the associated stakeholders for improving fisheries productivity and production in totality;
- The threats that will be impinging upon wetlands and improved wetland management for enhancing capture fishery and aquaculture ponds and inputs in the future; and
- Potentials/opportunities to achieve improvements in fisheries sector by managing wetland resources and by encouraging aquaculture practices with improved technology.

Based on the National Fisheries Policy (NFP) 1998 the fisheries strategy has been formulated to propose ways in which the policies can be implemented and support can be offered to guide the sector. To increase fish production and export earnings DoF has developed the National Fisheries Strategy. The building blocks of the strategy are as follows:

- *Inland capture fisheries sub-strategy:* The management of the inland capture fisheries must balance a diverse set of demands on the resources. To attain sustainable management of the Inland Capture Fisheries for the local fishing and user communities through collaboration of all concerned partners;
- *Aquaculture sub-strategy:* To support the continued development of aquaculture as a key supplier of animal protein and opportunity for resource development, through the provision of a regulatory structure to ensure quality inputs, and by the provision services to enhance knowledge to promote production;

- *Shrimp sub-strategy:* A shrimp sector recognised internationally for its high quality shrimp production using socially responsible and environmentally sustainable production methods, with support to all stakeholders to ensure its development to its full potential;
- *Aquaculture extension sub-strategy:* The provision, by the Department of Fisheries and partners, of an efficient, effective need based extension service to all categories of farmers to enable them to increase production to an optimum sustainable level by using appropriate aquatic resources.;
- *Human resource development sub-strategy:* Strengthen the human resource capacity of the Department of Fisheries, its partners and its primary stakeholders to ensure all levels have the requisite knowledge, skills and techniques to enable them to make productive use of their potentials.;
- *Quality control sub-strategy:* By supporting the implementation of industry controls on quality, ensure that all fish and fishery products marketed for export or domestic consumption satisfy the requirements for quality as detailed under HACCP and other regulations including traceability and social accountability.;
- *Marine sector sub-strategy:* Ensuring the sustainable management of the marine sector through the allocation of fishing rights and its management to communities and relevant fishing groups and by providing the regulatory framework for this management; and
- *Monitoring and Evaluation sub-strategy:* To develop systems able to monitor progress towards the NFP objectives and evaluate activities directed towards achieving those objectives.

The fisheries planning addresses several priorities of the Bangladesh National Fisheries strategy 2006 (Inland Capture Fisheries sub strategy) of Ministry of Fisheries and Livestock (MoFL). These are:

- Environmental management taking an ecosystem based approach to conserve wetlands and reduce dry season water abstraction;
- Biodiversity conservation, *e.g.* through sanctuaries and restoring fish migration routes where they have been blocked; and
- Piloting co-management between communities and local government in a large river.

4.2.2. Future strategies for country fisheries

A number of strategies have been considered in developing investment plans or portfolios for boosting up the fisheries production and improving the dependent livelihoods of the country. These are:

- Habitat and connectivity restoration for fish movement and migration;
- Protection of parental fish, their habitats and spawning grounds;
- Conservation and improvement of fish bio-diversity through different types of sanctuary practices, beel nursery programs, floodplain stocking with larger size fingerlings and management activities;
- Mass awareness and training activities on fisheries related activities;
- Community development with modern technology and financial support for community based biological management of waterbodies;
- Long term lease system with monitoring and management plan;
- Seasonal fishing ban during fish breeding and nursing time under good fisheries management practices;
- Alternate Income Generating Activities (AIGA's) for the fishermen and women to improve livelihoods & diversify their activities to reduce fishing pressure on the important habitats;

- Introduce Vulnerable Group Development (VGD)/ Vulnerable Group Feeding (VGF)/Test Relief (TR) to the poor fishermen to protect fishing during banning period;
- Development of tracability system to identify the sources of contaminants/banned antibiotics and other chemicals used for fish farming and fish processing times so as to take lawful and corrective measures to improve/ratify them;
- Increasing fish production by introducing different fish culture methods under the community enterprise approach in suitable habitats by conserving natural environment including rice-cum-/alternate fish culture;
- Production of quality and purebred fish seed for stocking and culture;
- Production of quality fish feed following the Code of Conduct (CoC);
- Development of fisheries infrastructures for facilitating fish handling and processing activities;
- Fish marketing, fish quality maintenance and preservation of fish;
- Strengthening of information dissemination & extension services and maintains database of all fisheries related information;
- Promoting Information and Communication Technology (ICT) to disseminate fisheries information and modern technology in the remote areas of the country for facilitating fisheries activities particularly the aquaculture;
- Fish farmers should have the government affiliated association or to be included in the fishermen association;
- Regular and long term study/Research on change of Bio-diversity, impact of sanctuary, habitat restoration; physical, chemical & biological changes of haor basin, fish production, fish migration and socio-economic condition of fisher folk;
- Implementation of Fish Act and compliance with Good Aquaculture Practice (GAP) and Good Management Practice (GMP);
- Ensure sustainable conservation, management and exploitation of resources from the sovereign marine waters;
- Stock assessment in conjunction to explore new fishing grounds;
- Undertaking stock assessment in conjunction to explore new fishing grounds by Research Vessel, formulation of National Marine Fisheries Policy;
- Rapid assessment of fisheries stocks by species in recently resolved South-West waters of EEZ
- Immediate moratorium on entry of new trawlers/fishing boats to the existing fishing fleet;
- Strict control on pouching of resources and illegal entry of foreign trawlers;
- Initiate collaborative research programmes to address biodiversity, climate change, strengthening of marine unit of DoF;
- Equip VTMS/AIS to all industrial fishing vessels;
- Explore economics of tuna and large pelagics beyond 200m depth contour of EEZ and ABJN;
- Enhance capacity of relevant agencies to implement MCS; and
- Introduce air surveillance system to control pouching by illegal entry of foreign fishing vessels.

4.2.3. Identification of driving forces of the strategies

An important element of development planning in the identification of those elements of the overall social, economic, environmental milieu which are in a state of change (as distinct from elements which are static and inertia-bound) and the underlying driving forces which are responsible for generating the identified change and transformation. Change

manifests itself as trends, cycles, shocks and rainfall events. Significant changes taking place in the fisheries of the region, as well as their probable causes, have been identified in previous chapters. The results of this analysis have been used to formulate strategic technical measures whose design objectives aim to either counteract or alleviate negative driving forces or supportive positive driving forces. Summaries of driving force/change couplets at international, national and regional levels are presented in Tables 4-2 through Table 4-4.

Table 4-2: International driving forces

Driving forces	Observed change
Global warming	A trend of increasing rainfall and river discharge within the region and its catchment area, resulting in increasing flood intensity which in turn increases capture fish production and adversely affect culture fisheries.
Decreasing world market prices relatively for indigenous Bangladeshi freshwater finfish (due to low pricing by India and Thailand).	Decline in export of freshwater finfish from the region.
Increasing world market prices for prawns due to general increase in demand.	General increase in exports of prawns from the region.
Increasing deforestation and natural resource exploitation in Bangladesh and in the catchment of neighboring country.	Increasing sedimentation and deteriorating water quality of effluent discharges into Bangladesh.
Increasing foreign assistance to fiscal development budget of Bangladesh.	Increasing number of capital intensive FCD/I projects in region, and increasing conversion of natural floodplains and wetlands to agricultural land. Increasing negative FCD/I impacts on fisheries and declining production. Increasing expenditure on artificial stocking of floodplains.

Table 4-3: National driving forces

Driving forces	Observed change
Strong consumer demand for fish in large urban retail markets, due to population growth and declining supply.	Strong upward pressure on domestic retail fish prices.
GoB strongly focused on collecting revenue from the all economic sectors, including fisheries. Overpricing of lease fees for jalmahals. Non-implementation of economically and socially more efficient NFMP.	Recent change from public auction leasing to sealed tender leasing. Increasing over-exploitation of fish stocks and declining catches. Lack of development investment by leaseholders. Increasing relative poverty of fishermen. Declining interest in bidding for jalmahal leases and decreasing revenues collected.
MOL ownership of jalmahals and general administration of jalmahal leasing, characterized by getting benefits by the rich and powerful group often by musclemen.	Increasingly strong resistance by MOL to implementation of NFMP and transfer of jalmahals to DOF. Increasing pressure to return NFMP jalmahals to MOL jurisdiction.

Table 4-4: Regional driving forces

Driving Forces	Observed Change
Increasing failure of smallholder farmers resulting in landlessness.	Increasing number of non-traditional fishermen entering fisheries sector and increasing fishing effort. Increasing extension of fishing activities to restricted fishing areas (such as privately leased jalmahals). Increasing use of illegal small mesh fishing gears. Decreasing fish abundance and production.
Leasing of jalmahals by district GOB administration, characterized by high level of musclemen's interference.	Increasingly strong resistance by district administration to implementation of NFMP and transfer of jalmahals to DOF
Resistance of jalmahal leaseholders to incursions into their leased fisheries.	Increasing militancy of fishermen, poaching and gang fishing. Increasing use of pahciradar to police jalmahals and increasing abuses against fishermen. Increasing conflict between leaseholders. Increasing violence and deaths.
Increased planting of HYV rice	Increased utilization of fertilizers and pesticides, resulting in deteriorating surface water quality and decreasing fish production.
Increasing population.	Increased disposal of sewage into surface waters, resulting in eutrophication and probably some increase in fish production.
Increasing pollution	Increased navigation induced river and sea water pollution; untreated industrial effluent.

Strategic objectives

The present investigation has been set out the following nine strategic objectives for robust, integrated and adaptive fisheries strategies for 2100.

- Restoration of Natural Resources
- Climate Change and Natural Disaster
- Fisheries extension in the new maritime boundary
- Human resource development
- Stabilization of increased economic growth
- Fishermen community empowerment
- Development of ICT system in Fisheries Management
- Mega Fisheries Research Project
- Strengthening the coordination function of Fisheries Management Agencies (like DoF) and Fishermen Organization

The major strengths in fisheries sector are marine and inland capture fisheries water bodies including rivers and wetland (beels and floodplain) which are the harbor of primary genetic resource for fisheries providing breeding and spawning ground in perennial and seasonal wetlands. However, these water bodies has been decreasing day by day

mainly due to increasing unplanned urbanization, improper water sector management, agricultural and industrial developmental activities. It is, thus, necessary to restore the fish habitats and seasonal refuge areas through identify the seasonal refuge areas in Inland open water bodies/wetlands; capacity and awareness building training program for officials and local fishermen and different Govt. and Foreign Funded conservation related projects/programs.

Fish sanctuary in depressions (Beels) and pools (Duars/Kums) of rivers should be established through strengthening the National Jalmohal Policy, 2009; research and identification of Mother fishery and breeding grounds for genetic resources and suitability measures for dominant floodplain SIS; capacity and awareness building training program for officials and local fishermen; different Govt. and Foreign Funded conservation related projects/programs.

Fish species is one of the major strength in fisheries sector in Bangladesh which is under threat of extinction due to extreme fishing pressure, indiscrimate fishing, inadeqaute management measures, etc. So, fish diversity should be conserved and protected through timely monitoring and evaluating the mobile court for implementing National Fisheries Policy (1998), Protection and Conservation of Fish Act (2015) and Fish Act (2015), Natural Water Body Conservation Act, 2000 and The Chingri Mohal Management Policy, 1992. It is also recommended to strengthen the implementation of acts and rules to stop the use of banned gears, increase the capacity and awareness building training for commercial, part-time and subsistence fishermen and also strengthen the policy, act and rules through incorporating the accountability and transparency assurance activities.

However, climate change and extreme natural disasters are one of the major threats for fisheries sector in Bangladesh, particularly the culture fisheries under threat of flooding, drought, river bank erosion, salinity intrusion from sea level rise, etc. Therefore, strengthening the potentiality against climate change has been ensured through identification of potential coping capacity, CCA and DRR options against Climate Change and Natural Disaster, like developing the Early Warning System.

Recently Bangladesh has gained the new resourceful maritime boundary which can be used effectively through identification and utilization of fishing grounds in the new maritime boundary; identification of major fishing ground; identification and development of major more innovative, adaptive and mechanized fishing crafts and adaptive fishing gears and knowledge sharing programs with Fishermen Community.

Another major strength for fisheries sector development is human resource, like officers and staffs of different fisheries development agencies, commercial and part-time fishermen which need to be more functioning through development of technical competency for agency staffs, implementing more capacity and awareness Building Training Programs, etc.

Table 4-5: Fisheries strategic action plan for 2100

Sl	Strategic Objectives	Weight (SO) (Sum{W, PI)	Strategies	Target Settings	Weight (PI) (1to5)
1	Restoration of Natural Resources	53:00	Restoration of fish habitats and seasonal refuge areas	Identify the seasonal refuge areas in Inland open water bodies/wetlands	5:00
2				Capacity and awareness building training program for officials and local fishermen	3:00
3				Different Govt. and Foreign Funded conservation related projects/programs	3:00
4			Establishment of fish sanctuary in	Strengthening the National Jalmohal Policy, 2009	5:00
				Research and Identification of Mother fishery and	5:00

Sl	Strategic Objectives	Weight (SO) (Sum{W, PI)	Strategies	Target Settings	Weight (PI) (1to5)
			depressions (Beels) and pools (Duars/Kums) of rivers	breeding grounds for genetic resources and suitability measures for dominant floodplain SIS	
5				Capacity and awareness building training program for officials and local fishermen	3:00
6				Different Govt. and Foreign Funded conservation related projects/programs	3:00
7			Conservation and protection of Fish Diversity	Timely monitoring and evaluation of mobile court for implementing National Fisheries Policy (1998), Protection and Conservation of Fish Act (2015) and Fish Act (2015), Natural Water Body Conservation Act, 2000 and The Chingri Mohal Management Policy, 1992	5:00
8				Strengthening the implementation of acts and rules to stop the use of banned gears	5:00
9				Capacity and awareness building training for commercial, part-time and subsistence fishermen	3:00
10				Strengthening policy, act and rules through incorporating the accountability and transparency assurance activities	3:00
11			Protection natural habitat from unplanned urbanization effect	Timely monitoring and evaluation of mobile court for implementing National Fisheries Policy (1998), Protection and Conservation of Fish Act (2015) and Fish Act (2015), Natural Water Body Conservation Act, 2000	5:00
12				Involvement of LGIs in protection fish habitat	5:00
13	Climate Change and Natural Disaster	8:00	Strengthening potential coping capacity, CCA and DRR options against Climate Change and Natural Disaster	Procurement of research institutions, University and consultancy farms for identification of potential coping capacity, CCA and DRR options against Climate Change and Natural Disaster	5:00
14				Development of Early Warning System	3:00
15	Fisheries extension in the new maritime boundary	13:00	Identification and utilization of fishing grounds in the new maritime boundary	Identification of major fishing ground	5:00
16				Identification of major fishing gears	5:00
17				Knowledge sharing programs with Fishermen Community	3:00
18	Human resource development	48:00	Technical competency for agency staffs	Technical training programs with project based field level experiences for agency staffs	3:00
19				Govt. and foreign funded training projects	3:00

Sl	Strategic Objectives	Weight (SO) (Sum{W, PI)	Strategies	Target Settings	Weight (PI) (1to5)
20				Procurement of different research and consultancy firms for training	3:00
21			Capacity and Awareness Building Training Programs	Technical training programs by agency staffs	3:00
22				Govt. and foreign funded training projects	3:00
23			Extension of Alternative Income Generating Activities	Govt. and foreign funded activity training programs	3:00
24				Credit/Loan Programs	5:00
25				Quality monitoring and activity evaluation programs	5:00
26			Strengthening Fishermen Community Association	Extension of Capacity Training Programs	3:00
27				Engagement to fisheries management planning, strategy formulation, operation, maintenance, monitoring and evaluation activities	3:00
28				Establishment of financial mechanism in maintaining association	3:00
29			Women empowerment and engagement in fisheries management	Extension of Capacity Training Programs	3:00
30				Engagement to fisheries management planning, strategy formulation, operation, maintenance, monitoring and evaluation activities	3:00
31				Micro-Credit/Loan Programs	5:00
32	Stabilization of increased economic growth	115:00	Strengthening the Small and Medium Entrepreneurs	Capacity building training	3:00
33				Micro-credit programs	4:00
34			Increased SIS production for domestic consumption	Identification of dominant SIS floodplain fisheries	5:00
35				Formulation and Implementation of SIS Conservation Act and Rules	5:00
36				Awareness building training for commercial, part-time and subsistence fishermen	3:00
37			Extension of pen/cage fish culture	Capacity building training for commercial fishermen, small and medium entrepreneurs	3:00
38				Identification of suitable site for per/cage culture	4:00
39				Govt. and foreign funded programs	3:00
40				Credit/loan programs	5:00
41			Extension of semi-intensive, intensive and highly intensive fish culture	Capacity building training for small and medium entrepreneurs	3:00
42				Identification of suitable site for fish culture pond	4:00
43				Credit/loan programs	5:00

Sl	Strategic Objectives	Weight (SO) (Sum{W, PI)	Strategies	Target Settings	Weight (PI) (1to5)
44			Shrimp/Prawn/Mud crab culture	Identification of suitable site for fish culture pond	4:00
45				Capacity and awareness building training for small and medium entrepreneurs and commercial fishermen	3:00
46				Govt. and private Hatcheries and Nurseries	3:00
47			Innovative fish marketing system	Procurement of consultancy farm to identify the causes and solution of post-harvesting losses	5:00
48				Mobile court for monitoring the implementation of Fish Feed and Animal Feed Act, 2010 and Fish Feed Rules, 2011	5:00
49				Development of value addition mechanism in supply chain (forward and backward linkage)	5:00
50			Development of potential ICT system between producer and whole seller	Identify the adoption potentiality and barriers for ICT system	3:00
51				Development of innovative ICT system	5:00
52				Formulation and implementation of Fisheries Information Act and Rules	5:00
53			Fishery-based industries	Identification of potentiality and barriers of fishery-based industries	5:00
54				Capacity and awareness building training to small and medium entrepreneurs	3:00
55				Credit/Loan programs	3:00
56				Monitoring the industries according to the Code of Conduct for selected segments of the Aquaculture Industry in Bangladesh, 2011	5:00
57			Agro-tourism services	Govt. and NGO initiatives	3:00
58				Capacity and awareness building training to small and medium entrepreneurs	3:00
59				Credit/Loan programs	3:00
60				Monitoring the industries according to the Code of Conduct for selected segments of the Aquaculture Industry in Bangladesh, 2011	5:00
61	Fishermen community empowerment	17:00	Community based fisheries co-management approach for developing the sector	Capacity and awareness building training to commercial, part-time and subsistence fishermen according to Guidelines of Participatory Water Resource Management	3:00
62				Formulation of Participatory Fisheries Resource	5:00

Sl	Strategic Objectives	Weight (SO) (Sum{W, PI)	Strategies	Target Settings	Weight (PI) (1to5)
				Management Guidelines and Act and Rules	
63			Strengthening the Fishermen Community Association	Extension of Capacity Training Programs	3:00
64				Engagement to fisheries management planning, strategy formulation, operation, maintenance, monitoring and evaluation activities	3:00
65				Establishment of financial mechanism in maintaining association	3:00
66	Development of ICT system in Fisheries Management	25:00	Fisheries Information Service Center (FISC)	Formulation of Fisheries Information Act	5:00
67				Procurement and Development of infrastructure for FISC	5:00
68			Digitalization	Development of quick and automated digital information solution from Zila/Upazila/Union Fisheries Offices to Fishermen	5:00
69				Development of digital database for key informer of fisheries management	5:00
70				Quick digital credit support system	5:00
71	Mega Fisheries Research Project	37:00	Fisheries Master Plan	Proposal preparation, compilation and finalization for fisheries master plan for Bangladesh	3:00
72				Institutional mobilization for Master Plan	3:00
73				Data collection, processing, analysis and baseline report preparation	5:00
74				Development of Master Plan	5:00
75			Suitable Fisheries Zoning Plan	Proposal preparation, compilation and finalization for fisheries zoning plan for Bangladesh	3:00
76				Institutional mobilization for Zoning Plan	3:00
77				Data collection, processing, analysis and baseline report preparation	5:00
78				Development of Zoning Plan	5:00
79			Genetic engineering/induced breeding research	Procurement of Research Institutions and University for conducting genetic engineering/induced breeding based research	5:00
80	Strengthening the coordination function of Fisheries Management Agencies (like	20:00	Strengthening the coordination function among Fisheries Management Agencies	Regular monitoring (quarterly) the coordination function according to the statement of the Bangladesh Fisheries Development Coordination Act, 1973	3:00
81				Strengthening the knowledge sharing meeting among agencies	3:00

Sl	Strategic Objectives	Weight (SO) (Sum{W, PI)	Strategies	Target Settings	Weight (PI) (1to5)
82	DoF) and Fishermen Organization		Strengthening the coordination function among Fisheries Management Organizations of different Upazila/Zila/Regions	Regular monitoring (quarterly) the coordination function according to the statement of the Bangladesh Fisheries Development Coordination Act, 1973	3:00
83				Strengthening the experience sharing meeting among organizations	3:00
84			Strengthening the coordination function between Fisheries Management Agencies and Fishermen Organization	Regular monitoring (quarterly) the coordination function according to the statement of the Bangladesh Fisheries Development Coordination Act, 1973	3:00
85				Strengthening the knowledge and experience sharing meeting among organizations in project design, planning, operation and maintenance, monitoring and evaluation	5:00

4.3. Challenges in Fisheries Sector

Perspectives for the fishery sector over the coming decades suggest that with the right mix of policy and investment, the potential can be good, in spite of increasing constraints. Based primarily on growth in aquaculture, but with prospects of upholding and adding value to the capture sector including new maritime boundary, increased output, and corresponding gains in value and employment could be envisaged. This should be achievable within current expectations of the quality and availability of country's physical and biological aquatic resources. The prognosis for aquaculture is positive, while that for capture fisheries, is at best slightly negative due to long term effects of a declining resource base, and the practical difficulties of management.

To this core production sectors can be added the networks of input supply, market and distribution, and post-harvest added value, particularly in the export sector. These in turn involve substantial numbers of manpower and generate significant economic output. There are important livelihood consequences for the many people involved. Small-scale fishers will be increasingly pressured by declining resources and increased competition, and will need to seek more diversified options. Growth in aquaculture, if primarily linked with more competitive commercialised production, may limit options for resource-poor producers, though niche opportunities may expand. While urban consumers may benefit from increased supply and stable or declining real prices, rural people may lose informal access to fish and face a shift from productive opportunities to various levels of part-time or irregular employment.

A range of public and private sector investments and initiatives will be needed to realise the potential for change, growth and expanding economic output. However, while prospects for the sector are positive, a significant challenge is presented in translating benefits effectively to the many millions of people of the country for whom fisheries are important. There is a number of challenges in fisheries; some are general and some vary according to hydro-meteorological regions. The major causes of resource degradation and challenges in fisheries sub-sectors are described as follows:

a. The inland open water capture fishery is threatened by gradual resource depletion (due to inadequately planned urbanization, road and railway communication, FCD/I interventions, etc), which if cannot be reversed by effective conservation measures may further deteriorate.

b. The inland aquaculture has been flourishing. But this is now facing challenge of deteriorating brood stock, scarcity of good quality spawn, fries, feed and other inputs.

c. Flood plain aquaculture is expanding now. But it has a risk of increasing water-logging, blocking migratory routes of indigenous fish species, disturbing biodiversity and creating social conflicts.

d. Shrimp and coastal aquaculture has been growing over the last three decades but productivity remains low. To a great extent, the bagda farming still follows extensive method which is unlikely to increase yield. Golda farming is facing scarcity of feed while bagda farming is facing scarcity of good quality and virus-free shrimp fry called post larvae (PL).

e. Coastal aquaculture (shrimp, finfish, crab, etc.) is not flourishing as per its potential due to poor investment.

f. Export of frozen food and fish, in some cases, particularly of shrimp and prawn is affected by international concerns for quality and social compliances while the GOB Quality Control measures remained inadequate to meet the growing needs.

g. Source of brood stock for shrimp hatcheries is shrinking because of disturbing the life cycle, shrimp juveniles and adults are almost fully caught and rarely any stock going back to the marine environment.

h. Indiscriminate killing of fish and other aquatic lives during shrimp PL collection even in the eco-sensitive areas like Sundarbans are increasingly threatening the ecosystem.

i. Reduced upstream fresh water flow and increased silt deposition on the river channels are causing salinity intrusion in estuarine rivers and obstructing the migratory routes. As a result breeding, spawning, nursery and natural grow-out areas of major species like shrimp, hilsha and carps as well as of hundreds of other species are adversely affected.

j. Key challenges in line with marine sector are: entry of illegal fishing vessels and pouching, lack of exploratory survey on stocks, licensing of mechanized fishing boats and control of effort at sustainable level, intense fishing deploying destructive and illegal gears, IUU fishing, address adaptation to climate change paradigm, etc.

k. Enforcement of regulatory measures is quite inadequate due to poor institutional capacity as well as serious infringement of rules and regulations.

l. Research in fisheries in the past was largely limited to identifying and releasing breeds for aquaculture. Only recently emphasis has been directed to protection of indigenous species and improved farming practices.

m. Attention given to knowing the field condition and update on a regular basis remains low mainly because of manpower constraint.

n. Extension service provided to the aquaculture farmers remains inadequate because of scarcity of field level officials at the Upazila level.

o. The fishers lack with securing lease and access to public water bodies. These are often leased to elite or elite-dominated associations (*Shomitis*). This constrains community level participatory and sustainable management of fisheries resources causing further depletion of resources.

p. Alternative livelihoods support to fishers during banned fishing seasons and sanctuary maintenance remained low and therefore ineffective. Without such support and Social Safety Net assistance for the poor fishers sanctuary management and resource conservation may remain ineffective.

4.4. Opportunities in Fisheries Sector

There is a number of key development trends and perceived constraints for primary sectoral activities. These are converted into potential outputs, and associated value added and employment, based largely on historic rates of change, modified as appropriate by expected short to medium term developments. Production opportunities for the next 10 years and their underlying assumptions identified tentatively include:

- Average annual growth in hatchery based seed supply of fish (5.0%) and shrimp (4.0%);
- Average annual growth in all inland fresh water aquaculture sectors by 4.75%;
- Average annual growth in shrimp aquaculture by 4%;
- Slow and steady average annual growth in the inland capture fishery by 0.5%;
- An increase is anticipated in the marine capture sector across all fisheries due to scope of fishing in the new maritime. In this case, average annual growth is 2.1 %.
- Average annual growth in overall fish production by 3.25%.

The assumptions underlying these projections are as follows:

- Current levels of donor and NGO investment will continue.
- Inbreeding issues associated with fish hatchery brood stocks will be corrected.
- Specific pathogen free (SPF) stocks of shrimp will be imported or developed. Hatcheries will co-operate in the sale of disease and chemical contamination free PLs.
- Food safety issues associated with Bangladesh seafood exports will be favourably resolved.
- Institutional and policy factors that lie at the root of the inland fishery declines will be resolved. Further habitat losses will not occur.
- The DoF will be able to effectively limit entry in the Marine/Coastal capture fishery. Gears such as ESBN will be banned.
- Identification of new homeports for fishing in the sea considering new maritime boundary.

A summary of proposed output (MT) for the next tenth year changes in inland aquaculture, coastal aquaculture, inland and marine capture fisheries is as follows (Table 4-6). Principal development areas within these groups are identified as follows:

Table 4-6: Tentative potential output projections

Particulars	Current (2014)	10th Year	Annual Change (%)
Seed supply			
Post Larvae (Million)	9,577	14,176	4
Fish spawn (kgs)	490,824	799,501	5
Production			
Inland aquaculture production (MT)	1,740,478	2,702,909	4.75
Shrimp aquaculture production (MT)	216,447	320,394	4
Inland capture fisheries (MT)	995,805	1,046,731	0.5
Coastal/marine capture fisheries (MT)	595,385	732,918	2.1
Overall growth in production (excl. seed) (MT)	3,548,115	4,868,316	Average: 3.25

Source: DoF, 2014

The primary emphasis will be on maintaining current levels of output as far as possible within the increasing constraints of land and water use, urban and agricultural intensification, and social pressures on poor communities. Co-management or community-based approaches can be developed to provide some level of resource management, catches of more valued species may be better maintained, and with effort controls, it may be more feasible for alternative or complementary income generating approaches to be developed and sustained. The following fisheries technologies are important for scaling up the fisheries.

Small scale pond carp polyculture of mixed Indian and Chinese carps along with small indigenous species will continue to the largest source of production and offers the greatest potential for expansion, with high returns to labour and significant value added.

Small scale cage culture though have minor production importance this form of fish culture may allow the entry of the landless poor and women into aquaculture and can generate income at critical times of year. Profitability of these systems depends on the availability of low cost feed ingredients and proximity to markets.

Commercial/Intensive Pond Culture will likely shift away from Pangas to carp polyculture or other systems. The major constraints for large operators are a lack of large contiguous pieces of land in addition to a lack of high quality feeds.

Stocked beels and oxbow lakes is a form of extensive aquaculture and unlikely to be of major importance. This activity can generate positive financial returns, and moderate production costs through beel-floodplain stocking by private entrepreneurs, or in association with government or NGO initiatives. This production unfortunately occurs at the cost of community access and floodplain biodiversity.

Rice-fish culture is likely only to achieve a modest increase in production, though this could expand much more with suitable support. Though benefits to fish and crop management are clear, poaching, pesticide use and water management issues are notable constraints.

Rice-prawn culture has the potential in certain areas; in the greater Noakhali and greater Faridpur areas, a considerable areas of seasonally flooded land could be adapted.

Pen culture after carp polyculture is probably the most important culture system in the country and has been increasing in popularity.

Shrimp (bagda) production has significant growth potential. Much of this could be accommodated through improved culture systems without major growth in area, though spatial expansion is also a possibility. Improved approaches will require better operational management with the support of extension, improved pond construction, better water management, a reduction in PL mortality, improved stocking ratios, and most importantly to the industry as a whole improvements in post harvest handling.

Externalities Fish farmers and other stakeholders need sustainable production to respond to demand. This means that to enjoy positive outcome in fisheries sector, there must be a steady supply and use of quality inputs and environmental issues must be included. Broadly, two categories of externalities should be considered, those generated by: i. activities that create unsuitable conditions for others; and ii. competition in access to a limited resource, which lead to economic inefficiency and less benefits (Nathan and Apu 2007). The general perception is that the influence of externalities in aquaculture practices is less in ponds/dighis than in seasonal floodplains, baors, coastal areas and other water bodies. Various forms of pollution such as: salinity from shrimp farms; antibiotics in feeds; discharge of nutrients; and escape of non-native species are the main issues, but they have not yet become serious constraints for aquaculture.

Environmental impacts Aquaculture in Bangladesh, like all terrestrial farming systems, faces a number of challenges, including increasing competition for limited resources, such as water, land and feed inputs; and environmental degradation of the resources utilized. In Bangladesh, the National Environment Policy is clear on issues concerning

sustainable social and economic development and maintaining environmental quality in the long-run. Interventions in Bangladesh aquaculture cover a wide range of different aquatic farming practices in terms of species and production systems. It offers enhanced fish production and income generation for rural and sub-urban areas. An increase of fish production in Bangladesh, using intensive culture methods on a larger scale could change the balance of required animal food in the country but could have a negative environmental impact.

Waste management The lack of adequate labor and technology in hatcheries; the practice of fish processing in the city markets; and inadequate waste management at wholesale markets; are largely responsible for the waste problem in the aquaculture sector. Fish processing wastes have been used on a daily basis as feed for hybrid magur and other animals. However, these need to be well managed according to the Environmental Protection Act. The Protection and Conservation of Fish Act empowers the government to make rules that prohibit the destruction of fish by poisoning of the water or the depletion of fisheries by pollution, effluents or otherwise.

Feed competition and impacts on ecosystem health Production of feeds on the environment may create larger impact in the future with the increasing use of feeds in aquaculture. Freshwater ecosystems include lakes and ponds, rivers, streams and springs, and wetlands. They can be contrasted with marine ecosystems, which have a larger salt content. Fish meal can be made from almost any type of seafood but is generally from wild-caught, small, marine fish that contain a high percentage of bones and oil, and is usually deemed not suitable for direct human consumption. Other sources of fish meal are from by-catch of other fisheries and by-products of value additions made during processing (fish waste). There is also the possibility of trace contaminants getting into the feed, which will cause diseases and fish mortality. The positive aspect of current aquaculture practices in Bangladesh is that most of the fish farmed are low-trophic level species so the impacts will not be that great on the ecosystem. Low-trophic species constitute a high proportion of the biomass in the ecosystem, achieving 80% of the conventional maximum sustainable yield (Smith et al. 2011).

Seed quality and impacts on overall production Aquaculture is the fastest growing food production sector in Bangladesh. Quality seed is a fundamental pre-requisite for sustainable and successful aquaculture. The issue of seed availability has always attracted the attention of aquaculturists, developers and policy makers and the response has been to produce enough quantities of seed locally. Wherever this has not been possible, introduction of seed or broodstock from other sources (e.g. import) has been the norm. As the quantity and availability of fish seed have improved, the quality issue has come to the forefront. This has received special attention in recent years when poor performance indicators (e.g. growth, production, survival, disease) have consistently been attributed to seed quality. However, it must be remembered that in all aquaculture systems, stocking quality seed does not necessarily ensure a successful crop. The success does depend on a range of other factors including post-stocking management practices (e.g. water quality, feed and disease management). There is a need to very clearly understand the relationship between quality seed and post stocking success on a species by species basis for important cultured species. Otherwise there is a danger of all crop failures (e.g. poor growth, mortality, low survival) being attributed to seed and seed quality alone. Seed which are active, healthy in appearance, uniform in size, potential for high survival, better growth, less/or no disease usually fit the definition of good quality seed, irrespective of the species. Some of the important factors which are perceived to have a significant impact on seed quality include broodstock health and genetic make-up and husbandry (hatchery and nursery) practices.

Feed adulteration Use of manufactured feeds in aquaculture in Bangladesh has grown rapidly in the recent years. More than 1 million MT of commercially formulated feeds and 0.3-0.4 million MT of farm-made feeds were produced in 2012, and sectoral growth is projected to increase substantially over the medium term. The adulteration or contamination of fish feed is an alarming problem in Bangladesh. It affects the life of each and every person irrespective of gender, age or economic status. It poses serious threat to the development of the growing children – even when a child is still in the womb of the mother.

Impacts on climate change: Greenhouse gas (GHG) emissions Climate change is expected to keep impact on food production systems, global biodiversity and overall human well-being. Aquaculture is no exception. The emission of greenhouse gas (GHG) in the fisheries industries is not well understood in Bangladesh. Blue Frontiers: Managing the environmental effects of aquaculture, has released a policy recommendations paper Sustainable Fisheries for Food Security Towards 2020 that aims to inform policy makers about the impacts of aquaculture on the environment and to stimulate debate on the optimal animal food production systems for the near future.

Public health concerns: Nutritional impacts and food safety Aquaculture can provide essential nutritional support for humans. More production and consumption of fish by the poor could improve their diets and reduce rates of malnutrition. Given the low economic capacity of poor households, most of them do not have access to ponds or options to improve their diets. On the other hand, floodplains, which are mostly open access are a free source of fish; recently a large area of floodplain has been brought under commercial cultured fisheries, which narrows down the opportunities of nutritional aspects for poor households. However, low-cost species such as tilapia and pangas (both are of small size) are a major option for the poor. Aquaculture might compensate for a reduction in the consumption of nutritious small indigenous species (SIS) from capture fisheries, although it might not adequately offset the most vulnerable households. To bring a balance in the long-term, several initiatives have been underway to increase the production of SIS in small homestead ponds, ditches and floodplains (Akhter 2013).

Gender issues Mainstreaming gender provides women a chance to resume their position in society, and to recognize and avail opportunities to generate wealth: thus, it is also a crucial component in alleviating poverty, achieving greater food and nutrition security, and enabling good governance and sustainable development of fisheries and aquaculture resources. Political will and the development of capacity to put mainstreaming into practice at all steps of the process is essential to achieve responsible fisheries and aquaculture practices, and thus to ensure sustainable resource governance and livelihood of people. The following activities are considered key:

- Conduct gender-specific analysis and apply mainstream results in plans, budgets, and M&E. Mechanisms to distribute comprehensive and accurate sex-disaggregated and gendersensitive data for fisheries and aquaculture enables targeted gender-responsive objectives and indicators at policy level.
- Generate and analyze project data for all gender aspects (livelihood factors, relationships, actions and results) to ensure that gender-specific disadvantages, gender equality and the promotion of women's participation are addressed in project impacts.
- Build gender considerations into new institutional responses and policies regarding climate change, resource depletion, aquaculture development and global trade. Issues to be considered include responsible governance of tenure, equitable resource access and rights, access to markets, benefits from aquaculture and codes of conduct for the industry.

5. State of Fisheries Consumption and Expenditure

5.1. Fisheries consumption and others

Bangladesh is one of the developing and most densely populated countries in the world. Rice and fish is the staple food of the Bangladeshi people and the demand for such commodities are constantly increasing, with the population growing by more than 3 million each year (BBS 2010). Historically, the country's natural water bodies were stocked during the monsoon through natural spawning. Fish farming had been a traditional practice in ancient India during the era of Hindu rulers before the twelfth century (Gatlin 2010) and the ponds and tanks were used for rearing fish for recreational (not commercial) purposes (FAO 2014).

Bangladesh has extensive and highly diversified fisheries resources. Fish play a crucial role in the diet and nutrition of its people. The fisheries sector has been playing a very significant role and has potential for future development of the agrarian economy of the country.

Fishers and fish farmers play a vital role in collecting fishes from natural water bodies and culturing fish in closed and semi-closed water bodies.

5.1.1. Consumption and expenditures

a) Per capita consumption and expenditure of fish

Fish is the most promising animal source of food in Bangladesh, accounting for more than 60% of total animal protein intake (DoF, 2015). BBS households survey 2010 reveals that more than 98% of them consumes fish at least once per week, and 60% takes fish at least every second day. These figures emphasize the importance of fish in the Bengali diet. Household Income and Expenditure Survey (BBS 2010) showed that per capita per day fish consumption is 49.5 g but the current consumption is 60 g (National Fish Week, 2015), national fish consumption trending notably upward during the period 2000–2010 and it is continuing.

Table 5-1 shows the monthly total expenditure on major food items against that on fish in different survey years by resident households. In 2010, at national level, monthly expenditure on fish was BDT 827 per household, an increase of more than 52% over 2005 and about 63% over 2000. In the last decade (2000–2010), disparity between rural and urban areas in terms of expenditure on fish increased by 3%. For 2015, at national level the projected monthly expenditure on fish would be BDT 1,028 per household an increase of more than 24% over 2010.

Table 5-1: Share of expenditure on fish among major food items by residence

	National		Rural		Urban	
Year	Total food Expenditure	Exp. on fish (BDT)	Total food Expenditure	Exp. on fish (BDT)	Total food Expenditure	Exp. on fish (BDT)
2015 (Projected)	7,459	1,028	6,864	872	8,950	1,429
2010	6,031	827	5,543	706	7,362	1,156
2005	3,209	394	3,023	346	3,756	530
2000	2,477	309	2,300	277	3,175	434

Source: BBS (2010)

In 2010, urban households were spending about 39% more on fish than rural households, while the difference was 36% in 2000. Between 2000 and 2010, the share of fish expenditure against the total monthly food expenditure of rural households increased by 61%, while it was about 64% at urban households.

b) Fish consumption patterns across rural and urban households

In 2010, per capita daily fish consumption was 49.5g or 18.1 kg yearly, an increase of 14.95% from 2005. There is a significant difference in fish consumption between rural and urban households. In rural areas, daily fish consumption was 45.8g while in urban areas this was 59.9g (BBS 2010). This was an increase of 13.3% and 17.2% over 2005 for rural and urban households, respectively.

c) Fish consumption patterns across income class

Table 5-2 shows the monthly expenses on fish consumption in rural areas. In rural areas overall households spent about 51% more in 2010 on fish compared to 2005. The small landholding households increased their share of expenditure on fish in 2010 more, compared to larger landholdings. This is surprising, as BBS households' survey shows that as households' landholding increase, the share of expenditure on meat, poultry, eggs, milk, edible oil and

fruits increases (BBS 2010). This suggests that the growth in fish consumption that occurred between 2005 and 2010 was pro-poor.

Table 5-2: Monthly share on fish expenditure by landholdings in rural areas

Size of land owned (acres)	Monthly average expenditure on major food items (BDT)	% of expenditure on fish 2005	% of expenditure on fish 2010	Change in Expenditure on fish 2005–2010 (%)
All HH	5,543	12.74	11.46	50.94
Landless	4,259	12.64	11.29	58.81
0.01–0.04	4,314	11.44	10.17	55.81
0.05–0.49	5,304	12.82	11.17	53.32
0.50–1.49	5,927	12.88	11.24	52.15
1.50–2.49	6,804	13.31	12.53	49.35
2.50–7.49	8,247	13.38	12.54	49.33
7.50+	11,014	15.30	13.61	49.87

Source: BBS (2010)

d) Fish consumption patterns by gender and age

Data on fish consumption by gender is not readily available. However, Bengali women and girls usually eat less fish than men or boys; this is the case for other protein-based food items such as eggs, milk, meat, etc. The head of the households always consumed the most fish, followed by the male children, and the female members consumed the least amount of fish (Mostafa et al. 2004). According to a focus group discussion with a women fish farming group of Mohespur upazila, Jhinaidah district (organized by BRAC/DoF assisted by IFAD/Danida), this is especially the case for rural middle-class and poor households (Nathan and Apu 1998). Within most poor households, women's diets are less nutritious than those of men, and pregnant and lactating women are more vulnerable to problems caused by poor nutrition. The availability of fish, or the opportunity to purchase better quality food can have significant health impact (Islam 2013).

e) Role of fish in diets

Fish provides a good source of high quality protein and contains many vitamins. It contains energy, protein, fat, cholesterol, vitamin B12, phosphorus, selenium, omega, carbohydrates, calcium and essential amino acids. The protein content of most fish averages 15 to 20%. Fish proteins contain all the essential amino acids and, like milk, eggs and mammalian meat proteins, have a high biological value (FAO 2014b). A number of fisheries related projects have focused on increasing the production of micro-nutrient rich small indigenous species of fish, such as mola, dela, darkina, chala, chapila, bata, etc (Akhter *et al*. 2013). Although for rural poor these fish are almost free (they harvest them from ditches and canals, rivers, other open waters, etc.), but they are expensive in city markets.

Table 5-3: Share of major food items in total food expenditure 2000, 2005, 2010 and 2015 (%)

	Year			
Food items	**2015 (Projected)**	**2010**	**2005**	**2000**
Total monthly food expenditure (BDT)	8,166	6,031	3,209	2,477
Cereals	-	35.95	39.00	38.02
Pulses	-	2.35	2.65	2.92
Fish	**13.8**	**13.71**	**12.24**	**12.48**

Food items	Year			
	2015 (Projected)	2010	2005	2000
Meat and Eggs	-	10.31	8.51	8.02
Vegetables	-	7.79	8,38	9.21
Milk/milk products	-	3.02	3.74	3.95
Edible oil	-	4.35	4.25	2.71
Condiments/spices	-	9.99	7.52	7.13
Fruits	-	4.08	3.23	2.97
Sugar/molasses	-	1.06	1.56	1.34
Beverages	-	0.73	0.68	1.97
Miscellanies	-	5.67	8.25	8.29

Source: Apu, N.A. 2014 (modified)

f) Changes in preferences for fish

It is important to address the demand for fish for consumption for low-income group households, which is a large, expanding market in the growing economy of Bangladesh. Like other working-class people, a large number of women garment workers who work in the industrial sector have limited time to do housework and cooking. Pangasius and tilapia are popular with them as they are easy to process and cheap to buy, so they can afford to buy fish once or twice a week. Fisheries research has concentrated on developing low-value species that is reflected in the market. Farmers grow improved and fast-growing pangasius, tilapia, bata and koi and their presence in the consumer market has ensured essential nutrition support for low-income groups (Hussain 2010).

People have now changed their buying strategy; they buy smaller 22 size carps (less than 1 kg) because imported fishes are usually more than 1.5 kg.

Recently, fish suppliers have been addressing the demand for live fish from low-income group households, which are a large, expanding market in the growing economy of Bangladesh (Apu and Himel 2013). Findings presented in Table 5-4 were collected by visiting three retail fish markets of Dhaka during the peak morning and evening selling hours (December 2013). Most of the buyers in the evening were female garments workers and other daily workers.

Table 5-4: Demand for live or formalin-free fish by size, price and income class

Local Name of Fish Species	Size	Price (BDT/kg)	Buyers Categories
Pangus, Silver Carp, Tilapia	5-6 pcs/kg	80–100	Day labor, garment workers
Thai Koi, Small Rui, Catla, Mrigal, Bata, Thai Puti, Taki	8-10 pcs/kg	120–150	Lower-middle-class households
Large-Size koi And Tilapia, Thai Puti & Local Shor Puti	Koi 4-5/kg Tilapia 2-3/kg	180–220	Middle-class households
Rui, Catla And Mrigal, Kalibaush, Shol, Ayr, Boal	1–1.5 kg	250–350	Well-off households
Large Rui, Catla And Mrigal, Kalibaush Shol, Ayr, Boal	2–5 kg or more	350-550	Well-off households
Marine fishes	2-5 kg or more	275-500	
Singh, Magur, Pabda, Gulsha	20–25 per kg	400–600	Well-off and middle-class households
Hilsa	850-950 gm/pcs	900-1,000	
Shrimp (Bagda)	30 pcs/kg	700-850	
Shrimp (Golda)	25 pcs/kg	750-850	
Small Indigenous Species (SIS)	-	250-400	

Source: Apu, N.A. 2014 (modified)

g) Factors influencing trends in consumption

Recent World Bank data show for 2013 the population growth of Bangladesh to be 1.2%, total urban population is 29% of the total population, and rate of population growth in urban areas 2.9% (World Bank 2014). They show that GDP growth is 6.0%, is inflation 7.5%; and the current GNI per capita (Atlas method) is USD 900 (World Bank 2014). These trends in population growth, increasing income and rapid urbanization will influence food consumption, and particularly in relation to fish as it is the second most popular food item (in terms of expenditure) of Bengali people. The fish production review of Bangladesh shows that the average growth rate was 5.61%, (including imports and exports), based on the last 10 years of production. This growth has remained stable over the last 10 years. However, in the last four years, the fisheries sector has showed better performance; during this period, average growth was 6.22% (Azad 2013).

6. State of the Country Fisheries

Waterbody Complexity

Waterbodies are very diverse and this diversity has implications for fisheries management.

Baors are oxbow lakes – old river channels that now at best have limited connections to their parent rivers through channels in the monsoon season. Many are partly closed as fisheries by fences or netting so that they can be stocked. They are mainly concentrated in the southwest of the country (Haque *et al* 1999).

Haors are extensive low lying and deeply flooded areas of floodplain bounded by natural river levees often now raised by "submersible embankments". They may contain several beels, some of which are perennial. They cover a significant part of greater Sylhet and Mymensingh (Agüero, 1989).

Beels are usually deeper depressions in the floodplain. Some are open and thus linked through canals to other waterbodies, others are closed or separate from other waterbodies (oxbow lakes outside the southwest region are usually called beels). Most hold water year round; some have sited up and are now largely seasonal. Anmade ditches or catch-ponds in the seasonally flooded areas of beels are called ***pagars*** or ***kuas***.

Bangladesh is endowed with rich and vast fisheries resources. Due to favorable natural conditions and geographical locations, the fisheries resources possess high potential of increasing production. Fish production in Bangladesh takes place under three broad environments namely, i) inland capture fishery, ii) inland culture fishery and iii) marine fishery. Inland fisheries occupy an area of 47.0 lakh ha and the marine fisheries occupy an area of 118.8 lakh ha along with 200 nautical miles of EEZ form the baseline.

Inland capture fishery habitat comprises rivers and estuaries, Sundarbans (water resources in the forest), *Beel* (deepest part of the floodplain, often with permanent area of water), Kaptai Lake (a man-made lake for generation of hydroelectricity) and floodplain (seasonally inundated) with an estimated area of 39.1 lakh ha. Inland closed water bodies comprise ponds, seasonal cultured waterbody, *baor* (ox-bow lakes), shrimp farms (both freshwater and saline waters), pen cultureand cage culture with an estimated area of 7.9 lakh ha. Thus, the total inland water areas (inland capture and culture fisheries) stand at 47.0 lakh.

In addition, the country has a coastal area of 118.8 lakh ha and a 710 km-long coast line along the Bay of Bengal, which supports a large artisanal and coastal fisheries. Further, the country has a 200 nautical mile EEZ in the Bay of Bengal (Mazid, 2002).

The country has limited access to marine fisheries resources in the Bay of Bengal and only demarsal fish and shrimp are being harvested. Other potential marine resources are yet to be exploited on commercial scale. The estimated total fish production of the country is about 35.5 lakh MT.

6.1. Hydrological Region Wise Fisheries

Bangladesh is divided into eight hydrological regions and every region has its own hydrological characteristics. In habitat context, the analysis shows that fishery resources (10.71 lakh ha) are highest in the northeast region followed

by southwest, northwest, south central, southeast, northcentral, river and estuary, and eastern hill region as shown in the following Figure 6-1. In the capture fishery habitats, the northeast region contributes the most (about 95.5%) and the lowest contribution (about 66.9%) comes from the southwest region. In culture fishery habitats, the region wise contributions are just reverse of the capture fishery although the contribution of the river and estuary region is nil.

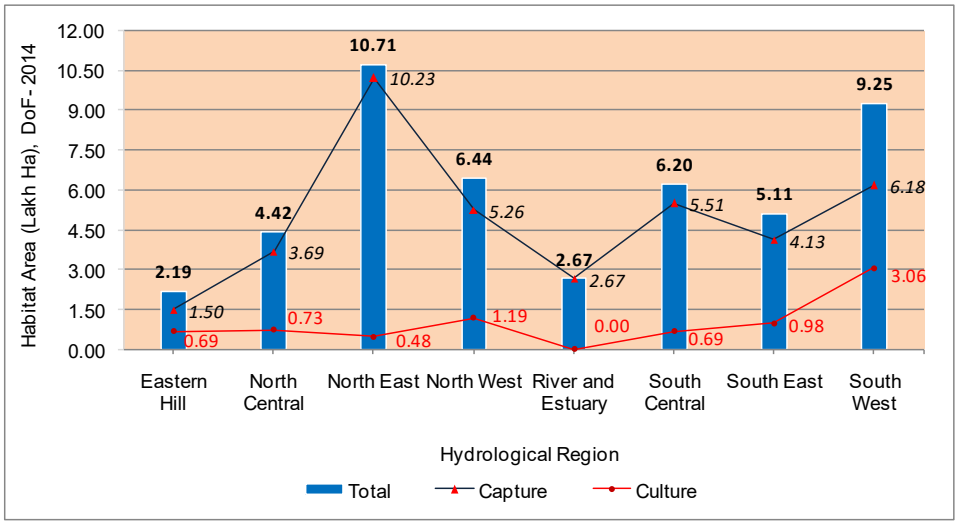


Figure 6-1: Fish habitats of the country by hydrological region under capture and culture fishery

In production context, the analysis reveals that southwest region (5.39 lakh MT) is the highest contributor in the country total followed by northwest, northcentral, northcentral, southeast, south central, eastern hill and river and estuary region as portrayed in the Figure 6-2. In the capture fishery productions, the northeast region contributes the most (about 73.3%) and the lowest contribution (about 17.9%) comes from the southwest region. In culture fishery habitats the region wise contributions are just reverse of the capture fishery.

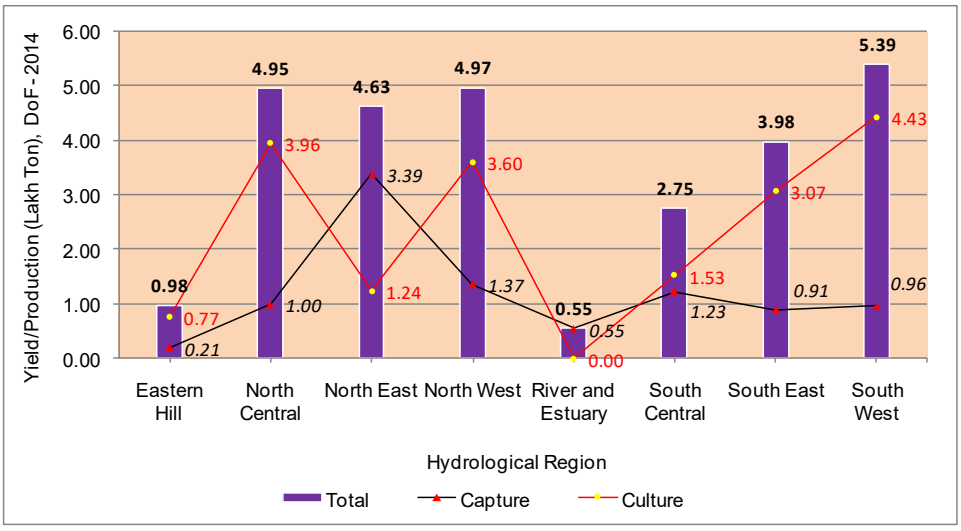
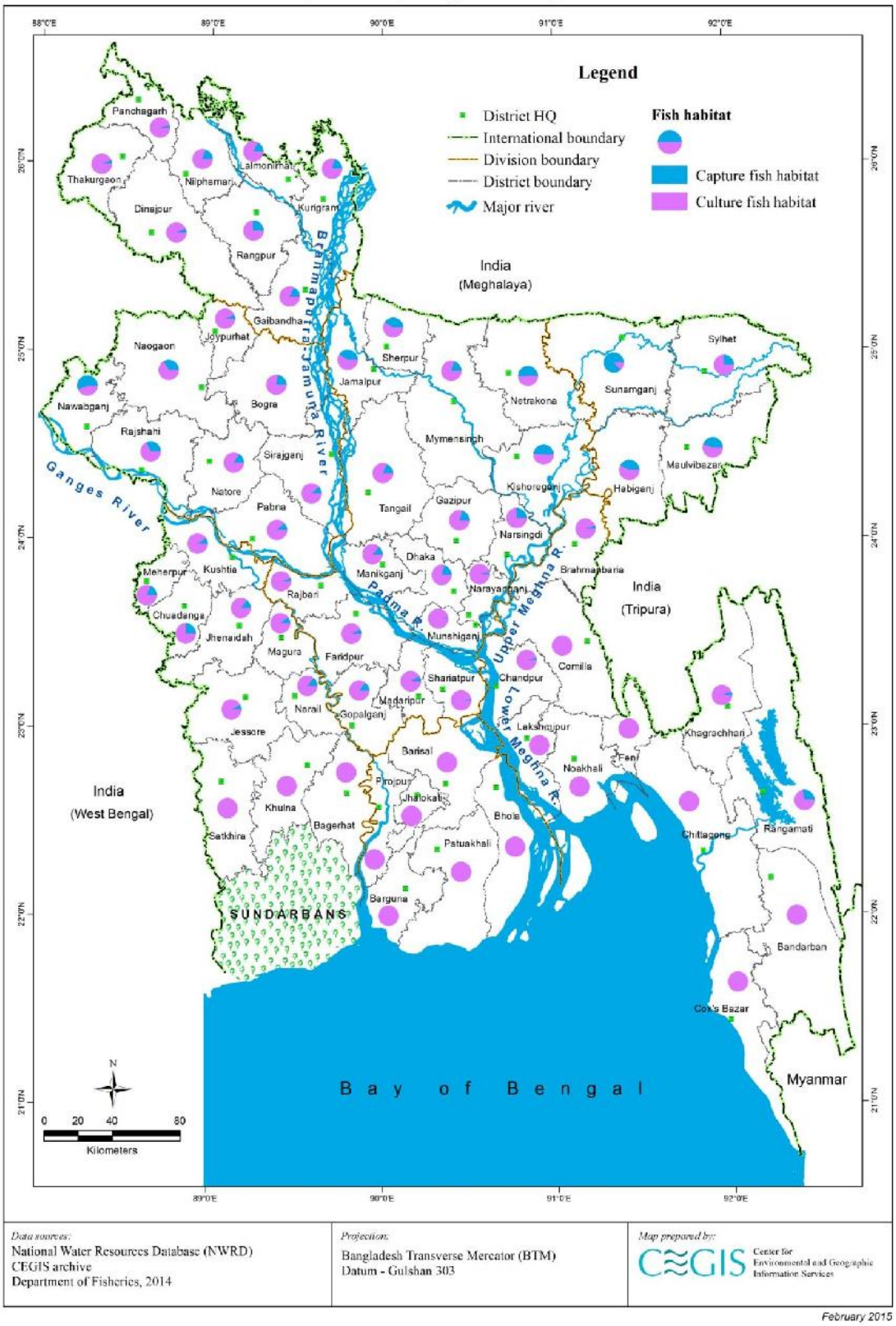


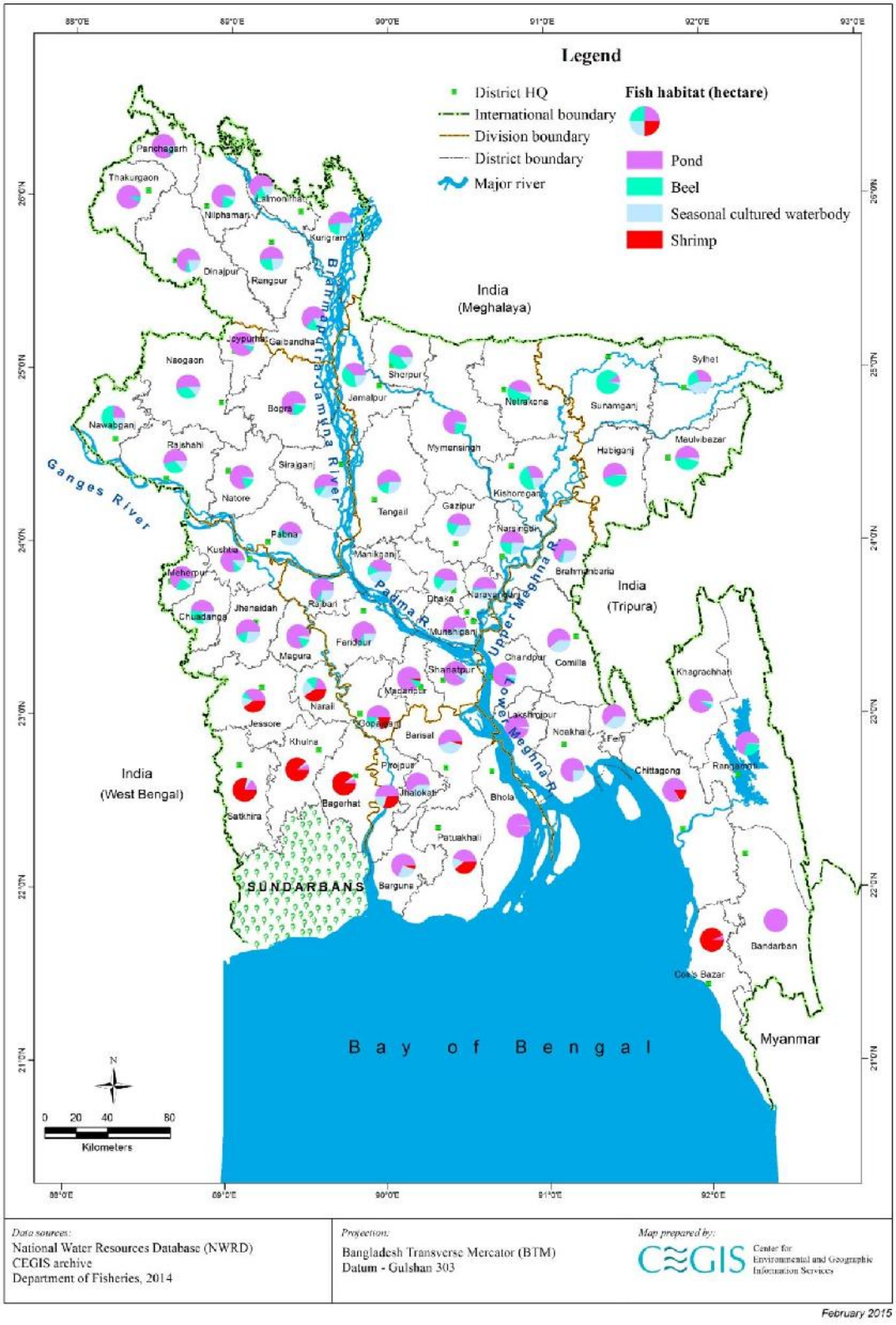
Figure 6-2: Fish production of the country by hydrological region under capture and culture fishery

The following maps (Map 6-1 and 6-2) show the district wise fish habitats of the country.



Map 6-1: District wise capture and culture habitats of the country

Source: FRSS, 2013-14



Map 6-2: District wise pond, Beel, seasonal cultured water body and shrimp farms of the country

Source: FRSS, 2013-14

6.2. Fisheries Habitat Trend

Analysis of time series fishery data for 12 years (2003-2014) reveals the declining trend of capture fishery habitat area and it has decreased to 3.91 million ha in 2014 which was 4.07 million ha in 2003. This means capture habitat area has been declined by an area of 0.16 million ha in a decade. Gradual downturn of capture fishery habitat has also been causing decline of capture fish production. The Figure 6-3 portrays the trend of capture fishery and its share in inland fishery.

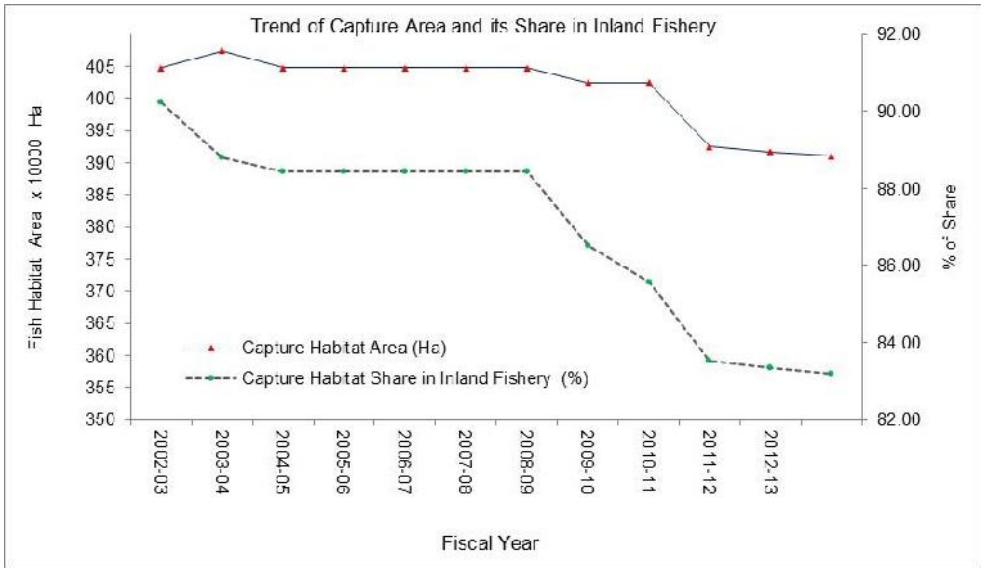


Figure 6-3: Trend of capture area and its share in inland fishery

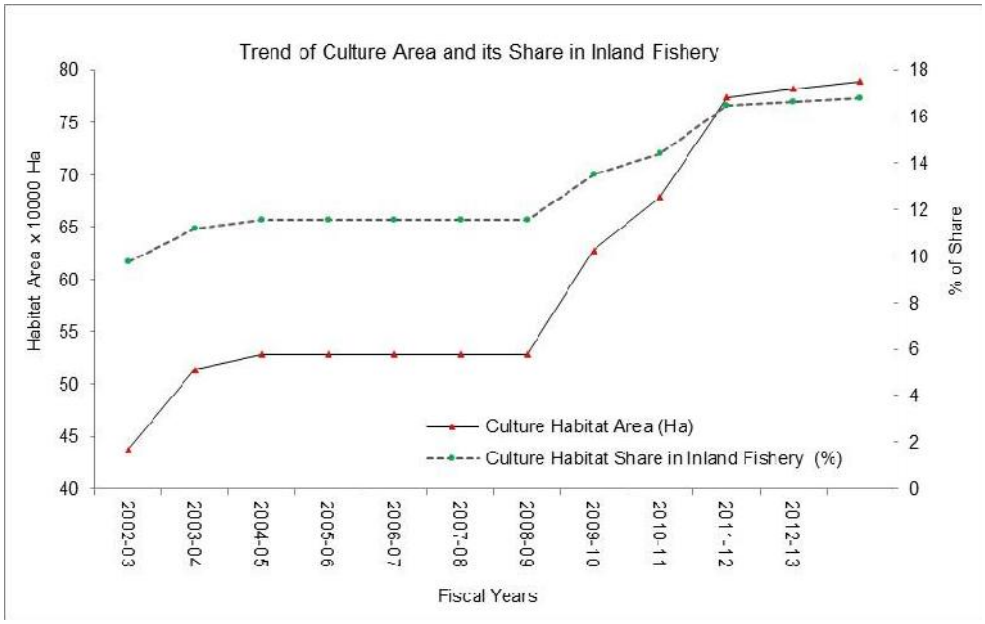


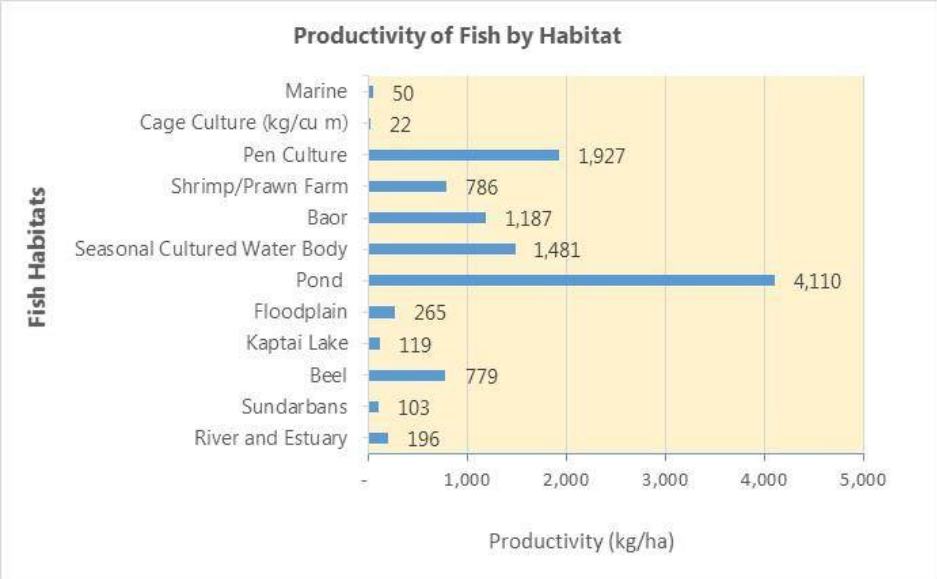
Figure 6-4: Trend of culture area and its share in inland fishery

Similar analysis for inland culture fishery for the period of 2003-2014 reveals the increasing trend of culture fish habitats. Culture fishery area has increased to 0.79 million ha in 2014 which was 0.44 million ha in 2003. This means culture habitat area has been increased by an area of 0.35 million ha in a decade. In accordance with such upturn of

capture fishery habitat, its contribution to the inland fishery has been increasing at higher rate as people are moving towards creating more aquaculture area by converting capture habitat area, agriculture field and other types of lands. The Figure 6-4 portrays the trend of culture fishery and its share in inland fishery.

6.3. Fish Productivity/Catch per Water Area

Thorough investigation of the FRSS, 2013-14 data, it is observed that the yearly average productivity of the pond aquaculture is the most (4,110 kg/ha) and the lowest catch (50 kg/ha) comes from the marine water. Productivity for cage culture is estimated differently and it is 22 kg/cu m. The productivity of individual habitats is shown in the following **Figure 6-5**.



Source: FRSS, 2013-14 (DoF, 2015)

Figure 6-5: Fish productivity of the country's fish habitats

6.4. Fish Production

In 2014[8], the estimated country total fish production is about 35.5 lakh MT in which inland culture fishery contributed over 57% followed by inland capture fishery and marine fishery as represented in Table 6-1.

Table 6-1: Country fish habitat and production status

Sector of Fisheries	2012-13				2013-14			
	Water Area (Ha)	% of Share	Total Production (MT)	% of Share	Water Area (Ha)	% of Share	Total Production (MT)	% of Share
A. Inland Fisheries								
(i) Inland Open Water (Capture)								
1. Rivers, Canals and Estuary	853,863	21.8	147,264	15.3	853,863	21.8	167,373	16.8

[8] FRSS, 2013-14

Sector of Fisheries	2012-13				2013-14			
	Water Area (Ha)	% of Share	Total Production (MT)	% of Share	Water Area (Ha)	% of Share	Total Production (MT)	% of Share
2. Sundarbans	177,700	4.5	15,945	1.7	177,700	4.5	18,366	1.8
3. Depression (Beel)	114,161	2.9	87,902	9.1	114,161	2.9	88,911	8.9
4. Reservoir (Kaptai lake)	68,800	1.8	9,017	0.9	68,800	1.8	8,179	0.8
5. Floodplain	2,702,304	69.0	701,330	72.9	2,695,529	68.9	712,976	71.6
Capture Total=	***3,916,828***	***23.6***	***961,458***	***28.2***	***3,910,053***	***23.582***	***995,805***	***28.07***
(ii) Inland Closed Water (Culture)								
(6) Pond	371,309	47.4	1,446,594	77.8	371,309	47.04	1,526,160	78.0
(7) Seasonal cultured water body	130,488	16.7	200,833	10.8	130,488	16.53	193,303	9.9
(8) Ox-bowLake (Baor)	5,488	0.7	6,146	0.3	5,488	0.70	6,514	0.3
(9) Shrimp/Prawn Farm	275,274	35.2	206,235	11.1	275,274	34.87	216,447	11.1
(10) Pen Culture	-	0	-	0.0	6,775	0.86	13,054	0.7
(11) Cage Culture	-	0	-	0.0	7	0.001	1,447	0.1
Culture Total=	***782,559***	***4.7***	***1,859,808***	***54.5***	***789,341***	***4.8***	***1,956,925***	***57.4***
Inland Fisheries Total	**4,699,387**	**28.3**	**2,821,266**	**82.7**	**4,699,394**	**28.3**	**2,952,730**	**83.2**
B. Marine Fisheries (up to 200 nautical miles in the EEZ)								
10. Industrial (Trawl)	-	-	73,030	12.4	-	-	76,885	12.9
11. Artisanal	-	-	515,958	87.6	-	-	518,500	87.1
Marine Fisheries Total=	**11,881,300**	**71.7**	**588,988**	**17.3**	**11,881,300**	**71.66**	**595,385**	**16.8**
Country Total (A+B)	**16,580,687**	**100.0**	**3,410,254**	**100.0**	**16,580,694**	**100.0**	**3,548,115**	**100.0**

Source: FRSS, 2012-13 & 13-14

6.5. Fisheries Production Trend

The trend of species group-wise catch in inland fisheries by sectors, 2004-2014 is shown in Figure 6-8. It appears from the production data analysis that overall production increased at an average rate of 6.08% during last 20 years, but the production in inland open water gradually declined at a very low rate with a slow upward trend since 1991-1992 to 2008-09 (Figure 6-6). The production trend of the capture fishery is found steady from 2011-12 to 2013-14 after fluctuations within the time period of 2009-10 to 2010-11. The reasons of increasing production from the open water sources are include the followings: floodplain stocking with carp fingerlings, Beel nursery programme, and the strengthening of conservation measures. On the contrary, for the last five years the capture fishery production is decreasing at the average rate of 2.2%. This means increase of fisheries interventions and management induced production cannot outweigh the loss of capture habitat induced production.

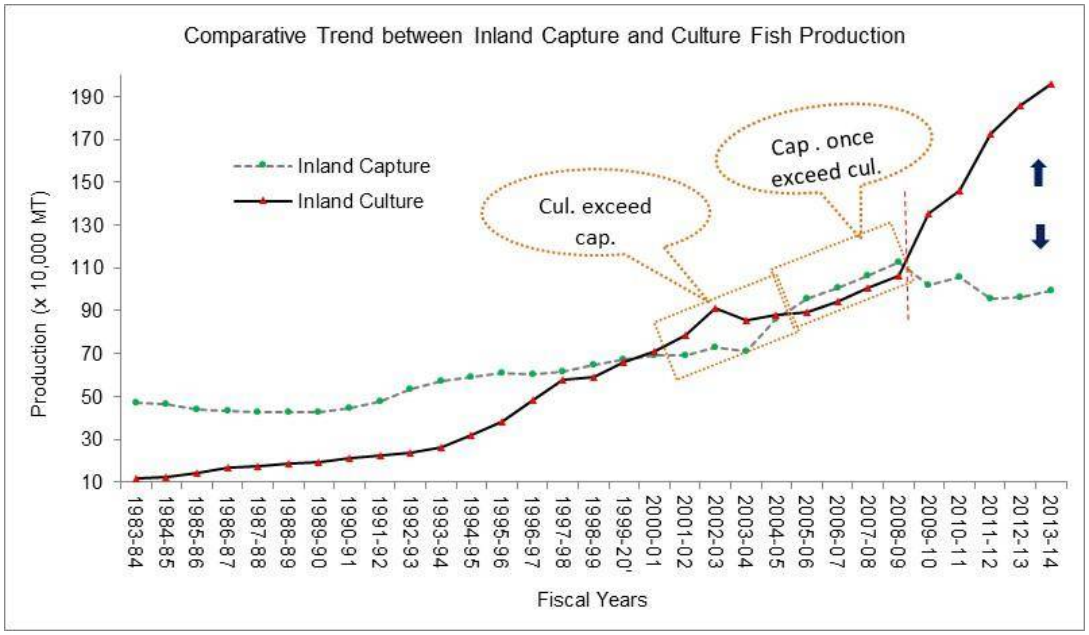


Figure 6-6: Fish production trends of the inland capture and culture fishery

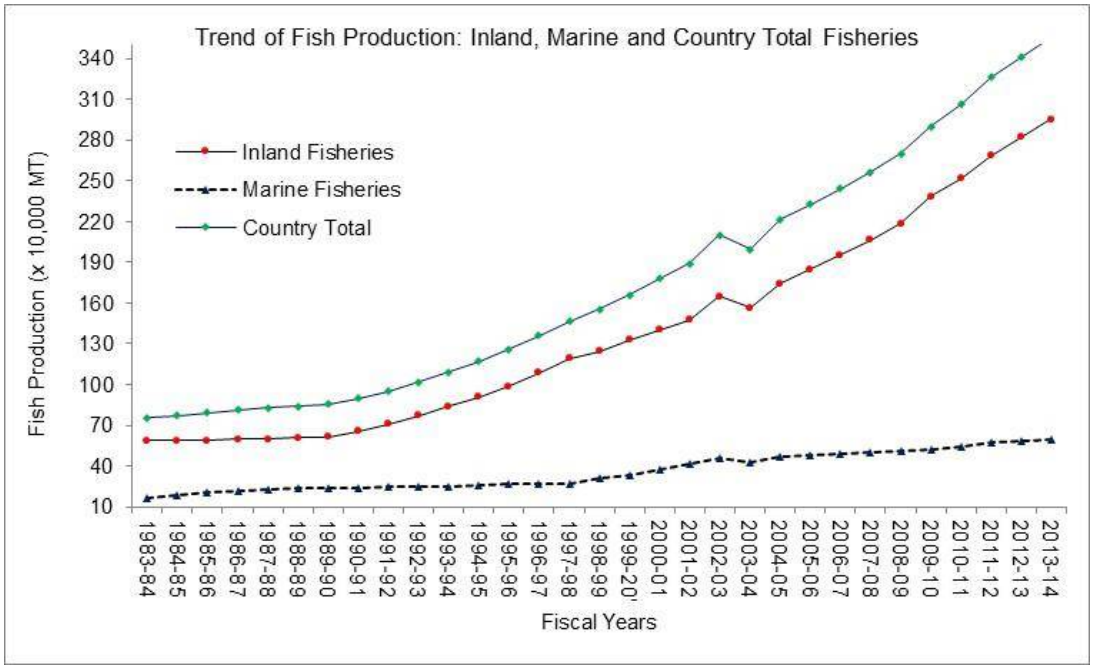


Figure 6-7: Fish production trends of inland, marine and country fisheries

Historically, the major sources of fish production were the inland open waters (rivers and estuaries, Beels, Sundarbans, Kaptai Lake and floodplain). But due to natural and man-made causes, like over fishing, implementation of FCD/FCDI project construction of embankment, dams, roads etc, indiscriminate use of pesticide in paddy fields, water pollution, siltation of river beds and other open waters, the fish population in inland open waters has been declined significantly. As such, the livelihoods of the fishing community have been adversely affected.

The overall species composition has been changed largely from 2003-04 to 2013-14 (Figure 6-8). It has been found that highly changed occurred in case of Cat fish group, while lowest change in Major Carp and other Minor Carp fish

group. Moreover, the entire fish group in marine fisheries has showed significant change during the last ten (10) years.

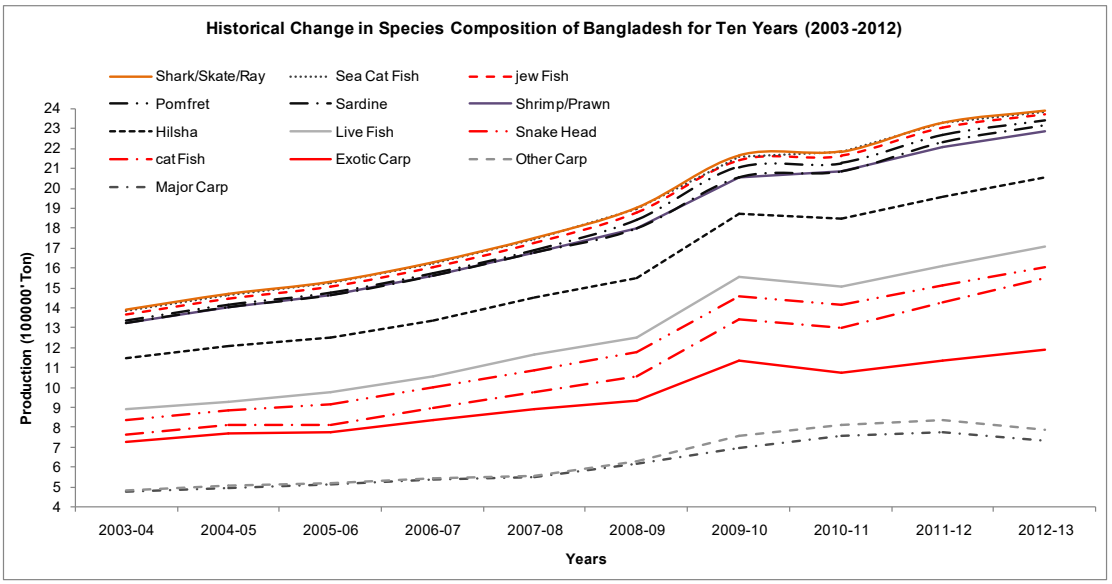


Figure 6-8: Species composition for ten years (2003-2012)

Moreover, fish species of Cat fish group showed highest positive growth performance in sharing national fish production for the last ten (10) years (2003-2013) followed by other minor carp, Pamfret, Indian Salmon, Bombay Duck, Live Fish, etc (Figure 6-9). However, growth rate in fish species of some guild (fish group) showed negative performance, especially Sea Cat Fish, Jew Fish, rest of the marine fish species and Snakehead fish group.

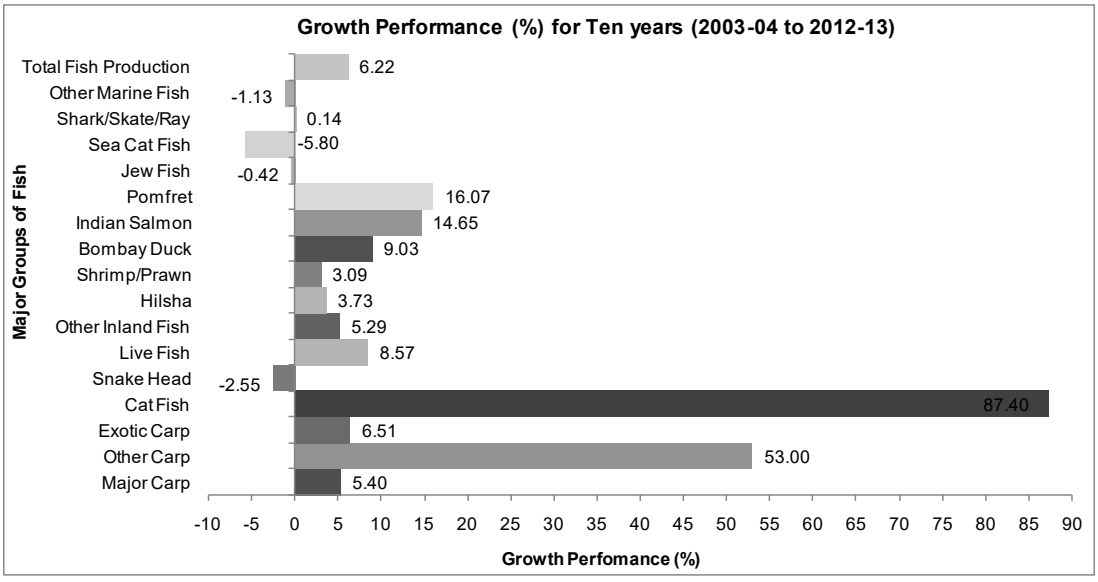
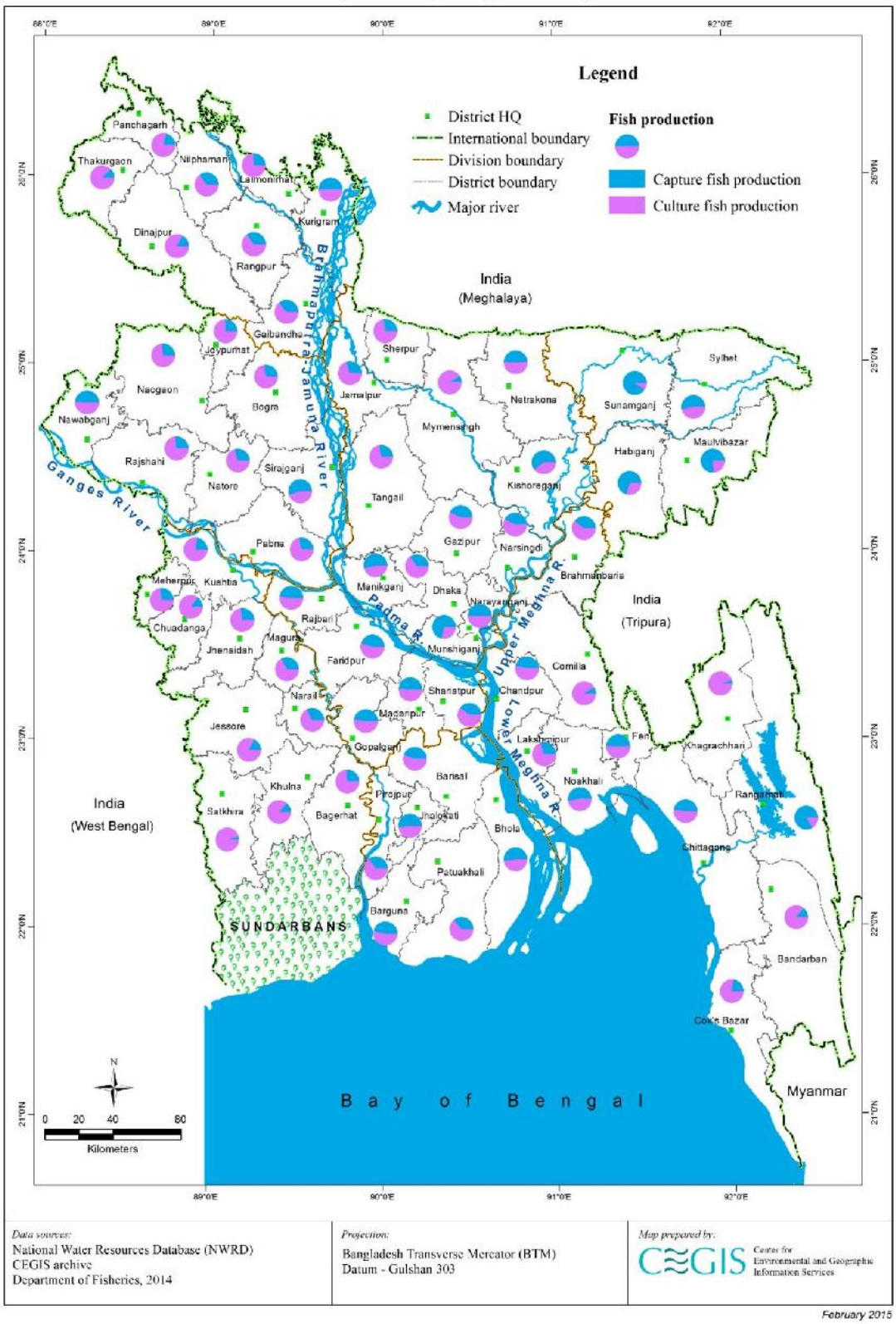


Figure 6-9: Species wise growth performance of annual fish production for ten years (2003-2012)

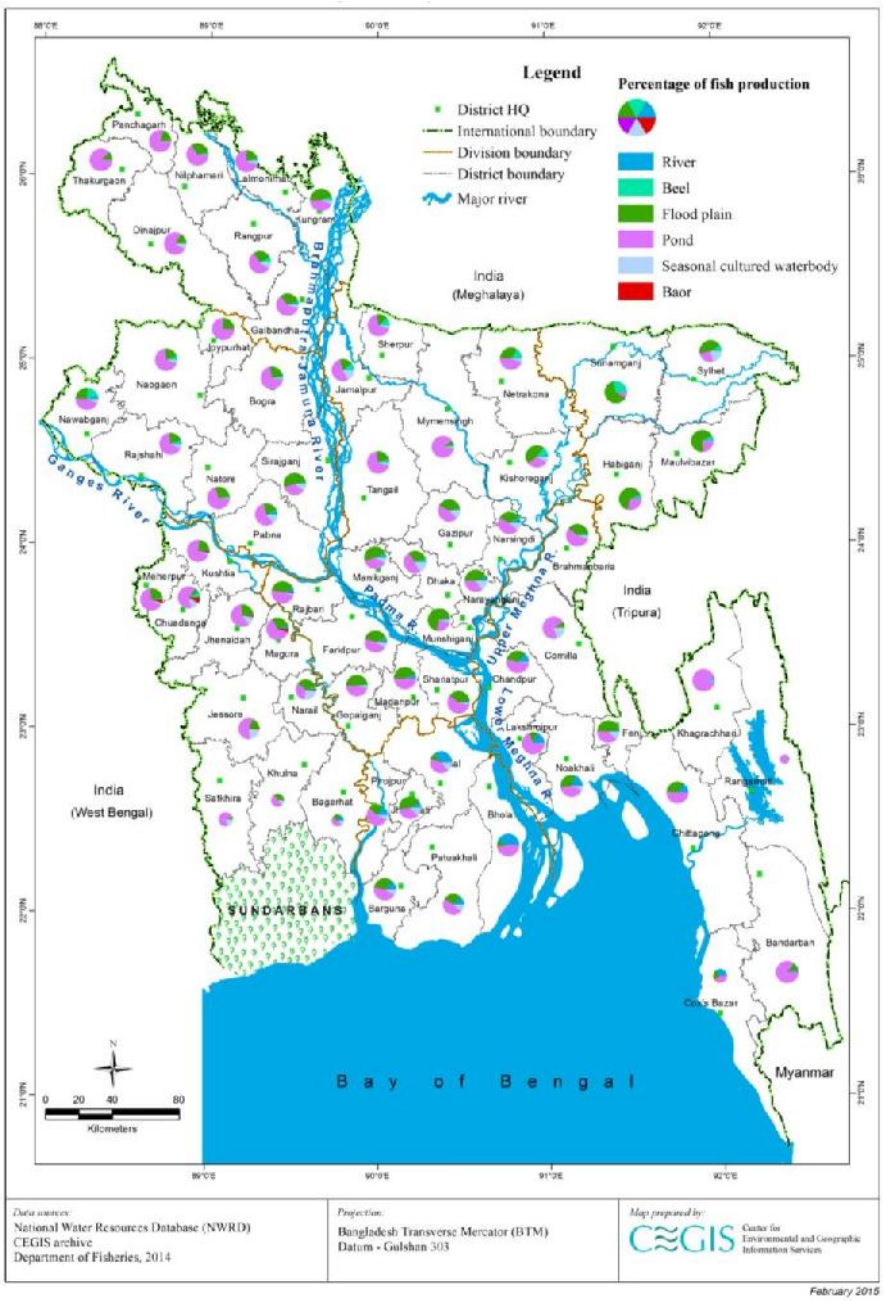
The following maps are showing district wise capture and culture fish productions with their production magnitudes. It is observed from the Map 6-3 that capture fishery is dominating broadly in the Haor region, Kurigram, Chapai Nawabganj, Sirajganj, Rajbari, Madaripur, Munshiganj, Manikganj, Narayanganj, Chandpur, Noakhali, Feni, Chittagong, Rangamati, Jhalokathi and Bhola districts. Other districts are culture fishery dominant.



Map 6-3: District wise fish production of the capture and culture fishery

Source: FRSS, 2013-14

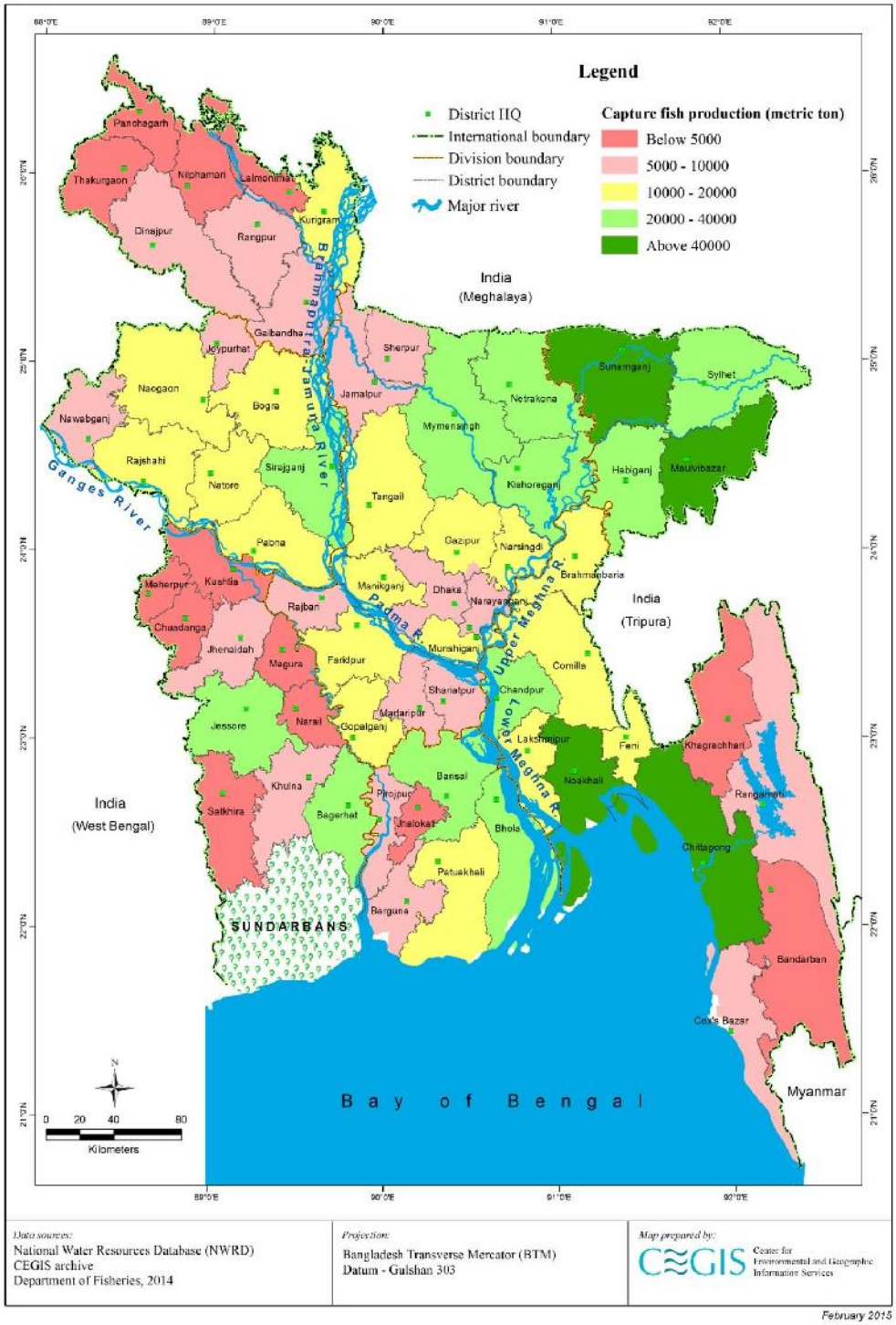
It is seen from the Map 6-4 that floodplain fish production is dominating broadly in the Haor region, Sirajganj, Munshiganj, Manikganj and Feni, districts. Riverine fish production is dominant in Bhola district. Other districts are culture fishery dominant.



Map 6-4: District wise percentage of fish production by habitat

Source: FRSS, 2013-14

It is observed from the Map 6-5 that highest fish production (above 40,000 metric tones) from capture fishery comes from Sunamganj, Maulvibazar, Noakhali and Chittagong districts. And lowest production (below 5,000 metric tones) comes from Thakurgaon, Panchgarh, Lalmonirhat, Meherpur, Kustia, Chuadanga, Magura, Narail, Satkhira, Jhalokathi, Khagrachari and Bandarban districts.

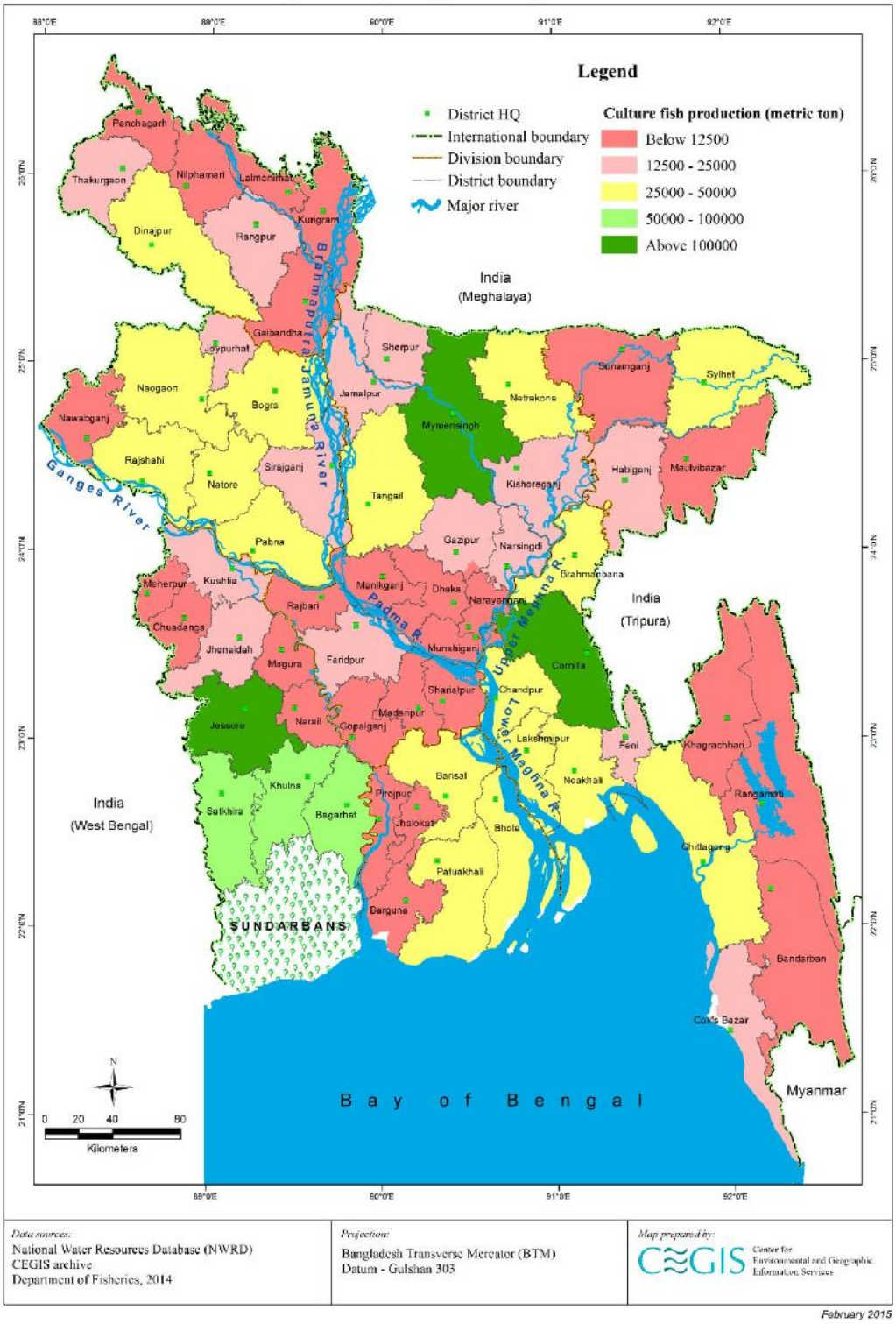


Map 6-5: District wise magnitude of capture fish production

Source: FRSS, 2013-14

The Map 6-6 shows that the highest fish production (above 100,000 metric tones) from culture fishery comes from Mymensingh, Comilla and Jessore districts. And lowest production (below 12,500 metric tones) comes from Panchgarh, Lalmonirhat, Kurigram, Gaibandha, Nawabganj, Meherpur, Chuadanga, Rajbari, Magura, Narail, Gopalganj,

Manikganj, Munshiganj, Dhaka, Narayanganj, Sariatpur, Madaripur, Pirojpur, Jhalokathi, Barguna, Khagrachari, Rangamati and Bandarban districts.



Map 6-6: District wise magnitude of culture fish production

Source: FRSS, 2013-14

6.6. Fish Biodiversity

6.6.1. Species richness and composition

Being a lowlying deltaic country, seasonal variation in water availability is the major factor, which generates different ecological scenarios and yielding wide range of fisheries biodiversity. Temperature, rainfall, physiographic variations in soil and different hydrological conditions play vital roles in detgermining evenness and richness of species diversity. A total of 260 species of freshwater fish is known to inhabit Bangladesh, 12 exotic fish species, 24 freshwater prawn species, 475 marine fish species and 36 marine shrimp species (DoF, 2015). Cyprinids and catfishes dominate the ichthyofauna of both inland and marine waters of the country. Based on percentage of weight (FRSS 2013-14), dominated species or group composition of fish of the country's inland and marine watersheds is 'other inland fish' (about 24%, leading by small cyprinids & catfish species) and lowest species group/single fishery is Indian Salmon (about 0.06%) as shown in following Figure 6-10. Hilsa is dominating the species composition as a single fishery by over 10%. Hilsa, pomfret, shrimp/prawn, major carps and large catfish are most commercially valuable species though knife fish (chital, etc.), 'live fish' (koi, singhi, magur), are also important. Miscellaneous species are of the highest importance for subsistence and self-provisioning. Major fish species from both inland and marine waters are as follows:

Inland fish: This includes major carp, large catfish, feather back, snackhead, glass fish, perch, seabass, etc. These species mostly perform longitudinal spawning migration and thereby defined also as ecological factors. Majority of small species are included in this category and important for subsistence consumption, although few are commercially in demand (i.e. koi). Most species carry out small distance lateral movement into shallow water and some of the species perform potamodromous movement those abode in relatively deeper water.

Marine fish: Marine fish and shrimp species live in different dipths of water. Among the fish species pelagic ones are shark, tuna, hilsa, etc. and demersal fish species are poa, kata, datina, etc. Shrimp, crabs, etc. live in bottom of the sea.

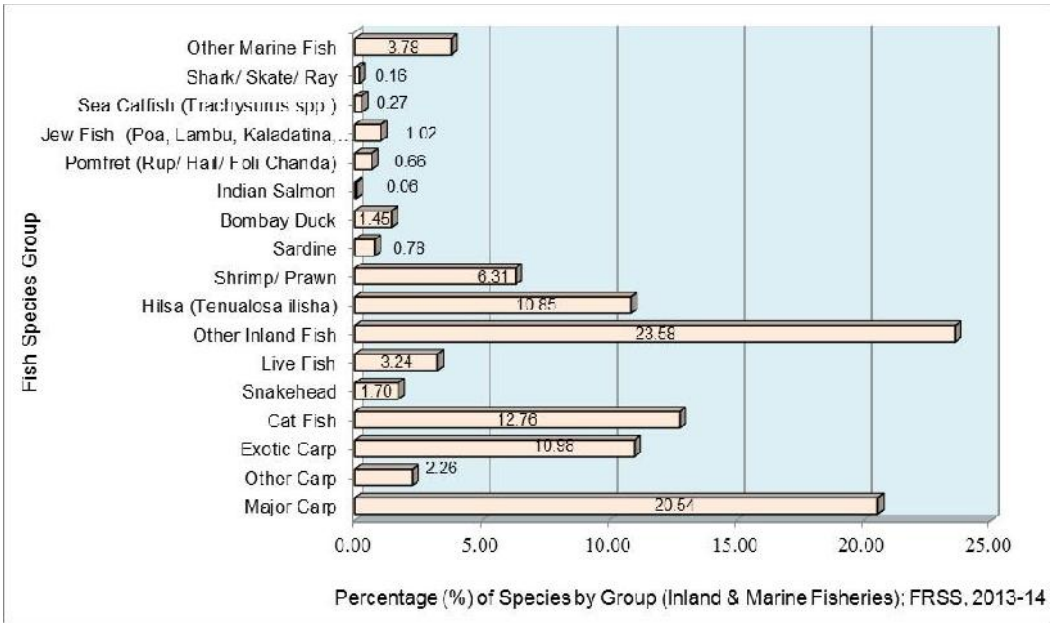


Figure 6-10: Fish species composition of the inland and marine fisheries

In the inland fishery, major carp (about 25%) dominates the species group while the lowest species group is small shrimp/prawn (about 2%) and othe groups are in-between as shown in Figure 6-11.

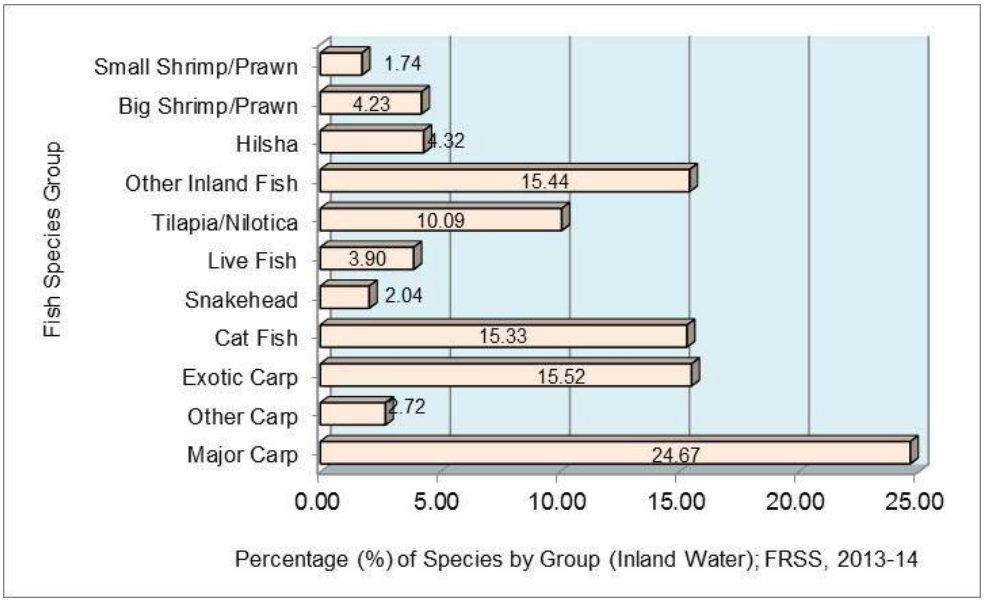


Figure 6-11: Fish species composition of the inland fishery

In the marine fishery, harvest is more from the artisanal fishery than the industrial fishery. In artisanal fishery, highest contributing species group is Hilsa (about 72%) and the lowest one is Indian Salmon (about 0.5%). In industrial fishery, other marine fish contributes the major segment in the species group by over 56% while the lowest segment is pomfret (about 0.7%). Species compositions for both fisheries are shown in Figure 6-12.

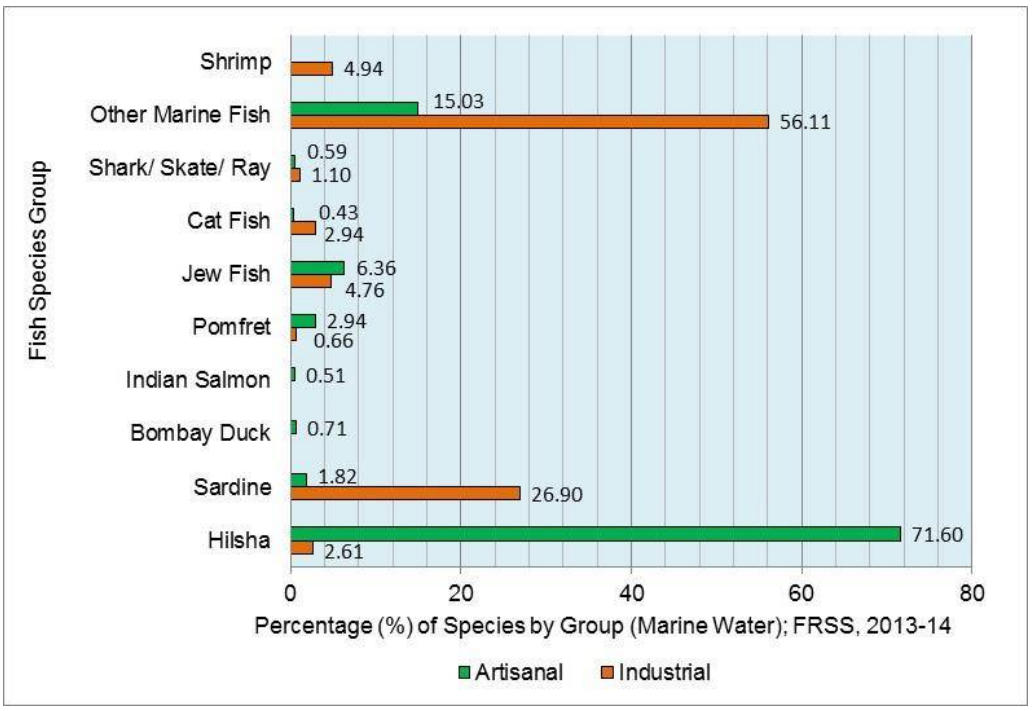


Figure 6-12: Fish species composition of the marine fishery

In floodplain fishery, the major contributor is 'other inland fish' by over 49% and the lowest species group is big shrimp/prawn by about 0.2% (Figure 6-13).

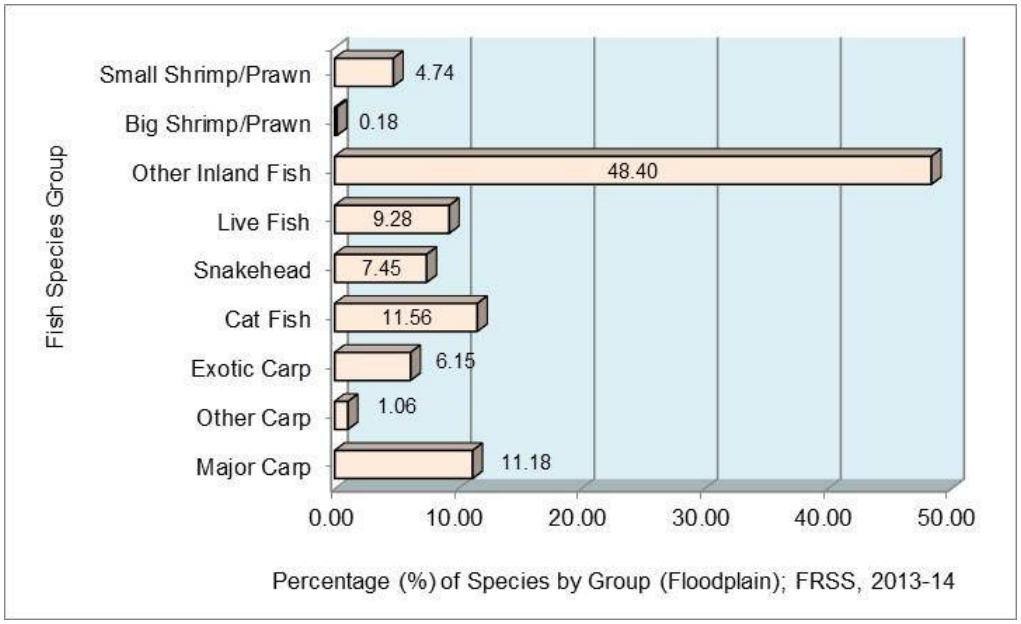


Figure 6-13: Fish species composition of the floodplain

Similarly, Beel fish species is dominated by other fish category which carries about 32% and the lowest contributor is big shrimp/prawn by (about 0.5%) and the rest is as shown in the following Figure 6-14.

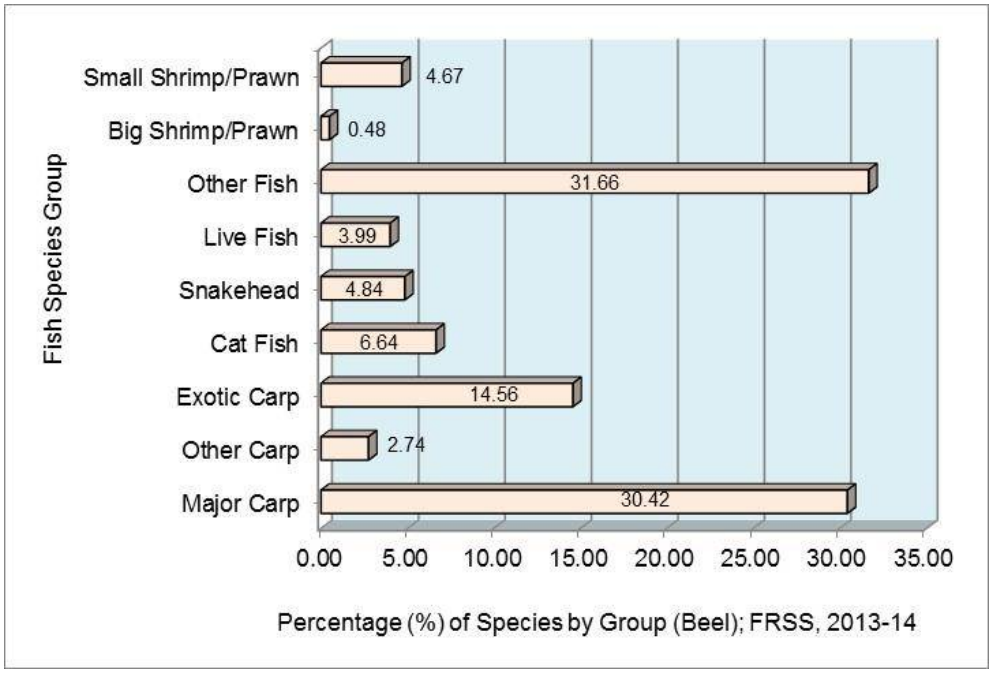


Figure 6-14: Fish species composition of Beel habitat

Fish species composition of the pond aquaculture is dominated by major carp (over 31.0%) while the lowest contributor is snakehead (about 0.1%) and the rest is as portrayed in the Figure 6-15.

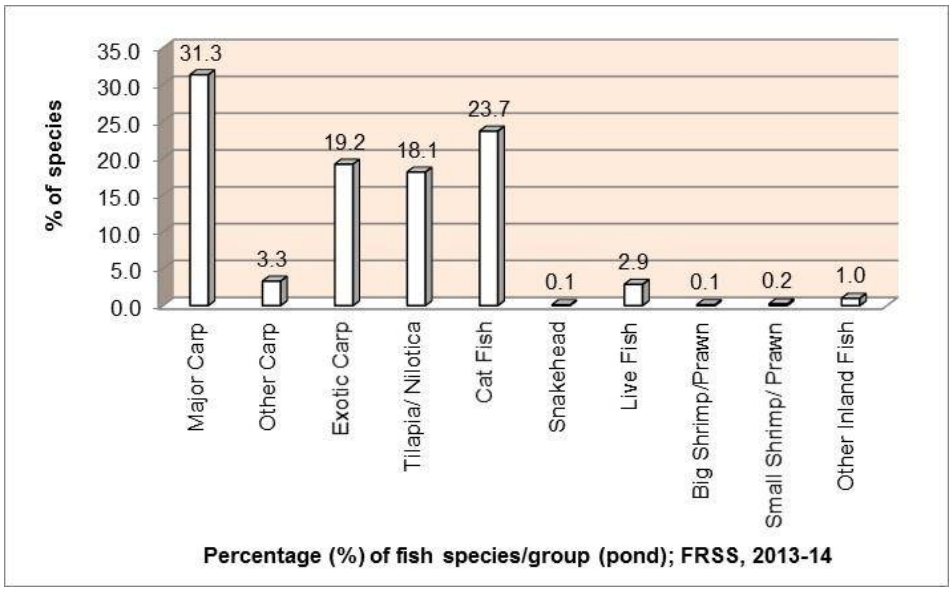


Figure 6-15: Fish species composition of pond habitat

Fish species composition of the Baor aquaculture is dominated by exotic carp (about 34%) while the lowest contributor is big shrimp/prawn (0.1%) and the rest is as portrayed in the Figure 6-16.

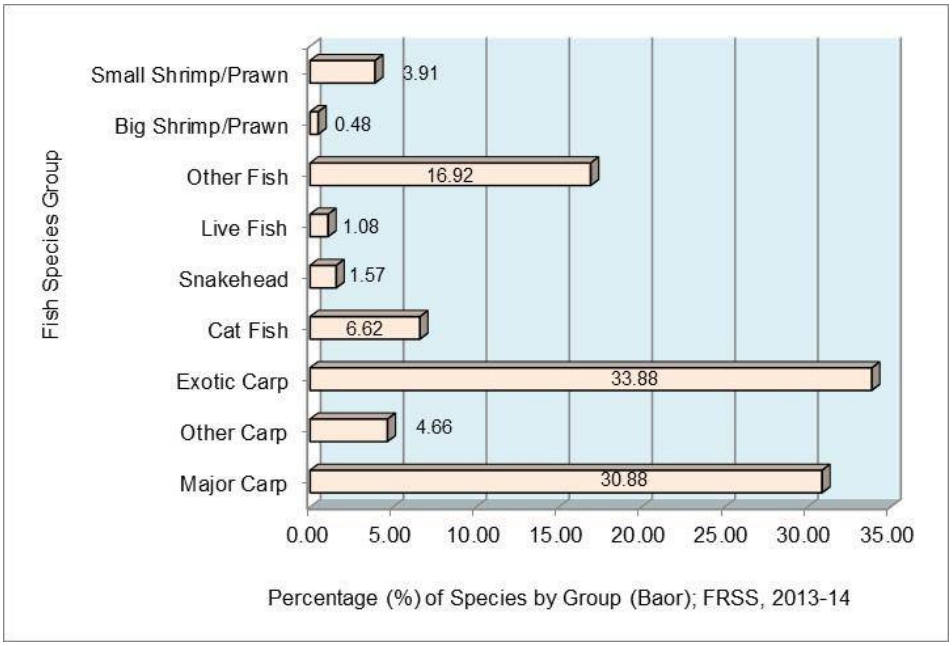


Figure 6-16: Fish species composition of Baor habitat

Ilish (*Tenualosa ilisha*)

Koral (*Lates calcarifer*)

Tiger shrimp (*Penaeus monodon*)

Poa (*Poma poma*)

Golda Chingri (*Macrobrachium rosenbergii*)

Koi (*Anabas testudineus*)

Rayek *(Cirrhina reba)*

Misc. (Pabda, Bacha, Banshpata, SIS)

Magur (*Clarias batrachus*)

Beush/Guizza ayer (*Sperata seenghala)*

Photo 6-1: Indicative fish species of the country

According to the IUCN Red Book, there are 54 fish species are threatedned in the country. Among them 14 species are listed as critically endangered; 27 as endangered and 14 as vulnerable (IUCN, 2000).

6.6.2. Species of Conservation Significance

The increasing pressure of flood control & drainage (FCD) and flood control, drainage & irrigation (FCDI) projects (changes in environmental and morphological conditions), non-FCD/I factors (indiscriminate and over fishing, naturally changes in morphological conditions, excess abstraction of beel water for irrigation), pollution, urbanization and infrastructure development have been driving some fish fauna towards extinction and some towards threatened. Some of such threatened freshwater species of fishes in Bangladesh are- Grey feather back (*Notopterus notopterus*), Freshwater eel (*Anguilla bengalensis*), Snakeheads (*Channa marulius*, *C. barca* and *C. orientalis*), angrot (*Labeo angra*), Darkina (*Rasbora rasbora*), Bhagna (*Labeo boga*), Olive barb (*Puntius sarana*), Mahashol (*Tor tor*), Baghair (*Bagarius bagarius*), Bacha (*Eutropichthys vacha*), Tara baim (*Macrognathus aculeatus*), Neptani (*Ctenopis noblis*), Napitkoi (*Badis badis*), and Bhangan (*Liza tade*). No such endangered or threatened list of marine fish is available in Bangladesh (Ahmed, 1995).

	
Mohashol (*Tor tor*)	Baghayer (*Bagarius bagarius)*
	
Chital (*Chitala chitala*)	Bacha (*Eutropiichthys vacha*)

Photo 6-2: Fish species of conservation significance of the country (indicative)

6.7. Fish Wastage

The estimated total fish production of the country is around 35.5 lakh MT of which 0.89 lakh MT becomes wastage every year considering 2.5% penalty factor of fish wastage due to inadequate fish processing units, modern and hygienic landing centers, transportation facilities in remote areas, inadequacy in ice plants, improper handling, etc. Wastage of fish has been projected for 2015 and 2016 with considering the penalty function of 2.25% as 0.82 lakh and 0.85 lakh MT. Declining trend of fish wastage would be achieved due to the expected improve in communication facilities (*dealt in Communication Development Area under Delta Plan*) and fisheries infrastructural and training facilities (*will* be dealt in this report). The estimated yearly wastage of country fish is presented in the Table 6-2.

Table 6-2: Projected fish production versus wastage by district

Point of Concern	Base Fish Production (Lakh MT), 2014	Projected Fish Production (Lakh MT)		Fish Wastage Penalty Factor	
		2015	2016	2015	2016
				2.25%	
		2015	2016	Wastage Fish (Lakh MT)	
Bangladesh	35.5	36.6	37.8	0.82	0.85

Source: CEGIS estimation based on Fisheries Road Map

6.8. Fish Demand

Fish requirement or demand based on human nutrition and protein contents in daily diets of Bangladeshi people may be viewed from different angles. Human nutrition based fish requirements of Bangladesh have been assessed for 2004 and this was around 2.76 million MT and total estimated requirement is 2.98 million MT considering the requirements for export, diverted for fish meal and poultry feed, and fish wastage. Similarly, for 2009 the estimated nutrition based fish requirement is 2.97 million MT while the total requirement is 3.22 million MT; for 2012 it is about 3.10 million MT and 3.38 million MT and for 2015 it is 3.24 million MT and 3.54 million MT respectively (Vision 2020-21 and Road Map). In this projection the amount of exported fish was assumed same for all projected years. Based on the real figures of fish export and fish required for making fish meal the present estimation is showing deviation from the earlier prediction. Likewise the previous, following points have been considered for projecting fish requirements/demands up to 2015: minimum nutritional requirements for the people; fish requirements for poultry and aquaculture feeds; export need; probable wastage during handling, transporting and processing; purchasing capacity of the people, etc.

For computing protein based fish requirements of the country, opinions of the nutritionists regarding protein intake needs have been considered. It is known from Fisheries Road Map, 2006 prepared by the MoFL that an average Bangladeshi needs to consume 45 gm of mixed protein per day and one third of the protein (i.e. about 15gm) should be of animal origin. It is generally agreed that at least 60% of the animal protein supply for the Bangladeshi people comes from fish. On this basis, fish is to supply 9 gm of the required protein. Assuming that on an average 18% of fish flesh is protein; 9 gm of protein may be obtained from 50 gm of fish flesh. It may be noted that 50 gm of fish flesh may come, on an average, from 56 gm of whole fish; this is based on the assumption that on an average 90% by weight of the whole fish is flesh; the rest consists of the bones, scales, fins, viscera, blood and other non-edible parts.

The amount of fish and fish products exported nationally, estimated wastage of fish, required fish for preparing fish meal, projected human population, required fish for human nutrition and estimated fish requirement have been represented in Table 6-4.

The projected human population of BBS has been used in this estimation. Assuming that fish would continue to contribute 60% of the required animal protein in the future and as such the estimated fish requirement only for nutritional purpose would be as represented for 2013 to 2021 and total estimated fish requirement satisfying other uses as attributed in Table 6-4 and year wise whole fish demand is shown in Figure 5-61 with the corresponding increase of population and other uses.

Table 6-3: Projected country fish requirements by 2015

Year	Projected human population (Lakh)	Required fish for human nutrition (Lakh MT)	Required fish for other Uses: Export +Wastage+ Diverted for fish Meal & others (MT)	Total Estimated Fish Requirement (Lakh MT)
2013	1,546	33.86	4.06	37.92
2014	1,567	34.32	4.46	38.78
2015	1,588	34.78	4.87	39.65
2016	1,610	35.26	5.29	40.55
2017	16.32	35.74	5.72	41.46
2018	16.54	36.22	6.16	42.38
2019	16.77	36.73	6.61	43.34
2020	17.00	37.23	7.07	44.30
2021	17.23	37.73	7.55	45.28

** Based on assumed per capita requirement of 60 g whole fish/day (Source: Vision 2021)*

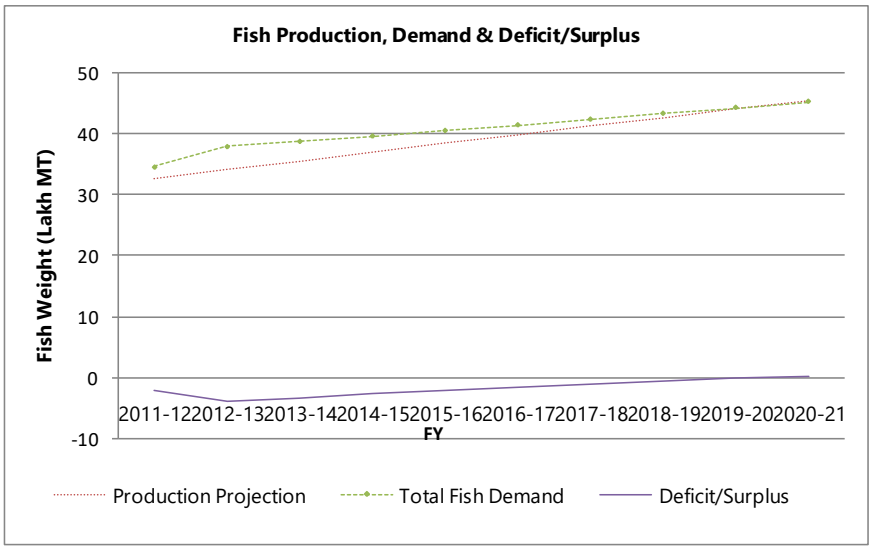


Figure 6-17: Projected fish demands and surplus of the country

From the above figure it is observed that fish becomes surplus even after the fulfillment of the total fish requirements of the projected population of the country estimated considering population growth rate of BBS, export, wastage and fish required for other uses. It is observed that a number of interventions/ measures were undertaken from 2013-14 and continued till 2015 but some results are also realized by this time, hence there is a jumping of production from 2013 to 2015. The following Table 6-5 represented the fish demand, production ans surplus/deficit status of the country.

Table 6-4: Fish demand, production and surplus/deficit

Items	**2013**	**2014**	**2015**	**2016**
Fish Demand (Lakh MT)	37.92	38.72	39.65	40.55
Fish Production (Lakh MT)	34.10	35.55	36.6	37.8
Deficit (Lakh MT)	-3.82	-3.23	-3.05	-2.75

Source: Estimated based on Vision 2021

6.9. Fish breeding and life cycle

6.9.1. Fish breeding patterns and locations

Inland water fish species are mostly resident, breed more or less in any water bodies except major carps, pangas and ilish which are migratory in nature. The species can be separated into two types of fish spawning patterns based on their preferred breeding habitat:

River breeders: Rui, Catla, Kalibaus, Mrigel, Chital, Ghagot, Ayre, Rani, Pabda, Pangas, Bacha, Garua, Shilon, Baspata, Kajoli, etc. and

Floodplain and beel breeders: Boal, Ghonia, Singi, Sarpunti, Magur, Koi, Bheda, Punti, Icha, Chanda, Mola, Golsha, Tengra, Khalisa, etc.

Floodplain and beel breeding pattern: Breeding starts at the onset of monsoon flooding, when water in adjacent rivers and channels flows into the beels. Piscivorous species (boal, shol and gozar) breed earlier than the non-piscivorous species. Most of the catfish, live fish and other small fishes move to the inundated shallow water area and start breeding at the end of March and early April. Flash flood in some areas and torrential rainfall with thunder stimulate breeding of boal, ghonia, pabda, koi, batasi, punti and lasu. Species such as ghonia, boal, foli, pabda, shol, gozar, lati, koi, lasu, etc prefer a newly inundated weedy area with shallow water and slow current. Boal, pabda and ghonia also breed in the khals connected to the beels.

River breeding pattern: Reproductive patterns are more diverse among the river breeders. Ayre, rita, ghagot and guizza dig pits for breeding in the shallow area in April and May and also known to breed around '*Katha*'. Chital and foli breed during May to June in shallow areas over hard substances such as stones, bamboo or submerged tree branches. Small fish including batashi, bashpata, chela, kachki, baila and baim breed shallow areas of rivers in April and rani prefers to breed in calm and quite places. The occurrences of substantial 'Jatka' schools and brood ilish in the Upper Meghna, the Meghna, the Padma, the Ganges, the Jamuna, the Passur, the Sibsa, the Kushiyara (in Hakaluki haor area reported in 'Prothom Alo' in 24 August 2010), etc are observed suggests that the species may spawn somewhere in the mentioned rivers.

Based on the differences in the spawning grounds, spawning seasons, and geographic distribution, the major carp in Bangladesh are often divided into four stocks named by the respective river system: i) Brhamaputra-Jamuna stock, ii) Upper Padma stock, iii) Upper Meghna stock, and iv) Halda stock (Azadi, 1985; Tsai and Ali, 1985).

The carp broods after breeding, sub-adults and juveniles usually go back to grazing grounds, which are usually deep having high abundance of food organisms in the Halda River. Local fishermen believe that major carp stocks graze in various Kums situated in the River Halda and the River Karnafuli during dry season (Table 6-5).

Table 6-5: Location of Kums / Kurs in the River Halda

Sl. No.	Name/ Location	Number of kums	Depth (m)
1	Nazirhat bridge	1	5 - 6
2	Nazirhat bridge Down	1	5 -8
3	Pashkarhat (Dhurang khal mukh)	1	8 - 10
4	Seepatolee / Kotawal ghona	1	10 - 12
5	Sattarghat Up	1	8 - 10
6	Sattarghat Down	1	12 - 14
7	Ongkureeghona	1	18 - 20
8	Karantoleer bak	1	20 - 21
9	Kantaijjarhat	1	20 - 21
10	Gardoyara (Up of Chengkhali sluice gate)	1	25- 30
11	Gardoyara (Down near broken mosque)	1	24- 28

Sl. No.	Name/ Location	Number of kums	Depth (m)
12	Taj Majheer ghat	1	12 - 15
13	Kagotiyar much	1	25 - 26
14	Bansalghat	1	20 - 24
15	Napiterghat / Amtua	1	18 – 20
16	Madaree khal much	1	15 – 17
17	Puraolee / Purakhalee / Dozkhalee	1	22 - 24
18	Azimer ghat	1	20 - 21
19	Khalifer ghona	1	12 – 15
20	Ramdashat	1	10 – 12
21	Maduna ghat Up	1	10 - 15
22	Maduna ghat Down	1	12 - 16
23	Sayarchar / Burishchar	1	20 - 24

Carp spawn or fertilised egg production has declined critically in recent years. It has declined from 34,000 kg in 1997 to 508 kg in 2014 (DoF, 2015[9]). Local fishermen believe that spawning stocks of major carps have reduced critically due to habitat degradation and illegal fishing. Local fishermen also reported that size of individual brood fish of major carps has decreased due to indiscriminate catching of broods, sub-adults and juveniles. Large *Catla catla* of 20-25 kg, *Labeo rohita* of 15-20 kg and *Cirrhinus cirrhosus* of 10-15 kg are scanty as they are caught before attaining such sizes.

6.10. Mother Fishery

Functionally, a mother fishery exerts a controlling influence on fish abundance over a wide area. Thus, if fish abundance is high in a particular mother fishery in a particular year, fishermen expect fish abundance also to be high in the surrounding areas. The reverse would also be expected: low fish abundance in the mother fishery would result in low catches in the surrounding areas.

Structurally, a mother fishery could consist of a single beel, or duar or spawning locality. Most of the Jalmohals can be treated as mother fishery. Among the mother fishery grounds following are important:

- Tangua Haor;
- Hakaluki Haor;
- Khaliajuri area; and
- Companiganj area.
- Halda River is the one and the only natural carp breeding ground in Bangladesh from where fertilized carp fish's (*Catla catla, Labeo rohita, Labeo calbasu* and *Cirrhinus mrigala*) eggs are collected by local fishermen. Halda River is one of the major rivers in the South-East region of Bangladesh. This is the only pure Indian major carp breeding ground of Bangladesh, perhaps in South Asia.
- Jamuna river

Adult brood Hilsa mainly spawn at major deltaic rivers, estuaries and coastal areas of Bangladesh. But it has four main mother and spawning grounds in Bangladesh (Halder and Islam, 2008). These are:

1. Dhalerchar of Charfashion in Bhola (about 125 sq. km area);
2. Monpura in Bhola (about 80 sq. km area);
3. Moulavichar of Hatia in Noakhali (about 120 sq. km area) of Bangladesh
4. Kalirchar of Sandwip (about 194 sq. km area) of Bangladesh.

[9] FRSS, 2013-14

Hilsa spawn more or less throughout the year, they have a minor spawning season during February-March and a major seasosn in September-October. Local fishermen catch migrating adults from February to May from different deltaic rivers.

After hatching from free floating eggs, the larvae remain in their nursery grounds where they feed and grow. There are mainly five nursery grounds where Jatka (Hilsa fish sized less than 25 cm) grows for six to ten weeks before going back to the sea for further growth and maturity. These nursery grounds are situated from Shatnol of Chnadpur to Char Alexander of Laxmipur (100-km stretch to Meghna River), from Madanpur/char Ilisha to char Pial of Bhola district (90 km of Shahbajpur channel of Meghna confluence), from Bheduria of Bhola to char Rustom of Patuakhali district (40 km area) and Narhira to Bhedarganj of Shariatpur district (20 km stretch of Lower basin Padma River) (DoF, 2013). These grounds have been declared as sanctuary for conserving jatka.

6.11. Hilsa Fishery

Hilsa is the largest single fishery in the open waters of Bangladesh both in inland and marine sectors. Nearly 11% of the country's total fish production of 3.85 lakh MT is contributed by this fishery having a value of Tk. 17,000 crore (@ Tk. 450/kg) (DoF, 2015). Approximately 4.5 lakh fishers are dependent on Hilsa fishery for their livcelihoods (WorldFish, 2015). The reduction in the depth and discharge of rivers due to construction of dams and barrages as affecting spawning, nursing, feeding, migration and also for increasing fishing pressure in the upstream rivers, landing of hilsa from the inland open waters has sharply declined. However, total production remained stable due to increased harvest from the marine sector.

Different species of hilsa and their distribution

The hilsa shad, *Tenualosa ilisha* belongs to the sub-family Alosinae of family Clupeidae and is largely an anadromous species. The systematic name of the species has been revised to *Tenualosa ilisha* (Fischer and Bianchi 1984). There are five species of Tenualosa: *Tenualosa ilisha* (the Hilsa of Bangladesh) extending from Burma to the Arabian Gulf is the most widespread and best studied. *T. toli* is now restricted to Sarawak (Malaysia) although previously recorded in Bangladesh, *T. macrura* occurs only in coastal waters of parts of Indonesia and Malaysia, *T. reevesi* is now rare in southern China, and *T thibaudeaui* is now very rare in the Mekong River of Vietnam and Laos.

Characteristics of hilsa

Hilsa lives and grows in the sea and migrates upstream to the rivers for breeding purpose. After breeding, they swim back to the sea for which it is known as diadromous. At the end of the nursery period, the juveniles also undertake migration to the sea for maturation. The mature hilsa again in the same way swim back to the freshwaters in the rivers for breeding and in order to complete their life cycle. They attain maturity in one to two years. Females grow faster and bigger than males. Fecundity depending on size varies from 0.5 to 2.0 millions.

Food habit of hilsa

The adult and sub-adult hilsa are plankton feeder and their food composition was found to be dominated by algae (41.65%), sand and debris (36.28%), diatoms (15.36%), rotifers (3.19%), crustaceans (1.89%), protozoans (1.22%) and miscellaneous (0.41%). It has a well defined gizzard like stomach.

Trends of Hilsa catch in Bangladesh

Hilsa is caught and landed throughout the year, but the peak landing season covers the month of September and October. During the last decade, the major fishing grounds have been shifted from the upper reaches to the lower reaches of the rivers and to the estuaries and coastal waters. During 2013-14, out of total Hilsa capture of 385140 MT, inland production contributed 127,514 MT and marine 257,626 MT. The production trend of Hilsa is shown in Table 6-6.

Table 6-6: Production trends of Hilsa for the last 15 years in Bangladesh *(Source: DoF, 2015)*

Year	Production (MT)			Increase rate (%)
	Inland capture	Marine Capture	Total	
1999-00	79165	140367	219532	2.34
2000-01	75060	154654	229714	4.64
2001-02	68250	152343	220593	-3.97
2002-03	62944	136088	199032	-9.77
2003-04	71001	184837	255839	28.54
2004-05	77499	198363	275862	7.83
2005-06	78273	198850	277123	0.46
2006-07	82445	196744	279189	0.75
2007-08	89900	200100	290000	3.87
2008-09	95970	200951	298921	3.08
2009-10	114768	198574	313342	4.82
2010-11	114520	225325	339845	8.46
2011-12	114475	232037	346512	1.96
2012-13	98648	252575	351223	1.36
2013-14	127514	257626	385140	9.66

Spawning season

The spawning season of hilsa vary from a few months to year-round. In Bangladesh there appears to be two distinct spawning seasons one which begins at July and continues to October and a second which occurs from January to March but the peak period is September and October with a minor peak at December –January.

Major Hilsa spawning ground and its banned area & time

Lower stretches and estuarine part of the Meghna River was found as the major spawning ground of hilsa. Among these areas, the Kalirchar (south of Sandwip), Moulavirchar (south of Hatia), around Monpura (east of Bhola), and Dhalchar (south of Bhola) near Char fashion were found as the most significant, areas of hilsa spawning. Banned on Hilsa fishing is imposed every year for 11 days during the full moon in the Bengali month of Ashin by Department of fisheries.

In these areas during the monsoon period (from August to October) water becomes entirely fresh (non-saline) and highly turbid. Due to high flood pressure and active tidal action water current creates turbulence, upwelling and repeated circular rings due to irregular bottom topography and water become highly oxygenated which helps to meet high oxygen demand during spawning activity of hilsa.

The physico-chemical parameters such as water transparency, water temperature, salinity, dissolved oxygen, total hardness and pH were monitored during the peak spawning season. Water transparency were 10±4.45 cm, surface water temperature 25.82±3.93°C, salinity 0 ppt, dissolved oxygen 8.50±1.44 ppm, total hardness 92.87±16.95 ppm and pH 7.96±0.36.

Nursery ground

By the occurrence of juvenile hilsa called jatka, the following two major nursery grounds were identified: i) Riverine nursery ground, and ii) Coastal nursery ground. The largest riverine nursery ground was identified in the river Meghna in and around Chandpur covering Mowa (Munshiganj) in the upstream through Nilkamal, Hazimara in the down. The catch of young hilsa (jatka) starts in these regions in November and continues upto June with peak in March. The coastal nursery ground extends from Kuakata (Patuakhali) to Dubla Island (Khulna) and in this area

comparatively large sized (11.0 to 15.0 cm) jatka are caught during December-January. The most important spots are Ashar char Sheolar char, Narikel baria, Fatrar jungale, Kochikhali Ovoyarannya, Laldiar char, Meherali and Kotka. In the riverine habitat jatka remains available until the first shower of pre-monsoon or until the clear water prevails. At this time planktonic biomass is usually higher than that of the monsoon period.

Crafts and gears used for hilsa harvesting

The crafts and gears used for hilsa fishing are mostly drift gillnet and Chandi bot. (Table 2). In the Padma river section, gillnet and Kosha boat are mainly operated. In the Meghna river section pocketed gillnet (Gulti jal), Kona jal and Chandi jal are being operated by Chandi boat. During the month of February-May beach seine nets are used for adult as well as jatka catching in this area. In the lower stretches of the Meghna river surface-, mid- and bottom-water gillnets are mainly operated for hilsa fishing. The fishermen of that area use Chandi, Kosha, Dingi and mechanised boats as well. Current jal is being used mainly in the Padma and Meghna Rivers (Chandpur, Haimchar, Doulatkhan and Char Tajumuddin areas) to catch jatka as well as adult hilsa. Among the different types of gear, maximum number of manpower (30 to 50 men) is needed for jagat ber jal operation Meghna River.

6.12. Fish Migration

The issue of fish migration is of particular interest to the management point of view, since many migratory fish stocks constitute transboundary resources, i.e. resources shared between two riparian countries. Following habitats are important for fish migration.

Dry season refuge habitats: Fish migrates to deep pools from unsuitable/riffle areas, particularly in the river mainstream channels, etc.

Flood-season feeding and rearing habitats: Fish moves to flooded lands in the country watershed area for meeting up the nutritional demand.

Spawning habitats: Rapids and deep pool systems in the rivers of the country and flood land habitats especially the beels and swamp forest are specialized habitats for spawning migration.

Migration routes: Entangle of rivers and khals in the whole country. Rivers mainly function as longitudinal fish migratory routes or connectivity. The drainage channels/Khals between floodplain habitats and river channels function as lateral fish migratory route or connectivity.

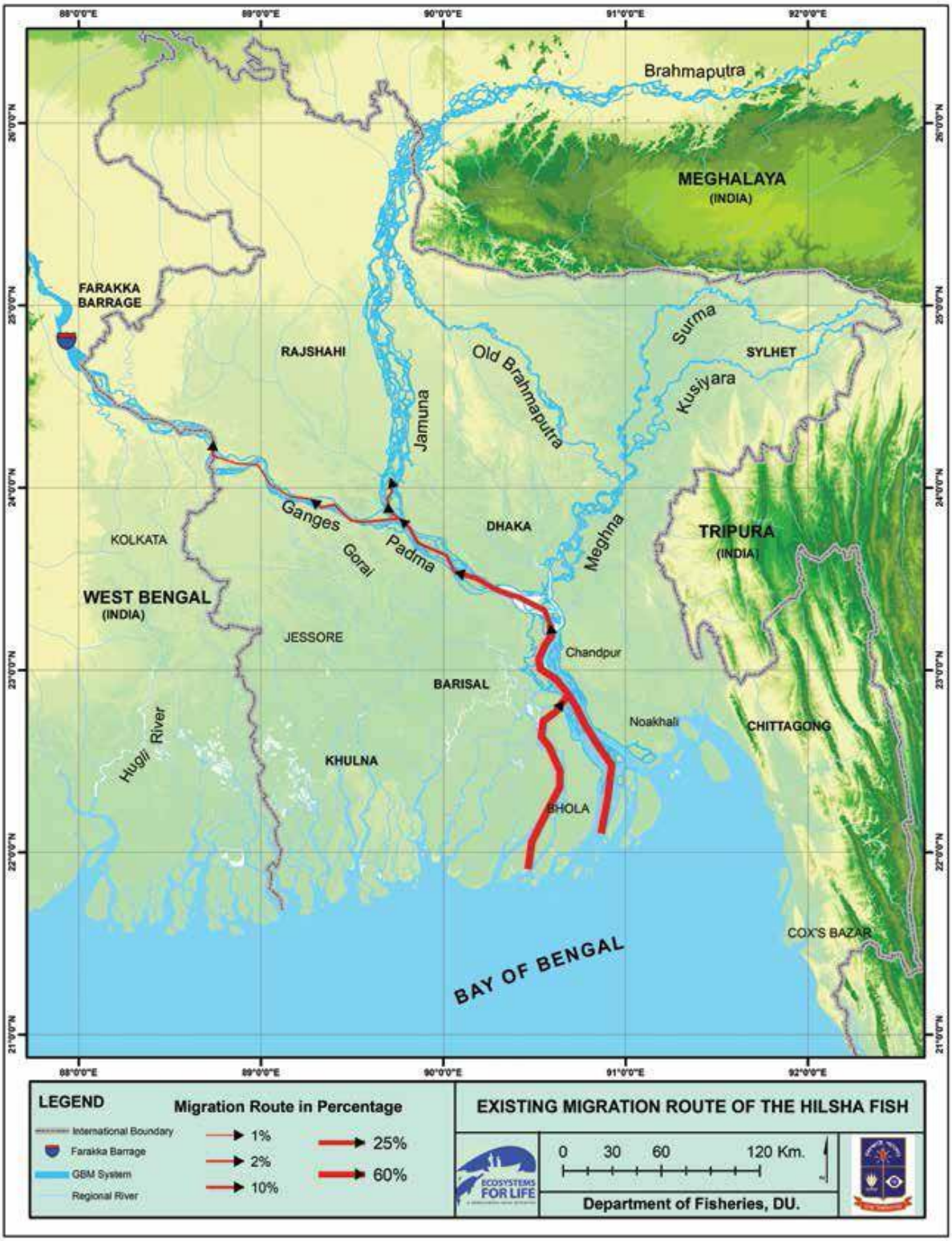
Hydrology: The annual floods that inundate large areas of the country are essential for fisheries productivity. Both longitudinal and lateral migration is strongly influenced by hydrology and its seasonality. Table 6-7 summarized the influence of hydrology on fish activity. At the onset of monsoon, March to May, rain starts with thunder and water accumulated in low pockets and beels. The river water level starts rising and eventually inundates the floodplain. Water from river and with the rainfall run off brings more food in the beels for aquatic ecosystem. The rapid growth of fish food in the floodplain is making it suitable for spawning, feeding and growth of fish. During early part of the pre-monsoon the major carp moves longitudinally from the beels and duars against the river current in the river to the spawning ground.

Table 6-7: Effects of hydrology on fish activity

Hydrological controls	Time	Fish activity
Early rain	February - April	Small fish prepare for breeding in the beel
Thunder	February - March	• Small fishes breed; and • Big fishes like carps and catfish prepare for breeding and spawning migration
Water level rise	March – May	• Breeding continues for small fish and spawning of migratory fish; and • Dispersion of hatchling of small fish over the floodplain area
Water current (pre-monsoon)	March - May	• Spawning migration continues; and • Hatchling movement between river and floodplain
Flood	June - September	• Grazing and feeding in the floodplain; and • Mixing and dispersion of species, migration and movement occur
Water recession	September - November	• Taking shelter to perennial water bodies like deep beels and river duars; and • Move from floodplain to river for shelter
Drought	December - February	Shelter in the deeper water area either in the river (duars/dors) or in the beels
Turbidity and water colour	-	Migrations of some fish are known to correlate to changes in water colour and turbidity and these are closely linked with phytoplankton blooms and changes in the sediment load carried by the river respectively
Lunar phase	-	Lunar phases are often much localized and individual events rarely occur basin-wide
Fish density		This may also stimulate migration, or be a complementary factor that triggers migration for feeding

Migratory pattern, route and abundance of Hilsa Shad

Generally two types of migratory patterns are seen for Hilsa Shad in Bangladesh. These are: (i) Southwest monsoon migration- Hilsa moves from the Bay of Bengal to the rivers like the Padma, the Meghna, etc. for breeding when consequent flooding occurs in all rivers; and (ii) Winter migration happens in February to March. Map 6-7 shows the existing migratory route of Hilsa Shad.



Map 6-7: Existing migratory route of Hilsa fish

Source: Internet

6.13. Fish pass/friendly structures

Protecting fisheries resources from the adverse effects of the unplanned flood control embankments, roads, different water resources development schemes, etc through establishing a type of structure for facilitating fish movements is recognized as fish pass/friendly structure. The structure is set on the embankment between two waterbodies by maintaining water velocity which is passable for most of the concerned fish species in intact and tiredless condition. All of these structures are purposively built to serve agricultural needs, and none have special features to increase their fisheries efficiency, or serve the needs of navigation. There are several options for providing fish pass facilities in FCD/I projects:

- Relying on existing hydraulic structures to give passage to migrating fish (with perhaps some modification of structure operation to increase its fisheries efficiency);
- Relying on public cuts to give passage to migrating fish;
- Installation of appropriate purpose-built structures designed only for fish migration; and
- Modifying the design of hydraulic structures so that they are also highly efficient in giving passage to migrating fish (i.e. make them multipurpose).

Photo 6-3: Vertical slot fish pass

There are two fish pass structures of vertical slot type has been established in Bangladesh. The first one has been established at Sariakandi built in 1991 to connect the Bangali River to the Jamuna River and the second one has been established in 1994 in the Kawadighi Haor at Kashimpur.

Fish pass structures need to overcome the problems of constantly declining fisheries biodiversity of the river and floodplain, conditions (water quality, inundation, connectivity) of fish habitats. The high velocity of the water and turbulence at the hydraulic structure are the prime factors preventing fish to migrate (Clay, 1995). For fish pass/friendly structure planning, the speed and endurance of migratory fish has been examined. Three aspects of swimming speeds, which vary with fish species, can be defined:

- Cruising speed: one that can be maintained for long period of time (hours);
- Sustained speed: one that can be maintained for minutes; and
- Darting speed: a single effort, not sustainable (estimated maximum duration, 10 seconds).

Following tables (Table 6-8, 6-9, 6-10 and 6-11) attribute the fish species wise length and corresponding cruising and maximum speeds considered/allowable for establishing fish pass/ friendly structures.

Table 6-8: Target carp large species for fishpass/friendly structure

Group	Species	Type	Minimum Size*			Maximum Size**		
			TL	Vc	Vm	TL	Vc	Vm
Native Carp	Rui	P	43	150	300	85	300	600
	Catla	P	43	150	300	90	315	330
	Mrigel	P	38	135	270	80	280	560
	Kalibaush	P	28	100	200	50	175	350
Minor Carp	Gonia	P	22	80	160	40	140	280
	Lachu	P	17	60	120	25	90	180
	Sarputi	P	14	50	100	25	90	180
Exotic Carp	Carpio	P	24	85	170	50	175	350
	Silver Carp	P	38	135	270	80	280	560
	Grass Carp	P	53	185	370	85	300	600

Source: FAP 6

P- Pelagic species; B- Benthic species; TL- Total Length (cm); * Average size at first maturity; ** Average size of largest individuals in stock;

Vc- Cruising swimming speed (cm/sec), estimated as 3.5 times body length per sec for pelagic species, and 0.75 times body length per sec for benthic species;

Vm- Maximum swimming speed (cm/sec) is estimated as 2 times cruising speed. Vm is assumed to be the maximum water velocity that can be negotiated through the fishpass.

Table 6-9: Target non-carp large species for fishpass/friendly structure

Group	Species	Type	Minimum Size*			Maximum Size**		
			TL	Vc	Vm	TL	Vc	Vm
Large Catfish	Boal	B	48	35	70	115	85	170
	Air	B	43	30	60	85	65	130
	Ghagot	B	43	30	60	80	60	120
	Baghir	B	80	60	120	180	135	270
	Rita	B	33	25	50	55	40	80
Knifefish	Chital	P	43	150	300	100	350	700
Herring	Ilish	P	28	100	200	45	160	320
Spiny Eel	Baim	B	38	30	60	80	60	120

Source: FAP 6

Table 6-10: Target barbs and catfish species for fishpass/friendly structure

Group	Species	Type	Minimum Size*			Maximum Size**		
			TL	Vc	Vm	TL	Vc	Vm
Small Barbs	Puti	P	3.5	10	20	10	35	70
	Mola	P	4.5	15	30	9	30	60
	Chela	P	5.5	20	40	15	55	110
Small Catfish	Kani Pabda	P	11	40	80	18	65	130
	Pabda	P	14	50	100	25	90	180
	Bacha	P	17	60	120	25	90	180
	Garua	P	16	55	110	25	90	180
	Baspata	P	7.5	25	50	10	35	70
	Batashi	P	5.5	20	40	7	25	50
	Tengra	P	9	5	10	15	10	20
	Gulsha	B	11	10	20	18	15	30

Source: FAP 6

Table 6-11: Target other small fish species for fishpass/friendly structure

Group	Species	Type	Minimum Size*			Maximum Size**		
			TL	Vc	Vm	TL	Vc	Vm
Loach	Rani	B	7.5	5	10	12	10	20
Spiny Eel	Chirka Baim	B	14	10	20	25	20	40
	Tara Baim	B	14	10	20	28	20	40
Knifefish	Foli	P	21	75	150	27	95	190
Needlefish	Kaikka	P	18	65	130	25	90	180
Sardine	Chapila	P	11	40	80	15	55	110

Source: FAP 6

6.14. Fish Hatchery and Nursery

The commonly cultivated six species - Rui (*Labeo rohita*), Catla (*Catla catla*), Marigal (*Cirrhinus mrigala*), Silver carp (*Hypothalmichthys molitrix*), Grass carp (*Ctenopharyngodon idella*) and Common carp (*Cyprinus carpio*) are considered to be the best culturable species of fishes in the inland water system. These fishes originally belong to riverine environment and when cultured in standing water bodies such as ponds and tanks, they attain maturity but normally do not breed under confined conditions. Special attempts are therefore made to breed them by artificially creating riverine conditions and stimulating there endocrine system. The technique of breeding fish by other than its natural course is known as induced breeding. Induced breeding techniques have been developed for production of quality fish seed of culturable varieties. It is one of the most dependable methods of producing pure seed of desired species of fish. Further this technique has helped to produce fish seed in those areas where natural collection of fish seed was not possible. Another six species including mono sex tilapia (*Oreochromis nilotica*), Thai pangus (*Pangasius sutchi*), Thai sharpunti (*Puntius gonionotus*), mirror carp (*Cyprinus carpio specularis*), bighead carp (*Hypophthalmicthys nobilis*) and bata (*Cirrhinous reba*) are culturing in the ponds of the country.

A total of 882 hatcheries: 92 Govt. hatcheries and 790 private hatcheries are scattered across the country. Following Table 6-12 and Table 6-13 distribute the division wise Govt. and private hatchery of the country respectively.

Table 6-12: Hatchling production of Govt. hatchery

Sl. No.	Division/Name of Hatchery	No. of Hatchery	Hatchling Production (Kg)
Fish Seed Multiplication Farm			
1	Dhaka Division	18	2,010
2	Khulna Division	8	730
3	Barisal Division	10	578
4	Rangpur Division	13	554
5	Rajshahi Division	15	1,942
6	Chittagong Division	15	1,048
7	Sylhet Division	7	648
***Sub-Total* =**		***86***	***7,510***
Other Govt. Hatchery			
1	Central Hatchery Complex, Baor Fish Development Project, Jhenaidah	1	1,252
2	Raipur Fish Hatchery and Training Centre, Lakshmipur	1	662
3	Hatchery of Bangladesh Fisheries Research Institute, Mymensingh	1	310
4	Hatchery of Riverine Station, Bangladesh Fisheries Research Institute, Chandpur	1	4
5	Parbatipur Hatchery, Dinajpur	1	550
6	Faridpur Training and Extension Centre, Faridpur	1	50
***Sub-Total* =**		***6***	***2,828***
Grand Total =		**92**	**10,338**

Table 6-13: Hatchling production of private hatchery

Sl. No.	Division	No. of Hatchery	Hatchling Production (Kg)	Tilapia Juvenile (Lakh)
1	Dhaka	194	114,729	6,178
2	Khulna	92	74,643	2,578
3	Barisal	29	9,866	445
4	Rangpur	73	42,458	136
5	Rajshahi	184	137,921	1,655
6	Chittagong	201	88,789	5,447
7	Sylhet	17	10,587	1,100
Total =		**790**	**478,993**	**17,539**

Note: About four lakh hatchlings contain in one Kg spawn and one Kg contains 1,000-1,200 Tilapia Juvenile. Other species include Chital, Golsha, Pabda, etc. (Source: DoF, 2014)

A total of 489,331 kg spawn has been produced from private and Government hatcheries in the year 2014. Collection of fish seed from natural grounds has decreased to about 2,695 kg in 2014 which was 3,326 kg in 2013. In 2013-14, there are about 55 *P.monodon* (Bagda) hatcheries and 27 *M.rosenbergii* (Golda) hatcheries under operation. About 11,588 million Bagda post larvae (PL) and about 27 million Golda post larvae (PL) have been produced in these

hatcheries. Almost all Bagda hatcheries are located in Cox's Bazar region, but major culture grounds are situated in the southwest region of Bangladesh. The DoF is restoring the natural Breeding habitats of the Halda River to protect natural breeding ground of Indian Major Carps. In 2014 the total natural collected carp spawn/hatchling is 508 kg.

6.15. Fish Production and Use of Feed

The commercial aquaculture and commercial fish feed production in Bangladesh have been increasing rapidly at the same pace in the past 10 years. Intensive and semi-intensive production of pangas, tilapia, koi, magur, shing and in some cases, carps is heavily dependent on the use of pelleted feeds. Total aquaculture feed production was estimated to have reached 1.4 million metric MT in 2014. Most of this is comprised of formulated commercially manufactured feeds, but some on-farm feed production takes place. Semi-intensive and low-intensity carp farming relies mainly on organic and inorganic fertilization, and 'raw' supplementary feeds which are usually agricultural by-products such as rice bran and mustard oil cake. There are approximately 100 feed mills in operation in Bangladesh. The Feed Act requires registration and licensing for all feed producers, ensuring that the macronutrient content of different categories of feed and raw materials is maintained at optimum levels. However, enforcement of the Act is currently limited.

6.16. Food Safety

Hygiene is generally poor throughout post-harvest value chains for fresh fish but people in Bangladesh are becoming increasingly concerned about food safety issues such as formalin and pesticide contamination. A variety of pesticides, including DDT, are used in open-air fish drying to protect against flies and other insects. Formalin is commonly used as a preservative to prolong the length of time for which unrefrigerated fish can be sold. Treatment of carps imported from India and Myanmar with formalin is particularly widespread. The Government of Bangladesh has approved the draft Formalin Use Control Act, 2013 to dissuade the misuse of formalin. Awareness raising programs for safe fish marketing have been undertaken involving the market management committees (MMC). Recently, sales of live fish at the city markets have increased, raising public concern about fish safety.

7. Climate Change Impact on Fisheries

Geographically Bangladesh is prone to various natural disasters and vulnerable to the adverse impacts of climate change. The adverse impacts of climate change have posed serious threats to the life and livelihood of the people throughout the world. Bangladesh is one of the most vulnerable countries to the impact of climate change. Likewise, many other sectors of livelihood, climate change has jeopardized the fisheries sector of the country. Already the impacts of climate change are being observed in natural sources of fish breeding, abundance, biodiversity and in the sector of fish culture as well. The reduction in fish production is eventually reducing the scope of livelihood of the concerned people. Though the impacts of climate change cannot be prevented, the related risks can be mitigated. Therefore, it is high time to raise awareness regarding climate change, associated risks and natural hazards, adaptation options and to take effective measures to protect the fisheries sector from its adverse impacts.

7.1. Climate Change Threat

The drivers of climate change usually affect fisheries differently include temperature, precipitation, evaporation, humidity, hydrology, wind direction and speed, incidence of extreme events, etc. These variables vary with region and season and can affect the productivity or distribution of fisheries resources in a variety of ways through altering hydrology. Alteration of different climatic parameters associated with water environment has been keeping deleterious impacts on fisheries resources substantially and has the potential to be acute in future.

Hydrology is one of the important master variables in freshwater systems. While temperature can have effects at all levels of organization (from the individual to the ecosystem), hydrology tends to act at the broader levels. On a regional scale, summer rainfall is expected to increase in southern and eastern Asia (IPCC 2001).

Changes in hydrologic regimes will affect species whose life histories require a larger scale (migratory species, big river fishes) in a different manner than those that are limited to a small scale (endemic species, headwater species).

Tropical fishes that spawn in seasonally flooded areas experience a recruitment bottleneck caused by the loss of juveniles entrained in off-channel areas and desiccation of eggs exposed by receding water levels (Welcomme 1979).

Small changes in water levels will eliminate this habitat, forcing these fishes to use areas devoid of their vital habitat structures; this would likely lead to population declines and might set off a cascade of new inter-specific interactions. Climate change has both direct and indirect impacts on fish stocks that are exploited commercially (Table 7-1) and following Table 7-2 summarizes the implications for fisheries and aquaculture due to changes in climate drivers.

Table 7-1: Impact types and factors to be affected

Impact Type	CC parameters act on	Altered factor
Direct	Habitation	Physical habitat
	Physiology & life history	Growth rate
		Development
		Reproductive capacity
		Mortality
	Behavior	Migration
		Feeding
		Breeding
Indirect	Production	Productivity
	Species structure	Species diversity and composition
	Physiology	Thermal tolerances
		Metabolism/Assimilation
		Food consumption
		Reproductive success
		Internal homeostasis

Table 7-2: Vulnerability to fisheries and aquaculture production due to changes in climate drivers

Drivers of change	Biophysical effects	Implications for fisheries and aquaculture
Higher inland water temperatures (possible causes: changes in air temperature; intensity of solar radiation and wind speed)	• Increase stratification and reduce mixing of water in lakes, reducing primary productivity and ultimately food supplies for fish species	• Reductions in fish stocks
	• Raise metabolic rates increase feeding rates and growth if water quality, dissolved oxygen levels, and food supply are adequate, otherwise possibly reducing feeding and growth • Potential for enhancing primary productivity	• Possibly enhance fish stocks for capture fisheries or else reduced growth where the food supply does not increase sufficiently in line with temperature • Possible benefits for aquaculture, especially intensive and semi-intensive pond systems

Drivers of change	Biophysical effects	Implications for fisheries and aquaculture
	• Shift in the location and size of the potential range for a given species	• Aquaculture opportunities both lost and gained • Potential loss of species and alteration of species composition for capture fisheries
	• Reduce water quality, especially in terms of dissolved oxygen • Changes in the range and abundance of pathogens, predators and competitors • Invasive species introduced	• Alter stocks and species composition in capture fisheries • For aquaculture, alter culture species and possibly worsen losses to disease (and so higher operating costs) and possibly higher capital costs for aeration equipment or deeper ponds
	• Changes in timing and success of migrations, spawning and peak abundance.	• Potential loss of species or shift in composition for capture fisheries • Impacts on seed availability for aquaculture
Changes in precipitation and water availability (flooding intensity, frequency, seasonality, variability)	• Changes in fish migration and recruitment patterns and so in recruitment success	• Alter abundance and composition of wild stock • Impacts on seed availability for aquaculture
	• Lower water availability for aquaculture • Lower water quality causing more disease • Increase competition with other water users • Alter and reduce freshwater supplies with greater risk of drought	• Higher costs of maintaining pond water levels and from stock loss • Reduce production capacity • Conflict with other water users • Change of culture species
	• Changes in lake and river levels and the overall extent and movement patterns of surface water	• Alter distribution, composition and abundance of fish stocks • Fishers forced to migrate more and expend more effort
Drought (as an extreme event 'shock' as opposed to a gradual reduction in water availability)	• Lower water quality and availability for aquaculture • Salinity changes	• Loss of wild and cultured stock • Increase production costs • Loss of opportunity as production is limited
	• Changes in lake water levels and river flows	• Reduce wild fish stocks, intensified competition for fishing areas and more migration by fisher folk

Source: Modified from WorldFish Center, 2007

7.2. Risk and Vulnerabilities in Fisheries Sector

The fisheries sector of the country is facing severe vulnerabilities and threats from the impacts of climate change, likewise the other sectors such as overall agricultural production, land use practices, livelihood strategies. The threats and vulnerabilities of the fisheries sector of Bangladesh are listed below:

- Deterioration of aquatic habitat and biodiversity;
- Gradual decline in fish breeding, nursery and production area;
- Drying out of floodplains, beels and other water bodies;
- Decreased water flow of river;
- Drawdown effect of the ground water level;
- Disconnection of river with the existing beels and baors;
- Closure and filling of fish migration route;
- Huge difference/increase in the temperature daily (day and night) and seasonally;
- Changes in the degree, intensity, time and pattern of rainfall;
- Increase in the degree and intensity of flood, drought, storm, heat wave and cyclone; seasonal changes in the quality and quantity of water.

7.3. Climate Change Impact in Fisheries Sector

The impact of climate change in the fisheries sector is observed in three different phases: firstly, impact in the overall production system of open water-bodies; secondly, impact on the production of fish culture and; thirdly, impact on the livelihood of all the related sectors. The impacts of climate change in the fisheries sector are depicted below:

1. **Inland Open Water-bodies:** Some obvious adverse impacts of climate change on fish production and biodiversity of open water-bodies are of great concern for the overall fisheries sector of the country. Some mentionable impacts are as follows:

- Abrupt decrease or cessation of water flow due to reduced navigability of river and all connected cannels (Khals);
- Reduced fish breeding due to habitat destruction/reduction has been decreeasing the new stock in the open water-bodies;
- Reduced/cessation of water flow due to increased rate of siltation has adversely affected the migration and natural grazing of fish;
- The physicochemical and biological characteristics of water is gradually deteriorating due to abnormal increase-decrease of water of open water-bodies, high difference in temperature, changes in time and pattern of rainfall;
- Intrusion of saline water especially during the dry season due to the increase of sea level increase is gradually decreasing the biodiversity of sweet water system;
- Increase and decrease of salinity in the coastal area is adversely impacting the breeding and natural growth of the fish;
- Above mentioned reasons are causing the change in ripingness and its breeding time of fish; even some species of fish stop breeding due to the lack of proper breeding condition;
- Fish diversity is decreasing and several species of fish are in endangered condition at present.

2. **Closed Water-Bodies:** Different impacts of climate change is adversely affecting the overall fish aquaculture sector. Some mentionable impacts are as follows:

- ***Production system in hatchery:*** Lack of required water, differences in high-low temperature and day-night temperature are hindering the production of brood fish and spawns. In some cases, this impact has baeen causing the closure of different hatcheries.
- ***Fish culture production system:*** Reduction of water retention capacity and water availability period of ponds and suitable water bodies for fish culture, drawdown of ground water level, deterioration of physicochemical and biological characteristics of water, high difference between the highest and lowest temperature are adversely impacting the fish production sector. Moreover, the increase in the expenditure in fish production due to these adversities have put the fish farmers in a very unfavorable condition.

3. **Marine fisheries**

- Sea level rise induced salinity intrsion in the upstream river especially during dry season.
- Due to rise/fall of salinity in coastal region, normal growth of fish along with their reproduction is obstructed.
- Change of breeding and grazing ground of Hilsha fish in the sea and in the coast.
- Change in fish species diversity and abundance in coastal region.
- Change in fishing grounds.
- Change and wastage of breeding and habitat of sea fishes and other aquatic organisms.

4. **Life and livelihood**

As the total fish production system is adversely affected due to the climate change, decreased average fish collection rate in open water bodies has made vulnerable the life and livelihood of the concerned people like fishing community. Throughout the country, almost 15% of the fishermen community has already changed their hereditary occupation for survival.

7.4. Steps to Address Climate Change Impact in Fisheries Sector

To ensure the development in fisheries sector, everybody is responsible for combating the climate change induced risks and impacts on fisheries. Hence, it is necessary to be aware of fisheries management strategy which is aligned with the sustainable development of this sector and at the same time, all concerned persons need to play a responsible role.

- Adoption of the programs for maintaining abundance of fish species and conservation of biodiversity along with the development of fish habitats in the open water bodies.
- Adopting activities for uninterrupted water flow through the development of all the connecting channels in the floodplains along with rivers, khals and beels.
- Developing strategies and actions to face the challenges of lack of water and deterioration of water quality, and fluctuating temperature for hatchery management.
- Development and expansion of the fish species suitable for culturing in adverse environment and within a short time frame.
- Establishment of area-based suitable and permanent fish sanctuaries.
- Construction of water reservoir and its efficient and effective use.

- Controlled extraction of groundwater and taking steps to reuse of it.
- Development and expansion of the cultivation of salinity tolerant variety of fishes.
- Raising awareness regarding the impacts of climate change and define roles and responsibilities in the fisheries sector and taking adaptive measures; and
- Coordinating with the nationally and internationally approved and ratified disaster management and climate change adaptation documents.

7.5. Adaptation in Fisheries Sector due to Climate Change

Adaptation is persevering and acclimatizing under changing environment. For mitigating the negative impact of climate change on life and livelihood of fishing and farming dependent people, following adaptation measures can be undertaken in both open water fisheries and in aquaculture.

Appropriate adaptation measures in open water fisheries due to climate change:

Considering the effects and risks involved in fisheries sector, including reduction in open water fishes, due to climate change; appropriate adaptation techniques can be applied to maintain a steady yield of fisheries and maintaining a steady standard of living of the concerned communities. Fish is an aquatic animal. Therefore, its overall growth and abundance requires a healthy aquatic environment, which is being constantly jeopardized due to climate change. For that reason, selection of fisheries management techniques in open water bodies based on suitable adaptive measures; awareness on the techniques used and developing implementation skills and; assuming responsibility to everyone concerned, should be made.

Considering the suitability of adaptation in the open water bodies, the adaptation techniques can be selected in the following areas:

- Development and restoration of aquatic habitat and biodiversity conservation.
- Enhancing fisheries stock (development of aquatic habitats, establishment of sanctuary, Beel Nursery, etc.).
- Development and expansion of community based water body management in rivers, beels, floodplains, Baors and lagoons of the rivers.
- Development and re-excavation of connecting drainage channels/Khals where required for unimpeded water flow.
- Increasing the depth of water bodies (via, excavation/re-excavation of rivers, drainage channels/Khals, beels) and;
- Ensuring undisturbed and unimpeded migration of fishes.

The probable climate change adaptation techniques in aquaculture:

The direct impact of climate change in aquaculture is impeding the optimum yield and increasing production cost. Therefore, identification of adaptive cultivable fish species to combat the effects of climate change and reduce climate change induced risks and vulnerabilities in fish cultivation and; development and expansion of their cultivation method, is very important. So-

- Creation of awareness on climate change risks, effects and disasters in all aspects of fish cultivation.
- Categorizing low and high temperature tolerant fish species, develop and expand their cultivation system.
- Development and expansion of cultivation system for rapidly growing fish species.

- Undertaking the expansion of safe fish cultivation system considering the effects and hazards of climate change.
- Development and expansion of cultivation system of salinity-tolerant fish species.

Considering the main drivers and hazards of climate change in aquaculture, selection of cultivable fish species and technical adaptation techniques in aquaculture is given below:

Table 7-3: Possible adaptation techniques for fish cultivation in changing climate pattern

No.	Hazards	Cultivable Fish	Adaptation Technique in Culture Management
1.	High Temperature	Tilapia, Shing, Magur and Koi	□ 15-20% of water-bodies should be covered with water hyacinth to protect the fishes from direct sunlight. □ 10-15% of pond bottom should be deepened by more that 2 feet. As a result, water is cooler than the other part of the pond and is more favorable place for fish shelter. □ If possible cooler water from external source should be supplied into the pond.
2.	Low Temperature	Tilapia, Pangus and Magur	□ Reduction of manure and food supply in pond □ 10-15% of pond bottom should be deepened by more that 2 feet. As a result, water is cooler than the other part of the pond and is more favorable place for fish shelter. □ If possible ground water should be supplied into the pond.
3.	High difference of day-night temperature	Tilapia, Shing, Magur, Pangus, Koi and Carp fry of at least 250g weight	□ 10-15% of pond bottom should be deepened by more that 2 feet. As a result, water is cooler than the other part of the pond and is more favorable place for fish shelter. □ If possible slight warm water from external source should be supplied into the pond in mid/last part of the night.
4.	Difference in precipitation time, pattern and quantity	Carp fry of at least 250g weight, Telapia, Sarputi and Chingri	□ Relatively bigger sized fish fry should be released in pond for 3-5 months. So that marketable sized fish can be caught in drought and heavy rainfall condition. □ Manure and feed should be supplied regularly and sufficiently, which will accelerate growth of fish.
5.	Reduction of water holding capacity and pond water availability period	Carp fry at least 250g weight, Telapia, Sarputi and Chingri	□ Relatively bigger sized fish fry should be released in pond for 3-5 months. So that marketable sized fish can be caught in drought and heavy rainfall condition. □ Manure and feed should be supplied regularly and sufficiently, which will accelerate growth of fish. □ Recycling of pond water should be introduced to reduce the pressure on ground water.
6.	Physico-chemical change of water quality		□ Introduction of those fish which can survive in relatively bad condition. □ Shing and Magur should be cultivated in the pond. □ Relatively bigger sized fish fry should be released in pond for 3-5 months. So that marketable sized fish can be caught in drought and heavy rainfall condition. □ Water exchange should be done regularly. □ Manure and feed should be supplied regularly and sufficiently, which will accelerate growth of fish.

7.	Reduction of water holding capacity		Telapia, Koi, Sarputi, Bata and Pangus	□ Relatively bigger sized fish fry should be released in pond for 3-5 months. So that marketable sized fish can be caught in drought and heavy rainfall condition. □ Application of bio fertilizer should be introduced. □ "Dhoincha" should be cultivated in pond bottom and external water should be supplied.
8.	Changes in Salinity	15+ ppt	Bagda, Vetki and Pairse	Fishes those can tolerate salinity level above 15 ppt for long time can be cultivate here.
		8-14 ppt	Bagda, Vetki, Pairse, Pangus and Telapia	Fishes those can tolerate salinity level within the limit of 8-14 ppt for long time can be cultivate here.
		0-7 ppt	Bagda, Vetki, Parse, Pangus, Golda and Telapia	Fishes those can tolerate salinity level within the limit of 0-7 ppt for long time can be cultivate here.

So far, Department of Fisheries (DoF) has taken some environment friendly measures to combat the effects of climate change. Activities include habitat development; sanctuary establishment; small-scale fish cultivation in open water bodies; release of larvae; establishment of beel nursery; expansion of weather-tolerant fish cultivation technologies, etc. Moreover, rehabilitation of fishermen and risk mitigation activities are also carried out by VGA and AIG.

Conclusion

Climate change is a continuous process, one that has been increasing in ferocity day by day and affecting the livelihood of people on relevant issues. Now the whole world is active in combating the effects of climate change. Bangladesh is one of the nations to be affected by climate change. For that reason, to combat the effects and risks sustained from climate change, fish cultivation and production in open water bodies needs to be kept stable and the selection and adoption of adaptive techniques or measures needs to be looked into with great importance.

8. Blue Economy

8.1. Introduction

Blue Economy is a new and evolving paradigm which was initially introduced by SIDS at Rio+20 but relevant to all coastal states and countries including Bangladesh with an interest in waters beyond national jurisdiction. The concept is based on the principles of social equity, improved human well-being, low carbon emission, resource efficiency and social inclusion. Blue Economy, now a day refers to a transition from a traditional economic path to a human-ocean centric development which could be seen as "living with the ocean and from the ocean in a sustainable way" (UNEP, 2012). Blue Economy is incorporated such activities that are directly or indirectly occurred in seas, oceans and coasts using oceanic resources and eventually contribute to sustainable development, inclusive economic growth, employment and human well-being. Conceptually oceans function as "development spaces" where spatial planning integrates conservation of natural resources, sustainable use, oil and mineral wealth extraction, bio-prospecting, sustainable energy production and marine transport. The Blue Economy breaks the mould of the business as usual "brown" development model where the oceans have been perceived as a means of free resource extraction and waste dumping; with costs externalised from economic calculations.

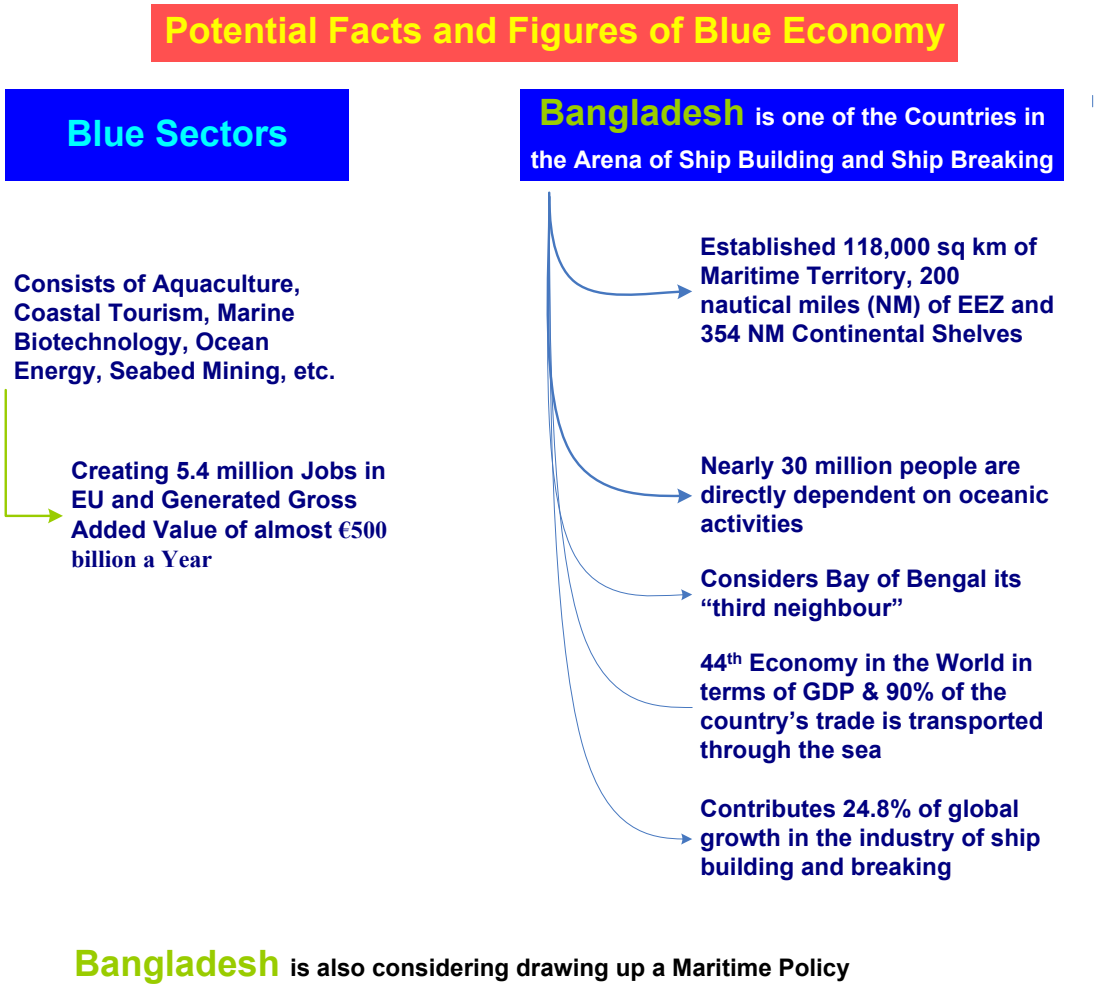
The marine environment provides humanity with a myriad of services ranging from food security and climate regulation to nutrient cycling and storm protection. These in turn underpin lives and livelihoods in sectors from tourism to fisheries.

The Blue Economy consists of numerous sectors including culture fisheries, capture fisheries, coastal tourism, marine biotechnology, ocean energy, seabed mining, etc. International shipping through sea is the carrier of world trade, transporting around ninety percent of global commerce. The seabed provides 32% of the global supply of

hydrocarbons with exploration expanding (UNCTAD, 2012). Advancing technologies are opening new frontiers of marine resource development from bio-prospecting to the mining of seabed mineral resources. The sea also serves huge potential for the production of renewable "blue energy" from wind, wave, tidal, thermal and biomass sources.

Around 72% of the surface of the blue planet is covered by oceans and constitute more than 95% of the biosphere. Life originated in the oceans and they continue to support all life forms by generating oxygen, absorbing carbon dioxide, recycling nutrients and regulating global climate and temperature (UNCTAD, 2012). Ocean contributes to poverty reduction by creating employment and about 3 billion people are directly or indirectly depend on marine and coastal resources for their livelihoods. It already has created roughly 5.4 million jobs in EU alone and generates a gross added value of almost €500 billion a year (Bangladesh-tap-blue-economy-analysis). Following Figure 8-1 portrays the potential facts and figures of Blue Economy.

The Bay of Bengal provides valuable resources and services to support human health, societies and economies. So, the common future will be significantly determined by the way we conserve, develop and tap into oceanic resources and services. It would need to arrest the decline of Bay's health and turn it into sustainable and productive space for life, livelihoods and leisure, particularly for a vast majority of artisanal population living along the coastline in the developing world, like Bangladesh. So a fundamental re-thinking and a new paradigm of Blue Economy are crucial.



Source: Internet (Modified)

Figure 8-1: potential facts and figures of Blue Economy

8.2. Importance of Blue Economy

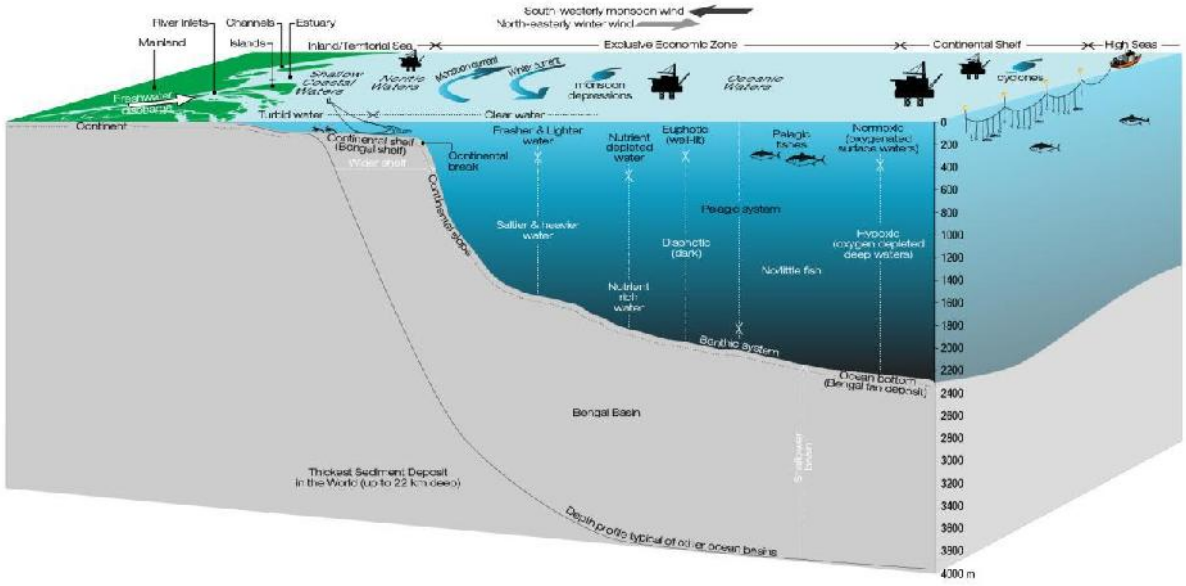
Bangladesh, after the resolution of disputes with India and Myanmar, established sovereign rights on more than 118,813 sqkm area of territorial sea and 200 nautical miles (NM) of Exclusive Economic Zone (EEZ) and all kinds of animal and non-animal resources under the continental shelf up to 354 nautical miles from the Chittagong coast (Bangladesh Stresses 'Blue Economy', 2014). Bangladesh also won the rights on all forms of living and non-living resources under the continental shelf up to 354 NM from the Chittagong coast. Currently, 32,440 sq kms, starting from the coastline to 40 metres depth, in the Bay are open to around 67,669 unlicensed fishing boats of which about 51% are non-motorized boats and the rests are motorized boats. The commercial fishing trawlers licensed by the government are not allowed inside that region. The government has two maritime areas set up for the licensed trawlers. The second region starts from 41 metres depth to 200 metres and the third from 201 metres to the border of the country's EEZ. There are only 242 trawlers that are allowed by the government for fishing in those regions.

The peaceful resolution of maritime conflict has opened a golden opportunity for the country to make blue-economic development by exploring and exploiting the vast untapped resources in the Bay of Bengal in sustainable manner. Taking the opportunity of new maritime boundary, the Blue Economy may be considered as a new horizon for socio-economic development through proper utilization of the potentials of the sea and marine resources for ensuring sustainable economic development of Bangladesh. This concept can significantly contribute in poverty alleviation, employment generation, acquiring autarky in sea food production in turn ensuring nutritional food security, protecting environmental balance, facing adversity of climate change and developing adapting capacity, and other economic possibilities.

8.3. Potential Fisheries Resources of the Bay of Bengal

The occurrence of marine species - both plants and animals - has largely been controlled by the physico-chemical properties of ocean water. Water discharges from the surrounding river catchments carry huge influx of sediments full of nutrients to the Bay, particularly along the near shore region. This has turned the Bay into a fertile marine fishing ground of the region. The near-shore up-welling zone not only has a high yield of nutrients, but also is a high primary production area for the phytoplankton and related zooplankton zones.

On the contrary, according to Gomes et al. 2000, highly sediment laden enormouse amount of river discharge into the Bay of Bengal (BoB) rendering it one of the most turbid seas (a) favored by some species of fishes (e.g., Hilsa), which also means (b) lesser sunlight penetration due to turbidity in concert with intense cloud cover during the monsoons that hinders photosynthesis and makes the sea biologically less productive.



Source: FAO, 2014

Figure 8-2: Schematic diagram showing salient characteristics of the marine system of Bangladesh using actual depth profile of the Bay of Bengal (vertically exaggerated), other elements not to scale

However, the BoB of Bangladesh is blessed with rich coastal and marine ecosystems, hosting a wide range of biodiversity, such as fishes, shrimps, molluscs, crabs, mammals, seaweeds, etc. (Table 8-1). A number of surveys examined the status of marine fisheries resources between 1970s and 1980s (Table 8-2), but no recent and comprehensive knowledge is available on the fisheries stocks, systematics, biological and ecological aspects of the coastal and marine fisheries of Bangladesh. The important fish families are Sciaenidae, Ariidae, Nemipteridae, Carangidae, Mullidae, Synodontidae, Trichiuridae, Leiognathedae, Pomadasyidae and Clupeidae (Table 8-3), and these ten families make up about 47% of the total biomass (Lamboeuf 1987), Croakers (Sciaenidae-12.8%) and catfishes (Ariidae-11.99%)being the dominant groups.

Table 8-1: Coastal and marine fisheries resources of Bangladesh

Category	Number of species (reviewed by)		
	Hossain 2001	**Islam 2003**	**Ahamed *et al.* 2012**
Bony fish	475	475	442
Cartilaginous (soft-boned) fish	50	–	–
Shrimp	25	24	56a
Crab	15	50	16
Lobster	5	–	3
Mollusc (Oyster)	301 (6)	301 (3)	336
Algae/Seaweed	56b	20-22c	168
Coral	13	–	66
Starfish/Echinoderms	3	–	4
Whale/Dolphin	11	–	–
Squids (Cuttlefish)	–	7 (2)	–

[a]Shrimp/Prawn; [b]Algae; [c]Seaweed

Table 8-2: Standing stock (in tons) of demersal fish, pelagic fish and shrimp of the Bay of Bengal during the1970s and 1980s.

Demersal fish	Pelagic fish	Shrimp	Reference
264,000-373,000	---	9,000	West (1973)
160,000	90,000-160,000	---	Saetre (1981)
200,000-250,000	160,000-200,000	4,000-6,000	Penn (1983)

Source: FAO, 2014

Table 8-3: Estimated biomass of marine fish of Bangladesh (Hussain and Rahman 2010)

Sl. No.	Fish Family/Group	Common Name(s)	Biomass (MT)	Relative Abundance (%)
1	Sciaenidae	Croakers	20,670	12.8
2	Ariidae	Catfishes	18,729	11.6
3	Nemipteridae	Threadfin breams	7117	4.4
4	Carangidae	Jacks, Scads	5039	3.2
5	Mullidae	Goat fishes	4,811	3.0
6	Synodontidae	Lizard fishes	4,663	2.9
7	Trichiuridae	Hairtail/Ribbon fishes	4,043	2.5
8	Leiognathidae	Pony fishes	3,998	2.5
9	Pomadasyidae	Grunters	3,415	2.1
10	Clupeidae	Sardines, Shads	3,109	1.9
11	Scombridae	Mackerels, Tunas	1,836	1.1
12	Priacanthidae	Bullseyes	1,433	0.9
13	Stromateidae	Pomfrets	1,348	0.8
14	Cephalopods	Squid, Cuttle fishes	1,296	0.8

Sl. No.	Fish Family/Group	Common Name(s)	Biomass (MT)	Relative Abundance (%)
15	Engraulidae	Anchovies	1,082	0.7
16	Gerridae	Silver-biddies	959	0.6
17	Harpodontidae	Bombay duck	783	0.5
18	Lutjanidae	Snappers	356	0.2
19	Rajidae	Skates, Rays	6,714	4.2
20	Others	---	69,679	43.3
Total =			**161,080**	**100%**

Source: FAO, 2014

The harvest of marine capture fisheries was 379,497 MT during 2000-2001 that ramped up to 595,385 MT in 2013-2014 (DoF, 2015) and sold as frozen (transported to large cities and overseas) or fresh in local markets. A considerable amount of fish are salted and dried, mainly for human consumption. Incidentally, the use of dried fish as a source of fishmeal is gradually increasing due to intensification of fish and poultry farming. Hilsa shad (*Tenualosa ilisha*) is the larget and single most valuable species with annual catch of 385,140 MT (DoF, 2015) and generates employment and income for 2.5 million people valued at $US 1.3 billion per year (BOBLME 2012, Hossain *et al.* 2014). At present 50-60% of global hilsa catch takes place in the coastal and marine waters of Bangladesh, 20-25% in Myanmar, 15-20% in India and the remaining 5-10% in other countries. A total of 47,668 MT tiger shrimp (*Penaeus monodon*) was caught from BoB during 2013-2014 (DoF, 2015), most of which directly go to the processing plant and end up in the markets of USA, EU and Japan. Over the last 10-15 years, live giant mud crab (*Scylla serrata*) and estuarine eel (*Muraenesox bagio*) have been exported to East Asian countries. Less than 20% exported live crab come from crab fattening by the marginal farmers of Satkhira, Bagerhat and Cox's Bazar coasts. Moreover, the harvest of young and undersized sharks and rays are dried, while the large sharks are dumped overboard after removing their fins and some other body parts. The majority of phaisa (*Setipinna phasa*) caught in the coast are used to make fermented fish product.

The hydrological conditions of the Bay of Bengal is favourable for a variety of shrimps and fishes. Although fishes remain scattered in the Bay in some places they get concentrated and constitute important fishing grounds. Four fishing grounds have been identified in the exclusive economic zone, such as south patches, south of south patches, middle ground and Swatch of no Ground.

South patches located at 91.30'E to 92.10'E and 20.55'S to 21.52'S, having a total area of 3,662 sq km. Depth ranging from 10m to 100m, but 90% of the total area is less than 40m deep. Bottom sediment is sandy or slightly muddy sand. Nearest distance of the ground from Chittagong and Cox's Bazar is 40 km and 10 km respectively. Salinity in surface water ranges from 26% to 32% and 30% to 35% in bottom water. Water temperature varies between 20^0C and 28^0C.

South of south patches located at 91.30'E to 92.20'E and 20.15'S 20.50'S, having an area of 2,538 sq km. The nearest boundary of this area is 5 km from Teknaf. Depth ranges from 10m to 100m. Within this ground 75% of the area is more than 40m deep. Bottom is sandy or muddy sand. Surface salinity ranges from 18% to 34% and bottom water salinity from 28% to 38%. Water temperature ranges between 22^0C and 30^0C.

Middle ground located at 90.20'E to 91.30'E and 20.25'S to 21.20'S, having a total area of about 4,600 sq km. The nearest distance from Cox's Bazar is about 65 km. The depth of 70% of the total area is more than 40m. Bottom sediment is soft mud or muddy sand. Surface salinity ranges from 22% to 34% and bottom salinity 28% to 35%. Water temperature is between 26^0C and 28^0C.

Swatch of no Ground located at 89.35'E to 90.10'E and 20.55'S to 21.55'S, about 30 km away from Dublarchar and 40 km from Sunarchar. Total area is about 3,800 sq km, of which 70% is more than 40m deep. Overall depth of the area

ranges from 10m to 100m. Bottom sediment consists of muddy sand. Surface salinity is 28% to 34%, while the bottom salinity is 30% to 35%. Water temperature falls within 24^0C to 30^0C.

All these fishing grounds are potential reserves for fish and shrimp. Most of the known commercial species of shrimps and fishes are harvested from these areas by trawlers or mechanized fishing boats. The following figure (Figure 8-3) shows fishing zones of the BoB.

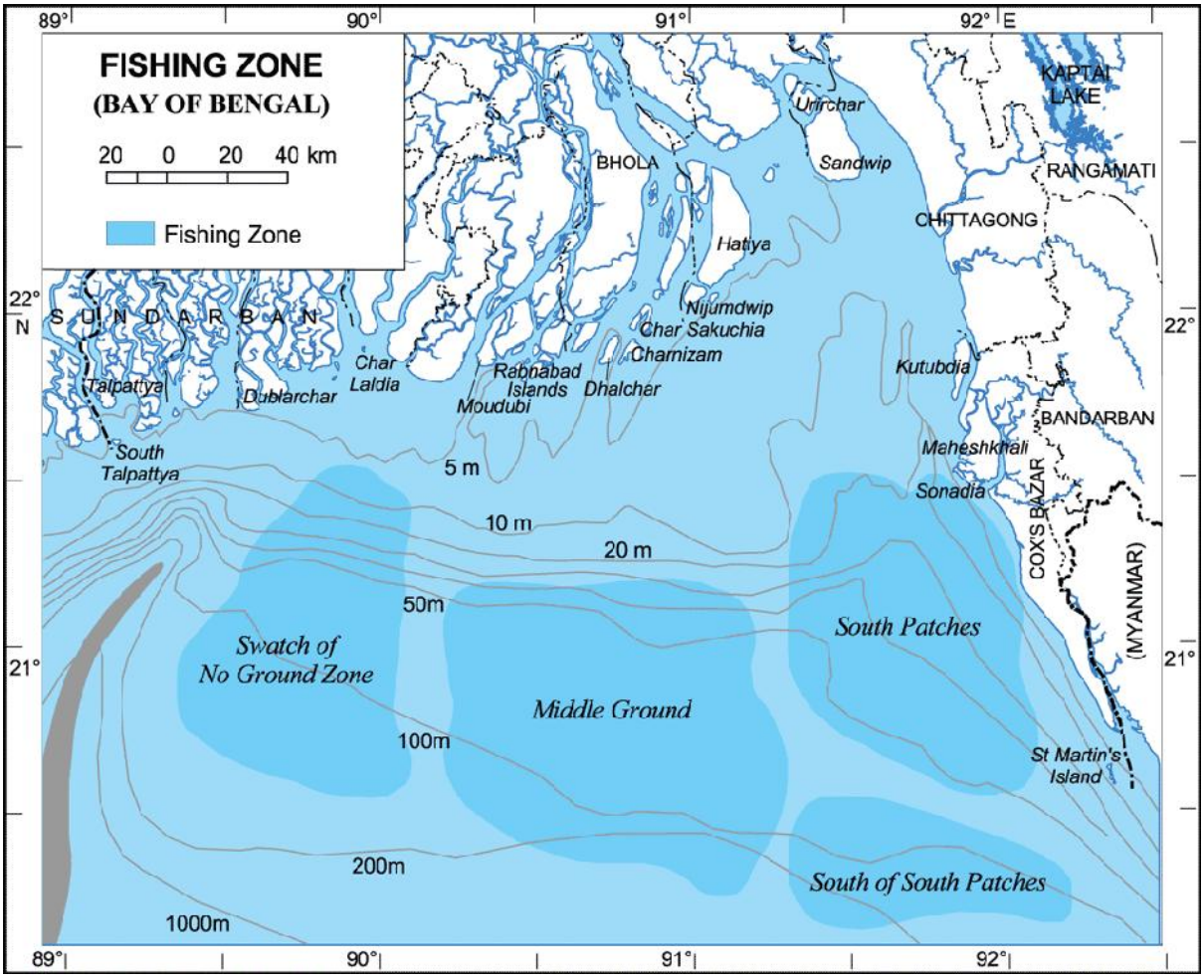


Figure 8-3: Fishing zones in the BoB along Bangladesh

It is observed from the figure (Figure 8-4) below that the growth rate of marine fisheries is declining from 9.5% (2001-02) to 1.1% (2013-14) despite the huge potential of exploitable marine resources. Compared to marine fisheries, the growth rate of pond aquaculture is much higher and the trend is steadily upward despite the limited resources. So, there is a huge scope of exploitation of fisheries resources in the extended area within the new maritime boundary. For the exploitation of such resources, the Government should come up with improved fishing technology, building capacity to the fishers, modern and equipped fishing vessels, ensuring security by increasing the enforcement activities of the Coast Guard, promoting lean period alternate income generating activities (AIGAs) along with relief in worst case, improved weather forecasting and signalling system, market monitoring system for controlling fish prices, controlling the influence of the musclemen and money lenders (*Dadan* businessmen), etc. The trend of marine fish production is shown in Figure 8-5.

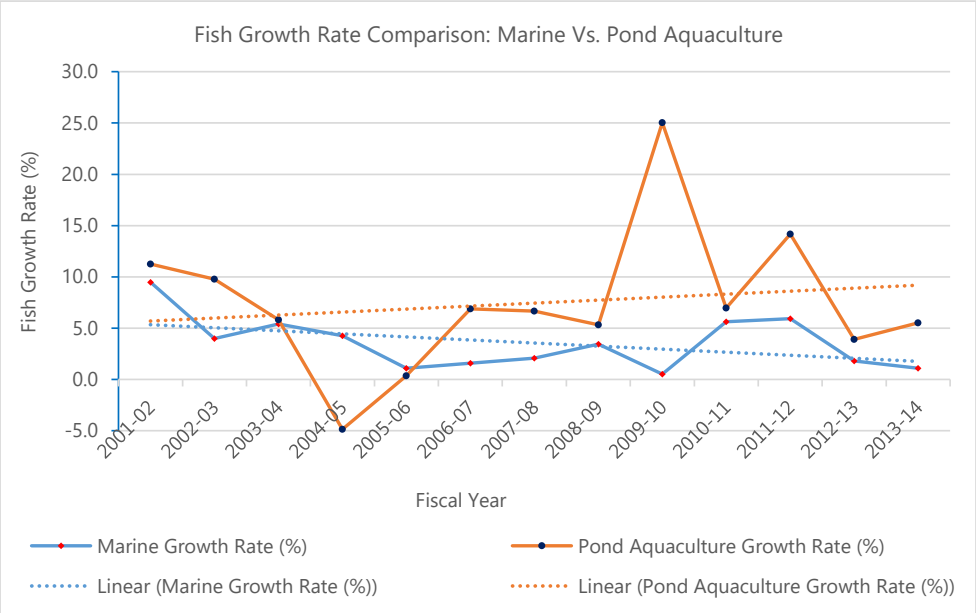


Figure 8-4: Trends of aquaculture and marine fish growth

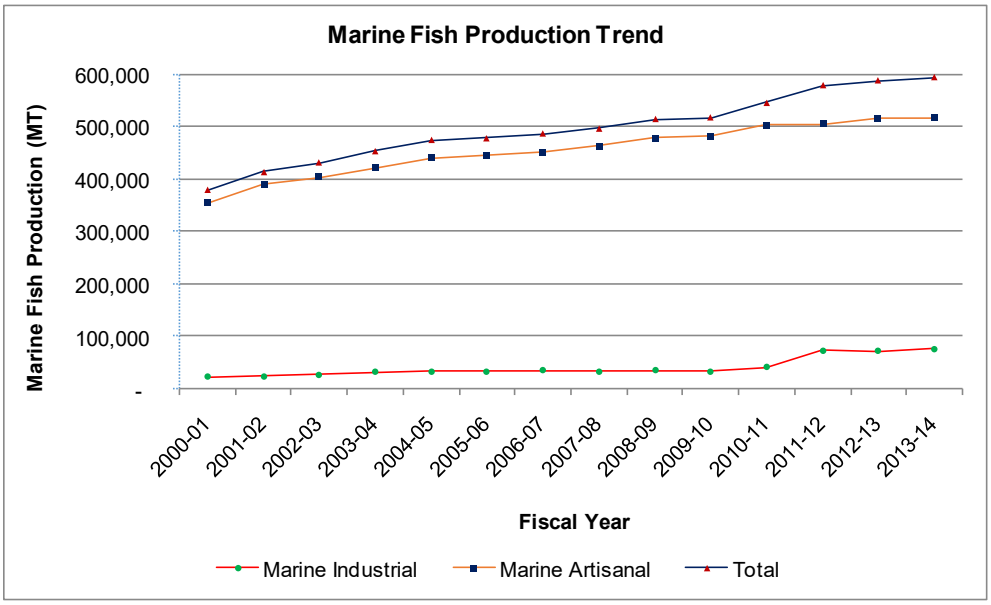


Figure 8-5: Trend of marine fish production

8.4. Fisheries Perspective of Establishing Blue Economy in Bangladesh

Fisheries resources are inevitable part in establishing the Bay of Bengal based blue economy. The strategies, but not limited to the numbers, should be established for the sustainable exploitation of the resources are as below:

Set of Total Allowable Catch (TACs): Total Allowable Catches (TACs) or fishing opportunities are catch limits (expressed in MT or numbers) that are set for most commercial fish stocks for how much of each species can be caught in a certain area. TACs could be an important strategy to protect endangered fisheries species of the Bay of Bengal.

Sustainable use of Fisheries Biodiversity: Usage of fisheries biodiversity in a sustainable manner means to use of fisheries resources at a rate that the concerned environment can renew them. It is a way to ensure that they produce maximum economic yields which meet the needs of both present and future generations.

Conservation of Marine Protected Area (MPA): Marine Protected Areas (MPAs) that are protected for conservation of marine life need to establish in the BoB. MPAs act as safe havens for marine life. There are many different types of MPAs including national marine sanctuaries and national estuarine research reserves. MPAs restrict human activity for a conservation purpose, typically to protect natural or cultural resources. Marine resources are protected by local, state, territorial, native, regional, or national authorities and differ substantially among nations. This could be done by limiting development, fishing practices and catch limits, moorings and bans on removing or disrupting marine life.

Individual Fishing Quota: Individual fishing quotas (IFQs) are one kind of catch share, a means by which government regulates fishing. The regulator sets a species-specific total allowable catch (TAC), typically by weight and for a given time period. A dedicated portion of the TAC is then allocated to individuals that is why fishing pressure reduced in that area.

Protection of Ecologically Critical Area: Ecologically Critical Area (ECA) is an environmental protection zone declared for conserving natural resources along with fisheries resources. The Sundarbans, a mangrove forests, is an ECA because it continues to suffer from over-exploitation of resources and illegal settlement development. St. Martin's Island is known for its coral-algal that overwhelms the rocky reefs of St. Martin's Island.

8.5. The Blue Economy- Opportunities

8.5.1. Marine capture fisheries

About 67,669 artisanal mechanized and non mechanized wooden boats and 242 industrial steel body trawlers are engaged in fishing in the coastal waters up to 60 km (within 40m depth) from our coastline. A considerable amount of fish are salted and dried, mainly for human consumption. Hilsa shad (*Tenualosa ilisha*) is the largest and single most valuable species with annual catch of 385,140 MT, and generates employment and income for about 2.5 million people valued at $US 1.3 billion per year. At present 50-60% of global hilsa catch takes place in the coastal and marine waters of Bangladesh, 20-25% in Myanmar, 15-20% in India and the remaining 5- 10% in other countries. A total of 47,668 MT tiger shrimp (*Penaeus monodon*) was caught from the Bay of Bengal during 2013-2014 (DoF, 2015).

The fishermen are hardly any capabilities of catching demersal fishes below 50 m depth of water. Long lines fishing are totally absent in deep waters. Future development prospects of aquaculture appear promising. Well-managed coastal aquaculture and mariculture offer significant scope for green growth and employment opportunities for coastal communities.

8.5.2. Marine aquatic products

Marine aquatic products consist of marine aquatic organisms which are mainly farming for human consumption and all the associated primary processing activities. Marine shellfish (e.g. oysters and mussels) & marine finfish as well as aquatic plants and animal algae could be considered for cultivation. Various types of macro & micro algae extract are used in cosmetic and pharmaceutical markets. There are several products on the market which contain PUFA's (poly unsaturated fatty acids) like omega-3 and omega-6, but also antioxidants. Today macro algae producers can target not only the human food market but also the animal feed market. Some scientists believe that macro algae will be a valuable source of proteins for human and animal consumption. Algae aquaculture can contribute to advances in fish medications and contribute to shelf life improvements achieved through marine bacteriological progress.

8.5.3. Human resources

A large section of army, especially the navy of skilled coastal and off-shore engineers, navigators, merchant mariners, fisheries technologists, biotechnologists and other professions are needed for establishing a blue economic zone. Well-trained, skilled and educated human resources are the driving force of the development of an economy and dynamic and sustainable development is not possible without skilled work force. Having assessed the need of world market and local industry, appropriate courses on marine science, ocean and coastal engineering, maritime education and trade are essential to introduce at tertiary education system that may create a huge opoortunity for employment.

8.6. Challenges for the Establishment of Blue Economy

Ballast water: Cruise ships, large tankers and bulk cargos carry millions of gallons of water from coastal port areas in one region in their ballast tanks to maintain stability in transit and discharged at the next port. Ballast water discharge typically contains a variety of biological materials, including plants, animals, viruses, and bacteria that has a negative impact on the marine environment. These materials often include non-native, nuisance, exotic species that can cause extensive ecological and economic damage to aquatic ecosystems, especially fish biodiversity.

Oil pollution: Liquid petroleum hydrocarbon from tankers, offshore platforms, drilling rigs and wells as well as spills of refined petroleum products and their by-products, heavier fuels used by large ships released into the coastal or marine environments due to human activity that generate oil pollution. The marine environment is made up of complex interrelations between plant and animal species and their physical environment. Harm to the physical environment by crude oil often lead to harm for one or more fish species in a food chain, which may lead to damage for other species fish.

Discard fish: Discards are the portion of a catch of fish which is not retained on board during commercial fishing operations. The practice of discarding is driven by economic and political factors. Fish which are discarded are often unmarketable species which are below minimum landing sizes. Discards form part of the bycatch of a fishing operation, although bycatch includes marketable species caught unintentionally.

Alien fish species: Fish species that have been transplanted from one location to another are referred as alien fish species. Introduction of alien species into a habitat disrupts the native eco-system. Invasive species can negatively impact ecosystems in a number of ways such as: Displace native species, Reduce native wildlife habitat, Reduce fish health and productivity, Alter ecosystem processes, Degrade recreation areas.

Destructive fishing gear: Trawls used for bottom trawling are extremely damaging for coastal and marine habitat. Bottom trawling is an industrial fishing method where a large net with heavy weights is dragged across the seafloor, scooping up everything in its path. Bottom trawling is unselective and severely damaging to seafloor ecosystems especially fish habitat.

Ghost fishing: Ghost fishing occurs when fishing gears is lost or abandoned at the sea. The gear can continue to catch fish, dolphins, whales, turtles, and other aquatic species as it drifts through the water and after it becomes snagged on the seabed.

In a developing country like Bangladesh, the role of marine resources in poverty alleviation, acquiring autarky in food production, protecting environmental balance, facing adverse impacts of climate change and other economic activities is unlimited. Alongside, the existing land-based development activities, the marine-based economic activities/management of sea and its resources through Blue Economy may be considered as a new horizon for development of the coastal countries and the small island developing states.

9. Fisheries Practice and Management

9.1. Employment in Fisheries

Employment in fisheries production Table 9-1 shows the employment in fisheries sectors, culture and capture fisheries (including marine). It is estimated that the entire fisheries sector[10] supports livelihoods of more than 16 million people (about 11% of the total population), directly and indirectly, including: carp hatcheries, nurseries, fingerling traders, fish farmers, shrimp farmers, workers in shrimp processing units, PL collectors, fish traders, wholesalers, transport workers, fish exporters, service providers and fishers of capture fisheries (Azad 2013). About 92% of them were employed in the aquaculture sub-sector, of which, just 6% were involved in the shrimp sector, which included farmers, traders and processors.

Of the total employed in capture fisheries (over 1.32 million), about 39% are engaged in marine fisheries. It is reported that about 0.5 million traditional hilsha fishers' livelihoods (38% of the total capture fisheries employment) directly depend on the hilsha catch (DoF 2012). More than 2.5 million people directly depend on hilsha through transporting, marketing, net and boat making, and exporting (Roy and Habib 2013).

Table 9-1: Employment in the fisheries sector

Employment in fisheries by sector	Number
Total employment in the fisheries sector	16,013,000
Total employment in aquaculture	14,697,000
Fish farmers	13,864,000
Shrimp farmers	833,000
Total employment in capture fisheries	1,316,000
Inland capture fisheries	800,000
Marine capture fisheries	516,000

Source: DoF (2014)

9.2. Fishing practices

Fish stocks in open water of the country have been declining with the changes of fish habitats and fishing methods. The decolonization and the partition of the subcontinent in the middle of this century have eradicated the monopolistic holders of genuine fishermen, who had generally conserved the fisheries resources at a sustainable level. Due to the lease system and the growing population stress increasing the non-fishermen involvement in the open water fisheries along with the poor management practices for protecting fish stocks and thus the fisheries resources are depleting. Whatever, the management has been practiced centering the 'jalmahals' in the study area are controlled by the powerful middleman. Changing spectacle to the management patterns government and the national and international NGOs has recently come up with community-based fisheries management (CBFM) with the participation of the core fishermen and the community. Successively, the CBFM practice is moderated into the co-management where government is an important stakeholder in addition to the community. Under this type of management fish stocks are expected to be enhanced and conserved in sustainable way through establishing fish sanctuary and reintroduction of reserve- and pile fishery in the study area.

9.2.1. Fishing vessels/crafts

Many types of fishing boats are used in the country, depending on water body type and fishing gear employed. A list of fishing vessels is presented in the following Table 9-2.

[10] Person involved in production, processing, marketing, transport workers and service providers

Table 9-2: List of inland fishing vessels of the country

Sl. No.	Boat/vessel types	Length (m)	Used nets/gears
1	Donga, dugout	<6.5	Light gear
2	Bachari nauka	<17	Seine netting
3	Dinghi nauka	<10	Various types of nets
4	Kosha nauka	4-10	Various types of nets
5	Chandi nauka	5-17	Drift netting for ilish

Source: FAP 6

Of the two sub-sectors of the marine fishery (industrial and artisanal), the industrial fishery is based on trawl fishery (shrimp trawl and fish trawl). At present, a total of about 242 deep sea commercial fishing trawlers are being operated in the Bay of Bengal of which 205 trawlers are engaged in harvesting bony fish and 37 trawlers are engaged in harvesting shrimp. Artisanal fisheries consist of about 67,669 fishing boats in total of which 32,859 motorized boats and 34,810 non-motorized boats (DoF, 2015) that are operating in coastal waters. Large-scale industrial fishery includes large trawlers that specially fish for penaeid shrimps.

9.2.2. Fishing gears and appliances

Around 44 types of inland artisanal fishing gears have been recorded in Bangladesh of which 21 types are the most common. Important gears include ber jal, borsi, chai, kerrant jal, thela jal, jhaki jal, dharma jal, kona jal, duri, uthar jal, taki jal, polo, kocha and savar jal. Different innumerable fishing gears are used by the fishers to exploit multi-species marine resources in Bangladesh. The specifications of gear depend on target species, hydrological conditions, portability, labour intensiveness, capital costs, gear material availability and profitability. Nets used in rivers are typically equipped with meter long bamboo floats which ride vertically in the water. This sinks the headline sufficiently to prevent it from becoming entangled in boat propellers. A list of gears that are operated regularly is given in **Annex 9-1**.

9.2.3. Specialized fishing methods

Several special fishing methods have been in practice in the study area. They are more complex than simple deployment of a fishing gear. Still in small numbers, the most important fishing methods which are intended to regulate fishing efforts and have the conservation concept are the pile- and reserve fishery. A rotation of harvesting fish in katha (brush park) at an interval of three years for the pile fishery and five to seven years for the reserve fishery. Katha is a widely used cost-effective fishing methods and a pile of tree branches used as a fish aggregation device in deep pools of rivers and beels. 'Donga' is a fishing method to harvest fish in seasonal beels, of which fish are harvested by a group of fishermen by using various types of fishing gears. 'Pagar' is a small ditch dug in beels to trap fish and also conserve water for irrigation. Usually fish in a pagar are harvested three times a year. However, some pagars are harvested eight to ten times a year. Small fishes are harvested by traps and big ones by polo.

Katha: Certainly, the most widespread and common special fishing method used in the region is the katha. This structure consists in its simplest form of a pile of tree branches and bushes (hence the quasi-synonymous term "pile fishery") set on the river or beel bottom. Fish are probably attracted into katha by the shelter provided and by the increased food supply (bark and periphyton). During the dry season, fish can become densely amassed in a katha and thus become easier to catch once they have taken refuge there. To harvest a katha a blocking net is set around the katha (often raised up to 2 m above the water surface to prevent carp from jumping out), the branches are removed and blocking net is closed up. Final harvest may be with a beach seine or castnet inside the blocking net.

The preferred furnish for katha is the branches of hijal because of their hardness and resistance to rot. Hijal branches can last 3 or more years in water without decomposition. Koroch is also used but the wood is lighter in weight and more buoyant and the bark is thin and not liked by fish. At least one species is not used because it releases a toxic chemical into the water. Hijal and koroch branches are not available everywhere in the region. In Hail Haor, Mango (*Magnifera indica*) Am, Jam (*Syzygium cumini*), Bot (*Ficus benghalensis*), Shobri and Shawra are used. In the Kangsha mainly Shawra, Mango and Jam tree branches are used. In the Kaliajuri area Barun, Mera, Jarul (*Lagerstromia speciosa*) and Jam are used, along with Hizal and Koroch. Bamboo stakes are often used to "fence" the katha so as to anchor it and prevent it being swept away. Some katha even have elaborate cane fences around them, and this converts them into a form of fish pen.

In a variant of katha known as 'dol fishing' a cap of floating water hyacinth (Germuni) is held in place over the katha with bamboo stakes. This practice is largely observed in different places like in Hail Haor, in the Upper Meghna at Bhairab Bazar and in the roadside borrow pits at the edge of Hakaluki Haor near Kulaura. Fishing using lights is common, and people believe that a water hyacinth mat protects their kathas from poachers using lights.

Normally, katha are installed during the time of water recession. In beels, katha are usually installed in the deepest part where soil type is clayey or loamy. The number of katha installed depends on the area of the beel. Usually one katha covers an area of about 35 m x 15 m (525 sq m). In rivers kathas are usually installed near duars. In the Kushiyara, kathas are installed at the erosion zone of the river (probably deepest part). Each katha is about 25-35 m long and 10-15 m wide.

Kathas are usually harvested in February and March. Katha is highly efficient in harvesting fish from beels and can result in a high percentage of harvest of the total beel stock each year. Katha selectively attract carps (Rui, Catla, Mrigel, Kalibaus, Gonia) as shown by the difference in species composition of annual and pile fishery catches. Small species such as Tengra, Itcha, Puti and Chapila are also attracted.

Katha installed in permanent beels are called 'pile fisheries' and are supposed to be fished only once every 3 years in order to allow large fish to grow to maturity. It is believed that individual fish return to the same katha each year. Since permanent beels cannot be drained so kathas are installed to attract fish and facilitate their capture. Some leaseholders harvest katha every year or every second year.

Dakban: De-watering is practiced in seasonal beels and roadside borrow pits. It is done by drainig water out using manually operated low lift mechanical devices or low lift pumps. The objective is usually to achieve a complete harvest of the fish stocks (to maximize profit from the leased water body) and therefore is quite destructive of fishery resources. A possible justification for de-watering for fishing of seasonal water bodies is that the fish would die in any case when the water body dries out. However, other approaches (excavation of refuge pits, construction of bunds to increase water storage volume) would probably yield greater returns in the long run.

Donga: It is a method for fishing seasonal beels. The donga is a pond excavated in the outlet khal of a seasonal beel. Several katha are installed in the donga. Bamboo screens and blocking nets are set across the downstream end of the donga to prevent fish from escaping. The beel is harvested by a large group of people in the conventional manner with various types of nets. To avoid capture, many fish move into the donga where they congregate in the kathas and are easily caught.

Pagar Fishing: Excavating several small ditches within the beels, which are called 'Pagar'. It is seen almost all over beels of the haor region. Dimensions

of a typical pagar are 15 m x 10 m x 1.5 m. A low dike (0.3 - 1.0 m in height) is raised around it, and a 1.0 - 1.3 m wide opening is left on one side. Pagars are used to trap fish and to conserve water for irrigation. During the months of August and September, owners of pagars installed katha. For katha mainly Shawra, Gub, Amli (Tetul) and Mango tree branches are used. Normally pagars are harvested thrice in a year. Harvesting information is provided in Table 9-3.

Table 9-3: Characteristics of Pagar Harvest

Sl. No.	Harvesting Time	Main Fish
1	End of Dec (1st harvest)	Shingi, Magur, Koi, Shoal, Lati, Cheng, etc.
2	End of Jan (2nd harvest)	Shingi, Magur
3	End of Feb (final harvest)	Shingi, Magur

Source: FAP 6

Moreover, the following specialized fishing methods are found in the specific areas in the haor region.

Polo: In Itna area, people sometimes cut shallow ditches to create a current, install a pen with bamboo trap and wait over them with 'Polo' (bamboo plunge basket). Small fish enter into the trap and big fish are caught using 'Polo'. Following heavy rainfall, large numbers of fishermen go gor polo fishing in the flooded fields. The catch dominates the larger brood fish.

Prawn fishing with grass: During the pre-monsoon season, people in the Khaliaiuri area catch prawns by floating grass in the river current. They throw grasses such as Chailla bon and Koipan bon into the river and prawns cling to the roots. The fishermen then retrieve the grasses with scoop nets after passing several hundred meters. Table 9-4 reveals a summary of different fishing gears together with their target species/group and depth of operation.

Table 9-4: Fishing gear used in the coastal/marine water in Bangladesh with target species and depth of operation (Ref)

Fishery/Gear	Target Species/Group	Depth of Operation
A. Industrial		
1. Shrimp trawl	Penaeid shrimps (especially, P. monodon)	40-100
2. Fish trawl	Pomfrets, Grunter, Croakers, catfish, Indian salmon, Jew fish, Ribbon fish, etc.	40-100
B. Artisanal		
1. Gill net		
i. Drift gill net	Hilsha shad (Tenualosa ilisha)	Down to 30
ii. Fixed net	Hilsha shad (Tenualosa ilisha)	8-10
iii. Large mesh drift net	Sharks	Down to 30
iv. Bottom set net	Indian salmon	Down to 80
v. Mullet gill net	Grey mullet	5-10
2. Set bag net		
i. Estuarine set bag net	Shrimps, Croakers, Ribbon fish, Bombay duck, Clupeids, Anchovies, etc.	5-10
ii. Marine set bag net	Shrimps, Croakers, Ribbon fish, Bombay duck, Clupeids, Anchovies, etc.	10-30
iii. Large bag set bagnet	Sea bass (*Lates calcarifer*)	10-30
3. Trammel net	Shrimp, croakers, cat fish	10-30
4. Bottom long line	Croakers	10-30

Fishery/Gear	Target Species/Group	Depth of Operation
5. Beach seine	Clupeids, Croakers, Anchovies, Ribbon fish.	8-10
6. Char pata net	Shrimps	Down to 10
7. Cast net	Fish and Shrimps	Down to 10
8. Push net	Shrimp (*P. monodon*) larvae	Down to 10
9. Fixed bag net (small mesh)	Shrimp (*P. monodon*) larvae	Down to 5
10.Drag net	Shrimp (*P. monodon*) larvae	Down to 2

9.2.4. Illegal fishing methods

Poisonous plants are used in the neighboring country of the catchment and this has caused massive fish mortality in the Sharighat and Juri rivers. A new threat is dynamite fishing in duars. Because of ongoing road construction in the neighboring country, dynamite is easily procured (or stolen) by miscreants, who cross into Bangladesh and throw dynamite into the Luba River sanctuary duars in order to kill the broodstock fish taking refuge there. This happens on a regular weekly basis. The Indian Security Force and the Bangladesh Security Force, who are empowered to ensure border security, allegedly turn a blind eye to this practice. According to the laws of Bangladesh the use of dynamite to catch fish is a criminal act. Furthermore, the slaughter of brood stock, some of which are rare or endangered species, while in overwintering grounds in Bangladesh by foreign miscreants is a matter which requires immediate and forceful intervention by the Bangladeshi law enforcement agencies

9.3. Fisheries management

Poor fishermen mostly depend upon the open water fishing for carrying their livelihoods in the Haor basin. Indiscriminate fishing practices conceding the overexploitation, considered as a major problem, in many cases resulting in loss of species diversity from the water bodies of the haor basin/planning area. However, to maintain the stock and production from open water fisheries, the following management attempts have already been made, some are continued and some are proposed to be executed in the planning area:

- Establishment of fish sanctuaries for the conservation of fish biodiversity;
- Enhancement of stock by releasing fish fingerling in open waterbodies;
- Practicing the Community-based Fisheries Management in open waterbodies;
- Leasing and licensing for fishing of 'Jalmohal' areas of waterbodies belongs to the Ministry of Land (MoL);
- Good Fisheries Management Practices in the shape of Mohanganj experiences;
- Restricting gear and fishing of fecund fishes in the breeding season;
- Habitat restoration programmes, including re-excavation of beel, connectivity and river duars (deep pools);
- Fish culture in seasonal floodplain areas under the community enterprise approach;
- Establishment of 'beel nursery' in a huge number of beels or in beel pockets, in connectivity and in other suitable places for recruitment of fish species in the wild stock;
- Proper care should be taken so that the intensive fish culture does not keep any adverse impact on the surrounding environment; etc.

9.3.1. Reserve and pile fisheries

The most important methods of biological fisheries management and fishing effort regulation practiced have been in the past (and to a lesser extent, still are in the present) reserve and pile fisheries.

Reserve fishery: A reserve fishery is one where fishing is carried out only once within a medium term period of 5-7 years in order to allow a build-up of the stock. Traditionally, reserve fisheries were jalmohals which were not fished out for either large or small fish species. Katha were normally installed in reserve fisheries.

Pile fishery: A condensed form of reserve fisheries are conventional pile fisheries with a three year harvesting rotation schedule. SIS harvesting is carried out every year while large fish are harvested only once every three years when the katha is dis-assembled. Conservation objectives are less in pile fisheries as compared to reserve fisheries. However, pile fisheries are still superior to annual fisheries (where the katha is harvested totally each year) in terms of production and conservation functions.

9.3.2. Fish sanctuaries

To protect and conserve aquatic biodiversity especially the fisheries resources in open water, one of the major technical interventions like establishment of fish sanctuary has been undertaken since the Conservation and Protection of Fish Act, 1950. Since 1960, fish sanctuaries have been established by the Government through different development projects, but these have not been sustainable and also not adequate. As soon as the projects were over, the sanctuaries ceased to exist. However, during the last decade fish sanctuaries have been established as part of testing community participation in management regimes through different projects such as, MACH, CBFM- 2, FFP and other Government financed projects. In most cases sanctuaries have been established in part of the water bodies leased to the community organization for fisheries management. Presently, more than 550 fish sanctuaries are reported to exist in over 300 water bodies in Bangladesh (DoF, 2014). Various fish sanctuaries, implemented by different projects are mentioned below in Table 9-5:

Table 9-5: Number of fish sanctuaries established under different projects and impacts

Name of Project	Area of Water Body (Ha)	No. of Fish Sanctuary	Sanctuary Area (Ha)	No. of Beneficiary	Changes in Fisheries
Fourth Fisheries Project (FFP)	39,040.04	75	1,361.45	59,712	Production increase from 120 kg/ha to 240 kg/ha
CBFM-1	-	>10	-	-	Increase in species diversity by over 28%
CBFM-2	9,359.05	164	85.19	14,618	Growth rate of fish production 81.42% in 2004 from 1997
PBAEP	545.03	18	26.20	2,118	Increase in species diversity by over 31%
IFAD	525.00	18	10.22	1,477	
Fisheries Resources Development Project in Closed and Open Jalmohal under New Jalmohal Policy	1,434.46	15	-	-	
MACH Project	-	75	276.70	-	Raised production on an average 233% & conserved locally extinct 8-10 species
Hilsa Sanctuary	0.00	5	-	-	
Fish Culture in Joboi Beel	-	4	-	-	
Fisheries Habitat Restoration Project in Inland Open Waters	642.43	3	4.5	-	
Fisheries Development and Management in Chara and Beel in Western Part of the Country	738.75	20	-	2,335	

Name of Project	Area of Water Body (Ha)	No. of Fish Sanctuary	Sanctuary Area (Ha)	No. of Beneficiary	Changes in Fisheries
Department of Environment (DoE)	-	Several Beels of Tanguar Haor	-	-	
New Fisheries Management Policy (NFMP)	-	11	-	-	Raised production by 17-50%
Sunamganj Community Based Resource Management Project (SCBRMP)	-	12	-	-	Increase in species diversity by over 51% from 2008 to 2010

Source: Bd Fish (Internet)

The community based fish sanctuary is community announced and practices project areas that are a no fishing zone with a core area and a buffer zone **Figure 9-1**.

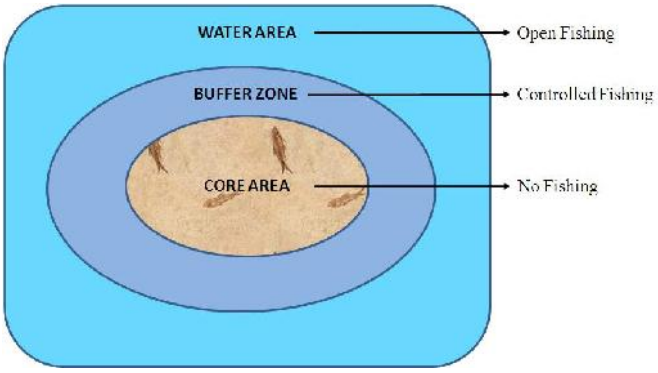


Figure 9-1: Schematic of fish sanctuary showing fishing pattern

Photo 9-1: Sanctuary in SCBRMP waterbody

Purposes of establishing fish sanctuary

- Creating opportunities for unobstructed growing up of the brood fish for continuing sustainable fisheries production and maintaining aquatic and avian biodiversity in open water bodies through stock enhancement and development;
- Controlling size and species wise fishing for ascertaining reproduction through fish spawning;
- Conserving and managing water bodies or parts of water bodies for safe habitats for fish;
- Restoring the ecosystem through creating favorable aquatic environment; and
- Creating opportunity for the conservation of fisheries resources through community based management approach.

For the successful implementation of the fish sanctuary, it needs to ensure the participation of jalmahal management committee formed by the local stakeholders and fishing community in and around the waterbodies for preparing jalmahal and sanctuary management plan, monitoring and evaluation. Based on the result of the evaluation, future action plan needs to be prepared.

Marine fishing grounds and establishment of fish sanctuaries

There are four major fishing grounds in the marine waters of Bangladesh. These are South Patches and South of South Patches (Lat. 20°50'N to 21°40'N; Long. 91°00'E to 91°50'E) covering an area about 6200 km^2, Middle fishing ground (Lat. 20°50'N to 21°20'N; Long. 90°00'E to 91°00'E) covering 4600 km^2 area and Swatch of no ground (Lat. 21°00'N to 21°25'N ; Long. 89°00'E to 90°00'E) covering 3800 km^2 (Shahidullah 1983). Four different areas in Middle Ground and South Patches have been declared as fish sanctuaries in the Bay of Bengal. But data on the detailed oceanographical status of these areas are yet to be generated. These data are needed to determine the suitability of the areas as fish sanctuary.

Hilsa fish sanctuary

Currently there are five hilsa fish sanctuaries in Bangladesh. These are: (i) the strip between Shatnol and Char Alexander in Meghna River; (ii) the Shahbazpur channel of the Meghna River; (iii) the Tentulia River adjacent to Bhola district; (iv) the Andharmanik River near the Bay of Bengal; and (v) the estuary of Padma and Meghna Rivers located in Shariatpur district. The first four were declared hilsa sanctuaries in 2003-04 and the fifth one was declared in 2010-11. For the Andharmanik sanctuary, the breeding season starts in November and ends in January. For the remaining four, the season spans March-April. At present, the five sanctuaries cover a total riverine area of 350 sq-km. The newly identified jatka/hilsa sanctuary, which deserves conservation for increasing of its population and sustainable harvest located at the confluences of three rivers, such Nayabhangani, Lata and Dharmogonj, which are branches of the Meghna River at around Hilzla-Mehendiganj of Barisal district. It has been selected based on diversity, abundance of jatka (juveniles of hilsa) and water quality suitable for them. It covers an area of 60 sq-km (Nasakathis, Harinathpur and dhulkhola point of Hizla upazilla and Bhasanchar point of Mehendiganj upazilla). It would be treated as sixth jatka/hilsa sanctuary of the country. The proposed ban period is March-April.

9.3.3. Beel nursery

Beel nursery is a good and fruitful way of increasing biodiversity and production of pure strain and native fish species through recruitment in the adjacent waterbodies during the monsoon. It is usually done through evolving nursery management of the selected waterbodies in seasonal floodplain, Beel, Khal and in some cases in river parts. Increasing the abundances of the carp fishery along with endangered species of fish in the natural waterbodies of the country has been emphasizing through releasing quality fries/fingerlings of different fish species. About 715 Beel nurseries have been established throughout the country by the fiscal year of 2013-14. But this endeavor of increasing fish biodiversity and corresponding production seems inadequate. Realizing the merits of the Beel nursery program, the Government approved Tk. 1,180.9 million for the "Establishment of Beel Nursery and releasing fingerlings in open water bodies" for its sustainability (DoF, 2014). An indicative and incomplete list of Beel nursey of the country presented in following Table 9-6.

Table 9-6: Selected beels for Beel nursery activities by DoF

Sl. No.	Upazila Name	Water bodies where implementation of beel nursery program under progress	Area (Ha)
Sunamganj			
1	Sunamganj Sadar	Dhapa Beel (Dhapa Group Jalmahal)	0.50
2	Deari	Udir Haor	0.60
3		Kaiya Beel	0.70
4		Dharer Beel	0.50
5	Sulla	Ganiar Dhara Beel	0.70
6		Dhubee of Satpara Bazar	0.50
7	Dowarabazar	Bagam Beel	0.50
8	Bishwambarpur	Haruar Beel	0.50
9	Tahirpur	Choto khal Baro Khal Beel	0.40

Sl. No.	Upazila Name	Water bodies where implementation of beel nursery program under progress	Area (Ha)
10	Dharmapasha	Makrua Beel	0.60
Kishoreganj			
1	Mithamain	Joaria Beel	0.80
2		Alir Dhona	0.70
3		Hiradori Beel	0.60
4	Pakundia	Beelvhara Beel	0.60
5	Hossainpur	Kaitrol Beel	0.50
6	Bajitpur	Deodanga Beel	0.50
7	Tarail	Joara beel	0.50
8	Nikli	Diga Beel	0.60
Netrokona			
1	Netrokona Sadar	Jal Gagutia Beel	0.50
2		Gobinda Chatoil	1.00
3	Kalmakanda	Mohishaura Beel	0.50
4	Barhatta	Hana Beel	0.60
5	Atpara	Bandhu Muja Beel	0.50
6		Ghariakhali Beel	0.70
7	Mohanganj	Rouha Beel	0.70
8	Kendua	Badua Alamchia Beel	0.60
9		Dhaleshary Beel	0.80
10	Khaliajuri	Dhalai Beel	0.70
11	Madan	Nagdora Beel	0.70
12	Purbadhala	Dhoba Beel	0.60
13		Atla Beel	
14		Rajdhola Beel	0.80
Sylhet			
1	Sylhet Sadar	Hilsa Beel	0.80
2	Companiganj	Dhalia Satbila Beel	0.60
3		Borrow pit adjacent to Katagong Bridge	0.80
4		Pkuria Beel Group	0.50
5	Bishwanath	Dholipara Majon Bari Fishery	0.50
6		Chauldhoni Haor	0.80
7	Dakshin Surma	Deojur Beel	0.60
8		Baro Lula Jalmahal	0.70
9		Madi Beel	0.50
10	Beanibazar	Sadarpur Beel	0.60
11		Adinabad Beel	0.50
12	Gowainghat	73 Baro Kikon Beel	0.80
13	Zakiganj	Dhobail Beel Group Jalmahal	0.70
14	Balaganj	Baro Dalai Beel	0.80
15		Baghmara Dhubi	0.70
Habiganj			
1	Habiganj Sadar	Diga Beel	0.60
2		Barang Khal -Peri Khal Group	0.50
3		Hingaria Sataria Jalmahal	0.60
4	Baniachang	Beel Ferani Prokasita Noabader Gong	0.60
5		Sangor Bhagaee	070
6		Vhaora Beel	0.60
7	Nabiganj	Diga Beel	0.70

Sl. No.	Upazila Name	Water bodies where implementation of beel nursery program under progress	Area (Ha)
8		Pani Khauri Beel	0.80
9		Old Bibiana Beel	0.70
10	Madhabpur	Nairajuri Beel	0.50
11		Katenga beel	0.70
12		Baicha Beel	0.50
13	Bahubal	Hugli Beel	0.60
14		Monupani Bakbakia Beel	0.60
15	Chunarughat	1 No. Mora Khoai river	0.70
16	Azmiriganj	Rania Khal	0.80
17	Lakhai	Ghar vhanga Khal	0.50
Moulvibazar			
1	Moulvibazar Sadar	Hamua Beel	0.60
2	Kulaura	Dhaliar Haor	0.70
3		Dhul Dhular Beel	0.60
4	Baralekha	Siali Jagri Beel	0.50
5	Sreemangal	Masaddar Alir Pond	0.50
6	Rajnagar	Old Matikura Beel	0.70
7	Juri	Nagua Dhulia Group Fishery	0.60
8	Kamalganj	Keolar Haor	0.60
9		Laoler Haor	0.50
Brahmanbaria			
1	Brahmanbaria Sadar	Choto Boalia Beel	0.80
2		Baro Boalia Beel	0.60
3		Beel Shakla	0.70
4	Banchharampur	Chandal Beel Fishery	0.70
5		Beel Baria dhoa	0.80
6	Sarail	Moral Gazaria Kuri Beel	0.50
7	Nasirnagar	Beel Baklongon	0.50
8	Kasba	Hatina Beel	0.40
9	Ashuganj	Araisida Beel	0.40

Source: DoF, 2011

9.3.4. Spill way fisheries

Water of many beels are drained out through the narrow canals/Khals in the economically under developed areas. Beels become dry up at the onset of dry season. As a result, fish habitats get damaged and fishermen around the beels become jobless due to low or no water in the beel and reasonably no fish. For facilitating the fisheries resources and dependent livelihoods, establishment of spill way on the drainage canal is considered as a suitable measure. The mechanism of constructing spill way is to allow water in the beels and excess water could spill over the structure and water could retain in the waterbodies at a certain height during the recession period.

As a result, fish will get its residence where it will grow up and propagate and dispersed in the floodplain during the wet season. Since fish production is expected to increase so fisher's livelihood would be facilitated from such specialized fisheries activities.This will also help the agriculture farmers through providing surface water irrigation facilities. The Government has allocated an amount of Tk. 21.5 million for the installation of the spill ways at suitable places of the country in 2013-14 fiscal years.

9.3.5. Net-Pen fish culture

The net-pen culture form of fish farming is a method of growing fish holding them captive within an enclosed space in rivers, floodplains or lakes whilst maintaining a free exchange of water. Containing fish in a pen culture is an alternative open system of commercial fish culture that allows interaction with the immediate environment, yet prevents the entry of undesirable animals and fish that may harm the cultured stock. This kind of practice is highly suitable for the community based approach. Pen fish culture after carp polyculture in ponds is probably will be the most important culture system in the country and has been increasing in popularity. Net-pen fish culture practice is running popularly in the Haor area. This culture practice is done in an area of about 6,775 ha all over the country (DoF, 2015)[11].

Merits and demerits of net-pen culture:

The merits and demerits of pen culture are in some cases common as those for cage culture. The following table (Table 9-7) presents the merits and demerits of pen culture.

Table 9-7: Merits and demerits of net-pen fish culture

Merits	Demerits
Intensive utilization of space	High demand of oxygen and gentle water flow
Safety from predators	Dependence on artificial feed
Suitability for culturing many varied species	Food losses
Easy of harvest	Water pollution
The flexibility of size and economy	Rapid spread of diseases
Availability of natural food and exchange of materials with the bottom	Risk of pouching;
Since, the bottom of the pen is the natural bottom, unlike the cage which kept either on the bottom or floating, has always a netting/screen separating the cage from bottom; the pen culture organisms are at an advantage that while enclosed they can procure food/exchange materials	Conflict with multiple uses of natural waters

Photo 9-2: Net-Pen culture practice

[11] FRSS, 2013-14

9.3.6. Seasonal cultured water body (Floodplain) under the community enterprise approach

Seasonal cultured water bodies means paddy field, floodplain, Boro pit, etc. which are undertaken for fish culture and about 130,488 hectare of floodplain area is converted into such type of modern aquaculture system under the community enterprise approach. Fish output from the rivers and khals, and open water bodies like beels and floodplains are declining and thus floodplain fisheries become crucial in providing food, income and employment for millions of people of the country. Excluding other open waters, floodplains in totality around 27.02 lakh hectares in area and are thought to be producing about 7.01 lakh MT of fish annually. Typical yields from these flooded areas are between 250-400 kg per ha. In comparison, average yield from the seasonal cultured water bodies is 1,539 kg/ha i.e. 4-6 times the naturally occurring fish production. This dramatic increase in productivity highlights the potential for development of floodplain fisheries along with the increase of paddy production with less input costs.

9.3.7. Floating cage culture

Fish farming in floating cages began in Bangladesh in last eight to ten years bringing the technology from Thailand by some NGOs. Cages are mostly used in open freshwater bodies where gentle current of water prevails. Fish farming in the floating cages are currently predominant in the different rivers under Chandpur, Narsingdi, Munshiganj, Barisal, Narayanganj, Mymensingh, Faridpur and Gopalganj districts. Around 8,000-10,000 floating cages comprising an area of about 7 ha across the country are being used by the fish farmers who are producing huge amount of Monosex Tilapia and Pabda annually. The advantages and disadvantages of cages compared with other culture systems include:

Merits of Cage Culture:

- Uses of existing water bodies;
- Technical simplicity with which farms can be established or expanded;
- Lower capital cost compared with land-based farms; and
- Easier stock management and monitoring compared with pond culture.

Demerits of Cage Culture

- Stock is vulnerable to external water quality problems e.g. algal blooms, low oxygen, etc;
- Stock is more vulnerable to fish eating predators such as water rats and birds; and
- Growth rates are significantly influenced by ambient water temperatures.

Cage culture systems may be intensive, semi-intensive and extensive in nature and the culture patterns are depending on stocking rates of fish, food supply, care and hydrological conditions of the habitats. Suitable fish species for growing commercially in cages are as follows: monosex Tilapia, Pabda, Thai Sharpunti and other major carps. Although farming of freshwater prawns, Macrobrachium rosenbergii, in cages is a new concept in Bangladesh.

Fixed cage

Floating cage

Photo 9-3: Cage culture practice in pond and river

9.3.8. Good fisheries management practices- Mohanganj Experience

Dissemination of Good Practices in Fisheries Sector has been implemented in Dingapota Haor of Mohanganj upazila of Netrokona District. A wetland conservation practice turned into social development activities. Unlike other parts of Bangladesh, good practices to follow fishing norms were also absent in Mohanganj. Over fishing, indiscriminate and illegal fishing, catching brood and immature fish, fishing during breeding season and by de-watering were a common scenario.

Good Practices for Management by Campaign

Dingapota Haor is one of the largest haor in Mohanganj with an area of around 8,000 ha. Instead of enforcement of law, the local administration decided to campaign on three good practices, such as (i) "Do not fish during fish breeding season (Boishakh, Joisthya, Ashar of Bangla year/mid April to mid July)", (ii) Do not use harmful gears for fishing and (iii) Do not catch fish by de-watering the beels.

Stakeholders

Under the initiative, the stakeholders were haor fisher community, fish and fish net traders, local government representatives, students and teachers, different public service recipients, ANSAR-VDP and Village Polices, NGO workers, political and local elites, religious leaders, women, children, etc.

Photo 9-4: Campaign of good fisheries management practice

Mode of Campaigns

With these three objectives, they started vigorous campaign in every corners of Upazila even taking the opportunity of Jummah Prayer in mosque to mosque with the leadership of UNO, SUFO and other upazila level GoB officials. UNO and SUFO used to deliver speech on the importance of aquatic resource conservation and enhancement of fish production. Under the approach, the administration visited every village and went door to door with such campaign and also went to each fishing units and talked to the fishers in the haor while fishing, to the fish wholesale markets, fish landing centers, hats and bazaars and met mass people with the messages. They communicated with the house-wife and children and requested them to influence their fathers/brothers/husbands to follow the fishing norms. They also started extensive mobile publicity with the messages. In addition, they used the local satellite channel for publicity through TV programme.

Fisheries Improvement

Resultant of the initiative, the people of Mohanganj started getting the positive results. Fish production of Dingapota haor increased by 3-4 times (Local DoF Assessments); availability of bigger sized fishes increased; many endangered fish species reappeared; aquatic biodiversity conserved at a satisfactory level; income of fishers HH increased significantly. Above all, mutual understanding and cooperation among the mass people established and common people could able to react beyond personal interest rather they started thinking about the betterment of the society.

Social Activities

With the success of first two years, the administration started some other social development activities. Poor resource user groups were organized and 09 Samities were formed. With the subscription of samity members, so far a total fund of Tk. 27.0 million was generated. These samities are providing interest less micro-credit to the ultra poor. A grocery shop established where people get their daily consumable products at a less price. Profits of this shop shared among the samity members. Along with the Upazila Parishad, Samities are now working on birth control, prohibiting early marriage, children education and proper sanitation. Upazila Parishad brought the poor resource users under VGF/VGD program.

After motivation and consultation meeting, extensive dissemination activities were carried out through different paths which are shown in the following diagram (Figure 9-2). Alongside, existing fisheries rules and regulations was implemented strictly with the cooperation of local administration and police by seizing and burning of unauthorized gears and nets during fishing prohibited period of 3 months. Following Figure 9-3 and Figure 9-4 portray good practice approach in fisheries sector, its dissemination and application of fisheries laws and regulations respectively.

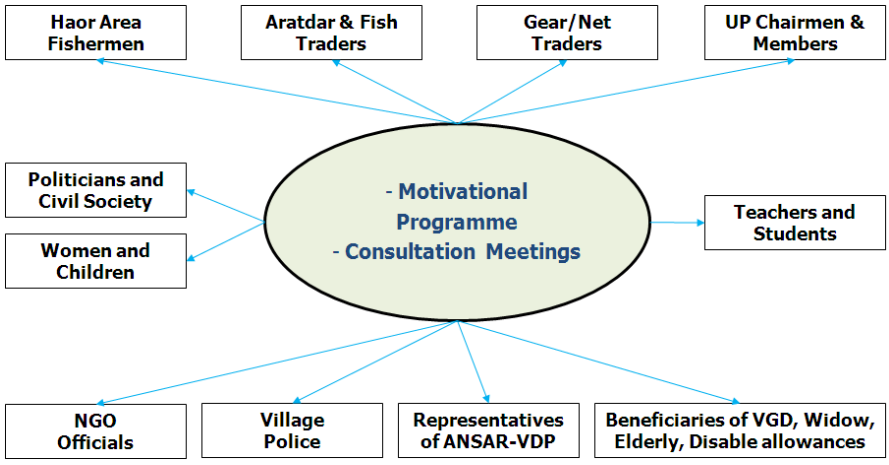


Figure 9-2: Good practices in fisheries sector and stakeholders

After motivational and consultation meeting, the dissemination activities were executed by using different tools.

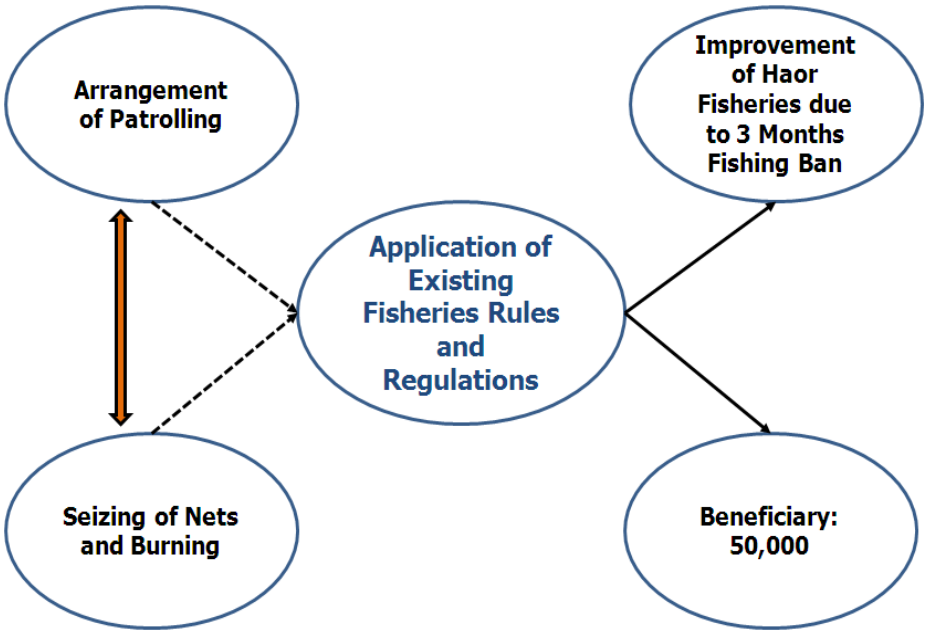


Figure 9-3: Dissemination of fisheries good practices approach

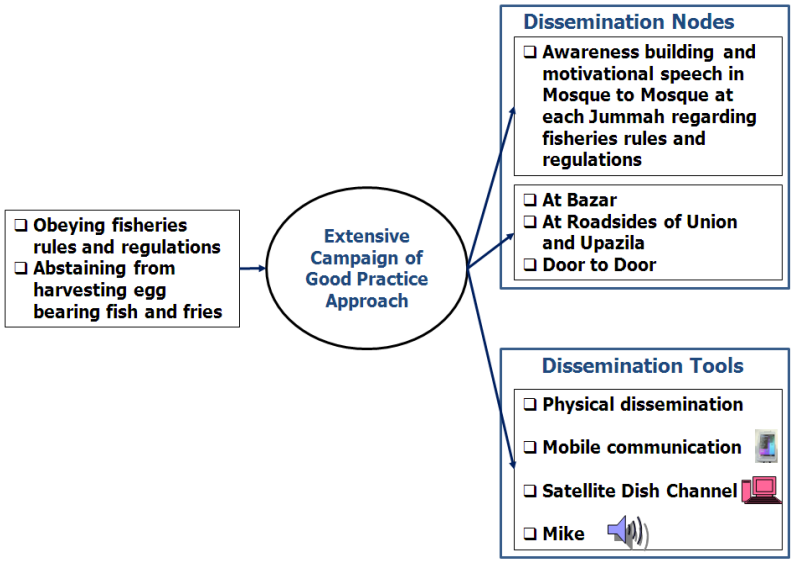


Figure 9-4: Application of fisheries laws and regulations

9.3.9. Jalmahal leasing system

Evolution of Jalmahal Leasing System

The management of open waters in Bangladesh is based on the sole objective of earning revenue. For the purpose of revenue earning, rivers are hypothetically segmented. Each segment is termed as Jalmahal or shayreeat mohal, or jalkar, or fishery (water estate). Perennial beels and seasonal beels are likewise Jalmahals shayreeat mohals, or jalkars and so are the oxbow lakes (baor). Large reservoirs and ponds near the palaces or residences of the erstwhile zamindars (landlords) are also Jalmahals since abolition of zamindari system in 1950 (Ali, 1992b).

Present Leasing Practice

Jalmahals are divided in two types based on area, such as jalmahal with an individual area of ≤ 20 acre and > 20 acre for the management aspects. Jalmahals of area with ≤ 20 acre are given management responsibility to Upazila Level Administration particularly to the Assistant Commissioner in Land (AC Land) while jalmahals of > 20 acre are given responsibility to District Level Administration particularly to ADC (Revenue). Currently, in the public sector, there are 35,285 Jalmohal, both in open and closed water system.

The estimated total Jalmohal area under ≤ 20 acre category is about 5,328 ha in the Haor region (with lack of some upazila data) and distributed by district, Table 9-8. The procedure is currently being practiced by the Ministry of Land with a minor amendment ordered by the same ministry on 28 September 1994. The amendment is as below:

"If an offer for rent incorporating an increase of at least 25% over the rent of the preceding year is not received even after repeated invitation of tenders for three times in succession, the tender committee shall invite tender for the fourth time after reviewing properly the location, area, and other related matters of the jalmahal. In case of inviting tender for the fourth time, the restriction that the bid value of the tender shall have to be 25% higher than the preceding year's tent shall not remain in force (Ali,1995).

Table 9-8: Number and area (≤ 20 acre) of Jalmahal by District

District Name	Number of Jalmahal	Area (Ha)
Sunamganj	497	1,765
Kishoreganj	111	279
Netrokona	98	343
Sylhet	377	1,367
Habiganj	580	1,010
Moulvibazar	183	383
Brahmanbaria	462	181
Total=	2,308	5,328

Source: Upazila Fisheries Offices (UFOs)

9.4. Community Based Fisheries Management

Involvement of community in fisheries management in different angles has been encouraged under different projects of the government. This has been done due to optimization of the resources and to ensure maximum sustainable yield (MSY). Community involvement approach under different projects is described as follows:

ADB Second Aquaculture Project- Under the Second Aquaculture Project, nursery ponds were prepared directly on the floodplain, in areas of residual water, and fry were placed in these ponds at a few days old (DOF, 1995). The fry are thus conditioned and start to grow, then as the flood waters rise and overtop the ponds, the young are released naturally. Ultimately the project adopted a procedure similar to that of Third Fisheries with similar results.

Third Fisheries Project- Originally this project was conceived as restocking 100,000 ha of floodplains with a mixture of major carp, silver carp, bighead and common carp of 7–10 cm length, at 20 kg/ha (World Bank, 1990). The fingerlings were protected for three months through an awareness campaign, persuading the fishing communities not to catch them during this period pending greater incremental benefits, and then allowing harvesting from October on as the flood waters subsided. The essential difference between this project and the Second Aquaculture Project was in the way the well-grown fingerlings were put into the water rather than the young fish.

Fourth Fisheries Project- The Fourth Fisheries Project started in 2000, involved the NGOs extensively for empowering the fishing community so that the benefits of mitigatory and compensatory interventions undertaken by the project could be retained by the community of project beneficiaries, i.e., the fishers. Improvement of inland open-water fisheries management through the development of sustainable, community-based institutions and supporting them in undertaking a program of adaptive management of their fisheries resources using technical measures such as stock

enhancement of floodplain fisheries, restoration of fisheries habitats, establishment of fish sanctuaries, and construction of fish passes.

CBFM2- The Community Based Fisheries Management Project, implemented by the Department of Fisheries (DoF), Bangladesh Govt. in partnership with the WorldFish Center and 11 NGOs, attempted to turn back the tide of years of environmental degradation in Bangladesh by conferring the responsibility for looking after inland fisheries resources to those whose lives depend on them i.e. the poor fishers and community people. With funding from DFID, the project managed to establish community control over 116 water bodies covering closed beels, open beels, floodplains and rivers. The project has been implemented through 11 partner NGOs who are working with 23,000 direct beneficiaries, spread over 48 Upazilas in 22 districts.

MACH- The Management of Aquatic Ecosystems through Community Husbandry project aimed to promote environmentally sound management of wetland resources (fish, aquatic vegetation, other wetland products and water) for the sustainable supply of food to the poor people of Bangladesh. This is a follow-up project to monitor the interventions and processes set by the MACH project and to provide support to the community bodies' set-up as part of the project.

One unique aspect of MACH is its decentralized approach to co-management that focuses on collaboration with local government. This approach involves the whole community neighboring the wetlands. MACH included supplemental income generating activities focused on the very poor and would be restricted from fishing for specific periods to restore the resource. More than 30% of those are poor women. The building blocks of the management are shown in Figure 9-5.

Tanguar haor management approach by IUCN

Tanguar Haor is declared as a Ramsar site and also as an Ecologically Critical Area (ECA). IUCN executed a management approach under the arrangement of co-management in this haor as it needed sustainable management strategy particularly in view of addressing the pressure on its resources following the moratorium on natural resources exploitation. The government has been keen to put in place a community based management system in Tanguar haor. The major constraint for initiating a community based management of Tanguar Haor was the ownership and leasing system for its fisheries resources. It was owned by the ministry of land and short term lease was to be given to the highest bidder. In 2001 ownership of Tanguar haor was transferred and subsequently the lease system was banned effectively.

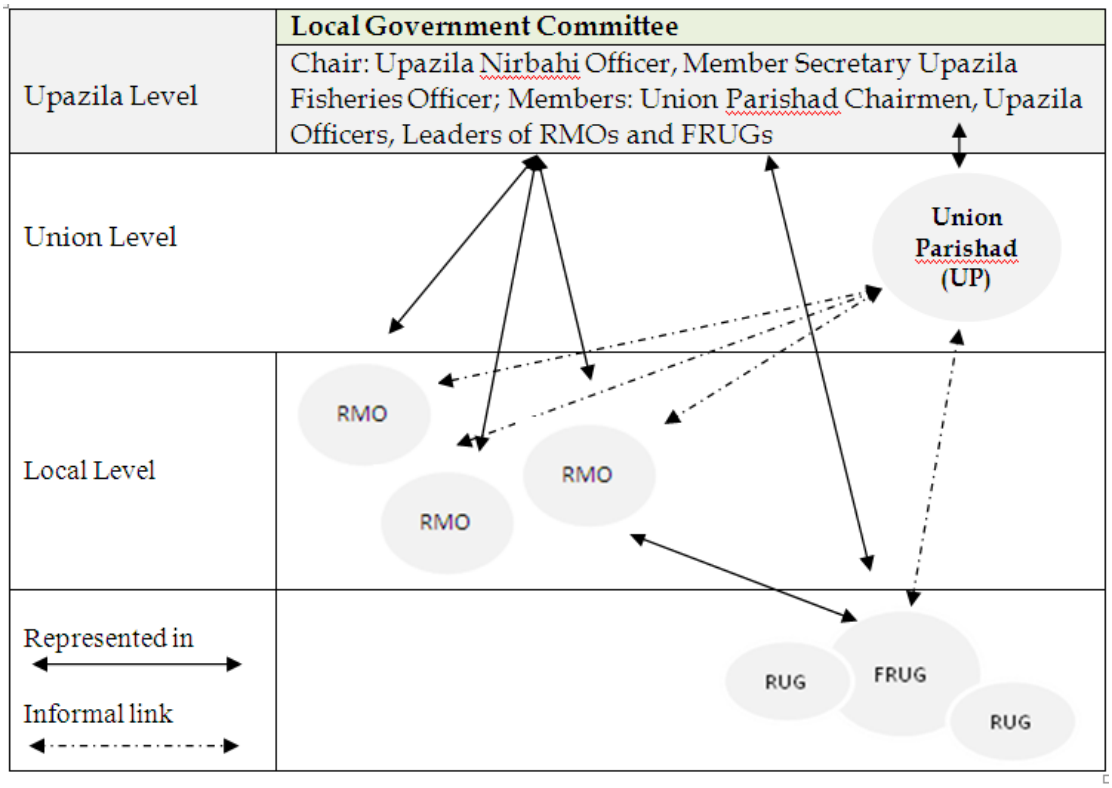


Figure 9-5: Institutional arrangement for community based co-management under MACH

Co-management approach by IPAC

Integrated Protected Area Co-Management (IPAC) has been embarked upon the strategic goal of scaling-up natural resource co-management at the policy and operational level by achieving recognition, acceptance and integration of this approach by the GOB into its management tactics. IPAC is provisioning to promote and institutionalize an integrated protected area co-management system for sustainable natural resources management and biodiversity conservation that results in responsible, equitable economic growth and good environmental governance. IPAC has built upon and provided additional support to the successful co-management interventions launched with USAID funding under the MACH project and NSP.

9.5. Post Harvest Care and Processing

9.5.1. Fish landing center

Landing centers provide modern and hygienic facilities for the fishermen and fish traders and there are facilities for berthing, landing, auctioning, cold storage, freezer storage and transport. Normally, post-harvest resource management care is taken properly in these centers. But sometimes, fishermen and fish traders are not very interested for utilizing these modern facilities due to ignorance and self-interest.

The country possesses a total of 237 fish landing centers and 5440 fish markets. The number of landing center and market are highest in Chittagong and Dhaka division respectively. Stakeholders in fish distribution, viz., arotdars, paikers and retailers are found to be 6219, 39506 and 122922, respectively (Table 9-9). About 85% of the landing centers are operated round the year while the rest are seasonal. The quantity of fish harvested from river, beel, Kaptai lake floodplain, pond, baor, coastal area/sea and shrimp/prawn farm were 5.25, 4.41, 0.13, 35.03, 38.22, 0.23, 10.93 and 5.80%, respectively (Rahman, *et al.*, 2013). The common constraints identified were

lack of adequate infrastructure facilities in the landing center and market, unhygienic environment, influence of middlemen, money lending at high rate etc. All the landing centers of the country are supposed to be regulated by the Bangladesh Fisheries Development Corporation (BFDC). Due to shortage of manpower, DoF also takes care of the centers.

Table 9-9: Country status of fish landing centres

Division	No. of Landing Centre	No. of Fish Market	No. of Aratdar	No. of Paikar	No. of Retailer	Samples of fish landing centres
Dhaka	50	2,099	1,899	12,704	42,499	
Rajshahi	16	969	1,283	6,399	23,313	
Khulna	12	465	570	5,556	17,793	
Rangpur	02	496	215	2,600	7,558	
Chittagong	76	809	821	5,768	17,134	
Barisal	65	267	1,095	2,490	6,070	
Sylhet	16	335	336	3,989	8,555	
Total	**237**	**5,440**	**6,219**	**39,506**	**122,922**	

9.5.2. Ice plants

It is reported from various sources like local fish depot, aratdars, fishermen, etc that nearly 70% of the fish production of the region is utilized in fresh or in live form although in more remote areas a large portion of the catch may be processed. Typically, fresh fish is sold wholesale in ungutted form. Limited use of ice is made to preserve fish destined for local markets, but all fresh fish (except livefish) destined for distant markets is iced.

Fresh fish are generally preserved in ice for local marketing. There are only a few ice plants in the country; the total output is not adequate and prices are often high. Most ice factories are at the large fish landing centres, namely, Chandpur, Barid, Khulna, Kuliarchar, Goalanda, and Chittagong. Most factories produce block ice in sizes varying from 70 to 80 kg. Often the water used to make ice is taken from polluted rivers and ponds. Some use underground water containing an excess of mineral salts. The Fisheries Development Corporation and the Central Fisheries Cooperative Society have set up ice plants at Chittagong. Wherever available, ice is used for long distance transportation of fish but is rarely used by the fishermen. Most fish is landed in a poor condition.

9.5.3. Fish marketing

There are about 5,440 fish markets in Bangladesh where number of Aratdars is 6,219; Pikar 39,506 and retilaer 122,922.

Fish Marketing Channels

Marketing channels are the alternative routes of product flows from producers to consumers (Kohls and Uhl, 2005). Value chain may be long or short for a particular commodity depending on the qualities of products, size and nature of consumers and producers and the prevailing social and physical environment. Dominant supply chains of major carps (rohu and catla), pangas and tilapia in Bangladesh are shown below: Three major value chains are identified for major Indian carps, pangas and tilapia. These are:

Value chain – I Fish Farmer – *Nikari* – *Paiker* – Aratdar – Retailer – Consumer

(For live Pangas)

Value chain - II Fish Farmer – *Aratdar* – *Paiker* - Retailer – Consumer

Value chain - III Fish Farmer – *Aratdar* – Retailer – Consumer

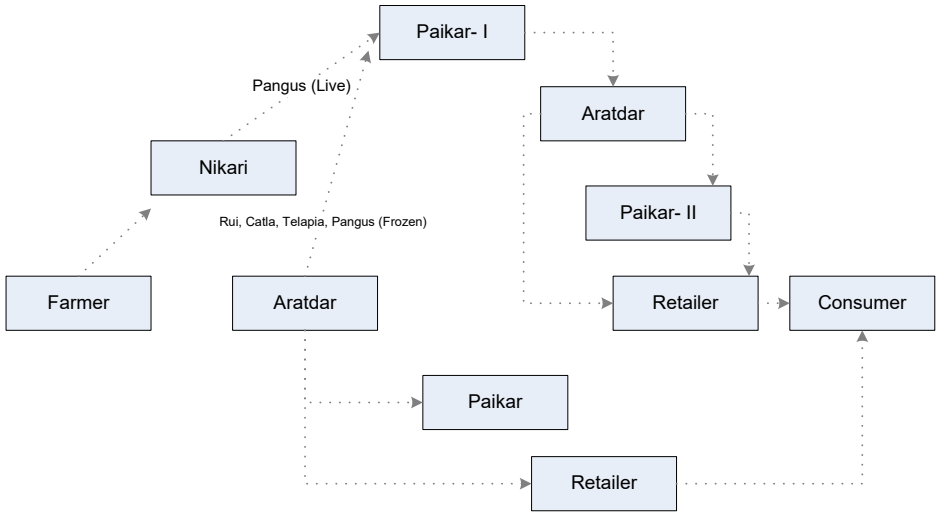


Figure 9-6: Value chains of major carps, pangas and tilapia in Bangladesh

Source: Modified from Alam et. al. 2012

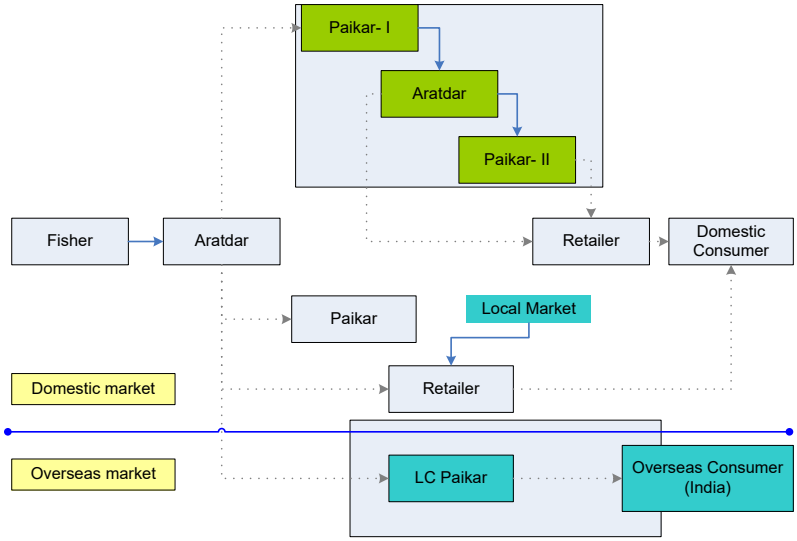


Figure 9-7: Value chains of Hilsa in Bangladesh

Major Value chains of hilsa in the study areas are as follows:

Domestic market

Value chain – I Fishermen – *Aratdar* - *Paiker* – *Aratdar* - Retailer - Consumer (Distant market)

Value chain - II Fishermen – *Aratdar* – *Paiker* – Retailer – Consumer (Local market)

Value chain - III Fishermen – *Aratdar* – Retailer – Consumer (Local market)

Overseas market

Value chain - IV Fishermen – *Aratdar* – LC Paiker – Consumer

Channel 1	Channel 2	Channel 3	Channel 4
Fry collector ↓ Fry Arathdar ↓ Shrimp farm owner	Fry collector ↓ Fry faria/money lender ↓ Fry arathdar ↓ Fry retailer ↓ Farm owner	Fry collector ↓ Fry faria/money lender ↓ Fry arathdar ↓ Fry commission agent ↓ Farm owner	Fry collector ↓ Local fria/ arathdar ↓ District fry arathdar ↓ Fry commission agent ↓ Fry retailer ↓ Shrimp farm owner

Figure 9-8: Different marketing channels of wild post larvae of P. monodon

Channel 1	Channel 2	Channel 3	Channel 4	Channel 5
Hatchery reared fry ↓ Shrimp farm owner	Hatchery reared fry ↓ Fry trader ↓ Shrimp farm owner	Hatchery reared fry ↓ Fry trader ↓ Fry arathdar ↓ Fry commission agent ↓ Fry retailer ↓ Shrimp farm owner	Hatchery reared fry ↓ Fry commission agent ↓ Local fry arathdar ↓ Fry retailer ↓ Shrimp farm owner	Hatchery reared fry ↓ Fry commission agent ↓ Shrimp farm owner

Figure 9-9: Different marketing channels of hatchery reared post larvae of P. monodon

Source: Aftabuddin et al., 2009

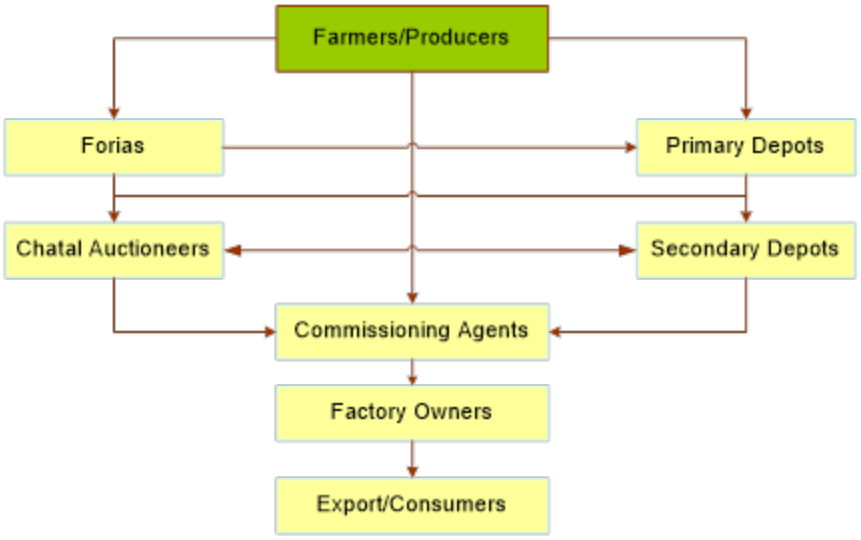


Figure 9-10: Shrimp marketing channel in Bangladesh

Source: Hassan et al., 2012

Crab harvesting and fattening as well as marketing have emerged as an important livelihood option for the people, especially women living in the fringes of the Sundarbans. Thousands of poor fishers, traders and transporters are directly or indirectly dependent on crab fishery in Bangladesh (Zafar, 2004). From Bangladesh mostly the live crab is exported. Mud crab marketing channels in particular were complicated, since market operators may perform more than one marketing function. The marketing channel of mud crab in Bangladesh starts from the wild catchers and passes through a number of intermediaries such as catchers, farmers, middlemen, depot owners, local agents for the exporter and finally from the exporter to the foreign countries.

9.5.4. Fish processing industry

It is estimated that around 70% of the fish production of the country is utilized in fresh or live form (although in more remote beels a large proportion of the catch may be processed). The main products are sun dried and semi-fermented fish. Smoking or salting is apparently not practiced.

Typically, fresh fish is sold wholesale in ungutted form. Limited use of ice is made to preserve fish destined for local markets, but all fresh fish (except livefish) destined for distant markets is iced. A small portion of the catch (large prawns, major carp, large catfish, chital, pabda, some small fishes) is destined for export and undergoes high quality processing in factories for earning foreign currency. There are 162 fish processing plants in the country out of which 74 are European Union approved (DoF, 2014).

9.6. Impacts of Past and Present Programmes of DoF

Fisheries department has been undertaken a number of Projects for boosting up the fisheries sector in terms of production, fish biodiversity and dependent livelihood. Followings are several such projects along with their impacts on fisheries sector (Table 9-10).

Table 9-10: Impacts of Past and Present Programmes of DoF

SL	Project Name	Implementing Agency and Period	Impact
1	Socio-economic impact of fish culture extension program on the farming systems of Bangladesh	ICLARM in collaboration with GoB agencies (DoF, BARC and BFRI) funded by IFAD and Danida Project Period: 1990-94	□ Minimal investment (even without credit provision) increased fish production and incomes of fish farmers; □ Carp and Tilapia yields were four times higher than they were before project extension activities; □ Production increased to 2.7 MT/ha/yr from 0.6 MT/ha/yr for carp polyculture and for Nile Tilapia it is 3.3 MT/ha/yr; □ Return on investment (ratio of net income to total costs) for disease free carp polyculture was about 500%.
2	Restoration of the natural breeding habitats of the Halda River Project	DoF funded by GoB Project Period: July 2007-June 2014	□ Natural spawning grounds in the Halda river are developed, protected and conserved; □ Restored productivity and bio diversity of existing aquatic resources by establishing fish sanctuaries in the Halda; □ Community participation is ensured under an effective institutional management framework for conserving natural spawning of the Halda; □ Alternate income generating opportunities during ban season are created, provided and explored.
3	Regional Fisheries and Livestock Development (Barisal Component) Barisal	DoF funded by Danida Project Period: July 2007-June 2013	□ Productivity improved and sustainability of poor households ensured □ Developed a decentralized, integrated and demand driven fisheries and livestock extension service to support resources from poor households. □ Formed a community based organization and farmer's associations. □ Improved linkage with private sectors
4.	Bangladesh Marine Fisheries Capacity Building Project	DoF funded by IDB/GoB Project Period: July 2007 – June 2015	□ MSY of estuarine, coastal fisheries resources and their standing stocks are assessed □ Standing stock of pelagic and demersal stocks of aquatic resources assessed. □ Undertook census and established data bank on different types of fishing craft and gears. □ Routine of coastal and marine fisheries maintained via development of catch assessment programs. □ Implemented MCS system to oversee and manage resources.
5.	Brood Bank Establishment Project	DoF funded by GoB Project Period: July 2007 – June 2013	□ Developed aquaculture industry in Bangladesh □ Overcame inbreeding problem and ensured supply of brood/fingerling □ Quality brood fish production ensured
6.	Fisheries Diploma Course Implementation Project	DoF funded Project Period: July	□ Developed skilled and technical manpower for fisheries sector □ Developed facilities for running fisheries

SL	Project Name	Implementing Agency and Period	Impact
		2008 – June 2014	diploma course.
7.	Greater Pabna Fisheries Development Project	DoF funded Project Period: January 2009 – June 2014	□ Increased fish production from both capture and culture fisheries in Pabna region □ Established fish sanctuary, stocked endangered fish fingerlings and created awareness to protect fish biodiversity. □ Developed infrastructure to improve fish habitat. □ Ensured livelihood security of the poor people of Pabna region.
8.	Emergency 2007 Cyclone Recovery and Restoration Project	DoF funded by ECRRP Project Period: July 2008 – June 2014	□ Provided aquaculture inputs to the coastal fishers to restore the aquaculture production chain □ Provided fishing nets and repaired boats of cyclone affected coastal fishers
9.	Jatka Conservation, Alternate Income Generation for the Jatka Fisheries and Research Project	DoF funded Project Period: July 2009 – June 2014	□ Increased Hilsa production by saving Jatka and brood Hilsa □ Strengthened and enhanced Hilsa Sanctuary activities □ Created alternate job opportunities for the Jatka/Hilsa fishers □ Created mass awareness to conserve Jatka/Hilsa
10.	Expansion of Aquaculture Technology Services up to Union Level Project	DoF funded: Project Period: July 2009 – June 2014	□ Increased fish production □ Used improved technology in bringing most of village ponds and other cultivable water bodies in selected unions □ Ensure participation of local fish farmers in delivering the required techniques and technologies □ Established a Union-based Aquaculture Extension (UAE) system with joint efforts from DoF, Union Parishad, Local Extension Agent for Fisheries and local fish farmers □ Involved and utilized Union Parishad in disseminating training activities and demonstration to local level fish farmers
11.	Aquaculture and Fisheries Management in Bhabodaha Area, Jessore	DoF funded Project Period: July 2009 – June 2014	□ Increased aquaculture production and enhanced the income of the fisheries □ Ensured fisher community organization's access to water resources by establishing, motivating and strengthening them. □ Involved women in pond aquaculture, improving their status □ Provided support for other AIGAs
12.	Greater Faridpur Fisheries Development Project	DoF Funded Project Period: January 2010 – June 2014	□ Increased fish production from capture and culture fisheries of Faridpur region □ Created employment opportunities for the poor and one landless members of in each family □ Developed water bodies and minor

SL	Project Name	Implementing Agency and Period	Impact
			infrastructure to improve fish habitat
13.	Poverty Reduction and Livelihood Security for the People of Economically Depressed Area	DoF funded Project Period: April 2010 – June 2014	□ Created employment opportunities in fisheries sector □ Trained and involved unemployed poor people in aquaculture and other income generating activities to develop their skills and knowledge □ Reduced malnutrition in the poverty region
14.	Development and Management of Identified Degraded Water Bodies and Conservation of Small Indigenous Fishes	DoF funded Project Period: July 2010 – June 2014	□ Restored aquatic habitat and ecosystem and increased fish production □ Conserved and enhanced the production of small indigenous fish species □ Established community based management of fisheries resources □ Uplifted the socio-economic condition of fishes in the project area.
15.	National Agriculture Technology Project (DoF) Component	DoF funded by IDA Project Period: July 2007 – December 2014	□ Applied a Decentralized, participatory, demand-led and knowledge based approach for agricultural extension □ Promoted farmer market linkages as part of the development of supply chains □ Improved post harvest technology and management practices
16.	Agriculture and Fisheries management Program in Haor Area	DoF funded Project Period: October 2010 – June 2016	□ Established beel nursery, fish sanctuary and stocked fish fry to increase fish production □ Elevated poverty of fishers and fish farmers □ Developed sustainable community based improved management framework for the selected water bodies □ Developed knowledge and skills of DoF, selected NGO employees and CBO members involved in the project □ Built capacity of DoF technical personnel for managing ICL resources along with CBO members & other stakeholders
17.	Fish Production Conservation and Strengthening Management Project at Kaptai Lake (Component – B DoF part)	DoF funded Project Period: January 2011 - December 2014	□ Supported increased fish production in Kaptai Lake □ Established training centers to train stakeholders to raise consciousness □ Supported legislative enforcement to implement fish act and regulations
18.	Re-excavation of Connecting River, Development of Irrigation Facilities and Fish Culture Project of Gazner Beel Area (Fisheries Component) under Sujanagar Upazila in Pabna District	DoF funded Project Period: January 2010 – June 2016)	□ Increase fish product ion both from culture and fisheries in Gazner Beel area □ Established fish sanctuary, stocked endangered fish fingerling and created awareness to protect fish biodiversity. □ Motivated fishermen community lives surrounding the beel.
19.	Control of formalin use	DoF funded	□ Identified the presence of formalin in fish.

SL	Project Name	Implementing Agency and Period	Impact
	in fish preservation and mass awareness campaign	Project Period: March 2011 – June 2014	□ Raised awareness to fish traders, consumers and all concerns through country regarding the attack of formalin as health hazards. □ Trained DoF well as other stakeholders to detect formalin in fish
20.	Hura Sagar Aquaculture and Fisheries management Project	DoF funded Project Period: July 2011 – June 2015	□ Improved the fish habitat in the riverbed □ Improved production of non stocked indigenous fish and biodiversity □ Established fish sanctuaries □ Increased high production by stocking fingerling □ Produced fish fingerling in the river □ Established CBO approach.
21.	Establishment of Fisheries Diploma Institute at Gopalganj, Kishorganj and Sirajganj Districts	DoF funded Project Period: July 2011 – June 2016	□ Offered Fisheries Diploma Course to eligible candidates to develop skilled technical manpower for the fast growing fisheries sector □ Established a well equipped three diploma institutes with modern teaching facilities
22.	Rehabilitation and Development of Fisheries Infrastructure to Increase Production of Quality Fish Seed and Fingerlings	DoF funded Project Period: January 2011 - June 2015	□ Increased good quality seed & fingerlings production □ Demonstrated and disseminated modern aquaculture technologies among the farmers □ Increased production capacity of infrastructures
23.	Integrated Agricultural Productivity Project (IAPP), Fisheries Component	DoF funded Project Period: July 2011 – June 2016	□ Enhanced the productivity of Fisheries in specific agro economically constrained and economically depressed areas □ Increased fish productivity □ Introduced adapting aquaculture technologies.
24.	Fishermen Registration and Issuing of Identity Card Project	DoF funded Project Period: January 2012 – June 2015	□ Identified the genuine fishermen for registration & supply the identity card (ID). □ Developed the database of genuine fishermen □ Supported financially to the family of decrease fishermen by natural disaster
25.	Fresh Water Prawn Culture Extension Project (2nd Phase)	DoF funded Project Period: July 2012 – June 2017	□ Established one prawn culture demonstration farm in Fiier Char, Satkhira and two training centers in Gopalganj and Barisal Districts □ Renovated and started operation of 10 small scale demonstration hatcheries and nurseries □ Started operation of Demonstration nursery ponds in potential Upazilas of 61 Districts □ Provided skill development training on prawn hatchery and farm management □ Extended GMP and GAP in prawn production and safe aquaculture food production □ Developed prawn brood in selected public and private farm
26.	Aquaculture Development and Extension Project (3rd	DoF funded Project Period: July	□ Increased fish production, enhanced income and fulfilled nutritional demand of the household of the hilly people

SL	Project Name	Implementing Agency and Period	Impact
	Phase) in Chittagong Hill Tracts	2012 – June 2017)	□ Developed hilly creeks/wetlands for aquaculture by making dam. □ Developed nursery for fish rearing □ Provided training on aquaculture to the local fish farmers
27.	Wetland Biodiversity Rehabilitation Project	DoF funded Project Period: July 2009 – June 2013	□ Improved the natural resource management system (NRMS) in the command area □ Increased the income of wetland dependent families as well as fish production □ Increased the populations and numbers of species present for key wetland dependent wildlife □ Improved the biodiversity of the wetland
28.	Strengthening of Fisheries and Aquaculture Food Safety and Quality Management System in Bangladesh	DoF funded by BEST Project Project Period: July 2010 – December 2014	□ Strengthened the national quality infrastructure for fish and fish products to meet safety and quality requirements in export markets □ Improved competitiveness and took advantage of global market opportunities in EU markets.

10. Constraints to Fish and Fisheries

10.1. Introduction

Fisheries resources are constrained by different human induced interferences like over and indiscriminate fishing, establishment of FCD/I projects, increase of surface water irrigation, untreated industrial effluents that pollute water quality, upstream water regulation, etc and climate change phenomena. Due to above constraints fish production is gradually declining and thus hampering the normal livelihoods of the dependent communities. Details of the constraints are described as follows:

10.2. Over and Indiscriminate Fishing

Increased population has been keeping stress on the waterbodies render the over fishing activities and in turn depleting the fisheries resources. Among other problems, increased fishing effort coupled with destructive fishing practices are recognized by all concerned as the major problems, causing loss of year classes (most fish are caught before reaching 1 year of age) and brood stock at a level too low to support the fisheries at a sustainable level in the floodplains.

Different studies on fisheries revealed that the fishing pressure in Bangladesh floodplains is so high that less than 2% of produced fish survives until the end of each year.

10.3. Impact of Water Management Project (FCD/I)

Human manipulationthat change the shape of a river's natural flow patterns can alter the ecological integrity or affect the riverine ecosystems resulting in the loss of native species and valuable ecosystem products. Excessive changes to natural flow regimes due to different water regulatory structures under the water management projects of FCD/I alter and degrade the ecosystem, which costs to both biodiversity and society (WCD, 2000).

Bangladesh currently possesses about 500 flood control schemes out of this 123 schemes which are mostly partial flood control type are situated in the haor basin comprising nearly 1,418 km embankment. A few of them are full

flood control or controlled flooding types of schemes. The embankments ensure a secured life and livelihood within the project area. On the other hand, it delinks the floodplain from the river causing impacts on fisheries resources. FAP 17 (1995) assessed such impacts which are reported below.

10.3.1. Embankment induced impacts on fishery

Loss of catch through loss of habitat

Whenever flood control projects reduce the area of flooded land in turn shrink the habitat of fish production. The results from unregulated floodplains, beels and canals outside the flood control projects showed that the annual fish yield or catch per unit area from this lost habitat varied geographically between regions and between land heights within the flood phase series F2-F4 and ranged from 68 kg/ha to 202 kg/ha with an arithmetic mean value of 119 kg/ha.

Reduction in catch per unit area (CPUA)

FCD/I development reduced fish catches through loss of habitat and reduced catch per unit area from the remaining regulated floodplains. There is a complex relationship between catch, degree of flood control, fish densities and the amount of fishing effort. Under full flood control, annual CPUA was reduced by 81%; under controlled flooding for deep water rice it was reduced by 37% but increased in two sites probably due to higher fishing effort. Under partial flood control CPUA values were found similar inside and outside the projects while in some cases it was found 20% reduction of CPUA.

Reduced fish density/abundance

Of the four projects providing full flood control or controlled flooding, statistical analysis revealed that fish densities were significantly lower in two of them. In two projects which provided only partial flood control, no significant differences in fish densities inside and outside embankments were detected. In a third, the Manu Irrigation Project (MIP), significantly lower densities were found prior to cuts in embankments and significantly higher densities later in the year following several cuts which allowed fish through the embankments. It is concluded from the results that flood control can result in a significant reduction in biological productivity by decreasing fish abundance even when sluice gates provide restricted access to floodplains.

Increased fishing effort

Under full flood control, lower flooding substantially reduced the opportunity for fishing and the amount of fishing effort per unit area of floodplain compared with that on unregulated floodplains. In contrast, controlled river flooding provided more stable and predictable hydrological conditions which stimulated increased fishing effort by small scale subsistence gears along village shorelines.

Reduced biodiversity

Full flood control and controlled flooding had an adverse impact on fish diversity. The effect of full flood control was more severe and resulted in a reduction of 33% in the total number of species reported annually. Under controlled flooding reduced biodiversities by 19% to 25% evidenced in the Northwest region while 4% reduction in the southwest due to low abundance of migratory species. Comparisons of different fish groups showed that there were greater reductions in diversities of migratory species than floodplain residents. Reductions of 95% and 29% to 45% were found for migratory species under full flood control and controlled flooding.

Reduction in migratory fish

The contribution to catches by migratory species was substantially reduced by full flood control or controlled flooding but relatively unaffected by partial flood control except in Manu Irrigation Project (MIP) where a reduction on regulated floodplains of 19% was found despite cuts in embankments.

Disruption of fish community structure

Fish community structure in flood controlled areas was disrupted not only by a loss of riverine and migratory species but also major changes in the composition of the remaining floodplain resident species. As the degree of flood control increased there was a corresponding loss in community heterogeneity and catches were increasingly dependent on a relatively small number of abundant floodplain resident species.

Reduced fish migrations

Full flood control and controlled flooding reduced lateral fish migrations between rivers and floodplains in two ways: firstly by reducing the number of entry points on to floodplains and thereby concentrating fish into fewer channels where they were more susceptible to capture, and secondly, by closing gates of regulators for extended periods during the premonsoon and monsoon. Controlled flooding however offer greater opportunity for fish enters floodplains than under full flood control since gates are opened intermittently.

Increased capture at regulators

Flood control structures on rivers and channels/khals were found deliberately used to prevent or hinder the passage of fish and facilitate their capture.

Reduced opportunity for mitigation measures

Exclusion of external river waters under full flood control for the increased cultivation of HYV T. aman substantially reduces the options available to mitigate against adverse impacts of fisheries compared with those available under controlled flooding for deepwater aman.

Reduced potential for stock enhancement

Whenever flood control results in a reduction in the extent and magnitude of flooding, the area available for potential stock enhancement by stocking floodplains with fish is reduced. The severity of this impact is related directly to the degree of flood control exerted by the project and the topography of regulated floodplains. Under full flood control there would be little opportunity for extensive stocking of open-water floodplains.

10.3.2. Dam induced impacts on fishery

Dams, built to change natural flow regimes, are important elements of the earth's freshwater hydrological system. Dams impound water in a reservoir during times of high flow, so that it can be released during the times that natural flows are inadequate to meet human water requirements. Through flow regulation dams provide benefits for many segments of society and worldwide many millions of people have benefited from their construction. Conversely, many people have suffered and much environmental damage has occurred as a consequence of dam construction.

Most dams have been constructed with the emphasis on maximising the economic use of water, with little or no understanding of the long-term consequences of alterations to flow volumes, flow patterns and water quality. WCD (2000) assessed the impacts of dams on river ecosystem. The findings of the study on fisheries area as follows: Reduction in downstream flooded area may cause a decline in fish populations, particularly in tropical climates where fish populations are often highly dependent on river-floodplain linkage. Dams also act as barriers preventing diadromus fish migrating and so causing decline in their numbers.

10.3.3. Erosion protection induced impacts on fishery

In a heavily trained river like the Lower Brahmaputra, river morphology has changed extensively due to the construction of the riverine structure. Morphological change include new char land (Sand bars) formation, river bank erosion, rapid movement of the river bed, deep scour hole formation, sedimentation and channel shifting. Due to the construction of a bridge across a large width of river, the river has been constricted by the construction of heavy training works resulting in flow convergence. Due to the construction of the spurs, sedimentation occurs at the

upstream side of the spurs, which disconnect the small channels coming from the flood plain. Flood plain river migration is an important phenomenon for the riverine fish species. The migration paths of the fishes are changed due to river flow change. Due to high velocity, small, juvenile and fry of fishes cannot swim against the current. For rapid morphological change due to structures, the submerged vegetated shallow char land, which are ideal for breeding, spawning, grazing and resting for fish are also destroyed. In the opposite side of the riverine structures, erosion in char land is observed and accretion of new char land also observed at the downstream of the protection work. It is also found that the changing morphology and hydraulic environment of river near different structures, directly affect the fish habitat. Near the hard point and guide bund like structures, large size bottom dwellers cat fish species are available, which prefer deep scour hole and high velocity water (Table 10-1).

Table 10-1: Major species found near different bank protection structures

Name of the structures	Habitat characteristics	Name of present dominant species (in order of abundance)	Name of dominant species 25 years ago (in order of abundance)
Hard Point	High water velocity, high vortex, deep scour hole.	Air (*Sperata aor*) Baghair (*Bagarius yarreli*) Kalibaus(*Labeo calbasu*) Pangas (*Pangasius pangasius*) Boal (*Wallagu attu*) Mrigal (*Cirrhinus mrigala*) Rita (*Rita rita*) Khorsula (*Rhinomugil corsula*) Ilish (*Tenualosa ilisha*) Ghaura (*Clupisoma garua*) Gang tengra (*Gagata cenia*)	Rui (*Labeo rohita*) Katol (*Catla catla*) Ilish (*Tenualosa ilisha*) Air (*Sperata aor*) Baghair (*Bagarius yarreli*) Boal (*Wallago attu*) Puti (*Puntius sophore*) Kajuli (*Ailio coila*) Mrigal (*Cirrhinus mrigala*) Chingri spp. Bele (*Glossogobius giuris*)
Near Bridge Guide Bund	Water velocity is high just upstream of the Bridge and in the downstream of the bridge. The river is wide and the water velocity reduced	Ghaura (*Clupisoma garua*) Baghair (*Bagarius yarreli*) Air (*Sperata aor*) Pangas (*Pangasius pangasius*) Gang Tengra (*Gagata cenia*) Rita (*Rita rita*) Ilish (*Tenualosa ilisha*) Gozar (*Channa marulius*) Shol (*Channa striata*)	Rui (*L. rohita*) Katol (*Catla catla*) Ilish (*Tenualosa ilisha*) Kajuli (*Ailio coila*) Boal (*Wallago attu*) Gulsha Tengra (*Ganata nangra*) Puti (*Puntius sophore*) Bele (*Glossobobius giuris*) Chigasi (*Aspidoparia morar*)

Source: CEGIS, 2012

10.4. Impact of Unplanned Road

Unplanned rural road development, often supported by the Food for Work Programme has resulted in blockage to flood waters and fish movements on floodplains. The adverse impact of rural road construction has been learnt from different studies that fisheries outside formal flood control areas are less abundant and diverse than in areas of partial flood control. To reduce the adverse impacts of rural road construction there is a need for institutional changes in the inter-sectoral planning process and a practical change to ensure greater provision of fish-friendly culverts (Figure 10-1) through roads wherever they cross existing canals and also traverse extensive areas of open floodplains.

The process of installing culverts requires the consideration of several important issues, including fish passage requirements and the hydrological and physical characteristics of the site. The various fish species have different

swimming and climbing abilities. It is therefore possible to "custom build" in-stream structures to cater for the fish species present in a particular catchment, although it is important to ensure that there is suitable habitat for the species upstream of the culvert. Four basic designs are proposed:

- No-slope (stream slope);
- Stream simulation;
- Hydraulic design; and
- Climber design.

Figure 10-1: Fish friendly culvert

10.5. Sedimentation

The high level of sedimentation in different river systems of the country can be expected to have a negative effect on fish production. Increased sedimentation is the result of deforestation in the upland catchment. FCD/I projects alter the pattern of sediment deposition on the floodplain, and especially severely affect prime fish refuge habitat through infilling of river duars. High turbidity reduces primary production (photosynthesis) and deters fish migrations. Sedimentation has only come to be regarded as a significant problem in the last few decades. The trend has been towards increasing sedimentation and this would result in a decreasing trend in fish production.

10.6. Water Pollution

10.6.1. Household and urban waste

Population increase is leading to an increase in the production of domestic sewage. Almost all of the sewage enters the aquatic environment. This nutrient loading likely result in a general increase in primary and secondary production, and in turn fish production. This factor should therefore be generating a continuous increase in fish production, paralleling human population growth (1.47% per annum over the last 10 years). On the other hand, during the dry season the water loses most of its capacity to purify itself of the biodegradable wastes might poses depletion of dissolved oxygen and corresponding increase of Biological Oxygen Demand (BOD) in turn hamper fish production.

10.6.2. Pesticides

Agriculture intensification invariably leads to increasing use of pesticides and residues in the environment. Lethal and sub-lethal impacts of pesticides reduce fish production. Fisheries study in the Northeast Region (FAP-6 1993a) states that the increasing use of pesticides in the region parallels the introduction of HYV rice. This presents a threat to floodplain fisheries as it leads to contamination of fish flesh by pesticides which have moved up the food-chain

rendering it unsafe for human consumption. Residue analysis of fish tissue from representative markets needs to be undertaken to establish the magnitude of the contamination problem at the regional level.

About 37,712 MT of pesticides were used in the crop field in 2008 (BBS, BBS, 2008; BRAC, 2000). Such a huge amount of pesticides used in this are contaminate habitat water and in turn deteriorate water quality and ultimately become pernicious to fish. Ali (1994b) reported the occurrence of chemical pesticides in the khals and ponds within the Meghna Dhonagoda Irrigation Project area and resultant mortalities of fish.

10.6.3. Fertilizers

Chemical fertilizers can increase fish production, but in large doses lead to negative impacts because of excessive aquatic macrophyte growth and direct chemical effects. According to FAP-6 (I993a) report, the haor region shows an increasing trend of fertilizer use for crops. Agriculture and Food Security report (2014) estimates the total fertilizers for 2011-12 amounting to 38.75 lakh MT used in the country. Among the fertilizers, urea comprises 72.3% of the total followed by TSP 12.9%, Gypsum and mixed fertilizer 7.7%, MP 3.9% and SSP 3.2% and others. Average loading in the environment in 2011-12 was 1.83 kg/ha for the country as a whole (2,118,847 ha) and 200 kg/ha for rice hectarage alone (1,749,736 ha). Some 60-70% of nitrogen fertilizer may remain residual in the soil and become dissolved in flood or irrigation water. Assuming that about 30% of the applied fertilizer remains in the environment, the concentration of fertilizer dissolved in the water column would be 0.6 mg/l. In higher elevation areas with lower water inundation, and where two or three crops are grown each year, the annual loading would be greater. Nutrient-rich runoff would eventually make its way to khals and rivers and cause eutrophication.

10.6.4. Industrial effluents

Inadequately treated effluent discharges of diversified industries of the country and sometimes of the neighboring countries along with other dying factories cause lethal and sub-lethal toxicity to fish of the riverine habitats. This is considered as one of the severest factors/reasons of the open water fish decline.

10.7. Climate Change Threat

This issue is depicted elaborately in Chapter 7 caption under Climate Change Impact on Fisheries.

11. References

Akhter, S., Barman, B.K. and Thilsted, S.H. 2013. Production of micronutrient-rich small fish in the floodplain. Dhaka, Bangladesh: WorldFish and Department of Fisheries, Bangladesh.

Ahmed, M. (1995). Biodiversity Conservation of Bangladesh. Compilation of Theme Papers on Environmental Studies. Bangladesh Technical EducationBoard pp136-150. Dhaka, Bangladesh.

Ali, M. Y., 1997. Fish, water and people: reflections on inland openwater fisheries resources of Bangladesh.

Apu, N.A. 2014. Farmed fish value chain development in Bangladesh: Situation analysis and trends under World Fish/ILRI project. Dhaka, Bangladesh: WorldFish.

Apu, N.A. and Himel, F.B. 2013. Initial performance assessment of fish hatcheries in southern Bangladesh under USAID-AIN project. Dhaka, Bangladesh: WorldFish.

Azad, S.A. 2013.Fisheries sector of Bangladesh: Achievements and potentials. Dhaka, Bangladesh: Department of Fisheries.

Bangladesh Economic Review, 2014. Finance Division, Ministry of Finance, Government of the People's Reublic of Bangladesh.

Bangladesh Economic Review, 2014. Finance Division, Ministry of Finance, Government of the People's Reublic of Bangladesh.

BBS (2010). "2010 Statistical Yearbook of Bangladesh"Bangladesh Bureau of Statistics (BBS). Government of Bangladesh, Dhaka.

BBS (2013). "Statistical Yearbook of Bangladesh 2012" Bangladesh Bureau of Statistics (BBS). Government of Bangladesh, Dhaka.

Beer, M., Voelpel, S.C., Leibold, M. and Tekie, E.B. (2005), Strategic management as organizational learning: developing fit and alignment through a disciplined process, Long Range Planning, 38, 445-465.

Boyd, C. E. 1982. Water quality management for pond fish culture. Elsevier Scientific Publishing Co., New York, NY. 318 pp.

DoF, 2015. "Fisheries Statistical Report of Bangladesh, 2013-2014" Fisheries Resources Survey System, Department of Fisheries. Ministry of Fisheries and Livestock, Government of the People's Reublic of Bangladesh.

DoF, 2014. "Fisheries Statistical Report of Bangladesh, 2012-2013" Fisheries Resources Survey System, Department of Fisheries. Ministry of Fisheries and Livestock, Government of the People's Reublic of Bangladesh.

DoF (2003). Department of Fisheries Website. Government of Bangladesh. HTML: www.fisheries.gov.bd

Dudley, R. G., 1972. Growth of Tilapia of the Kafue Floodplain, Zambia: Predicted Effects of the Kafue Gorge Dam. Trans Amer. Fish Soc. 2: 281-291.

FAO (Food and Agriculture Organization of the United Nations).2014b. Fisheries and Aquaculture topics. Composition of fish. Topics Fact Sheets.Rome, Italy: FAO. ttp://www.fao.org/fishery/topic/14869/en

FAP-6. 1993a. Fisheries specialist study, Northeast Regional Water Management Project (FAP-6). Shawinigan Lavalin (1991) Inc. and Northwest Hydraulic Consultants and local associates.

Fischer, W. and G. Bianchi (eds.), 1984. FAO species identification sheets for fishery purposes. Western Indian Ocean (Fishing Area 51). Prepared and printed with the support of the Danish International Development Agency (DANIDA). FAO, Rome. Vol. 1-6: pag. Var.

Gatlin, D.M. 2010. Principal of Fish Nutrition. SRAC Publication No. 5003. Southern Regional Aquaculture Centre.

Hussain, M.G. 2010. Genetic studies and stock improvement of commercially important carp, pangas and tilapia species.Bangladesh: BFRI. http://180.211.164.225/rmis/pdf_detail_info.php?linkid=6069

IPCC, 2000. The Special Report on Emissions Scenarios (SRES) is a report by the Intergovernmental Panel on Climate Change (IPCC).

Islam, M. 2013.Increased consumption of small fishes effective for mother and child health. Paper presented at a seminar. WorldFish and CSISA-BD. 19 December 2013. Rangpur, Bangladesh: WorldFish.

IUCN Bangladesh. 2000. *Red Book of Threatened Fishes of Bangladesh*. IUCN - The World Conservation Union, 116 pp.

Khondker, M. 2004 (edited). Limnology. University Book Publishers. Dhaka, Bangladesh.

Kotler P. (1988), *Marketing Management: Analysis, Planning, Implementation, and Control*, 6th edition, Prentice-Hall International Edition.

MoFA, 2014. Bay of Bengal Maritime Boundary Arbitration between Bangladesh and India.

Mostafa, A.R., Hossain, M., Nahiduzzaman, M., Sayed, M.A., Saha, D. and Azim, M.E. 2004. Fish consumption amongst poor people in Bangladesh: Effects of gender, location and wealth class. Bangladesh: Faculty of Fisheries, Bangladesh Agriculture University.

Nathan, D. and Apu, N.A. 1998. Women's independent access to productive resources: Fish ponds in the oxbow lakes project, Bangladesh. *Gender, Technology and Development* 2(3):397.

National Fish Week, 2015. Department of Fisheries, Ministry of Fisheries and Livestock, Government of the People's Reublic of Bangladesh.

Rahman, M., S. Khatun, M. B. Hossain, M. N. Hassan, A.A. Nowsad, 2013. Present scenario of landing and distribution of fish in Bangladesh. Pak J Biol Sci. 2013 Nov 15;16(22):1488-95.

Smith, A.D., Brown, C.J., Bulman, C.M., Fulton, E.A., Johnson, P., Kaplan, I.C., Lozano-Montes, H., Mackinson, S., Marzloff, M., Shannon, L.J., Shin, Y.J. and Tam, J. 2011. Impacts of fishing low-trophic level species on marine ecosystems. Science 333(6046):1147–1150

Tsai, C. and L. Ali. 1985. Open-water Fisheries (Carp) Management Programme in Bangladesh.

UNCTAD (2012). Review of Maritime transport 2012. ISBN 978-92-1-112860-4

Weisheng, Lu. 2010. Improved SWOT approach for conducting strategic planning in the construction industry. J Constr Eng Manag-ASCE 136(12): 1317-1328.

Welcomme, R. L., (1979). The fisheries ecology of African floodplains. CIFA/T3. F.A.O. 51 PP.

Wheelen T.L. and Hunger J.D. (1995), *Strategic Management and Business Policy*, 5th edition, Addison Wesley, Reading, MA.

Annex 9-1: List of Fishing Gears

List of selective and non-selective fishing gears and target fish species (Limited)

Type of fishing gear /Local name	Habitat of Operation	Salient Features of Gears	Target species	Catch/haul (kg) CPUE	Photograph of Gears
Fish nets					
Gill nets					
Punti jal (YRG)/ Monofilament gill net	Mainly operated in floodplains both during day and night	Made of cotton twine or monofilament with length of 10-30m, width of 0.5-1.0m and mesh size of 22-32mm having floats and sinkers in most cases	Punti, kholisha along with singh, taki, etc.	0.5-1.0	
Koi jal (YRG)/ Multifilament fixed gill net	Mainly operated in floodplains both during day and night	Made of cotton twine or monofilament nylon with length of 15-30m, width of 1-2 m and mesh size of 38-45mm having floats and sinkers in most cases	Koi, kholisa, etc.	0.75-1.25	
Kerrent jal (YRG)/ Multifilament fixed gill net (*Banned govern mentally*)	Operated in river, khal, floodplain and beel both during day and night	Made of cotton twine or monofilament nylon with length of 10-25m, width of 0.5-1.0 m and mesh size of 10-20mm	Small Indigenous Species (SIS)	1.5-2.0	
		Mesh size of 30-50 mm	Juveniles of Indian major carps, boal, air, etc.	2.5-4.0	
Lift nets					
Sitki jal (*Complete ban on Sitki jal is demanded by the jalmahal*	Operated in river, khal, floodplain and beel both during day	Monofilament twine (current jal materials) is used to prepare the net having weights and	Boal, ghonia, sharpunti, etc.	3.0-5.0	

Type of fishing gear /Local name	Habitat of Operation	Salient Features of Gears	Target species	Catch/haul (kg) CPUE	Photograph of Gears
operators)	and night	floats with mesh size of 50-70mm is highly detrimental to fish			
Taki jal	Operated in river and big khal both during day and night	Twine nylon thread is used to prepare the net with mesh size of 50-60mm	Rui, catla, mrigel, ghonia, chital, aire, etc.	3.0-5.0	
Veshal/Khara jal/Tonga jal (SG)	Operated in river and khal both during day and night	Triangular lift net fixed with bamboo poles operated from a bamboo platform with mesh size of 5-15 mm	Tatkini, rui, bata, tengra, baim, baila, punti, Small Indigenous Species (SIS)	0.4-1.0	
Chhip jal/Dharma jal	Operated in river and khal both during day and night	Square lift net with four bamboo sticks as strain with mesh size of 10-20 mm	Bata, tengra, baim, baila, punti, Small Indigenous Species (SIS)	0.05-0.25	
Tar jal (SG) *This gear and fishing method is seriously harmful to many species. Restriction or ban should be imposed on the use of this gear*	Square shaped tar jals are operated against the current from boats at the mouth of secondary rivers (with two otters) used in the daytime	Bachari boats with a crew of six to seven are required for the operation of this gear with mesh size of 5-15 mm	Veda/royna, tengra, tara baim, punti, shol, etc.	4.0-6.0	
Seine nets					
Ber jal (YRG)	Operated in river, khal, floodplain and beel both during day and night	Big size net made of twine nylon threads with mesh size of 5-20 mm	All kinds of fishes including chapila, pabda, punti, gulsha, bashpata,	3-6	

Type of fishing gear /Local name	Habitat of Operation	Salient Features of Gears	Target species	Catch/haul (kg) CPUE	Photograph of Gears
			etc.		
Fash/piya jal (OG)	Operated in river, floodplain and beel both during day and night	This gear is fixed in the water with two bamboo poles to form a large net wall with length of 20-200 m, width of 1-6 m mesh size of 45-300 mm	Kalibaush, bacha, ilish, garua, koi, etc.	2.5-5.0	
Cast nets					
Ural jal (Cast net)/Jhaki jal/ Toura jal/ Fik jal *mainly use in subsistence fishing*	Operated in river, khal, floodplain and beel both during day	Conical shaped jal made of nylon thread with sinkers with mesh size of 5-15 mm	Tengra, singhi, koi, taki, icha, punti, etc.	0.2-0.3	
Push nets					
Thela jal	Operated in river, khal, floodplain and beel	Triangular push net with bamboo frame. Fisherman or woman wades in the water, some time up to neck, pushing the net along the bottom with mesh size of 5-10 mm	Small indigenous species (SIS)	0.05-0.15	
Drag nets					
Tana jal (Drag net)	Operated in river, khal, floodplain and beel both during day and night	Nylon thread net with two bamboo pole having mesh size of 10-20 mm	Gura chingri, punti, baim, etc.	0.15-0.2	
Fish Traps					

Type of fishing gear /Local name	Habitat of Operation	Salient Features of Gears	Target species	Catch/haul (kg) CPUE	Photograph of Gears
Chai	Operated in khal and beel both during day and night	A basket trap used for catch SIS species setting against water current	Gura chingri, tengra, baila, etc.	0.25-0.3	
Dughair/koi dughair (YRG)	Conical trap operated in secondary river, khal, and beel both during day and night	Mouth of the trap is set against the direction of the water flow. These traps are also fixed along the edges of paddy fields one after another at small intervals.	Climbing perch, prawns, cat fish, etc.	0.25-0.5	
Thaga (SG); It is illegal (Fish Act, 1950) and disrupts fish migration as well as destroying fish spawning grounds	Fish barrier, operated in primary and secondary rivers both during day and night	A series of long bamboo sticks are placed across the river with a long seine net	All types of fresh water species	-	
Polo	Operated in closed waterbodies with less water	Made of bamboo	Shol, gozar, rui, kalibaus, etc.		
Spear					
Kocha	Operated in river, khal, floodplain and beel	Made of bamboo and steel spear	Shol, gozar, boal, magur, etc.	-	
Hook and Line					
Borshi	Operated in beel,	Made of nylon thread with	Boal, baro baim, etc.		

Type of fishing gear /Local name	Habitat of Operation	Salient Features of Gears	Target species	Catch/haul (kg) CPUE	Photograph of Gears
	floodplains and khal	steel/iron made hook			
FADs					
Katha (UG)/Jhag/ Jhata/Brush Shelter	Operated in secondary rivers, canals, beels, floodplains and reservoirs. To fish the katha, it is encircled with a ber jal or seine net	Katha are usually constructed with branches from bushy trees such as the hizol (*Barringtonia spp.),* gamboling (*Eugenia sp.*) or babla (*Acacia spp.*).	Boal, rui, carpu, catla, chital, baro baim, mola, chanda, taki, etc.	-	
Kua (UG)/ Deep pit/Khad/ Pukur/ Danga	Kua means a fish pit on floodplain beels	The kua fishery begins in late October and continues until late April, with a peak period from December to February.	Punti, chanda, shingh, taki, gutum, baim, etc.	-	-
Other nets/gears/ traps					
Bandoira jal	Operated near embankments of inundated rivers. Four persons are required to operate the net	It is a fixed gear (25 m x 25 m in size, fixed with 20 bamboo poles)	Catla, rui, mrigel, laso and kalibaus	-	-
Bel jal	Operated in rivers and big khals	A triangular bigger size net (like Thela jal)	Icha, chanda, punti, tengra, chapila.	-	-
Dak jal	Operated in river duars	Typically, a group of eight canoes (each with 2 fishermen and a Dak jal played out from the stern) arranges itself into a rough circle	Rui, catla and boal	-	-

Type of fishing gear /Local name	Habitat of Operation	Salient Features of Gears	Target species	Catch/haul (kg) CPUE	Photograph of Gears
Dara jal	Operated in rivers of Sunamganj	The net is attached to a long rope which is operated by two fishermen. The net is used to encircle fish and an auxiliary net is used to scoop harvest the fish so trapped.	Catch demersal fish species	-	-
Savar jal	Operated in rivers	A cone shaped very fine-meshed net	Carp spawn and fry	-	-
Net: Dol jal, Dori, Donino jal, Duri, Ghana ber jal, Ghurti jal, Goira jal, Horhoria jal, Jam jal, Kati jal, Laua jal, Leski jal, Pati ban, Pawla jal, Pine jal, Uthar jal, Vat jal, Vim jal, etc.					
Trap: Uich, Chungi, etc.					

* *Jal:* Local name for fishing net

R = Reservoir; F = Floodplain; RR = River; YRG = Year round gear; SG = Seasonal gear; UG = Unusual gear; OG = Occasional gear.

BASELINE STUDY: 17

Livestock

Authors

Mohammed Ali[1]

Kawsar Hossain[2]

[1] Mohammed Ali, Livestock expert, Euroconsult Mott Macdonald.

[2] Kawsar Hossain, Assistant Director. Department of Livestock Scinces

Executive Summary : Study 17

Livestock is a key component of the agricultural economy of Bangladesh. The contribution of the livestock sector to overall GDP has been provisionally estimated at 1.78% for 2013-14. In 2012-13, it was 1.84% (Bangladesh Economic Review-2014) and in 2011-12 it was 2.5% (www.dls.gov.bd). Its share of agricultural GDP in 2013-14 was 14.08% (provisionally estimated). Despite its modest share of overall GDP, livestock serves an essential role as a source of protein, employment generation, export earning, and provision of food security. Livestock resources play an important role in the sustenance of landless people, livelihood options for the rural poor families and are potentially important for poverty reduction.

Bangladesh is a nation endowed with enormous potential. To explore this potential, the BDP 2100 formulation project is conducting this baseline study to determine the overall situation of the livestock sector. The study aims: (1) to identify gaps in relevant policy and planning documents; (2) to identify challenges and potentials of Bangladesh livestock; (3) to formulate development options for planning; (4) to outline an insight for long-term planning in the Delta Plan; and (5) to accumulate updated data and a relevant knowledge base of the sector.

The methodology adopted in preparing the baseline report is based on secondary data collected from the Department of Livestock Services (DLS), Bureau of Statistics (BBS), Livestock Research Institutes (BLRI), Bangladesh Economic Reviews, from different reports, plans and research/study findings and websites.

With a view to enhance milk, meat and egg production, employment generation, export earnings, and to ensure public health, the government of Bangladesh has adopted a number of policies and promulgated acts such as the National Livestock Development Policy- 2007; National Poultry Development Policy- 2008 Diseases of Animal Act- 2005; Animal and Animal Products Quarantine Act-2005; Fish Feed and Animal Feed Act-2010; Livestock Extension Policy (Draft) - 2013, etc.

Agriculture, including livestock and fisheries, has emerged as a growth driver in the 21st century. The potential of the livestock sub-sector is much higher than generally estimated at present. Bangladesh has serious shortages of milk, as people want to consume it as nutrition for the whole family, not merely the children. Bangladesh, however, has to depend on imported milk products.

The country's demand for milk, meat and eggs for 152 million people is enormous. Estimation of DLS reveals that existing production of milk, meat and egg against demand is around **43%, 67% and 64%** respectively. Therefore, a pragmatic livestock development policy with short, medium and long term action plan to address the situation is necessary.

To improve the productivity of livestock, the government has adopted the National Livestock Development Policy (NLDP) 2007. The policy identified ten critical areas for policy issues: the issues are dairy development and meat production; poultry development including duck; veterinary services and animal health; feeds and fodder management; breeds development; hides and skins; marketing of livestock products; international trade management; access to credit and insurance; institutional development for research and extension.

Commercial poultry is a fast growing sector. There are about 1.5 lakh commercial poultry farms all over the country (DLS: 2012-13). Besides, most rural families traditionally rear poultry birds in backyards, contributing significantly to the rural economy. It provides family nutrition and acts as a ready cash source. It is, therefore, an important option for poverty reduction. Considering the importance of the poultry sector, Bangladesh has adopted the National Poultry Development Policy 2008. The policy has emphasized four issues of poultry development, namely: (1) poultry production; (2) entrepreneurship development; (3) extension and research; and (4) quality control. The policy has not been supported by an elaborate action plan.

MoFL has formulated a Livestock Development Policy in 2007, which is now used as an operational policy document for the breeding of animals. Animal breeding strategy has been elaborately outlined in the National Livestock Development Policy 2007. A strong breeding strategy to preserve the positive qualities of native breed such as: considerable adaptability to adverse climatic conditions, surviving on poor nutrition with minimum management practices, resistance to many diseases, suitability to the economy of poor and subsistence farmers need to be taken under special programme of breeding.

Fodder and feed are the most important inputs of livestock rearing. Shortage of feeds and fodder is one of the major constraints for development of the livestock sector in Bangladesh. The livestock owners are forced to practice stall feeding system of rearing due to lack of grazing facility. Shortage of fodder and high prices of feed ingredients are affecting smallholders significantly. Pasture land has reduced significantly all over the country due to cultivation of High Yielding Varieties (HYV) of rice to meet the demand of the growing population. Climate change is causing unusual behaviour in temperature; rainfall, flooding pattern etc., and saline water intrusion in coastal region are affecting either natural growth or damaging pasture grasses. Besides, adulteration of commercial feeds is a potential threat for livestock development. Therefore, key policies issues need to consider are creation of pasture land; training of farmers on fodder cultivation and fodder preservation; and quality control of animal and poultry feed.

Processed products of livestock are available in the market in a limited form. There are 206 private sector tanneries operating in the country to process hides and skins. Processing of milk is carried out commercially both in the public sector (Milk-Vita and Savar Dairy) and private sectors (Arong, Pran, Tulip, Farm fresh, etc.). Meats are processed only in the private sector (Bengal Meat), but there is no egg processing industry in the country. Marketing of processed livestock products is seen in big cities, but in a very limited form. One key area should come into focus in livestock product marketing system is that the investment in this area is mainly focused on supply chain efficiency, product quality and price stability. However, development of an appropriate policy framework to promote such investment with entrepreneurs focuses on warehousing, customized transportation, product certification and customized outlets including farmer's specialized market may be the priority policy options.

Quality control is an important issue for the marketing of livestock products. Quality standards are controlled by the Bangladesh Standard Testing Institute (BSTI). The Local Government institutions such as city corporations and municipalities oversee the ante-mortem and post-mortem examination of slaughtered animals by the veterinarians of DLS deputed to work with them. Inadequate regulatory functions to ensure quality standard of livestock products is a great problem for consumer's safety.

Bangladesh still has far to go to attain international quality standards for export of its livestock product. The country has not yet reached the full capability to meet the recommended safety level of the quality standard for livestock products for Sanitary and Phytosanitary (SPS) measures regulated by the World Organization for Animal Health (OIE) and Codex Alimentarius Commission.

Bangladesh is exporting mainly leather and leather products. During 2011-12, export earnings were BDT 30077 million [BBS Statistical Pocket Book 2013]. There is great potential to increase the export earnings through processing of slaughter house by products (bones, horn, hooves, hair etc.).

Unofficial cross border trade of livestock and poultry (live and in product form) happens frequently in the country. Entrance of live animals and birds through illegal trade by-passing the quarantine stations established by the government to enforce the 'Animal and Animal product Quarantine Act- 2005'. They are a potential threat for transmission of diseases. Cattle, eggs, day-old chicks, poultry feed ingredients, etc. are the main livestock items entering the country through unofficial cross border trade. About 40% of total slaughtered cattle come through cross border trade. Government and institutional support in reducing the production gap may reduce unofficial cross border trade.

Slaughtering and dressing operations are not well organized. There are many abattoirs in rural and urban markets where slaughtering, flaying and dressing operations are carried out indiscriminately in open spaces. Local government

authorities have constructed many slaughter houses in cities, towns and at upazila level. There are about 192 slaughter houses at district level, 1215 at upazila level and more than 3000 slaughtering points in rural market places, cities and towns. Un-skilled manpower working in the slaughtering and flaying process cause a considerable damage to the quality of leather.

Slaughter houses generate valuable by-products such as blood, bones, hoofs, rumen and visceral content, hair, etc. Only a small portion is collected from the organized slaughter houses and is processed by cottage type factories. The major portion is drained away or thrown in open places causing environmental pollution and economic loss.

Impacts of climate change on livestock and poultry production is mainly related to outbreak of different emerging and re-emerging diseases. Rising sea levels will inundate lands reducing grazing facilities. Intrusion of saline water in coastal regions will not be conducive for livestock rearing due to enhanced stress factors. Frequent tropical cyclones and tidal surges, and prolonged rainy seasons will affect livestock productivity.

A major concern is the environmental pollution due to indiscriminate disposal of slaughter house effluents, tannery wastes and chemicals, poultry slur and disposal of livestock farm wastes. A strong regulatory function along with awareness building in the society on environmental issues may be an important priority option for the planners because it is a major concern for public health.

Three Major public sector institutions functioning for livestock related activities are: Department of Livestock Services, responsible for all livestock related activities in the country including extension and regulatory functions; Bangladesh Livestock Research Institute, functioning for research; and Bangladesh Agricultural University and few other universities, also dedicated for livestock related education and research.

The coordination among the extension, research and educational institutions is almost non-existent. The mandates of DLS and BLRI require reformation to meet the requirements in the present day's context of private sector and NGO involvement in livestock development activities. The present mandate does not cover adequately with the regulatory needs for the country.

Access to fresh water is very important for livestock. About 665 million litres of fresh water sources for consumption are necessary per day for livestock in the country. Water requirement for fodder cultivation, washing purposed, evaporation and spillage has not been included in calculation. The livestock rearing is widely influenced by the water resources, large natural water bodies are unique source of natural feed for ducks and for this reason duck farming in haor areas is found in large numbers.

During dry and summer months, water for human consumption, irrigation, fisheries and livestock purposes becomes very scarce in most part of Bangladesh particularly in northern and southern regions. Water requirement for livestock is an important factor of livestock productivity and therefore, has been included in this study report.

Addressing climate change adaptation and knowledge gap in appropriate technology development, technology diffusion and adoption to cope with the adverse effect of climate change is essential in Bangladesh in the context of integrated mixed farming system. It is very important particularly in coastal region, in drought prone northern region and also floodplain areas including haor and other hydrological areas of the country.

However, Govt. effort to enhance productivity and overall development of livestock sub-sector has been reflected in different decisions. Govt. has already declared livestock as agro-based industry, and provided Tax-holiday facilities to entrepreneurs, liberalized import of medicine, vaccines, etc.

Bangladesh government has ratified the UN convention of eliminating all forms of gender disparity in 1984 and therefore, has adopted the policies and plans to empower the women. Contribution of women in family nutrition and family income through kitchen gardening, chicken, ducks and small ruminant rearing activities should be recognized and incorporated almost in all the future national policies accordingly.

This baseline report outlines number of the important issues constraining the livestock sub-sector and potentialities in different key areas and recommends options for policy issues to think over. Priorities may be decided through a collective effort of planners, scientists, extension workers, economists, and representation from all stakeholders.

1. Introduction

1.1. Background

Bangladesh Delta Plan 2100 is a long term (50 to 100 years) perspective plan mainly for water sector development issues in Bangladesh as well as the livelihood, food and nutrition security issues of the people. With a view to formulate a long term perspective plan, a baseline situation is required to know for all future driving components of livelihood, food and nutrition security. Information in the baseline study will help in planning exercise of the country.

Livestock is an important next driving component of agricultural economy of Bangladesh performing multifarious roles. It is the sustenance of landless people, livelihood options for the rural poor families particularly women and is potentially important for poverty reduction; Income generation, contribution to food and nutrition security, employment generation, land cultivation, post-harvest threshing, draft power for transportation, fuel for cooking, manure for crop and vegetables, export earning, cultural and religious uses etc. are some of the contribution of livestock. So, its importance is big enough.

Most of the rural households are rearing livestock including poultry for ready source of cash and it provides them with employment. It is estimated that about 20% of employment is directly associated with livestock sub-sector and partly employment is about 50%. Cultivation of land by using cattle is about 50 %.(DLS-data sheet, 2013-14). In Bangladesh about 47.6 percent of the total labour force is engaged in agriculture sector for their livelihood that is predominantly poor (Bangladesh Economic Review, 2012).

Nutritional status of the people, particularly Children and lactating mother is far below the WHO threshold. A study published by the WFP/UNICEF/ Institute of Public Health Nutrition (IPHN) on household Food security and Nutrition Assessment (HFSNA) 2009 found that nationally the rates of acute malnutrition is 13.5%, underweight is 37.4%, and stunting is 48.6%. The study estimated that more than 2.1 million children are acutely malnourished and 550000 suffer from severe acute malnutrition. The prevalence of underweight children is 37.4%, above the WHO threshold (30%) and the prevalence of low birth weight is 36%, twice the WHO threshold level (15%) which indicates an alarming and challenging public health concern. Since 1992 the prevalence of child malnutrition in Bangladesh has shown some decline. The stunting rate decreased remarkably from 71 percent in 1992 to 41 percent in 2011. Similarly the underweight rates showed a substantial decline from 61 percent in 1992 to 36 percent in 2011. The rates still remain unacceptably high (13.5%), just below the WHO emergency threshold of 15%, and indicates a critical situation for these acutely malnourished children under five years of age. This situation may deteriorate under any natural disaster influencing the livelihood of the people. Child malnutrition in Bangladesh has been found to be strongly associated with food insecurity. Therefore, it needs to be addressed with appropriate interventions.

Livestock being the most important protein source providing about 44% of protein demand of the country, a ready cash source of the poor families and the sustenance of landless people, livelihood options for the rural poor families particularly women and is potentially important for poverty reduction, it is therefore, the most suitable intervention to address the malnutrition situation in the country. As per estimation of DLS, the country's existing production against demand for milk, meat and egg is 43.44%, 67.16% and 63.65% respectively. Deficit for milk, meat and egg against demand is 56.56%, 32.84% and 36.35% respectively. So, there is a great scope to explore this sub-sector to get rid of the above mentioned situations.

An income stream from livestock rearing is generated through the production and sale of milk/ meat and eggs. Livestock rearing has additional benefit of improving the nutritional status of the farm household as the milk; meat and eggs are partly consumed by them and helps improving family nutrition.

About 44 percent of the animal protein comes from livestock resources. The existing plans and strategies have been emphasized the need for food and nutritional security in the country. The baseline study will contribute to identify the

critical challenges to address and opportunities to explore in preparing an integrated long term (50 to 100 years) development plan to ensure a sustainable food and nutritional security for all.

In livestock sub-sector, backyard poultry, goat and sheep rearing are the important activities mainly performed by the rural women. Therefore, their contribution should be recognized and incorporated in all the future national policies accordingly.

Gender discrimination and disparity prevalence among women particularly women of poverty and economic dependence, their experience of violence, negative attitude to them, racial and other form of discrimination, limited power exercise, lack of influence in decision making, etc. are the social realities in many countries including Bangladesh. Female headed households without excess to land (landless) unemployed youths (female) and destitute women are probably the most vulnerable group to food and nutrition security in the country. Bangladesh government has ratified the UN convention of eliminating all forms of gender disparity in 1984 and therefore, has adopted the policies and plans to empower the women. Contribution of the women in family nutrition, and family income through kitchen gardening, chicken, ducks and small ruminant rearing activities are most common and suitable practices in Bangladesh.

However, livestock sub-sector is facing lots of constraints. It has lots of potentialities too. The Government of Bangladesh adopted few policies to address the constraints and explore the potentials of livestock sub-sector and promulgated few Acts to protect the interest of producers and consumers and of course, for overall development of livestock sub-sector.

1.2. Objectives

The overall objectives of this study is to provide necessary information on present livestock situation of the country and thereby ensuring the long term planning input for a sustainable food and nutrition security in the country.

The specific objectives of this study are summarized as follows:

Objective 1: To identify gaps in relevant policy and planning documents;

Objective 2: To identify challenges and potentials of livestock in Bangladesh;

Objective 4: To formulate development options for planning exercise;

Objective 5: To outline an insight of long term Delta Plan; and

Objective 6: To accumulate updated data and relevant knowledge base of livestock sector.

1.3. Deliverables

For the baseline study the following deliverables has been provided:

- ✓ Base line study report;
- ✓ Statistical figures, key issues and gaps in policies for planning exercise.

1.4. Methodology

The methodology adopted in preparing the baseline report is based on secondary data collected from the Department of Livestock Services (DLS); Bureau of Statistics (BBS); Livestock Research Institutes (BLRI); Bangladesh Economic Reviews; and also from different reports and plans; research/study findings; website information of different organizations; and personal contacts.

2. Policy Review

Livestock is an important sub-sector of Agriculture. Its contribution to overall GDP in 2013-14 has been provisionally estimated 1.78 (Bangladesh Economic Review-2014) and share in Agricultural GDP is 14.08% (Provisionally estimated). The estimated GDP in 2012-13 of this sub-sector was 2.51 and the growth rate was 3.49 (web site report of DLS). In 2011-12, the over GDP was 2.50 (DLS-website). Despite this modest share in GDP, the volume and the worth has increased BDT 99037 million to BDT 102496 million in 2013-2014. Despite its modest share of overall GDP, livestock serves an essential role as a source of protein, employment generation, export earning, and provision of food security. Livestock resources play an important role in the sustenance of landless people, livelihood options for the rural poor families and are potentially important for poverty reduction.

Government of Bangladesh has adopted the following policies and promulgated Acts to enhance Milk, Meat and Egg production, generation of employment and to ensure public health and safety issues:

1. National Livestock Development Policy- 2007
2. National Poultry Development Policy- 2008
3. Diseases of Animal Act- 2005
4. Animal and animal products Quarantine Act-2005
5. Fish Feed and Animal Feed Act-2010.
6. Livestock Extension Policy (Draft) - 2013.

The current Livestock Development Policy 2007 has come into force in 2007. The First one was formulated in 1992 but was not well executed due to lack of proper action plan and was not formulated through the process of well analysis of the constraints and not sharing and reflecting the views of the main stakeholders. The main Issues focused in the first policy were: (1) Dairy Development and Beef Fattening (2) Poultry Development (3) Breeds and Breeding (4) Feeds and Animal Management (5) Veterinary Services (6) Institutional Analysis of DLS and BLRI (7) Marketing of animal products (8) International trade.

In the first Policy, Insurance and credit, activities on Extension and research have been ignored. But it is one of the vital issues for sustainable development of this sub-sector. Appropriate interventions in value addition activities in private sector have not been emphasized for market development. The first policy was not translated into a operational action plan for its total activities and budget allocation.

2.1. National Livestock Development Policy (2007)

Considering the importance of Livestock including poultry for its contribution to the national economy (1.78% of overall GDP in 2013-14), source of dietary animal protein and livelihood options for the rural poor families, and potentiality of poverty reduction, a comprehensive Livestock Development Policy has been prepared to address the key challenges and opportunities for a sustainable development of Livestock sub-sector.

The specific objectives of NLDP 2007 are:

a. To promote sustainable improvements in productivity of milk, meat and egg production including processing and value addition.
b. To promote sustained improvements in income, nutrition and employment for the landless, small and marginal farmers; and
c. To facilitate increased private sector participation and investments in livestock production, livestock services, market development and export of livestock products and by- products.

The NLDP 2007 identified the following ten critical areas for policy issues:

a. Dairy development and meat production.

b. Poultry development including duck.
c. Veterinary services and animal health.
d. Feeds and fodder management.
e. Breeds development.
f. Hides and skins.
g. Marketing of livestock products.
h. International trade management
i. Access to credit and insurance.
j. Institutional development for research and extension.

All the above issues have been explained in the NLDP 2007 with short policy frame work on each of the issues.

A brief account of present status of the policies has been shown in the matrix of different policies.

Gaps: In the National Livestock Development Policy 2007, mandates of DLS has not been clearly defined to enforce the regulation and acts for quality control, disease surveillance and also other regulatory functions to ensure quality services, nutritional security and safety. Mandate of DLS needs to be redefined at the present context of NGO and private sectors involvement in livestock development activities. Gender issues have not been reflected in the policy.

2.2. National Poultry Development Policy, 2008

This Policy has been created in the light of NLDP-2007 with a view to:

1. Accelerate production
2. Employment generation and entrepreneurship development
3. Promoting Extension and research

Policy Issues are:

- **Production:** Production of poultry, poultry products and poultry feed.
- **Employment generation and entrepreneurship development:** Poverty reduction; investment, credit and insurance facilities; marketing of poultry and poultry products; value addition of poultry products and exporting.
- **Extension and Research:** Curative and preventive measure of poultry diseases; development of human resources; institutional capacity building**;** promoting poultry research and to facilitate registration to farmers.
- **Quality control:** Chicks; poultry feed; meat and eggs; vaccines and medicines.

Implementation strategies are:

Poultry production

In NPDP 2008, the strategies of poultry production have been outlined as:

Commercial poultry production: In which, policies has been mentioned regarding location and isolation distance for establishing commercial and breeding farms; to ensure bio-security measures before establishing a poultry hatchery; Hygienic way for farm waste disposal.

Backyard poultry production: Improving productivity of local stock through existing system of crossing; strengthening extension activities of DLS; Research through conservation of biodiversity and their genetic potentiality; Integrated approach of research and other organization to improve and demonstration of appropriate technologies for rural areas; increasing Duck production in Govt. Duck Breeding Farms and to encourage private sector entrepreneurs; Training on hygienic system of farm-waste disposal.

Poultry feed

Production and import:

Support to entrepreneurs for production, processing and preservation of maize and soybean; support to entrepreneurs for importing oil seed and investing in soybean oil extraction mill; support to produce balanced, nutritious and cheaper poultry feed production from local ingredients; supporting research on unconventional feed ingredients; use of certified bone meal for its safety issues; restriction of bone meal from swine origin and tannery wastes has been emphasized in this section of policy framework.

Entrepreneurship development

Government of Bangladesh has decided to provide incentive for implementing the programme on poverty reduction, investment, credit and insurance facilities and marketing of products. Encouraging for value addition and exporting of poultry product has also been emphasized.

Extension

Strengthening extension activities for poultry rearing includes: man-power development of DLS for efficient and quality services up to field level; expansion of health services up to union level with responsible officers and field workers. Exposition and to establish small poultry farms for demonstrative purposes; prevention and control of poultry diseases; manpower development; institutional capacity building; research and development have been emphasized to ensure a quality extension service.

Government has to provide and facilitate the following services:

(1) Research; (2) Health services; (3) Extension services; (4) Training;

(5)Counselling; and

(6) Supervision

Quality Control: Govt. has suggested the quality standard for the inputs of poultry production such as chicks, poultry feed, poultry vaccines and medicines, etc.

The strategies of implementation for this policy issue have not been outlined in NPDP 2008.

A brief account of present status of the policy has been shown in the matrix of different policies.

Gaps: The policy has not been supported by an appropriate operational action plan to ensure quality control of poultry feeds, chicks and enforcing laws, disease surveillance to contain trans- boundary transmissible diseases and also to ensure quality of value added items produced by the private entrepreneurs. No strong directives to ascertain environmental issues. Guideline to stop cross boundary illegal trades of poultry products and government interventions to protect private sector poultry enterprises from loss due to emerging diseases has not been outlined in the policy. Rural women are the driving force of backyard poultry and small ruminant rearing activities. But the Policy did not reflect the gender issues.

Observations:

A strong policy directive is necessary on the following issues:

1. Quality control of poultry Feed/ Chicks.
2. Disease surveillance, cross boundary illegal trades
3. Environmental issues
4. Protection of private sector from loss due to emerging diseases.

2.3. National Breeding Policy

A science based well organized and pragmatic breeding policy has not been formulated in Bangladesh. MoFL formulated a Livestock Development Policy in 2007 and now being used as an operational policy document for breeding of animals. In this policy document animal breeding guidelines and directives are being considered as 'Animal Breeding Policy'. In the NLDP 2007 directives for breeding animals have been outlined categorically.

Artificial insemination (AI) of cattle and buffalos are now in practice but it is not yet in practice for goat and sheep in upazila and district level offices. There are 3212 numbers of AI sub-center and AI points all over the country. During FY 2013-14 (up to Feb 2014) about 1.85 million cows have been inseminated artificially.

No regulatory function to oversee the consistency of policy directives in animal breeding practices of NGOs. This is why the breeding approach toward breed development is not in a systematic and well organized condition.

Bangladesh Government had adopted a breeding policy for the first time in 1982 in which provision of using breeding bulls of 50% Shahiwal and 50% Holstein Friesian (cross-bred bulls) was recommended for breeding local cows in urban and per-urban areas. But for rural areas it was recommended to use bull of 50% indigenous and 50% Holstein Friesian blood for breeding local cows. This policy has been revised in 2007 and recommended that cows in urban and peri-urban areas should be bred to get offspring with 50% indigenous and 50% Holstein Friesian bloods. For rural areas it is recommended that quality of the indigenous animals should be improved through selective breeding within the indigenous best to the best crossing.

Animal breeding is a time consuming process. Annual progress is very low. A successful breeding programme requires several years to come across, and it gives a permanent result in genotypic quality of the animal resources and ensures a sustainable improvement of the quality. Therefore, regularity in fund and input flow is essential throughout the process.

Breeding technology for Livestock development in Bangladesh is just coming across the rudimentary stage. Available seed materials are imported from exotic origin. But not all of the exotic breeds are well adoptable under Bangladesh climatic condition. A very little effort has been extended by the Government (DLS, BLRI or Agricultural Universities) to conserve, develop and utilize the potentiality of local Red Chittagong breed of cattle; adequate attention has not been given to very prolific breed of Black Bengal goats, Bengal sheep and indigenous chicken. These breeds could have developed into a high yielding breed through adopting appropriate breeding method.

Gaps: Programme for Animal evaluation procedures, performance of animal recording system, animal selection and breeding plan, etc. are important aspects to consider for animal breeding policy. But emphases have not been given to those aspects in the current breeding policy. Animal Breeding is knowledge-based activity and requires regularity in the flow of breeding resources but regularity in resource flow has not been ascertained in the policy. Well-trained manpower is necessary to carry out the targeted programme successfully to achieve the goals, but neither targeted goal nor policy directives for creating well-trained manpower has been included in the breeding strategies.

Observations:

A strong breeding strategy is required to preserve the positive qualities of native breed such as: considerable adaptability to adverse climatic condition, surviving on poor nutrition with minimum management practices, resistance to many diseases, suitability to the economy of poor and subsistence farmers. These positive qualities need to be emphasized in formulating a pragmatic breeding policy for a sustainable breed development. Unplanned and sporadic attempt is not conducive for breed development.

2.4. Vision 2021

Livestock sub sector has a set of target for the Vision 2021 of the nation with a view to ascertain the food and nutrition security of the country. The targets are:

1. To meet the demand of standard nutrition for 85% of the population and the per capita availability of milk 150 ml per day, meat 110 gm per day and eggs104 pieces per year.
2. Number of unemployed people will be reduced to 24 million from 28 million by 2013 and to 15 million by 2021. Job opportunities to create for 11.2 million people.
3. The livestock sub-sector to contribute toward reduction of poverty and extreme poverty by 25% and 15% respectively.
4. Information technology to use in livestock sub-sector significantly to increase the income of poor.

Vision 2021 has the goal to turn Bangladesh into a middle income country. The agricultural sector needs to be enhanced through increasing productivity of its all sub-sectors (crop, fisheries, livestock and forestry). Livestock sub-sector deserves special attention for its economic, cultural and religious importance. It is the sustenance of landless people, livelihood options for the rural poor families and is potentially important for poverty reduction; Income generation, contribution to food and nutrition security, employment generation, land cultivation, post-harvest threshing, draft power for transportation, fuel for cooking, manure for crop and vegetables, export earning, cultural and religious uses etc.

Observations:

To acquire a sustainable productivity level, livestock sub-sector needs to look into:

(1) Breed development;
(2) Animal and poultry feed (production); and
(3) Extended veterinary services.
(4) An immediate plan of action and its execution is necessary to achieve the targeted goals.

2.5. National Livestock Extension Policy 2013

National Livestock Extension Policy 2013 (draft: submitted for Govt. approval) reflected the increasing trend of livestock production related service demands; increasing trend of investment; veterinary public health, food security and food safety issues; effective extension service; supply chain development; dissemination of models and technologies; strong linkage among research, extension, education and farmers; impediments of farmers access to services; increasing demand of organic products; family level small scale farming; and also other driving factors.

Bangladesh demands accelerated growth of meat, milk and egg production to meet the protein requirement for growing population. In fact, the production of milk, meat and eggs are increasing and the gap in demand and supply is further widening due to population growth. The country imported milk products worth US $ 214 million in 2012-13 and import figure is staggering. This warrants rethought and proactive action through a pragmatic National Livestock Policy. The ambitious plan could not achieve the desired targets mainly due to financial constraints or limited allocation of budget. It requires using more funds to improve service delivery and technical inputs like vaccines and improve diagnostic services and establish effective public–private partnership.

Gaps:

Different stakeholders mainly private and public sector service providers are the main player involved in the process of livestock and poultry development in the country. Govt. has the regulatory role to play. The procedure of synergetic and complementary role necessary to implement the policy has not been suggested in the policy framework**.**

Observations:

A well thought action plan on NLEP-2013 and flow of inputs is necessary to execute the policy issues.

Table 1 Matrix: on Livestock Development policy-2007

Policies	Agency	Key Issues of Development	Programme undertaken by/ responsibility.	Implementation status	Remarks
Livestock Development Policy 2007	Ministry of Fisheries and Livestock (MoFL)	Dairy development and meat production	MoFL through different projects, LGRDC, Private sector, and NGOs	Continuing as per policy. Production increases many fold than previous	Cattle has been emphasize but very little attention has been paid to Buffalos
		Poultry development including duck.	MoFL through projects, Private sectors. NGOs	Continuing as per policy	Poultry Development policy 2008 is in function.
		Veterinary services and animal health.	DLS, NGO's and Pvt. companies	Policy mandates are being followed by DLS.	Reformation in regulatory mandate is required due to NGO &Pvt. Sectors involvement.
		Feeds and fodder management	DLS, NGOs, Pvt. Sector, Large enterprises.	DLS undertook the programme through NATP but in a limited capacity.	Commercial level of feeds and fodder production does not exist. Processing of crop residues and argil. By-product for animal feed is necessary.
		Breeds development	MoFL/DLS, NGO(BRAC), BLRI, BAU.	Breeding of cattle is in practice as per NLDP-2007. AI is going on for cattle and buffalos. Beef breed Upgradation project of DLS is in operation.	Coordination of agencies; strict control measures on breeding materials needed. AI for other species does not exist.
		Hides and skins	MoFL, Mo Commerce, Mo Industries, Tanneries, Financial institutions,	Pvt. Sector are being encouraged. Shifting of Tanneries is going on to reduce environmental pollution	Tanneries claim that they are exporting finished leather and leather goods instead of Wet blue. as the ban has been imposed on wet-blue.
		Marketing of livestock products	MoFL/ DLS, Mo Commerce, Pvt, sector	Pvt. Sector's involvement is increasing in value addition process.	Regulatory body is to be formed for quality control.
		International trade management	MoFL/ DLS, Ministry of Commerce, Pvt, sector, Diplomatic Missions in abroad.	Hides and skin is being exported to international markets. Other livestock products are in the rudimentary stage.	Quality standard for Sanitary and Phyto-senitary (SPS) measures regulated by the World organization for Animal health (OIE) and Codex Alimentarius Commission need to be acquired.

Policies	Agency	Key Issues of Development	Programme undertaken by/ responsibility.	Implementation status	Remarks
		Access to credit and insurance.	Ministry of finance, Banks, Insurance co, and other financial institutions.	Insurance coverage of livestock and poultry enterprises does not exist.	Bangladesh Bank may create a credit and insurance fund for small farmers.
		Institutional development for research and extension.	BLRI/MoFL, Ministry of Education, University Grant commission (UGC),	Is in consideration of GoB. Progress is not clearly visible.	Immediate reformation of institutions, education, research, and training, curriculum, is needed.

Table 2 Matrix: on Poultry Development policy-2008

Policy	Agency	Key Issues of Development	Programme undertaken by/ Responsibility	Implementation status	Remarks
National Poultry Development Policy, 2008	Ministry of Fisheries and livestock (MoFL)	**Production:** Production of poultry and poultry products and Poultry Feed production	DLS/MoFL, Pvt. Enterprises, MoA for maize production	Maize production is increasing. Soya meal production has been encouraged through oil extraction from Soya grains	Importation to be reduced, Feasibility study requires for oil extraction from soya grains.
		Employment generation and entrepreneurship development: Poverty reduction; Investment, credit and insurance facilities; Marketing of poultry and poultry products; Value addition of Poultry products and exporting.	DLS/ MoFL, BLRI, Banks, Insurance Co., Export Promotion Bureau, Private sector, NGOs, Mo Youth, etc.	Poverty is reducing substantially, Credit & insurance facility is under consideration of the Govt.; 09 live bird market has been developed including 04 in Dhaka city. Private initiative is present in value addition activities, and export of poultry products.	Bangladesh Bank may create a credit and insurance fund for small holders. Necessary support in private sector is required for extending export. Market information system to be strengthened. Certification and quality assurance of value added product is required.
		Extension and Research: Curative and preventive measure of poultry diseases; Development of Human Resources; Institutional capacity building**;** promoting poultry research and to provide registration to farmers	MoFL, DLS , BLRI and Agricultural Universities and private sector enterprises.	DLS is producing necessary vaccines against common diseases. Registration of farms is going on. 78171 poultry farms have been registered with DLS up to February'14. (E. Review of Bangladesh 2013-14) Poultry research has been undertaken by BLRI Through 09 research projects.	Vaccine production to be increased as per demand of the country. Institutional capacity building with reformation of mandates is required. Development of native poultry breed is to be emphasized. Registered farms to be supported by credit and insurance facilities.

Policy	Agency	Key Issues of Development	Programme undertaken by/ Responsibility	Implementation status	Remarks
		Quality control: Quality ofChicks; Poultry Feed; Meat and eggs; Vaccines and medicines.	MoFL, Mo Food, Mo Health/ Drug Administration of BD.	Quality control has been emphasized. Quality of vaccine is done in the LRI laboratory of DLS. Imported vaccines are not tested for quality. Government is trying to ensure safety level of quality standard for livestock products. for Sanitary and Phyto-senitary (SPS) measures regulated by the World organization for Animal health (OIE) and Codex Alimentarius.	Mandate of DLS for quality control is to be reformed. Lacking of supervision and monitoring activities Coordinated body to oversee the quality is necessary. Planning for update the regulatory mechanism is urgent. Targeted effort to reach the quality standard for livestock products. for Sanitary and Phyto-senitary (SPS) measures regulated by the World organization for Animal health (OIE) and Codex Alimentarius is necessary.

Table 3 Matrix: on National Breeding policy.

Policies	Agency	Key Issues of Development	Programme undertaken by/ Responsibility	Implementation status	Remarks
National Breeding Policy	Ministry of Fisheries and livestock (MoFL)	Cattle & Buffalo development for milk production	MoFL/DLS/ BLRI and Argil. University; NGO (BRAC), Banks, Insurance companies,	Cattle breeding are going on as per NLDP 2007; A.I in Buffalo started for the first time. DLS established 2813 AI sub-centre / AI point all over the country. A I coverage is 36%. No A I for goat/ sheep at upazila/ district offices. NGO involvement in AI activities has accelerated the AI program in the country.	Small holders are the key person for milk production. Their choice for Cattle breeds to be considered for adopting Pragmatic breeding policy. Immediate action on research for native bird's development is important. Policy for short, medium and long term perspective is necessary.
		Cattle, Buffalo, Goat and Sheep development for meat production	MoFL/ DLS/ BLRI, Agricultural University.	Beef breed development project of DLS; Breeding of cattle with frozen semen of Brahma Breed from USA has been experimentally tested and got good result; However, semen of other breeds (local25% x HF 75%) are also being tested. AI of buffalos started for the first time with improved breed of buffalos. A buffalo bull station has been established at Savar. Buffalo calf rearing station has been established at Santos in Tangail district.	Policy should include Beef breed development through appropriate selection and best to the best crossing procedure of our native breed. AI activities to be intensified also for goats and sheep. Conservation of Black Bengal goats for its prolific characteristics must be emphasized. Policy for short, medium and long

Policies	Agency	Key Issues of Development	Programme undertaken by/ Responsibility	Implementation status	Remarks
					term perspective is important.
		Chicken and Duck for egg production	MoFL/ DLS, BLRI, Agril. University, Pvt. enterprises, NGOs, Bank, Insurance co.	Breeding policy for developing chicken and ducks is in action. Rural small holders are rearing indigenous Chicken and ducks traditionally in scavenging system. Private sector initiatives with exotic birds are the driving force for the growth of poultry enterprises in the country. There are about 1.5 lakh poultry farms of small, medium and large category (DLS website). Among them 78171 farms are registered with DLS so far. There are 35 Poultry and duck farms in public sector engaged in poultry development activities.	Hatching and Brooding character of indigenous chicken is valuable for rural farm families. Breeding policy for chicken and ducks should be planned to conserve these valuable traits of indigenous birds.

2.6. Poverty Reduction Strategy Paper (PRSP)

In PRSP, Livestock sub-sector has been considered as an important tool for poverty reduction in the country. The PRSP 1 and 2 emphases the GoB strategies to explore the full potentials of livestock sub sector. Govt. of Bangladesh has identified ten critical issues to explore the potentials of livestock sub-sector. A suitable environment to explore the potentials and to reduce the risk will encourage the private sector to come forward. Public institutions (DLS, BLRI, etc.) have the supportive role. Man power development through training of these institutions for all relevant technologies will be required to explore the potentials. Dairy and poultry farms are knowledge-based and its success depend on many inter related and inter dependent factors. Therefore, intensive livestock farming are commercially considered as risky enterprise at the present context. However, technological, financial and marketing support will encourage the private entrepreneurs to explore the potentials of livestock sub-sector. Monitoring and supervision of farms of small holders with adequate technological, financial, marketing and other necessary supports at village level will play a vital role for addressing the critical issues of livestock development and an effective and sustainable approach of poverty reduction strategy. Strategic Goals and Targets of Livestock Sub-Sector in the PRSP- II are summarized below:

Livestock sub-sector in National Strategy (FY 2009 – 11) for Accelerated Poverty Reductions (NSAPR) II

Table 4 Livestock sub-sector in NSAPR-II

Goals	Targets	Policy Agenda
1. Increasing productivity in livestock sub-sector	1. Increase livestock production 2. Increase income of poor livestock farmer	1. Implement livestock policy related Action Plan 2. Increase budgetary allocation for livestock sub-sector 3. Continue strengthening capacity of DLS 4. Encourage community based livestock service 5. Develop livestock market services

Goals	Targets	Policy Agenda
	4. Develop business services and market for livestock & poultry farmers	
2. Promoting poultry development	1. Raise poultry production 2. Raise income of poor & women poultry farmers	1. Continue fiscal and technical support to private poultry farms 2. Strengthen capacities of disease investigation network of DLS 3. Strengthen bio-security measures to protect poultry industry from infectious diseases 4. Support poor women to undertake commercial poultry production
3. Promote milk and meat production	1. Increase milk, meat and egg production 2. Develop milk and meat processing facilities	1. Encourage private & NGO participation in dairy development through AI, embryo transfer & breed up-gradation program 2. Continue buffalo development program 3. Continue goat development program 4. Strengthen support to small scale dairy and poultry farms 5. Strengthen market channels keeping focus on poor women
4. Strengthening livestock research and extension	1. Develop new breeds of livestock and poultry 2. Strengthen and expand extension services	1. Strengthen BLRI for livestock research 2. Emphasize research on emerging diseases of livestock and poultry 3. Strengthen DLS to extend livestock extension services up to Union level 4. Develop improved animal husbandry practices & veterinary services and disseminate them to poor & women

[Source: National Strategy for Accelerated Poverty Reduction (NSAPR)-II]

Policy Issues of Livestock Development: Scope and Challenges.

Table 5 Policies and Policy Issues of Livestock Development with their scope and Challenges.

Policy/ Papers/Plans	Policy issues: Scope and challenges.	Suggested Policy Frame work	Gaps
National Livestock Development Policy (NLDP) – 2007	Dairy Development: **Scope:** Smallholders are very potential due to its scope to provide self-employment to the rural poor. Dairy keeping is an alternate source of income to many poor families with limited access to land Round the year demand of milk in the market is high. It requires less land, less operational capital and least influenced by the seasonal variation. **Challenges:** Lack of scientific knowledge of dairy cattle rearer; Scarcity of Feeds and Fodder, High price of concentrate feed Outbreak of Diseases, limited access to veterinary services, lack of credit facility and insurance. Unstable market price of milk. Lack of good producing breed of dairy cattle.	-Expansion of Cooperative Dairy development like Milk Vita in potential milk producing areas -Replication of Contact farmer and community based Dairy Development scheme. - Promoting Integrated farming with crop and fish culture. - Promotion of Supply chain based processing and marketing of Milk and milk products. - Establishment of a regulatory body i.e. Dairy Development Board -Research to intensify through establishing Dairy Research Institute.	-No action plan targeting the production. -No specific directives to make available the land for grazing and fodder cultivation necessary for dairy development. - Coordination of extension services and research does not exist. - No strategy to ensure stable market price of inputs and outputs that act as a driving force of the production system.

Policy/ Papers/Plans	Policy issues: Scope and challenges.	Suggested Policy Frame work	Gaps
National Livestock Development Policy (NLDP) – 2007	Meat Production: **Scope**: Demand for beef and mutton is increasing gradually and the cattle and goat rearing activities are very potential economic activities for income generation and is an important tool for poverty reduction. Number of cattle and goats slaughtered annually is about 3.5 million and 15 million respectively. Native Black Bengal Goats are high prolific. It can be raised on low quality feed and with little investment. It has a very good demand in domestic and international market for its meat and skin. About 40% of total slaughtered cattle come through cross border trade and more than 40% of goats are slaughtered for the ritual of Eid-ul-Azha. **Challenges:** Lack of appropriate beef cattle breed, scarcity of Feeds and Fodder, High price of concentrate feed, outbreak of Diseases, inadequate veterinary services, lack of credit facility and insurance.	-In order to ensure quality meat production, Animal Slaughter Act and Animal Feed Act is to be enforced. - Butchers are to be trained for appropriate method of slaughtering, processing and preservation. - Beef Breed to be developed for increased productivity. - Backward and forward linkage to be developed to improve private sector entrepreneur for beef fattening. - Local Govt. and Private sectors to be encouraged to establish Scientific slaughter house in Municipalities and Upazila. -Black Bengal goats to be promoted by ensuring disease prevention, availability of quality semen for Artificial Insemination and knowledge transferring through special projects. - Buffalo and sheep to be developed in potential areas through special project.	- No clear directives for enforcing the acts and laws. - Adequate supportive measure to private sector has not been indicated. - Price controlling measures for inputs and outputs have not been clearly defined in the policy.

Policy/ Papers/Plans	Policy issues: Scope and challenges.	Suggested Policy Frame work	Gaps
National Livestock Development Policy (NLDP) – 2007	Poultry Development: Scope: - Backyard Poultry Production is an integral part of our rural agricultural farming system; Production is low but profitability is high due to low cost of rearing (practically no cost involves as they are scavengers and feed on on-farm by products). - Relatively cheaper source of animal protein as compared to other sources. - Commercially operated intensive farming with exotic breeds of improves genetic stocks are in operation with minimum investment and space. It is a potential source of self-employment and income generation. -Demand for poultry meat and egg is very high. Challenges: - Unplanned and indiscriminate growth of commercial poultry farms around cities and urban areas are creating environmental hazard due to indiscriminate disposal of on-farm wastes. - No guideline for environmental protection and bio-security is in practice while establishing poultry farms. - Indiscriminate use of drugs in poultry farming is a great concern of public health. - Inadequate access to departmental services for the farmers due to lack of manpower. - Shortage of feed/ feed ingredients and quality chicks and their high price. - Lack of quality control for medicine, vaccine, biological products, feed/feed ingredients, chicks, poultry products, birds, drugs and their residues in poultry meat. - Shortage of vaccines. - There is no organized marketing system for poultry and poultry products. - Insufficient credit facility for poor small holders. - Outbreak/threat of emerging and re-emerging diseases.	-Successful pro-poor scavenging/ semi-scavenging model poultry rearing to be replicated. - Formation of smallholders group, CBOs and producers group to be facilitated. - Enforcement of regulation through formation of a legal body for feed/ feed ingredients to be established. - Production and consumption of safe products to be ensured. - Organic Products from poultry to be encouraged and promoted. - Supply of quality day-old-chick to be ensured through establishing guidelines. - Guide lines for environment-friendly commercial poultry farm to be developed end enforced. - Small commercial farms to be brought under profit oriented cooperative of large farming system. - Govt. owned Poultry farms to be utilized for breeding and multiplication of poultry breed, Training of farmers, Technology testing and demonstration purposes. - Ducks and other minor species of bird (Geese, quail, pigeon, Guinea fowl, etc) to be promoted. - BLRI, the National reference laboratory for Avian Influenza and other emerging diseases to be strengthened to international standard. - Avian Influenza preparedness plan to be implemented. Disease surveillance and monitoring be strengthened. - All commercial poultry farms to be registered with DLS for providing necessary services and monitoring diseases. - Bio safety protocol of MoFL to be followed by all concerned.	- No strong directives to ascertain environmental issues. - No guide line to diplomatic missions for promotional activities in international market - No guide line to stop cross boundary illegal trades of poultry products. - Govt. Interventions to protect private sector poultry enterprises from emerging diseases has not been outlined in the policy.' Disease surveillance and monitoring is absent or very weak. - Policy did not reflect adequately the gender issues.

Policy/ Papers/Plans	Policy issues: Scope and challenges.	Suggested Policy Frame work	Gaps
National Livestock Development Policy (NLDP) – 2007	Veterinary services and animal health; Scope: -Lack of adequate veterinary services in the country. Estimated ratio of Veterinary surgeon to Farm animals and birds is 1: 1.7 million. So, there is a tremendous scope of strengthen the services. Private sector investment in this sector is getting momentum. - The farmers require adequate vet. Services. Great demand of these services makes it a potential sector for private investment. Challenges: - Input necessary to provide services is inadequate. Subsidies at present form in vaccine production are deterrent for private investment. - Checking authority for quality of domestic and imported Vaccine is absent. - There is no discipline in vaccination against targeted diseases due to lack of a strategic plan. - Movement control and quarantine is not practiced during outbreak of contagious diseases and epidemic condition. - Absence of registration system for addition of feed additives, such as Toxin-binder, Protein concentrate, Antibiotics, etc. Some of these are potentially harmful for human health. - Drug traders do not have adequate knowledge to handle the drugs/vaccines, preservation, distribution, transportation and maintaining cool-chain for vaccine. Selling drugs like Antibiotics, Hormone, sedatives etc without genuine prescription is their normal practice. - Limited disease diagnostic facilities due to lack of manpower, fund, etc.	- Soft loan to be provided to the private sector veterinary services. - Special Project to be taken to develop Community based veterinary services - Mobile veterinary Services to be provided - An autonomous controlling body to be established to ensure quality of drugs, medicines and all other materials .- License to Veterinary Pharmacist is necessary. - strengthening of veterinary research necessary -Strengthening of Veterinary public health in a close association with Health services of the Government. - Strengthening of Disease investigation network of DLS, For disease surveillance, quarantine and emergency measures during outbreak of emerging diseases. - Strategy to develop to control Trans-boundary contagious diseases. - A separate cell for veterinary Medicine in the Drug administration needs to be open. - Private sector disease diagnostic centre, clinic, hospital to be encouraged.	No strong recommendation to extend veterinary health services at union level; No guideline and targeted efforts to create technical manpower; Re modeling the veterinary services is not clearly defined to ensure national need for present context of private sectors involvement in the livestock services.

Policy/ Papers/Plans	Policy issues: Scope and challenges.	Suggested Policy Frame work	Gaps
National Livestock Development Policy (NLDP) – 2007	Feeds and Fodder management; Scope: - There is a tremendous demand for Feeds and fodder for livestock rearing .There is a great potentiality to produce feeds and fodder in the country because most of the ingredients are crop residues. - Round the year production of crop yield an enormous amount of residues. These can be utilized in a scientific manner to use as feeds and fodder for large and small ruminants. - Fodder can be produced in the non-cultivable fellow land, road sides and in the inner/outer slope of embankments. Challenges: - Reduction of Grazing field or no grazing field is available. Increased population pressure needs more areas to produce crops. So, there is no spare land to cultivate fodder. - Productivity of livestock and poultry cannot reach the optimum level due to shortage of quality feeds and fodder. - High price of feed ingredients. - Adulteration of commercial feed by the miller to reduce the cost - Quality control system of commercial feed is not functioning properly. - Increased salinity in coastal area is a potential threat to char lands for grazing large ruminants.	-Community based fodder cultivation is to be emphasized. - Along road side, highways, rivers and embankments, in state owned fellow land and along with crop to be utilized for fodder production. - Crop residues to be promoted, private sector to be supported, Ago-byproducts and unconventional feed resources to be utilized. - Animal Feed Act to be implemented to ensure feed quality. - Improved husbandry practices to be ensured through training of farmers. - Human resource to be developed for feed and fodder production.	No guide line to ministry of land to provide land for pasture and fodder cultivation. No guideline for emergency shelter with feed during cyclonic storm or flooding. No guide line for processing of crop residues and agricultural processing byproducts to convert into nutritive cattle feed.

Policy/ Papers/Plans	Policy issues: Scope and challenges.	Suggested Policy Frame work	Gaps
National Livestock Development Policy (NLDP) – 2007	Breed Development; Scope: - A number of well adopted native Livestock breeds are available in Bangladesh. Such as: Red Chittagong cattle, Black Bengal goats, Bengal sheep, Naked neck indigenous chicken and native water fowls. - Traditionally the rural farm families are habituated in rearing native variety of cattle, goat, sheep and poultry birds. They are low producer. For a better performance and better economic benefit, breed up-gradation is a logical approach. - There is a scope to improve our native one out-crossing with exotic breed. - Breed up-gradation will increase productivity in many folds to ensure food and nutritional security. Challenges: - lack of well thought breeding goals, - Indiscriminate use of breeding materials (Semen), - Very little ideas of farmers about breeding materials. - lack of knowledge of farmers on rearing practice for improved breed - Lack of coordination in different organizations performing the same functions	- Conservation and utilization programme of potential indigenous breed for subsistence farming is required. - Strengthening Man power and human resource development programme in breeding to be developed. - Frozen semen unit for different large and small ruminants to be established. - Breeder's Association to coordinate livestock breeding activities to be formed. **Suggested Short term policy (up to 5 Years):** includes importing at least one million doses of semen of HY Holstein-Friesian breed to inseminate the HY cross bred cows in the country those are reared under intensive way. DLS to maintain record and private sectors to encourage for importing such semen. Cross-bred cows under semi intensive rearing system: F-1 generation of HFxL to be used. For Native one, Progeny tested Shahiwal, local Pabna variety, RCC, and other improved native variety to use for breeding of cattle. **Suggested medium term policy (6 to 10Years) :** includes the HY cross bred cows in the country those are reared under very intensive way Holstein-Friesian of high milk yield to be used. . For Native one, Progeny tested, local Pabna variety, RCC, and other improved native variety to use for breeding of cattle. Suggested long term policy (10 yrs. And beyond) : Policies have not been prescribed in the NLDP-2007. But to be decided by conducting national seminars involving all relevant stakeholders. Breeding policy of BUFFALO for Milk Production, Cattle for Meat production, And other species of livestock have been suggested but not operational action plan has yet been adopted.	The policy directives are not enough to ensure Regulatory system to import breed, price of breeding materials and their quality; Indiscriminate use of breeding materials (Semen for Artificial insemination) by the NGOs to be monitored through a regulatory body. The policy did not explain the reasons for selection and inclusion of the breeds in the breeding policy (Why the exiting breed have been selected for dairy and beef cattle development has not been explained in the policy)

Policy/ Papers/Plans	Policy issues: Scope and challenges.	Suggested Policy Frame work	Gaps
National Livestock Development Policy (NLDP) – 2007	Hides and Skins: **Scope:** Hides and skins are valuable item and it contributes about 6 to 7 percent of total export earnings. It has a great potentiality to increase many folds through careful flaying and reducing damage during processing. There is an increased demand of leather products in domestic and international market for its diversified uses. A large quantity (about 40%) of hides and skins are produced during a single occasion of the 'Eid-ul-Azha' festival. Slaughtering of animals potentially generate valuable byproducts like blood, bone, hoof, hair, rumen and visceral content, that can be utilized in various purposes. **Challenges**: Hides and skins are removed from the slaughtered animals by unskilled persons resulting much damage to the vale of the products. Indiscriminate slaughtering practices are a potential source of health hazard and environmental pollution. Unskilled manpower in the processing practices. Financing, particularly in the initial market where middle man can not purchase raw hides and skins due to adequate financing facilities leading to illegal cross border pilferage. Lack of environment friendly disposal method of tannery wastes. Lack of promotional activities in the international markets.	-Training of Butchers and small Merchants to be trained - An autonomous body to be formed for quality control and certification. - Environmental legislation on slaughtering and Tannery operation to be formed. - Private sector to be encouraged to establish industries to utilize Slaughter house and tannery byproducts for producing high quality protein supplement for animal feed. - Access to micro-finance and banking facilities for intermediaries.	No guide line to stop cross border illegal trades of hides and skin. No guideline and regulatory measures for exporting finished leather goods instead of blue-wet lather (exporting Blue wet leather has been banned since July 1990). No directives to diplomatic mission of Bangladesh working abroad to arrange organized market promotional activities and exposition.

Policy/ Papers/Plans	Policy issues: Scope and challenges.	Suggested Policy Frame work	Gaps
National Livestock Development Policy (NLDP) – 2007	Marketing of Livestock Products; Scope: Milk Marketing: There is a great demand of milk and milk products in the country. Only 43% of total demand for milk is produced in the country. (Demand is 14.02 Million Metric Ton per year considering 250 ml/day/person. but the production is 6.09 Million Metric Ton. The deficiency is 7.93 Million Metric Ton). Due to tremendous demand, there is a potentiality of intervention of private sector for marketing milk and milk products. Meat Marketing: Demand for meat in the country 6.73 Million Metric Ton per year, But existing production is 4.52 Million M.Tones. Only 67% of total requirement is produced in the country. Considering the increased demand, there is a potential scope for intervention in this sector. Hygienic slaughtering and processing is the present day demand for Bangladeshi societies particularly in urban populace. Export: Mainly Leather and Leather products 30077 million taka (2011-12). There is a great potentiality of increasing the export earning through improving processing practices. Slaughter house byproducts can best be utilized and processed for export earning. Import: Live Animals and Animal Product Imports: 22859 million taka (2011-12), Importing items are mainly Milk powder, Machineries and equipment, Animal Breeding materials and live genetic stocks. etc. Import of these items can be reduced to a large extent through proper policy framework to produce in the country. Challenges: Milk Marketing: Absence of systemic marketing of milk, gaps in marketing information, there is a large difference in price of milk in producing rural areas and urban areas. Unstable price of milk, Feed cost are high that influences production cost, Meat Marketing: Are mainly constraints by different factors like: absence of good beef cattle breed, Low yield of native breed, High costs of Feed ingredients is not encouraging beef cattle rearing in a cost effective way. Limited access to credit facility of the small holders for beef cattle rearing, etc. **Export constraints are**: Livestock commodities are short to meet the domestic demand. The country has not yet reached the full capability to meet the recommended safety level of quality standard for livestock products for Sanitary and Phyto-senitary (SPS) measures regulated by the World organization for Animal health (OIE) and Codex Alimentarius Commission. The main constraints to achieve the standard is due to: inadequate veterinary services, Lack of trained and skilled man power, lack of diagnostic facility, inadequate financial support, lack of disease surveillances and health inspection of animals, lack of National Food export and import inspection and certification system and updated demand drive regulatory functions. Import Constraints are: lack supervising body for quality certification of imported products, Illegal cross border trade of livestock and poultry products.	Farmers group, Cooperative, community based organizations to be formed; Farmers information Network to be formed for trade related information. Organized Marketing system will be established,; MIS to be established for livestock product marketing; Private sector to be encouraged for processing and value added product of meat, milk and eggs. Govt. to intervene the market to control the price of livestock products if necessary.	No directives for executing regulatory measures for quality control. No operational action plan for quality assurance of livestock products. No guide line for quality standard of products.

Policy/ Papers/Plans	Policy issues: Scope and challenges.	Suggested Policy Frame work	Gaps
National Livestock Development Policy (NLDP) – 2007	International Trade Management **Scope:** There is a tremendous scope of reducing the gaps between import and export. Appropriate measures in every aspects for reducing import and increasing export is the future target. **Challenges:** The country has not yet reached the full capability to meet the recommended safety level of quality standard for livestock products for Sanitary and Phyto-senitary (SPS) measures regulated by the World organization for Animal health (OIE) and Codex Alimentarius Commission. Cross border trade of live animals does not follow the exact method of quarantine exposing the total livestock population in risk of disease outbreak..	DLS and MoFL will set Focal point to deal with the International and regional trade agreement and ensure implementation of notification and obligations. Training of DLS, MoFL and trade related industries will be provided to deal with international and regional agreements effectively and efficiently. Capacity building through institutional reform of DLS. Participation of private sector to ensure all activities related to international trade.	No directives to diplomatic mission for promotional activities in abroad and expositions. No directives to producer to maintain quality standard of livestock products.

Policy/ Papers/Plans	Policy issues: Scope and challenges.	Suggested Policy Frame work	Gaps
National Livestock Development Policy (NLDP) – 2007	Access to credit and Insurance; Scope: Rural poor families are actively involved in Livestock rearing practices. Livestock rearing is only the means of livelihood for many families. They can be well facilitated with capital for rearing livestock to increase the productivity of their small and large ruminants including their native chicken and ducks. This sub-sector of Agriculture reverses more attention to ensure food and nutritional security. Challenges: Most of the potential livestock rarer do not have enough money to invest for a cow or beef cattle. Small holders even do not have enough capacity to well fed their animals. Lack of insurance of their livestock resources, they are always at risk of losing their means of livelihood.	Formation of Community based organization linking with Govt., NGOs, Bank, insurance companies, etc. Establishing Credit fund in Bangladesh Bank to facilitate soft loan to the poor and subsistence farmers. Micro finance package for all species of livestock rarer including small holders and women. Training to smallholders on financial management. Monitoring of financial institutions for best use of the resources .Technical support services and financial services should monitor the activities in a disciplined manner. Strategy for insurance coverage to be established. Database for livestock mortality, disease and productivity to develop and maintained by DLS.	No guide line for establishing a credit and insurance fund with Bangladesh Bank. No criteria have been set for landless and marginal farmers to get credit from bank. Action plan is not clearly defined.

Policy/ Papers/Plans	Policy issues: Scope and challenges.	Suggested Policy Frame work	Gaps
National Livestock Development Policy (NLDP) – 2007	Institutional Development for Research and Extension. Scope: Institutional arrangement both for extension and research are not adequate to provide deserving services to the nation. So, there is a scope of remodeling service delivery system of DLS. Mandate of DLS needs to be redefined in the context of Private sector and NGO's participation in the process of livestock development activities. There is a scope of increasing linkage between research and extension services of DLS. There are scope for research on every aspect of livestock and poultry rearing to explore the potentiality of our native breed. There are scopes of strengthening capacity of DLS to deliver required services to enforce the laws and regulations; Quality control of Feed, Drugs, Medicines, Vaccines, Semen and Breeding materials; Extension services; Disease investigation and surveillances; Veterinary Public Health; Conservation of Native breed; policy formulation and deciding the strategies. Challenges DLS is the main service provider and responsible for providing extension services. Few of the challenges are: Structural and organizational deficiency; Weak linkage of research and extension; Weak Management system; Shortage of manpower; Lack of regular skill development training; insufficient budget allocation. Mandate of DLS is not updated to meet the requirement in the context of Private sector and NGO's involvement in Livestock development activities.	Extension service: Private sector, NGOs, CBOs to encourage to provide quality services to the rarer. DLS to reform for efficient performance of regulatory functions, Disease surveillances, quality control to ensure food safety. Updated service delivery system of DLS to extend. Resource allocation to increase for DLS, A body to form for certification of livestock products, Vaccine and biological products and to protect the consumer's right. Quality control measure of breeding materials, Fodder cultivation, setting up of Laboratories for pathology, Feed analysis, and quality assurance of the products, better utilization of training institutions have been suggested. Research: Strengthening the capacity of BLRI and regional stations to carry out research on prioritized issues. Private sector and NGOs to encourage for research work, Mandate, function and structures of BLRI to overview for strengthening and extending coordination, Research capacity to increase of BLRI, Universities/ Academic institutions to ensure safe production of animal products and byproducts, and inputs for livestock development. Man power development to carry out research in the global context. Reframing the BLRI to improve the carrier development option of the scientists.	No directives to rearrange manpower with organizational set up of DLS and BLRI. No guideline to re arrange Mandate of DLS and BLRI at present context of NGOs and private sectors participation in livestock activities.

Policy/ Papers/Plans	Policy issues: Scope and challenges.	Suggested Policy Frame work	Gaps
NATIONAL POULTRY DEVELOPMENT POLICY 2008	1. Production: (Planning issues are : 1. Backyard Poultry Production; 2. Commercial Poultry Production; 3.Poultry Feed Production) Scopes: Commercial poultry rearing: It is an important tool for poverty Reduction strategy; Commercial poultry Production is a major contributor to the eggs and poultry meat supply in the market; comparatively Low investment and minimum space is required to start a small enterprise. Demand for poultry meat and eggs are encouraging to attract the unemployed persons to involve in poultry farming. **Backyard Poultry rearing**: About 80% Bangladeshi people in rural areas are traditionally habituated in poultry keeping in their homestead because it does not require any intensive care and feed on scavenging. It contributes in family income and provides nutrition. Feed Production: There are scopes of producing major feed ingredients and Soya meal can be produced locally. Challenges: Shortage of feed/ feed ingredients and quality chicks and their high price.; Lack of quality control for medicine, vaccine, biological products, Unplanned and indiscriminate growth of commercial poultry farms around cities and urban areas are creating environmental hazard due to indiscriminate disposal of on-farm wastes; Indiscriminate use of drugs in poultry farming is a great concern of public health; Inadequate access to departmental services for the farmers due to lack of manpower; chicks, poultry products, birds, drugs and their residues in poultry meat.; Shortage of vaccines.; lack of organized marketing system for poultry and poultry products.; Insufficient credit facility for poor small holders. Outbreak/threat of emerging and re-emerging diseases.	Strategy of implementation has been suggested in the policy. Important conditions have been set forth to maintain the isolated distance of poultry farms and sheds. Such as: one commercial farm to another to keep at least 200 meters, one breeding farm to another to keep 5 kilo meter. Breeding farm of Parent stock and Grandparent stock to be 2 kilometer apart from one to another. Bio-security measure to ensure in each farm, safe disposal of farm waste has been suggested. For backyard poultry keeping, importance has been given to conserve bio-diversity and positive genetic characteristics of native variety. Demonstrative farms to establish, distribution of ducklings to intensify from Govt. organizations, Mixed farming (Duck and Chicken) has been discouraged. Entrepreneurship development from private sector for producing Poultry feed ingredients, Govt. support to establish soya bean oil extracting mill from imported soya grains, Technological support to extend to the feed manufacturer from local ingredients. Establishing Database for poultry feed ingredients, production and demand and for necessary information. Use of unconventional feed stuff, Certification of imported Protein concentrate from the country of origin. Restriction of using tannery waste and importing meat meal/ bone meal from swine origin has been suggested in the policy.	The policy has not been supported by a operational action plan to regulate Animal feed act, quality control and enforcing laws of quarantine act. Disease surveillance to contain trans- boundary transmissible diseases and also to ensure quality of value added items produced by the private entrepreneurs. Gender issues or recognition of women's contribution is missing.

Policy/ Papers/Plans	Policy issues: Scope and challenges.	Suggested Policy Frame work	Gaps
NATIONAL POULTRY DEVELOPMENT POLICY 2008	1. Employment generation and entrepreneurship development: (Planning issues are: 1. Poverty Reduction. 2. Investment, credit and Insurance. 3. Marketing. 4. Processing and exporting.) Scope: Due to good demand, low capital investment and minimum space, poultry rearing is a good option of business enterprise. It is an important tool for poverty reduction strategy of the GO and NGOs. Bangladesh is deficit in meat and egg Production (5806.4 Million numbers) so there are scope of investment in poultry enterprises. Credit and insurance facility will encourage the entrepreneurs to produce the poultry products. There are scope of organic poultry production reared in backyard system which may create demand in local and international market. Rearing and processing of Poultry following the international standard will help to create international market. Challenges: High price of feed ingredients, inadequate veterinary and extension services, improper marketing system, lack of processing and preservation facility, lack of soft loan facility and risk reduction factors, indiscriminate disposal of farm wastes, lack of bio security measures, risk of outbreak of diseases, lack of skilled manpower, etc are the main constraints of encouraging employment generation and entrepreneurship development.	Poultry raring has been considered as one of the best option for poverty reduction. DLS will ensure technical and support services to the poor and subsistence farmer for backyard poultry rarer. Subsidized rate of electricity for poultry enterprise will keep continuing. Initiative will be taken for insurance facility. Support will be provided to the manufacturer of inputs. Tax holiday will remain continuing up to a reasonable period. Cooperative society of the poultry farmers has been encouraged, Support to the poultry processing activities has been encouraged. All information regarding marketing will be provided to the farmers through establishing a wing in DLS. Initiative through Municipality/ Local Govt. institutions for Bio-security measures in Live Bird Market and disposal of wastes has been suggested. Govt. will provide quality certification for exporting poultry products. Quarantine issues will be ascertained for import and export of poultry products..	No guide line to diplomatic missions for promotional activities in international markets. -No guide line to stop cross boundary illegal trades of poultry products. - Govt. Interventions to protect private sector poultry enterprises from emerging diseases has not been outlined in the policy' - No strategy to attain the international standards of quality for livestock products.
NATIONAL POULTRY DEVELOPMENT POLICY 2008	2. Extension and Research: (Planning issues are: 1. Curative and Preventive measures. 2. Human Resource Development 3. Institutional Development. 4. Poultry Research,) Scope: There are scope of addressing existing extension services of DLS. Extension activities will encourage poultry farm to grow and to increase production to meet local demand. Extensive research on every aspect of poultry production, processing and marketing, prevention and curative measures is necessary to increase	Necessary skilled Manpower for extension service to commercial and backyard poultry has been suggested. Field level extension work will be intensified. Disease investigation laboratory at regional level to be modernize. Epidemiological activities of poultry diseases will be strengthen and the disease reporting system will be formed. Necessary step for strengthening of disease surveillance system and awareness building measures will be	No guideline/strategy to stop cross boundary illegal trades of poultry products and government interventions to protect private sector poultry

Policy/ Papers/Plans	Policy issues: Scope and challenges.	Suggested Policy Frame work	Gaps
	productivity of commercial and native stock. There are scope of coordination between extension and research which is necessary to resolve the constraints. Challenges: DLS is facing a lot of constraints to provide mandatory services due to lack of adequate skilled manpower, Budgetary allocation, Infrastructural facilities, etc. Curative and preventative measures can not be ascertained due to lack of adequate disease diagnostic facilities. Value addition facility of poultry product is very limited, Promotional activities for international market development are very poor or practically nonexistent. There is no coordination between Extension and research work.	taken. International and regional cooperation will be sought to protect Trans-boundary diseases. Training Institute of DLS will be utilized for training of Farmers and departmental manpower. Govt. to take initiatives on 1) Research (2) Health care services (3) Extension services (4) Training (5) Counseling (6) Supervision. Private sectors to be encouraged to research on conservation of genetic potentials of native bird Govt. will coordinate research activities of different organizations.	enterprises from emerging diseases. No strong directives to ascertain environmental issues associated with the livestock farming. Targeted effort is necessary for institutional development. But no target has been set for this purpose.

Policy/ Papers/Plans	Policy issues: Scope and challenges.	Suggested Policy Frame work	Gaps
NATIONAL POULTRY DEVELOPMENT POLICY 2008	3. Quality control: (Planning issues are: 1. Chick quality; 2. Feed quality; 3. Vaccines and Medicines.) Scope: Quality of product is an important factor for sustainable development of any industry. Therefore, quality control is necessary for Poultry birds, feed, Medicine and also poultry products for safety assurance and market development (both domestic and international). Challenges: The country has not yet reached the full capability to meet the recommended safety level of quality standard for livestock products for Sanitary and Phyto-senitary (SPS) measures regulated by the World organization for Animal health (OIE) and Codex Alimentarius.	Govt. to arrange a grading system for chick quality. Govt. to take measure to control the quality of feed and feed ingredients, poultry products, biological products, etc as per prevailing laws through relevant departments. Registration, Disease control measures, quality control of feed, and relevant all other issues will be regulated by the Animal Disease act-2005, Animal disease control Rules-2008 and Fish Feed and Animal Feed Act- 2008.	No strong directives to ascertain environmental issues.

2.7. Livestock related Acts in Bangladesh

The government of Bangladesh has adopted few regulatory measures on livestock related activities; such as production, processing, marketing, export and importing, etc. and promulgated different Acts; such as:

1. Animal and Animal products Quarantine Acts- 2005
2. Diseases of Animal Act- 2005
3. Fish Feed and Animal Feed Act-2010

2.7.1. Animal and Animal products quarantine Acts-2005

This Act has been promulgated with a view to protect the livestock resources of the country from Trans- boundary diseases and for public health safety.

It is mandatory to obtain a quarantine clearance for importing any live animal of animal product to use in the country. This includes:

- All mammals except human being,
- All kinds of birds' species.
- All kinds of reptiles.
- All kinds of fisheries species except fish
- Any other species that the Govt. decides through gazette notification.

Almost all items of animal products and by-products including breeding materials (Semen) have been included in this Act. The term 'Import' has been defined as any of the above mentioned items coming inside the country using the Sea, land or air routes; and the 'Export' means that are going outside using those routes.

Observations:

As a part of implementation of this Act, the govt. of Bangladesh has decided to establish 24 Quarantine station in different entry points such as; Air ports, Land ports and Sea ports. 6(six) of them have already been established and started operations. Violation of this Act is punishable.

2.7.2. Diseases of Animal Act- 2005

The Govt. of Bangladesh has promulgated this act in order to control the transmission of animal diseases. Like any other countries, there are many animal diseases prevailing in the country in sporadic form. Incidence of epidemics in large and small ruminants are not reported in near past. Epidemics in poultry birds, however, were reported for Avian Influenza of strain H_5N_1 in different districts.

The country is under threat of getting outbreak of different emerging and re-emerging diseases including Trans-boundary transmissible diseases. Controlling of these diseases is prerequisite for livestock and poultry development in the country.

The Acts have been promulgated to ensure healthy veterinary services in the country. A list of bacterial, viral, protozoan and parasitic diseases of large and small ruminants and poultry birds have been included in the Act.

The Act has the provision of imposing ban on sale, slaughter or marketing and also on movements during outbreak.

Observations:

This Act is in action and ban on sale movement and slaughtering has been imposed for some times during some incidence of outbreak in different parts of the country including coastal region (during anthrax outbreak in cattle in some part of northern districts. And also in 'Dalchar' area of Charfasson Upazila in Bhola district for PPR disease in goat and Avian Influenza of the strain H_5N_1 in poultry birds in different districts.

Establishment of all the 24 quarantine station with adequate facilities will help to prevent and control trans-boundary animal diseases in the country. Continuous and effective disease surveillances, monitoring and reporting system has to be developed to identify the disease and take action accordingly. Violation of this Act is punishable.

2.7.3. Fish Feed and Animal Feed Act-2010

This Act has been promulgated to ensure quality of feed using in fisheries and livestock sub-sectors and came into effect in 2010.

In the Act the term 'Animal' includes: All mammals except human being; all kinds of birds' species; all kinds of amphibian reptiles; all kinds of fisheries species except fish; any other species that the Govt. decides through gazette notification.

The term 'Fish' includes: All cartilaginous or boney fish; salt or sweet water prawns or shrimps; all kind of amphibians; all species of Tortoise / turtles; all crustacean species; all species of molluscs; all echinoderms (sea cucumber); frogs and any stage of their life-cycle; any other species that the Govt. decides through gazette notification.

Animal feed has been defined as any item or its mixture prepared artificially or in any other ways that the animals consume to live on or that nourishes the animals.

License from the appropriate authority (DG of DoF or any first class category officer empowered by DG in case of fish feed; and DG of DLS or any first class category officer empowered by DG in case of animal feed) is mandatory to involve in the commercial operation of the above activities. Violation of this Act is punishable.

Observations:

- This Act has an implication on production, processing, marketing, selling, distribution and also adulteration and quality control issues of animal feeds. Enforcement is hardly noticeable.
- Appropriate authorities may be delegated for the implementation of Acts/ Regulations.

3. Livestock Projects in Operation

Department of Livestock Services (DLS) has completed a number of ADP and donor assisted projects and implementation of about 15 projects is now going on. A number of future projects have also been proposed. The list of such completed, on-going and future project is given below:

3.1. On-going Projects: Department of Livestock Services (DLS)

Sl. No.	Name of the Project & Duration of Implementation	Project Code	Project Cost (PA)
1	2	3	4
1	Modernization of Vaccine Production Technology & Extension of Laboratory Facilities Project (1/7/08-30/6/2016)	6410	5687.00
	Buffalo Development Project (Component-A). (01/01/2010-30/06/2017	7053	1932.00
3	Small Scale Dairy and Poultry Farmers Support Services in Selected 22 District (01/10/2010-30/06/2015)	7040	1962.00
4	National Agricultural Technology Project (DLS Component)(01/07/2007-31/12/2014)	5700	7534.56 (6691.00)
5	Establishment of the Regional Duck Breeding Farm Along with Hatchery (3rd Phase) (01/07/2011-30/06/2015)	5150	17703.99 (-)

Sl. No.	Name of the Project & Duration of Implementation	Project Code	Project Cost (PA)
6	Integrated Agricultural productivity project(IAPP)(DLS Component)(01/07/2011-30/06/2016)	5140	3524.60 (3193.48)
7	Upazila Livestock Development Centre(ULDC) Project (3rd Phases)(01/07/2011-30/06/2016)	5170	8093.48 (-)
8	Conservation & Improvement of Native Sheep through Community Farming & Commercial Farming Project " Component-B" (2nd Phase) (01/07/12-30/06/17)	5023	2873.86
9	Livestock Disease Prevention and Control Project (01/07/2012-31/12/2014)	5024	5044.78 (-)
10	Establishment of National Institute of Livestock & Poultry Management and Disease Diagnostic Laboratory Project (30/06/2012- 30/06/2015)	5025	2785.32 (-)
11	Establishment of Serajganj Govt. Veterinary College(01/01/2013-31/12/2015)	5015	5420.01
12	Beef Cattle Development Project (01/07/2013-30/06/2016)	5026	2556.76 (-)
13	Establishment of Jhenaidah Govt Veterinary College(2nd Phase) (01/07/2004-30/06/2017)	5036	1485.00 (-)
14	Breed Up-gradation Through Progeny Test Project (2nd Phase) (01/07/2014-30/06/2019)	5037	4413.00 (-)
15	Establishment of Institute of Livestock Science and Technology Project (01/07/2014-30/06/2019)	5038	20737.64 (-)
	Total (DLS)		

3.2. Completed Projects of DLS

Sl. No	Project Name	Project Period	Cost (Lakh TK)	Agency
1	Small Scale Dairy and Poultry Farmers support services in 22 selected districts (1st revised)	Oct 10 - Jun 14	1962.00	DLS
2	Artificial Insemination & Embryo Transfer Project (2nd Phase) (1st revised)	Jul 11 - Dec 13	5413.00	DLS
3	Regional Fisheries and Livestock Development Project (Noakhali Component)	Jul 07 - Dec 12	9672.00	DLS
4	Strengthening of support services for combating Avian Influenza in Bangladesh Project	Jan 08 - Nov 13	3580.79	DLS
5	Avian Influenza Preparedness and Response Project	Mar 07 - Jun13	10897.00	DLS
6	Breed Upgradation Through Progeny Test (2nd phase)	Jul 08 - Dec 13	1158.00	DLS
7	Re-excavation of connecting rivers, Development of irrigation facilities and Fish Culture Project of Gazner Beela area under Sujanagar Upazila in Pabna District (DLS Part)	Jan 10 - Jun 13	165.22	DLS
8	National Agricultural Technology Project (DLS part)	Jul 10 - Jun 13	15642.00	DLS

Sl. No	Project Name	Project Period	Cost (Lakh TK)	Agency
9	Strengthening of Institutional Improvement of Department of Livestock services.	Jul 05 - Jun 10	1025.00	DLS
10	Second Participatory Livestock development project	Jul 05 - Jun 11	3764.00	DLS
11	Establishment of Upazila livestock development Centre (UDLC) (phase- II)	Jul 05 - Jun 09	4572.00	DLS
12	Development of Animal Nutrition and Technology Transfer Project	Jul 05 - Jun 09	1252.00	DLS
13	Development of Chittagong Govt. Veterinary College Project	Jul 05 - Jun 09	1098.00	DLS
14	Establishment of Regional Duck Breeding Farm along with Hatchery (phase- II) (revised)	Jul 02 - Jun 09	3534.00	DLS
15	Quality Control of Livestock Vaccines, medicines, A.I Instruments and animal feeds project	Jul 05 - Jun 09	771.00	DLS
16	Establishment of Government Veterinary Collage in Jhenaidah	Jul 05 - Jun 09	1748.00	DLS
17	Expansion of Artificial Insemination program & Embryo Transfer technology Implementation Project (revised)	Jan 02 - Dec 07	4164.00	DLS
18	Breed Upgradation Through Progeny Test	Jul 02 - Jun 06	942.00	DLS
19	Establishment pf Govt. Veterinary Collage at Dinajpur	Jul 97 - Jun 05	2192.00	DLS
20	Establishment pf Govt. Veterinary Collage at Barisal	Jul 97 - Jun 05	2076.00	DLS
21	Production of Vaccine for prevention of Livestock diseases	Jul 97 - Jun 05	6061.00	DLS
22	Small Holder Livestock Development in Five Southern Districts	Jul 00 - Jun 05	5375.00	DLS
23	Modernisation of Central Cattle breeding and dairy Farm, Savar, Dhaka	Jul 02 - Jun 05	873.00	DLS
	Total		87937.01	

3.3. Proposed Future projects of DLS

Sl No	Projects/Programs	Proposed Project Period	Cost (Lakh TK)	Agency
1	Artificial Insemination & Embryo Transfer Project (3rd Phase)	Jul 14 - June 19	80000.00	DLS
2	Breed Up Gradation through Progeny Test Project	Jul 14 - June 19	5000.00	DLS
3	Animal Breeding program Strengthening Project	Jul 15 - June 18	9500.00	DLS
4	Small Holder Dairy Development Project in Milk Potential Area in Bangladesh	Jul 15 - June 18	11000.00	DLS
5	Community Based Livestock Development Project	Jul 15 - June 18	45000.54	DLS
6	Fertility & Reproductive Performance improvement Project	Jul 15 - June 18	12200.00	DLS

Sl No	Projects/Programs	Proposed Project Period	Cost (Lakh TK)	Agency
7	Upgrade heifer production & Dairy Farm Extension Project	Jul 17 - June 20	80000.00	DLS
8	Deshi Cattle Breed Development and Conservation and Community Based Rearing Project	Jul 16 - Jun 19	78000.00	DLS
9	Income Generation and Poverty Reduction Through Community Based Cattle rearing Project	Jul 14 - June 19	78300.00	DLS
10	Buffalo Development Project 2nd phase	Jul 16 - Jun 22	98000.00	DLS
11	Development of Buffalo Dairy Cows Project	Jul 15 - Jun 20	90000.00	DLS
12	Small Scale Dairy and Poultry Farmers support services in 22 selected districts 2nd phase	Jul 16 - Jun 22	68000.00	DLS
13	Livestock Infertility Disease Control Project	Jul 11 - Jun 15	50000.00	DLS
14	Enhancing Support Services for Early Pregnancy and Early Mastitis detection in Cow.	Jul 15 - Jun 18	90000.00	DLS
15	Livestock Disease Prevention & Control Project	Jul 16 - Jun 20	18000.00	DLS
16	Animal Health Services Strengthening Project	Jul 17 - Jun 20	15000.00	DLS
17	DLS Capacity Strengthening Project	Jul 16 - Jul 20	99000.00	DLS
18	Modernization of Vaccine Production Technology and Extension of Laboratory Facilities	Jul 16 - Jun 19	72000.00	DLS
19	Vaccine Production Strengthening Project	Jul 16 - Jun 19	8000.00	DLS
20	Livestock Services Development & Extension Project	Jul 15 - Jun 18	30000.00	DLS
21	Vaccine Production Development & Strengthening Project	Jul 15 - Jun 18	17000.00	DLS
22	Vaccine Research & Development project for disease control by priority basis	Jul 10 - Jun 15	75000.00	DLS
23	Calf & Kid Health management Project	Jul 16 - Jun 19	8000.00	DLS
24	Strengthening of Support Services for Reducing the outbreak of Foot and Mouth Disease in Bangladesh	Jul 15 - Jun 18	11000.00	DLS
25	Animal Health human resource development Project	Jul 18 - Jun 21	15000.00	DLS
26	Animal Nutrition Technology Development & Transfer Project (2nd phase)	Jul 15 - Jun 19	15000.00	DLS
27	Fodder & other unconventional feeds supply & development project	Jul 16 - Jun 19	10000.00	DLS
28	Livestock & Poultry farm Management Developed through Training & mass media campaign	Jul 16 - Jun 19	15000.00	DLS
29	Technology transfer and extension of Feed development & research project	Jul 17 - Jun 20	12000.00	DLS
30	Enhance the productivity of goat, sheep and buffalo through modern technology extension project	Jul 17 - Jun 20	8000.00	DLS
31	Milk Marketing Development Project	Jul 16 - Jun 19	5000.00	DLS
32	Establishment & Development of Dairy Society	Jul 15 - Jun 18	5000.00	DLS
33	Value Chain development of Dairy Marketing	Jul 17 - Jun 20	5000.00	DLS

Sl No	Projects/Programs	Proposed Project Period	Cost (Lakh TK)	Agency
34	Sustainable Beef Breed Development in Bangladesh	Jul 15 - Jun 18	14000.00	DLS
35	Improvement of the management practices of calf rearing for prevention of Calf Morality	Jul 16 - Jun 19	5000.00	DLS
36	Goyal Development Program for the Hill Tracts area of Bangladesh	Jul 17 - Jun 20	4000.00	DLS
37	Development & Extension of Unconventional Poultry Project	Jul 15 - Jun 20	1000.00	DLS
38	Establishment of de-worming area in Bangladesh	Jul 15 - Jun 18	15000.00	DLS
39	Establishment of Beef Society in Selected region of Bangladesh	Jul 16 - Jun 19	3000.00	DLS
40	Establishment of Meat Processing Plant in different region of Bangladesh	Ju 16 - Jun 19	12000.00	DLS
41	Farmers training & inputs development of Fattening Project	Jul 15 - Jun 20	7000.00	DLS
42	Mini Abattoirs establishment at District Level Project	Jul 17 - Jun 20	8000.00	DLS
43	3rd Participatory Livestock Development Project	Jul 15 - Jun 20	15000.00	DLS
44	National Agriculture Technology Project	Jul 15 - Jun 20	20000.00	DLS
45	Livestock farm Management Developed through Training & Mass media Campaign	Jul 18 - Jun 21	10000.00	DLS
46	Strengthening credit access of the small & medium livestock enterprises Project	Jul 17 - Jun 20	7000.00	DLS
47	Develop Cross Breed Dairy Cows and Extension Project	Jul 18 -Jun 21	8000.00	DLS
48	Abattoir Surveillance Project	Jul 17 - Jun 20	3000.00	DLS
49	PPR control activities project	Jul 15 - Jun 20	11000.00	DLS
50	Conservation & Improvement of Native Sheep through Community Farming & Commercial Farming Project 3rd Phase	Jul 17 - Jun 21	12315.16	DLS
51	Sheep Development and Extension project	Jul 15 - Jun 18	7000.00	DLS
52	Department of Livestock Services infrastructure Development project	Jul 11 - Junn 15	12000.00	DLS
53	Grant Parent stock & Parent stock farm support project by commercial bank	Jul 16 - Jun 20	100000.00	DLS
54	Establishment of Institute of Live stock Science & technology	Jul 14 - Jun 19	20737.64	DLS
55	Feed Analysis & Quality Assurance system development project	Jul 18- Jun 20	8000.00	DLS
56	Selective area based poultry processing plant development project by commercial bank	Jul 16 - Jun 21	500000.00	DLS
57	Scavenging Deshi poultry support project by the NGOs	Jul 15 - Jun 20	30000.00	DLS

Sl No	Projects/Programs	Proposed Project Period	Cost (Lakh TK)	Agency
58	Govt. Farms renovation & modernization project	Jul 15 - Jun 18	7000.00	DLS
59	Develop improved scavenging & semi scavenging poultry production & marketing system for poor small holders project	Jul 18 - Jun 21	10000.00	DLS
60	Establishment of Regional Duck Breeding farm along with Hatchery project 3rd phase	Jul 09 - Jun 14	6000.00	DLS
61	Promote Organic semi scavenging duck production project	Jul 17 - Jun 20	11000.00	DLS
62	Renovation of existing pig farm with establishment of 2 rearing units	Jul 18 - Jun 21	3000.00	DLS
63	Mass media campaign & consumer awareness development project	Jul 17 - Jun 20	4000.00	DLS
64	Existing poultry farm development & extension project	Jul 16 - Jun 19	10800.00	DLS
65	Scavenging Deshi poultry Conservation & development project	Jul 15 - Jun 21	80000.00	DLS
66	NCD control activities project	Jul 16 - Jun 19	6000.00	DLS
67	Support of Commercial layer farmers project by commercial bank	Jul 16 - Jun 21	500000.00	DLS
68	Adarsa Bari akti khamar project	Jul 15 - Jun 20	16000.00	DLS
69	Increase duck production project by NGO	Jul 16 - Jun 19	8000.00	DLS
70	Commercial egg processing project by the commercial bank	Jul 16 - Jun 19	20000.00	DLS
71	Strengthening credit access of the small & medium livestock enterprises project	Jul 17 - Jun 20	100000.00	DLS
72	Commercial duck production & development project	Jul 16 - Jun 19	18000.00	DLS
73	Enhance the capacity of department of Livestock services project	Oct 06 - Sept 11	12346.29	DLS
74	Extension of Livestock digital service at the union level project	Jul 15 - Jun 20	12000.00	DLS
75	Animal Quarantine system development	Jul 16 - Jun 19	15000.00	DLS
76	Non infectious Disease prevention and control project (milk fever, mastitis)	Jul 15 - Jun 20	15000.00	DLS
77	FMD control activities project	Jul 16 - Jun 20	10000.00	DLS
78	DLS capacity strengthened for public good activities project	Jul 17 - Jun 20	5000.00	DLS
79	Establishment of field disease investigation laboratory in 20 important strategically located dist. In Bangladesh	Jul 18 - Jun 21	7000.00	DLS
80	Development of a quality assurance institute project	Jul 15 - Jun 18	5000.00	DLS
81	Enhance the diagnostic capacity at 490 upazila veterinary clinics	Jul 16 - Jun 21	7000.00	DLS

Sl No	Projects/Programs	Proposed Project Period	Cost (Lakh TK)	Agency
82	Establishment of national institute of livestock & poultry management & disease diagnostic laboratory project	Jul 16 - Jun 21		DLS
83	Dhaka &Rangpur Zoo modernization project	Jul 15 - Jun 20	15000.00	DLS
84	Avian Influenza preparedness & response project 2nd phase	Jul 17 - Jun 21	15400.00	DLS
85	Zoonotic disease activities & development of VPH project	Jul 15 - Jun 20	7000.00	DLS
86	Zoonotic disease control project	Jul 18 - Jun 21	5000.00	DLS
87	Disaster management & risk reduction ensured	Jul 16 - Jun 21	15000.00	DLS
88	Safe environment & waste management ensured	Jul 17 - Jun 20	8000.00	DLS
	Total		3024599.63	

4. Processing of Livestock Products

Bangladesh has plenty of opportunity in processing industry of livestock and poultry resources that can employ thousands of youths including educated one. Only a few companies are operating in the market and many more can join and help the growth of this sub-sector up to the potential level. Livestock products are mainly milk, meat eggs and hides and skins. A brief account of the processing of these products is given below:

4.1. Milk

Milk processing includes mainly pasteurization, yogurt making, butter and butter-oil making and cheese making. All these products are being sold in the large cities of the country. There are many public and private entrepreneurs are now involves in processing and marketing of dairy products. Milk vita' and 'Savar Dairy' are public sector involvement while Arong is the brand name of BRAC (NGO), 'Pran' 'Aftab', , 'Farm fresh' 'Tulip', etc. are the private sector entrepreneurs in processing and marketing the processed dairy products.

About 15 crore litres of milk is processed annually by the private sector entrepreneurs. The growth rate of milk processing is about 15%. Total production is 270 crore litres per year. Powder milk production capacity of Milk vita, BRAC and Pran, is about 7000 MT per year.

Bangladesh Milk Producer's Cooperative Union Ltd (BMCUL), best known today by its popular brand name, 'Milk Vita', started milk processing in a cooperative efforts in1965. Now it is the largest dairy processing and marketing cooperative organization in Bangladesh. Milk Vita currently represents almost half of country's total processed milk production (52%). Members of the Milk Vita marketing cooperative deliver milk to collection points and then transported to a chilling plant before processing. Milk Vita members receive technical training, livestock breeding supports, veterinary and extension services, and various other production inputs from the organization.

BRAC (NGO) launched BRAC Dairy in 1998 with brand name 'Arong' to assist its village organizations in dairy production and market development offering microfinance loans for livestock and provides multi dimensional market services, including transportation, pasteurization, processing, branding and distribution. BRAC procures milk through dealers from approximately 40,000 farmers and transport it to BRAC Dairy's 100 chilling stations located mostly in Khulna, Dhaka, Rajshahi, and Rangpur divisions. BRAC generally offers competitively higher prices than others. So the farmers consistently receive a fair market price. BRAC processes milk at Gazipur under the brand name 'Aarong'. BRAC (Aarong) products include fresh and powdered milk, flavoured milk, flavoured yoghurt and sour curd. BRAC is the second largest dairy operation in Bangladesh, representing about 21 percent of the countries processed milk output.

However, at present BRAC collects around 100,000 litres of fresh milk from the farmers in 26 districts per day and now uses half of its capacity. The social business venture now sells around 30 tonnes of milk powder per month.

Program for Rural Advancement Nationally (PRAN), one of the largest agro-processing and business companies in Bangladesh, started ultra high temperature (UHT) treated milk production in Bangladesh in 2002 for School Nutrition Program. PRAN started milk processing partnered with Land-O-Lakes, Tetra Pak, and the U.S. Department of Agriculture (USDA). The technical expertise developed during this project was also shared with other companies to expand local commercial production of UHT milk. Today, PRAN is perhaps the third largest dairy operation in Bangladesh, representing about 10 percent of the market.

Quantity of milk processed by some enterprises is given below:

Table 6 Market share of liquid milk among the different enterprises

Processing companies	Establishment Year	Average milk collection ('000 liter/day)	Market share (%)	No. of producers supplying milk
BMPCUL (Milk Vita)	1973	200	52.08%	150,000
BRAC Dairy (Aarong)	1988	80	20.83%	70,000
Pran Dairy	2001	40	10.42%	30,000
Amo milk	1996	10	2.60%	5,000
Bikrompur Dairy	1998	10	2.60%	6,000
Ultra Shelaide Dairy	1998	10	2.60%	4,000
Aftab Dairy	1998	8	2.08%	4,000
Tulip Dairy	1998	3	0.78%	2,000
Grameen/CLDDP	1999	7	1.32%	6,000
Grameen-Damone	2007	1	0.03%	-
Rangpur Dairy	2007	8	2.08%	7,000
Akij Dairy	2007	4	1.04%	500
Savar Dairy	1974	6	1.54%	Public Farm
Total milk collection/day		387,000 Liter	100%	284,500

Source: S K Raha (2009), Adopted from M A Hamid and KM Hossain (2014)

4.2. Meat

Beef, Mutton and Broiler meat are being processed for marketing as 'ready to cook' even 'ready to eat' forms. These products are usually for fast food delicacy. **Public sector** intervention in meat processing does not exist. **Private sector's** intervention in marketing of processed meat has been started in recent years. A private entrepreneur 'Bengal Meat' came with processed meat in the city markets and operating their business through 40 outlets in Dhaka city area. They are processing and marketing beef items like smoked roasted beef, Beef Pepperoni, Beef Bacon, Beef Sausage, Sandwich meat, etc.

Aftab, a private entrepreneur is also marketing processed poultry meat (Nuggets, Sausage. etc.). In recent years, BRAC (NGO), CP, Golden Harvest etc. are the private companies also involved in meat processing and marketing of poultry meat items such as; Chicken meat ball, Chicken Fritz. Chicken Nugget, Quick fry chicken Fillet, Sandwich meat, Smoked chicken, Chicken Sausage, Chicken Shashlik, etc. Dressing of birds with small de-feathering machines is found almost in every live-bird-market.

4.3. Egg

Processing plant of eggs and processed egg products are not marketed by any entrepreneurs except but grading and packaging the shell eggs have been started very recently.

4.4. Hides and skins

Bangladesh produces approximately 200-220 million sq feet of raw hides and skins, about 85% of which is exported in crust and finished form (Govt. imposed export duty on wet-blue leather in 1977 and imposed ban on exporting wet-blue from July 1990). The rest is used for producing leather goods to cater to the domestic market. Since the production and supply of leather depend on the availability of livestock and demand of the meat, the total supply of leather cannot be increased drastically. Therefore, the only way of increasing earnings from this sector is the production and export of higher value leather products for which international market to be expanded and promotional activities to be strengthened. Export earnings from leather sector remained below BDT one billion. But by 2008-09, the annual export earnings from leather and leather goods increased to US$ 381.14 million (Bangladesh Tanneries Association website).

Some reputed tanneries of Bangladesh are Dhaka Leather, Apex Tannery, Lexco, Karim Lather, Samata Tannery, Bay Tannery, Lexco, Reliance, Kalam Brothers, AL-Madina, Millat, Progoti, Anwar, Amin, Crescent Kid Leather etc.

There are about 192 slaughter houses at district level, 1215 at Upazila level and more than 3000 slaughtering points in rural market places, cities and towns to generate hides and skins. Un-skilled manpower working with the slaughtering and flaying process cause a considerable damage to the quality of leather. Besides hides and skins, slaughter houses also generate, blood, bones, horns and hooves, visceral content, hairs, etc. But a very little portion of these by-products are processed by a few small cottage level factories and rests remain uncollected and thrown away resulting economic loss and environmental pollution.

There are about 206 tannery units in Bangladesh (in 2010) mostly located at **Hazaribag** area of Dhaka city and they use locally available raw hides and skins.

According to the records of the Bangladesh Tanners Association, about 60000 workers are employed in the tanning industry. Besides, there are about 100 qualified technologists including foreign nationals who are working in different tanneries. Total capital invested in the tannery industry so far is estimated at Tk.2.5 billion. About 1,500 persons are involved in the process of collecting raw hides and skins and making them available at tannery units. About 100 organizations import chemicals for use in tannery industry (source: Bangladesh Tanners Association).

Tannery wastes are being used as poultry and fish feed and are a serious concern of public health. In view of these, the High Court on August 8, 2011, directed the government to stop the use of tannery waste in poultry feed as well as fish meals within 30 days. Directives of the court for shifting tannery industries from Hazaribag to Savar, the new hub are progressing in a slow speed. Tannery is a big source of environmental pollutions discharging about 21,600 square meters of liquid wastes daily and also produces 150 tons solid waste a day. These harmful wastes, including chromium, lead, sulphur, ammonium, salt and other materials, are severely polluting the capital city and the river Buriganga, Liquid wastes are drained out at river Buriganga and causing serious problems to the public health issues.

Improving the situation with necessary infrastructural facility of transforming crushed leather into finished leather and processing of other by-products will create opportunity of higher export earnings.

The researcher recommended building of appropriate Effluent Treatment Plants (ETP) for neutralizing harmful chemicals before disposal of the waste into the environment and called upon the government to fix a legal limit value for discharge of tannery effluent to surface water.

Observations:

The following policy issues should be taken into consideration:

1. Improvement of slaughtering and flaying Process
2. Improvement of curing and storing
3. Improvement of disease and health management of livestock.
4. Diversification of lather products.
5. Market promotional activities in international markets.
6. Value added dairy and poultry products.
7. Quality control of livestock products for international quality standard.
8. Increasing import tax on milk powder and providing subsidies/ incentives in production will help to increase milk production in the country.

5. Marketing of livestock products

Almost all the livestock products are being marketed in Bangladesh. The main products are: Milk, Meat, Eggs and Hides and skins.

5.1. Milk Marketing

Marketing system of milk prevailing in the country is both traditional and commercialized. In traditional system, raw whole milk is sold in the market directly by the dairy owner or through middleman. There are processed products of milk mainly in the form of pasteurized milk, Chocolate milk, Yogurts, powder milk, butter, cheese, ice-cream, butter-oil (ghee), etc. A lot of sweetmeat makers are also processing the milk to prepare delicious items. Traditional milk marketing routes are as follows:

Figure 1 Traditional milk marketing routes

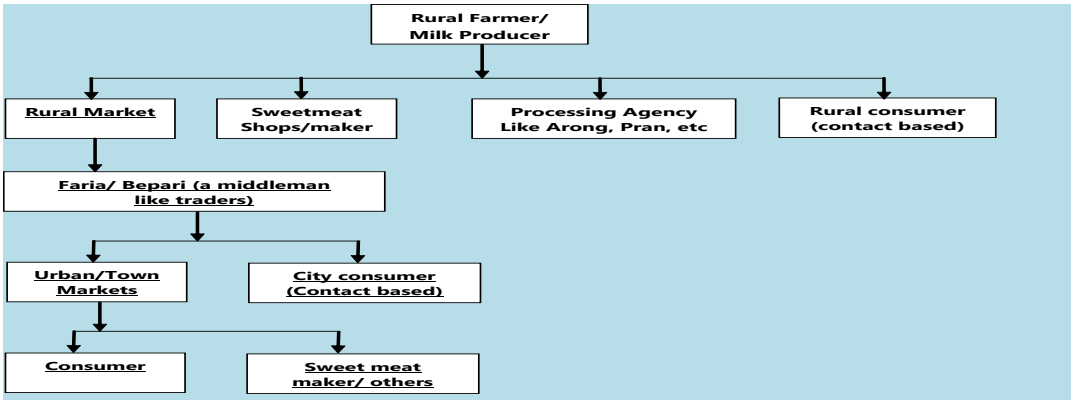
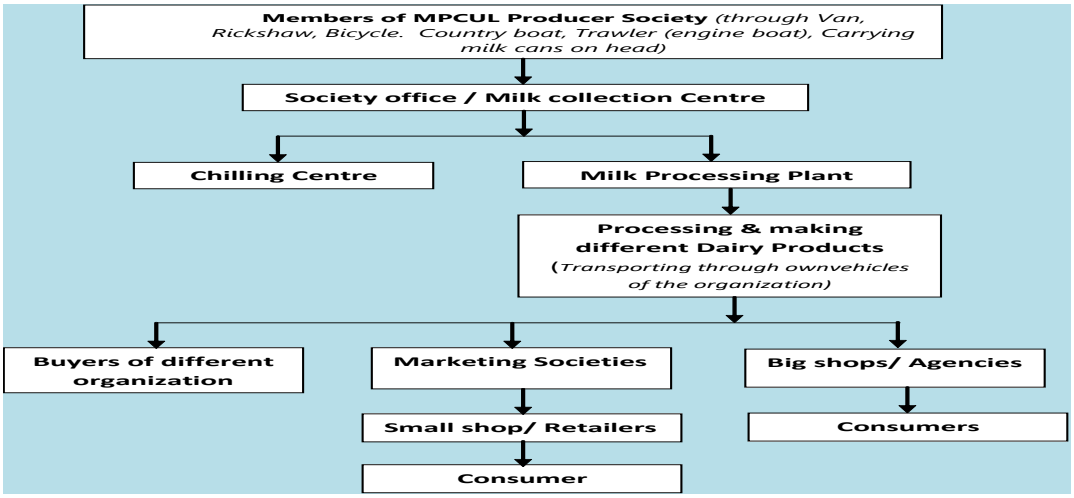


Figure 2 Milk marketing routes of Milk Producers' Cooperative Union Limited (MPCUL).



5.2. Meat Marketing

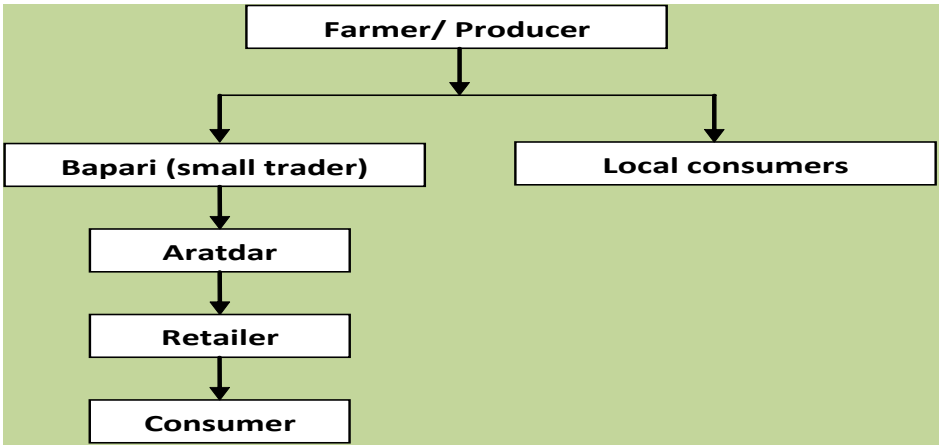
Meats are sold in the market traditionally by the butchers. Processed meat is also marketed in supper shops in cities. Private sectors involvement in meat processing has started in recent years. 'Bengal Meat '(a private enterprise) is processing meat and marketing at present in Dhaka and Sylhet city only. They are marketing processed 'Ready to cook' and even 'Ready to eat' items of meat products in Dhaka city area through 40 customized outlets. Most of the

meat products are for the fast food delicacy. BRAC, Aftab, CP, Golden Harvest etc. are the private enterprises processing and marketing poultry meat items in cities.

5.3. Egg and Poultry Marketing

Eggs are sold in number rather than weight. However, grading system is not widespread practice, only seen in super shops. Some companies are marketing graded eggs in packages. Native poultry birds (Chicken, Ducks, Pegions, Geese, etc.) are sold in the traditional rural markets by the rearer. The birds are sold either directly to the consumers or to the small Ferias who collect and supply those to the 'Arat' located in the towns or cities. The traditional poultry and egg marketing system generally have the following routes:

Figure 3 Traditional Poultry and egg marketing routes:



Price of Livestock products varies considerably from place to place. Price instability of livestock products are one of the major constraints of livestock development. The price depend on many factors such as, Market demand particularly during religious festivals, price of feed and other inputs, flow of production and supply, etc. The farmers sometimes bound to sell milk at lower price due to excess supply of milk during the peak production season — mainly from January to June and also due to transportation problem during 'hartal' (strike)/political agitations. However, existing market price of different product at different locations is shown below:

Table 7 price of different product at different locations

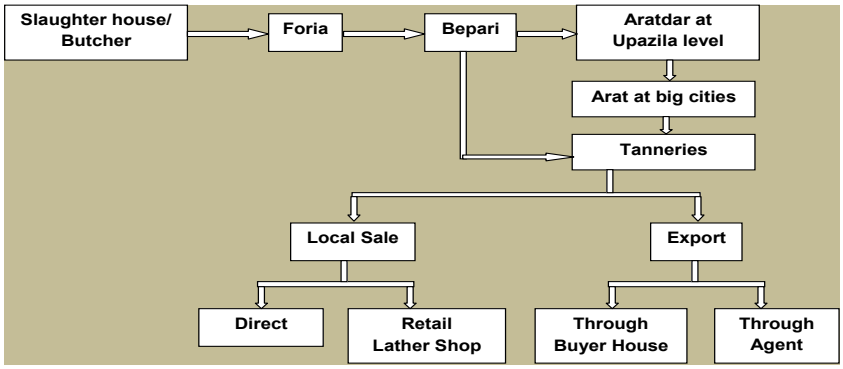
Products	Production centre	Faria/Middleman	Collection Centre	Local Markets
Milk (Tk./ Litre)	40-45	45-50	Depend on fat content	58-65
Poultry (Tk./kg)	90-100	110-120	120-125	140-160
Eggs (Tk./Doz.)	80-85	85-90	90-95 (Arat price)	95-100
Beef (Tk./kg)	300- 350	No middleman	No collection centre	350
Mutton (Tk./kg)	500-550	No middleman	No collection centre	500-550

Source: Personal contact and market survey as on 23/03/2015.

5.4. Hides and skins Marketing

Hides and skins are marketed by a chain of middleman. Collection and marketing routes of hides and skin is as follows:

Figure 4 Marketing Channel of Hides and Skins in Bangladesh



5.5. Quality Control

Quality control is an important issue of marketing of livestock products. Quality standard is controlled by the Bangladesh Standard Testing Institute (BSTI). The Local Government institutions such as city corporations and municipalities are performing the ante-mortem and post-mortem examination of slaughtered animals by the veterinarian of DLS deputed to work there. In Upazila level, the task is lying with the Upazila Parishad through DLS officers. Sanitary inspectors belonging to health department has the mandate of examining all food items including milk and milk products but in fact, the inadequate regulatory functions to ensure quality standard of livestock products is a great problem for consumer's safety issues. Adulteration and use of harmful chemicals to preserve the products are in practice of the dishonest traders. **It is also apprehended** that a lot of milk products getting date over are coming and are being used in the country. Such a consignment was detected in Chittagong city during the tenure of the Care Taker Govt. in 2008.

Bangladesh is yet to go long to attain the international quality standard for its exporting of livestock product. The country has not yet reached the full capability to meet the recommended safety level of quality standard for livestock products for Sanitary and Phyto-senitary (SPS) measures regulated by the World organization for Animal health (OIE) and Codex Alimentarius Commission.

5.6. Food Safety issues of Livestock products

Prevention and control of diseases and parasites has an important and significant role in all livestock production system. This is one of the significant ways in reducing production costs. With dairy cattle, this problem becomes even more important because of the public health concern.

Many of the diseases like foot and mouth disease (FMD), Haemorrhagic Septicaemia (HS), anthrax, brucellosis, tuberculosis, black quarter, fasciolosis and ascariosis that affect dairy cattle causing great economic loss and some of these diseases are transmittable to the people. Therefore, it is of utmost importance that dairy man should follow approved practices in preventing and controlling diseases and parasites.

Similarly poultry diseases like Ranikhet disease (New Castle Disease) causes conjunctivitis in human, Avian Influenza (H_5N_1) in some cases are fatal for human being.

However, food from livestock origin should be produced, processed and marketed following the recommended procedure to ensure the safety issues.

Milk: Adulteration is a great concern of public health issues. Milk is adulterated with low quality and date over powder milk. Harmful chemical (formalin) in a very low concentration is suspected to use to prevent from getting spoiled. Milk powder adulterated with Melamine powder had been reported in imported milk powder few years back. Milk is a perishable product and putrefaction starts soon after milking if not handled properly. Unhygienic way of handling milk is a food safety and public health concern.

Meat: Animals are fattened using hormone; steroid, etc. are a well-known malpractice. High Court directives were imposed during Eid festival last year to stop this malpractice. Unhygienic slaughtering and processing causes bacterial contamination and may cause food poisoning. Use of tannery wastes in poultry and fish feed was a decade long practices. Women work to sun-dry solid waste, generated from boiling of tanned leather off-cuts and shaving dust. The dry waste is ground and supplied to poultry feed mills or farmers. Records suggest the practice of making poultry-fish feed out of tannery waste has been going on for over a decade.

On December 30, 2003, The Daily Star reported that the feed, produced by crooked traders in the capital's Hazaribag, contained chromium, a chemical used in tanning hides. The toxic feed consumed by fish or poultry enters the food chain and can damage liver and kidney, and cause cancer and other diseases. Later, more media reports exposed the extent of feed contamination.

The High Court on August 8, 2011, directed the government to stop the use of tannery waste in poultry feed as well as fish meals within 30 days.

Egg: Egg handling and preservation system in the common market is unhygienic. Quality of fresh laid eggs starts deteriorating soon after laying if not preserved at recommended temperature of 55°F-68°F. Rotten eggs are being sold due to inappropriate preservation system. It is a general belief that, low quality eggs are being used by the bakers to make cheaper cakes. Eggs from the diseased flock may be a potential source of salmonella infection, food poisoning and other transmittable Zoonotic diseases to human being.

However, all these malpractices and mishandling are a great concern of food safety issues and is a great public health concern. We must get out of these malpractices and mishandling to have the quality standard for livestock products for Sanitary and Phyto-senitary (SPS) measures regulated by the World Organization for Animal Health (OIE) and Codex Alimentarius Commission.

Observations:

Regulatory functions of the government to be strengthened. Analytical capability of the analytical laboratories along with adequately trained manpower development and monitoring of the flow of good and services from the point of initial production until it is in the hand of ultimate consumer through special programme to attain International quality standard and enforcing laws with due importance may help to improve the situation.

5.7. Slaughterhouse Management

Most of the meat in the market is handled by the butchers under unsatisfactory sanitary condition. Slaughtering and dressing operation are not well organized. There are many abattoirs in rural and urban markets where slaughtering, flaying and dressing operations are carried out indiscriminately in the open places. Local government authorities have constructed many slaughter houses in cities, towns and at Upazila level. There are about 192 slaughter houses at district level, 1215 at Upazila level and more than 3000 slaughtering points in rural market places, cities and towns. Un-skilled manpower working with the slaughtering and flaying process cause a considerable damage to the quality of leather.

Flaying operations in most of these slaughter houses are being done by unskilled persons using ordinary sharp pointed knives causing flay cuts and irregular shapes in hides resulting a considerable financial loss. Goat and sheep skins are removed by using hang and pull system of flaying and therefore, deformities in the skins are very few. Department of agriculture marketing demonstrates flaying and preservation of hides and skins.

There is no mechanized slaughter house in public sector. 'Bengal meat', a private sector enterprise started mechanized slaughtering arrangement and marketing of meat and meat products. Local government authorities in Upazila, municipalities, and city corporations are responsible for the cleanliness and sanitation of the slaughter houses.

Slaughter house generate valuable by-products such as blood, bones, hoofs, rumen and visceral content, hair, etc. Only a little portion is being collected from the organized slaughter houses and is processed by cottage factories. The major portion are drained away or thrown in open places causing environmental pollution and economic loss.

Observations:

To improve the management of slaughter houses, sets of trained and educated butchers is important. The existing system of indiscriminate slaughtering, flaying and processing of meat needs to be monitored regularly. Meats, hides and skins and other slaughterhouse by-products to be collected, processed and marketed following standards of Sanitary and Phyto-sanitary requirements,

5.8. Poultry Slur management

Commercial poultry operations are exerting large amount of slur every day. There are about 1.5 Lakh small, medium and large poultry enterprises all over the country. These farms generate immense amount of waste every day. The Poultry Sector Development project of CIDA-DLS facilitated a study in 2002 on best possible ways of composting and utilizing poultry wastes found that the commercial poultry farms generate approximately 4475 MT of poultry wastes per day or 12.92 million MT per year.

An environmental study has also been conducted in four Upazila around Dhaka city by the Poultry Sector Development Project (PSDP) of CIDA-DLS to know the extent and nature of pollution from the poultry industry in Bangladesh due to inappropriate disposal of poultry farm wastes. The study reveals that manure disposal or application can result in a nutrient imbalance in the soil, negatively affect air quality as well as heighten the chances of polluting through leaching into ground water or runoff into surface water.

Observations:

- Special programme of composting of Poultry slur to convert into bio-fertilizer is necessary.
- Special programme to educate crop grower, fruit and vegetable producers, tea planters and nursery owner of the benefits of using poultry manure as a source of plant nutrients
- Water quality of both surface and ground water should be monitored regularly.
- Manure management issues should be included in the policies and regulation should be developed along with technical support and extension services to producers.

6. Import of Livestock Products

6.1. Import of Milk powder

No reliable information and statistics are available on actual requirement and availability of milk powder in the country. According to Chittagong custom source, powder milk import has been recorded 58,771 MT in 2012-13 and 53,539 MT in 2013-14.

Live Animals and Animal Products have been imported of worth BDT **22859** million during FY 2011-12 (Statistical Pocketbook of Bangladesh 2013 p-265). Import items are mainly milk powder and some other dairy products; farm machineries and equipment, for dairy and poultry production and processing, animal breeding materials, feed ingredients, live genetic stocks, etc. The World Milk Day is being observed across the globe on June 1, 2001. Bangladesh started observing this day for the first time in 2013.

To mark the "World Milk Day-2013", Department of Livestock Services (DLS) in cooperation with the Food and Agriculture Organization of the United Nations (FAO), Acme Laboratories, and SATV organized a seminar at Bangladesh Agricultural Research Council (BARC) auditorium in Dhaka. In the seminar the eminent personalities pronounced quoting Bangladesh Bank (BB) that Bangladesh has been spending more than BDT 7000 million annually to import

powdered milk to meet the country's demand. Bangladesh now produces only 47.80 lakh tonnes of milk against the total requirement of 1.46 crore tonnes.

The World Milk Day-2013 seminar, suggested the Govt. to provide subsidy to dairy farmers and milk processors to overcome the problems in milk production,

Not only the dairy and poultry products, but a wide variety of production inputs such as Poultry genetic stock such as Parent stock and Grandparent stock of Broiler and layer ,poultry feed ingredients, machineries and equipment's are also being imported in the country.

Poultry feed consists of 55-65% maize, 5-7% protein concentrates and 15-25 % soya meal. But the country has to import about 70-80% of maize, 100% of protein concentrate and about 90% of soya-meal. Therefore, poultry feed is largely import dependent.

Import of dairy and poultry products can be reduced to a large extent through careful interventions to address the constraints, providing all production related input facilities to the farmer; such as feeds/feed ingredients, and fodder, breeding materials, pasture for grazing, medicine and drugs, etc. and strengthening all production related services such as extension and research, veterinary services, artificial insemination facilities, vaccination, training, marketing facilities, etc. Besides, imposing taxation on imported livestock products and through proper policy framework to explore the potentialities will help to enhance livestock productivity.

Import of livestock products can be reduced to a great extent through reducing constraints and exploring the potentialities. Increase in local production will lower the import of livestock products.

Table 8 A comparison of approximate Price for imported and local milk powder

<table>
<tr><th>Brand Name</th><th>Price (Tk.)/kg
(at wholesale level)</th><th>Average Price /kg (Tk.)</th></tr>
<tr><td colspan="3">Imported Brand:</td></tr>
<tr><td>DANO</td><td>630</td><td rowspan="6">Tk. 636/-</td></tr>
<tr><td>Anchor</td><td>630</td></tr>
<tr><td>Red Cow</td><td>640</td></tr>
<tr><td>Diploma</td><td>600</td></tr>
<tr><td>NIDO</td><td>680</td></tr>
<tr><td>Total:</td><td>3180</td></tr>
<tr><td colspan="3">Local Brand:</td></tr>
<tr><td>Marks</td><td>500</td><td rowspan="4">Tk.500/-</td></tr>
<tr><td>Denish</td><td>480</td></tr>
<tr><td>Arong</td><td>520</td></tr>
<tr><td>Total:</td><td>1500</td></tr>
<tr><td colspan="2"></td><td>Difference: Tk. 136/- per kg.</td></tr>
</table>

Source: Personal contact and sample market survey of powdered milk price as on 15/04/2015.

6.2. Effect of import on local production and employment generation

In Bangladesh about 47.6 percent of the total labour force is engaged in agriculture sector for their livelihood that is predominantly poor (Bangladesh Economic Review, 2012). Livestock sub-sector has created both direct and indirect employment opportunity, It is estimated that about 20% of employment is directly associated with livestock sub-sector and partly employment is about 50% {DLS Data sheet 2013-14). Dairying is one of the major components of animal

agriculture and part of mixed farming system in Bangladesh contributing country's economic growth and reducing poverty level in rural areas.

Dairy generates regular cash income and dairy production, processing and marketing generate more employment. But, presence of imported milk discourages local production because it reduces the local demand. Commercial/ industrial sectors are the largest consumer of imported milk powder. They produce many delicious food items like ice-cream, condensed milk, etc. using powder milk. Due to lack of proper marketing system and adequate milk processing facilities, the country is not in a position to produce milk powder to meet the demand of commercial/ industrial sector.

Milk powder is convenient to use and perhaps cost effective to the major users. Market milk contains 4 % fat (on average) and 9% Solid not fat (SNF). Therefore, 100 litres of milk will require getting 13 kg of powder milk (Whole). 100 litres of milk cost about Tk. 4000 (considering milk price at production centre). Considering collection, processing and marketing cost, per kg of powder milk production is about Tk. 500. Whereas, imported milk is sold at about Tk.636. Imposing higher duties on import of milk powder will result in reduced import and encourage entrepreneurs to start producing milk powder locally at the cost effective rate. It will create opportunity of employment of the people and the small holders will get premium price of their products and therefore, they will be encouraged in dairy production activities.

Recommendations:

1. A well planned policy framework is necessary to increase productivity through addressing constraints in production system.
2. Immediate action to stop import of livestock products particularly milk powder products.
3. Illegal cross-border trades of livestock products to be stopped.
4. Awareness building of people to use domestic livestock products.

7. Exports

Among the livestock products, Bangladesh is exporting mainly Leather and Leather goods. During 2011-12 export earning was of worth BDT 30077 million [BBS Statistical Pocket Book 2013]. There is a great potentiality of increasing export earnings through processing and exporting of slaughter house by products (bone, horn, hooves, hair etc.).

Export earnings during 2012-13 from raw and processed livestock products were BDT 41335.20 million and in 2011-12 export income was BDT 34928.40 million (Source: Export Promotion Bureau-2012-13 collected from (www.dls.gov.bd)

Bangladesh has far to go to attain the international quality standard for its exporting of livestock products. The country has not yet reached the full capability to meet the recommended safety level of quality standard for livestock products for Sanitary and Phyto-senitary (SPS) measures regulated by the World organization for Animal health (OIE) and Codex Alimentarius Commission.

The main constraints to achieve the standard is due to: inadequate veterinary services, Lack of trained and skilled man power, lack of diagnostic facility, inadequate financial support, lack of disease surveillances and health inspection of animals, lack of inspection and certification system and updated regulatory functions in national food export and import process. However, business community aspires to export poultry products by 2020.

Poultry sector is import based; so, the sustainability of such export is questionable. However, consistent import-flow or arranging production of the poultry feed ingredients in the country is necessary to attain sustainable export capability of poultry products.

Export of livestock product can be increased many folds by exploring the potentialities in local production and reducing constraints in this sector.

Recommendations:

- The constraints should be removed through special programmes/ projects.
- Export barriers to be minimized.
- Efforts to attain the internationally acceptable safety level of quality standard for livestock products
- Inspection and quality certification system to be introduced immediately.
- Export of non-traditional items of livestock products to be encouraged.

7.1. Hides and skin

Bangladesh produces approximately 200-220 million sq. feet of raw hides and skins, about 85% of which is exported in crust and finished form. The rest is used for producing leather goods to cater to the domestic market. Bangladesh earns about BDT 1600 million annually from exporting crushed, finished and leather goods.

There are about 192 slaughter houses at district level, 1215 at Upazila level and more than 3000 slaughtering points in rural market places, cities and towns to generate hides and skins. Un-skilled manpower working with the slaughtering and flaying process cause a considerable damage to the quality of lather.

There are about 206 tannery units in Bangladesh (in 2010) mostly located at **Hazaribag** area of Dhaka city and they use locally available raw hides and skins.

According to the records of the Bangladesh Tanners Association, about 60000 workers are employed in the tanning industry. Besides, there are about 100 qualified technologists including foreign nationals who are working in different tanneries. Total capital invested in the tannery industry so far is estimated at Tk. 2.5 billion. About 1,500 persons are involved in the process of collecting raw hides and skins and making them available at tannery units. About 100 organizations import chemicals for use in tannery industry (source Bangladesh Tanners Association).

Tannery wastes are being used as poultry and fish feed and are a serious concern of public health. In view of these, the High Court on August 8, 2011, directed the government to stop the use of tannery waste in poultry feed as well as fish meals within 30 days. Directives of the court were also for shifting tannery industry are progressing but in a slow speed. However, the tanneries are being shifted to Savar Tannery hubs from Hazaribag area of Dhaka city.

Tanneries are generating pollutants. Tanneries discharge about 21,600 square meters of liquid wastes daily and also produces 150 tons solid waste a day. These are the potential pollutant to the environment. Liquid wastes are drained out at river Buriganga and causing serious problems to the public health.

Besides hides and skins, slaughter houses also generate, blood, bones, horns and hooves, visceral content, hairs, etc. But a very little portion of these by-products are processed by very few small cottage level factories and rests remain uncollected and thrown away resulting economic loss and environmental pollution.

Improving the situation with necessary infrastructural facility of transforming crushed lather into finished lather and processing of other by-products will create opportunity of higher export earnings.

7.2. Cross border Trade

Bangladesh and India share about 4096-km(2545 mile)long international border, the fifth longest land border in the world including 262 km in Assam, 856 km in Tripura, 18 km in Mizoram, 443 km in Meghalaya and 2217 km in West Bengal. It also share about 331 km border with Myanmar.

Incidence of nonofficial cross border trade of livestock and poultry products exists in the country. A wide spread incidence of entrance of live animals and birds as well as dairy and poultry products through nonofficial routes is a

potential threat to transmitting diseases. Cattle, dairy products, Day-old Chicks, eggs poultry feed ingredients, etc are the main livestock items coming through nonofficial border trade. About 40% of total slaughtered cattle come through cross border trade. It is reported that nonofficial cross border traders become more active during the rituals of Eid-ul-Azha festival when the cattle enter the country in good numbers and raw hides and skins of the slaughtered cattle is believed to go outside through cross border trade.

Recommendations:

- The cross border trade of livestock and livestock products to be stopped to save our livestock resources.
- Special programme for awareness building of people to use domestic livestock products is urgently in need.
- Border security especially for cross border trade of livestock products to be intensified. A legal bilateral agreement to resolve the problems is necessary.

8. Constraints in small holder livestock Production

Small holder Dairy: There are three categories of small holder dairy producers in rural and peri-urban areas of Bangladesh. These are: Small holder having 1-3 cows of local variety for dual purpose use (milk and draft power) which accounts for about 65% of all cattle population; small holders having 1-5 cross bred or local variety for milk production purpose and small or medium category of dairy farm having 6-10 or more cross bred cows for commercial dairy purposes.

Small holders with 1-3 local cows get cash income through direct sales of milk and their offspring. Small holders with 1-5 crossbred cows or good quality local cows in their farms sale milk to the milk collector or to the organization that provide them micro credit, feed and veterinary services and pay them on weekly/fortnightly or monthly basis. Farmers with 10 -20 cows produce milk for sale in towns/ cities through some middleman or agents. However, the constraints of small holders are summarized below:

1. Lack of knowledge on management aspect with limited skill
2. Shortage of fodder and feed ingredients.
3. High price of concentrate feed or feed ingredients.
4. Disease problem and limited coverage of veterinary services.
5. Lack of credit facility and insurance coverage
6. Limited processing and storing facilities.
7. Inadequate market information
8. Unstable or variation in market price of products.

Recommendations:

1. Training of farmers on husbandry practices, management, preventive and curative measures of diseases, fodder production, preservation and feeding practices as well as timely availability of vaccine, medicine and all other inputs at a reasonable price is required.
2. Creating a credit and insurance fund with Bangladesh Bank for small holders in particular.
3. Ensuring the reasonable market price of the products as well as the inputs (Feed, medicine, vaccine, etc)
4. Ensuring veterinary services at union level.

8.1. Feeds and Fodder shortage

Fodders and feed is the most important input of livestock rearing. Crop residues and naturally grown grasses along side roads, river bank, char lands, etc. are the main feed for the cattle in Bangladesh. Shortage of fodder and high price of feed ingredients are affecting the small holders significantly. Dairy units are running off due to shortage of fodder or grazing land/ high price of feed ingredients.

In coastal region particularly the southern part of Khulna district had abundance of grasses within the polder areas during early eighties. But the scarcity of grass starts due to logging of saline water in the shrimp culture 'Gher' inside polder. As a result most of the small holders have run out of dairy rearing. For the same reason, number of buffalos also has reduced significantly,

The pasture land has reduced significantly all over the country due to cultivation of High Yielding Varieties (HYV) of rice to meet the demand of growing population. Climate change is causing unusual behaviour in temperature, rainfall, flooding pattern etc., and affecting either in natural growth or damaging the pasture grasses. Besides, adulteration of commercial feed by the miller; Inadequate or no quality control system of commercial feed is traceable and increased salinity in coastal area is a potential threat to natural growth of grasses in the char lands for grazing of animals.

Fodder cultivation is not generally practiced by the smallholders, because of land constraints belonging to them. However, Private dairy farmers grow the fodder for their cows either in their own land or leased out lands from others. Most of the poor families do not have their adequate land to grow fodders. They are to depend on naturally grown grasses in alongside roads, embankments and polders, and also on aquatic plants. The smallholders suffer from shortage of fodder during cropping seasons. Seasonal variation is experienced by the farmers in availability of forages. Crop residues and a very little amount of green forages are given to their animals throughout the year.

The dairy farmers cultivate maize as fodders and fodders of exotic and high yielding varieties for their animals. Some of these are perennial type, such as: Napier, Para, German, Sudan grass, Jumbo, etc. However, fodder cultivation in cultivable land depends on opportunity costs with other crop. **Constraints of feeds and fodder availability for cattle** can be summarized as follows:

- Scarcity of grazing land;
- Scarcity of land for fodder cultivation.
- Low quality and adulterated feed in the market
- Use of crop residues as household cooking fuel and other purposes.
- Change in cropping pattern
- Lack of standards and quality control system
- Lack of knowledge of feeding system
- Lack of coordinated effort.

There are also a lot of opportunities of feeds and fodder production or improvement in the country; such as:

1. Rapid growing high yielding varieties of fodder may be grown in public places like: Road sides, Highway sides, Railway trace slopes; Embankments, Khas lands, etc. These may be leased out to the local people and may be formed co-operative societies for this purpose. 'Ayls' (earthen demarcation of crop fields) in irrigation project may also be utilized. **About 5695 km embankments including 3433 km in coastal region, 2835 km railway traces, 21571 km roads and highway (National 3570 km, Regional 4323km, and Upazila feeder road 13678 km),** besides, a lot of 'Ayls' under millions of hector irrigated lands may be utilized for fodder cultivation. In early eighties such an effort was noticeable on the Road/ Embankment sides at Manikgonj area, but failed due to proper patronization or due to mismanagement or any other causes. So it is a questionable effort of fodder production to some experts.
2. Leguminous crop as inter cropping between two crops without affecting main crop is possible.
3. Under the fruit trees, some perennial varieties or leguminous varieties of fodder may be grown.
4. Unconventional feed items may be utilized.
5. Crop residues may be processed for quality feed items. Use of modern technology for improving existing crop residues is possible.
6. Farmers may be motivated for keeping at least a small part of their crop land for fodder production through providing them input (Fodder seed/ cuttings, fertilizer, etc)

7. High yielding varieties of fodder may be introduced
8. Newly formed char-lands may be allotted for pasture use.

In regards to poultry feed, annual demand presently is 2.7 million MT. Commercial feed mills generate 2.57 million MT and local mills are able to produce 0.13 lacs MT (as stated in the International Poultry Show and seminar-2015 organized by the World Poultry Science Association, Bangladesh Branch). About 70- 80% of major ingredients of poultry feed such as Maize, Soya meal, and Protein concentrates are imported.

8.2. Forage availability for dairy animals

The availability of green forage is largely affected by season, for example, forages are available in large quantities in monsoon and it is scarce in dry season and during flood. These cause the forage supply to animals in our country highly fluctuating. Figure below shows the fluctuation in the availability of green forages round the year. This fluctuating supply of forages is one of the reasons for low average milk yield throughout the year. There are two major feed shortage periods in the country. The most severe one is during July to October when most of the fields are under rice cultivation and all low lying areas are flooded. Another feed shortage period is during late March to late April (dry period) when the winter forages are finished and summer species are just sprouting.

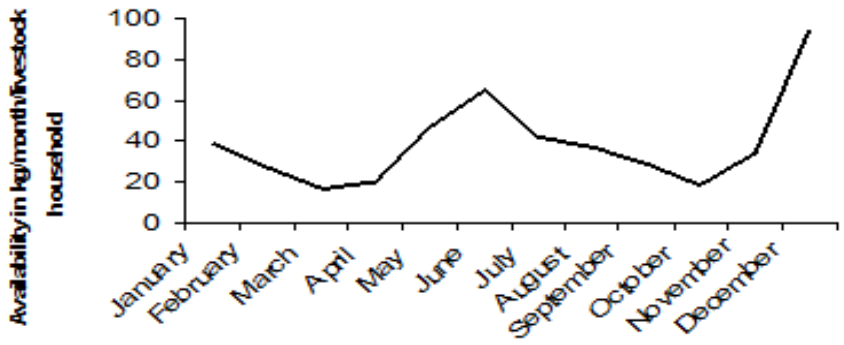


Figure 5 Availability fluctuation of green grass round the year

Source: Akbar and Khaleduzzaman 2009; (Adopted from M A Hamid and KM Hossain-2014)

8.3. Nutrient availability for dairy animals

Animal feed and nutrient shortage in the country has been reported in many survey studies. According to DLS report (2005), the availability of feeds and fodder for dairy animals was 70.8% DM, 17.5% DCP and 65.7% ME. And in a recent study, the availability of feeds and fodder has been found to be 80.3% DM, 26% DCP and 66.1% ME with the deficits of 19.7% DM, 74.1% DCP and 33.9% ME, respectively (Sarker et al 2012).

Table 9 Nutrients availability for dairy animals in Bangladesh

Demand/Supply	DM (000, MT)	DCP (000, MT)	ME (Mill. MJ)
2003-2004			
Demand	43,200	2,770	366,000
Supply	30,600	484	240,600
Balance	-12,600	-2,286	-125,400
Availability (%)	70.8	17.5	65.7
2010-2011			
Demand	45,900	2,960	392,000

Demand/Supply	DM (000, MT)	DCP (000, MT)	ME (Mill. MJ)
Supply	36,900	769	259,000
Balance	9,000	2,190	-133,000
Availability (%)	80.3	26.0	66.1

Source: DLS and Sarker et al 2012**.** (Adopted from M A Hamid and KM Hossain-2014)

Observations:

Key Policy issues should be:

1. Integration of livestock with agro-climatic zone-based land use planning for creating pasture land particularly in coastal region.
2. Training of farmers on fodder cultivation and fodder preservation.
3. Quality control of commercial feed for animal and poultry.
4. Research on processing of crop residues to convert as quality feed.
5. Availability of High Yielding Variety of fodder planting materials including Maize.

8.4. Diseases

Diseases are the potential threat to livestock sub-sector. More than 15% of animals and 20% poultry die of different diseases every year and much are going out of production due to diseases resulting huge economic loss. However, major animal diseases like **Anthrax, Hemorrhagic Septicaemia (HS)**, **Black quarter (BQ), Foot and Mouth Disease (FMD)** in cattle and **Peste de Petits Ruminants (PPR)** and Goat Pox in goats are generally endemic but often appear in epidemic form. **New Castle Disease (ND), Infectious Bronchities (IBD) and Gumboro** in chicken and **Duck plague** and **Duck virus Hepatitis** in ducks causes great loss of the poultry resources in Bangladesh. The country is in severe risk of Avian Influenza also.

Vaccines are produced for most of the above mentioned diseases in the country but not adequate to meet the demand. **Gambaro disease** is also fatal to chicken and only a small quantity of vaccine is produced in the country. **Avian Influenza (H5N1 strain)** vaccine is not produced in the country at all.

Rinderpest in cattle has already been eradicated from the country and obtained recognitions of the World organization for Animal health (OIE) in 2010. Besides, the cattle and poultry also suffer from protozoan and **parasitic infestation** due to moist humid climatic condition in Bangladesh. Economic loss due to parasitic diseases is enormous. The animals immediately do not die but the animal health and production are seriously affected. Parasitic diseases can be easily controlled by improving management and regular de-worming with appropriate medicine which is not so much expensive. Almost 100% of the animals are infested with one or more parasitic diseases in Bangladesh.

Nutritional disorders are also very common in livestock and poultry birds due to shortage of feeds and fodder and also lack of knowledge of the farmers.

DLS has been producing 16 different kinds of livestock and poultry vaccines and has produced about 116.86 million doses of vaccines up to February 2014. DLS has also provided veterinary services to about 43.15 million animals and birds during the last financial year 2013-14. (Source: DLS website).

Vaccine production target of DLS and production of vaccine for different diseases of animals and birds for the year 2013-14 is given below:

Table 10 Vaccine production

Vaccines	Production Target (2013-14)	Availability/ Production	Remarks
Cattle vaccines:			
Anthrax	13000000	5617000	
Black Quarter (BQ)	850000	1133040	
Foot & Mouth Disease	1000000	927648	Imported quantity could not be ascertained.
Hemorrhagic Septicaemia HS	700000	897200	
Peste de Petits Ruminants (PPR)		3783000	
Goat Pox	300000	0	
Poultry Vaccine:			
Ranikhet (New Castle Disease) Produced: BCRDV: 72638700 + RDV: 57396300	3100,00,000	130035000	Imported quantity could not be ascertained
Fowl Cholera	4000000	4234700	
Fowl Pox	12000000	11837000	
Pigeon Pox	1200000	2466200	
Gumboro	15000000	23635000	Imported quantity could not be ascertained
Duck Plague	37000000	18369000	
Marex-	1000000	885000	
Salmonella	1550000	1779800	
Others:			
Rabbis (LEP)	6050	1240	
Rabbis (HEP)	6050	0	

Source: DLS, Bangladesh.

Observations:

- A massive programme on disease prevention and control of cattle and poultry diseases, awareness building and Mass programme for de-worming of animals against parasitic diseases is required.
- Awareness building through training programme is essential on maintaining the recommended withdrawal period of medicine before marketing the products. This is a food safety and public health concern.
- Institutional capacity building equipped with adequate manpower and inputs is necessary.
- Extending veterinary services up to union level with adequate infrastructural facilities is essential.
- Livestock extension services and regulatory functions to be reformed at the present context of NGO and private sector involvement in livestock services.
- Expansion and modernization of diagnostic and disease investigation services.

8.5. Genetic potentialities

Genetic potentiality for production of milk /meat and eggs of native variety of cattle and poultry birds is very low. Production characteristics of some native species of livestock and poultry are given below:

The indigenous (deshi) cows are small non-descriptive *Bos indicus* type, with three main types large deshi, small deshi, and Red Chittagong. Their productivity of milk is very low (1-2 Kg) having a prolonged inter calving period. Average body weight ranges from 125-200 kg. Genetically these are non-descriptive type. Economic return is hardly positive.

The crossbred cattle are mainly derived from crossing local with different exotic breeds, such as; Holstein, Friesian, Sindhi, Shahiwal, Jersey etc. at different level of genetic combinations. **Average age at first calving is 45 months and have lactation period of about 7 months**, **Average milk production is 300-450 litre per lactation (about 1-2. litre in a day) with about 4.5-5.5 percent milk fat. First Calving is about 33 Months to 40 Months. Inter-calving period is about 18-24 months.**

Buffaloes in Bangladesh are mainly indigenous in origin and most of them are riverine type and some are swamp type (Indian water buffalo type) and have low productivity, mature body weight is 350-450 kg and are seasonal breeders and come in heat in post monsoon months with the increased availability of fodder in the char lands and calve in spring. The average milk yield is about 2.5 to 3 kg per day and lactation period is 7 to 8 months. So they are not good dairy purpose buffalos. These are mainly maintained for draft purposes. There are also some cross breed with Murrah, Nili-Ravi, Surti and also Jaffrabadi in south eastern and northern border districts.

Native Goats belong to the Black Bengal breed. The breed is famous for its high prolificacy, tender meat and skin quality. The Black Bengal goat is well adapted to hot humid climate and produces twins and triplets even more and have the potential of being developed all over Bangladesh. The average live weight of adult goat is 16 to 18 Kg. Goats are mainly reared by marginal and landless households. A very little milk is also obtained from this type of goats and consumed in family purposes.

Sheep found in the coastal area are coarse wool type, small in size about 10-12 kg adult live weight and well adapted to the saline environment.

The local "deshi" Chicken are *gallus gallus* type found mostly in this sub-continent and is poor egg producer. They lay 40-50 eggs in a year with characteristics of pronounced brooding. They live on scavenging. Hatching and brooding characteristic as well as scavenging habit of local chickens are economically very important for rural people and is a desirable character of native birds.

The Ducks of indigenous variety collect feeds from the ditches and natural water bodies. Khaki Campbell' ducks of exotic origin are also very popular and found everywhere in Bangladesh. People of Haor and coastal areas are very fond of duck rearing. Higher salinity is harmful for ducks. Indigenous variety of ducks produces 100-120 eggs in a year, more resistant than exotic one.

Observations:

1. A well thought knowledge based breeding policy is required for livestock and poultry species
2. A strong breeding strategy is required to preserve the positive qualities of native breed. (Positive qualities are: considerable adaptability to adverse climatic condition, surviving on poor nutrition with minimum management practices, resistance to many diseases, suitability to the economy of poor and subsistence farmers). These positive qualities need to be emphasized in formulating a pragmatic breeding policy.
3. Research on native genetic resources should be emphasized and must include in priority policy options.

8.6. Impact of Climate change on Livestock resources

Climate change issues are a worldwide concern for its influences on every biological species. Bangladesh is not beyond this concern. The concern is mainly due to impact on crop, livestock and fish production.

The Intergovernmental Panel on Climate Change (IPCC) released its 'Climate change report -2014' warning that climate change is already having widespread effects on every continent and throughout the world's oceans.

Bangladesh is one of the most vulnerable countries in the world to Sea Level Rise (SLR) with two-thirds of its land area less than 5 meter above sea level. Sporadic measurement of soil and water salinity along the coastal area indicates intrusion of saline waterfront toward land already occurring in many areas.

Susmita Dasgupta (WB, 2014) in an article wrote that most research to date has focused on the long-run effects of progressive inundation from Sea Level Rise (SLR), along with associated losses from heightened cyclone-induced surges. Climate change will cause significant changes in river salinity in the southwest coastal area of Bangladesh during dry season (October to May) by 2050, which will likely lead to significant shortages of drinking water in the coastal areas, scarcity of water for irrigation for dry-season agriculture and significant changes in the coastal aquatic ecosystems.

Over 90 percent of fresh river water in Pirojpur, Bagerhat and in Barisal will be at risk. Under this worst scenario, river water (with salinity < 2ppt) will no longer be utilizable for dry season agriculture in Barguna, Bhola, Jhalokati, Khulna, and Patuakhali districts. Assessments of such location-specific economic impacts of the changes in river salinity, and identification of suitable adaptation alternatives, are urgent.

Since the feed for livestock comes mainly from crop residues and naturally grown grasses (mostly seasonal) will certainly be affected with the scarcity of irrigation water for cultivation of rice.

However, probable impact of climate change on livestock has been apprehended as:

1. Outbreak of emerging and re-emerging disease will be enhanced.
2. Rise in sea level will inundate char lands reducing the grazing facilities.
3. Intrusion of saline water in coastal region will increase stress factors and therefore, will not be conducive for livestock rearing.
4. Vegetation will be destroyed leading to a serious feed scarcity resulting in reduction of livestock population.
5. Frequent tropical cyclone and tidal surges, prolonged rainy seasons, will seriously damage all the sub-sector of agriculture including livestock and fisheries.

8.7. Salinity Intrusion in southern and south-eastern districts (Coastal regions)

It is apprehended that climate change will cause intrusion of saline water in coastal region which will not be conducive for livestock rearing because it will influence all the production factors. The following impact of saline water intrusion will be serious concern to livestock development process in the coastal region of the country.

1. Salinity intrusion in southern and south eastern region will reduce the existing grazing facilities for cattle.
2. Widespread outbreak of emerging and re-emerging diseases will occur.
3. Vegetation will be destroyed leading to a serious feed scarcity resulting in reduction of livestock population.
4. The Livestock option of livelihood of the people will no longer exist leading to a serious problem on overall food and nutrition security of the millions of people in the coastal region.

Observations:

- A well planned and well protected polder project and river bank protection programme may help to overcome the situation.
- Converting the newly formed char land to pasture lands for grazing of cattle, buffalo, goats and sheep will encourage people in livestock keeping.
- Traditionally the coastal regions are known to be conducive for buffalo rearing. Therefore special programmes to support private sectors on buffalo farming for milk production and processing of milk will create opportunity of employment and improve livelihood of millions of coastal people.
- Introduction of Saline tolerant crops/ fodder/pasture
- Research and development to cope with the situations.

8.8. Cyclone and tidal surge

Bangladesh has experienced two super cyclone named **'Sidr'**, and **'Ayla'** since 2007. In November 2007 the cyclone *Sidr* swept over the coastal zone of Bangladesh, causing loss of many lives and significant damages to crop, livestock and fisheries resources and the livelihoods of vulnerable people. Only 18 months later, in May 2009, cyclone *Ayla* ripped through the same zone, causing loss of many lives and inflicting heavy damage on properties and productive assets of poor families. Approximately 10,000 animals have died and many more was lost. Crop residues used for animal feed and naturally grown grasses in the Char land were damaged. An acute shortage of feeds and fodder in coastal region have been experienced by the rearer following the cyclone led tidal surge. Productivity runs off due to shortage of animal feed and outbreak of diseases caused further damage to the livestock resources in coastal areas. . However, frequency of such natural disaster is the result of climate change due to environmental degradations in the region.

MoFL through Ministry of Local Govt. has constructed few earthen platforms called 'Killa' alongside multi-purpose cyclone shelters. BWDB is also constructing some earthen 'Village-Platforms' to save the resources from damage due to cyclones and tidal surges

Observations:

Natural disaster cannot be controlled but we must have to have the protective mechanism to protect ourselves. To protect the people and assets, a short, medium and long term strategy for well-planned polder project, aforestation, awareness building, and livelihood development projects should be considered and the activities responsible for degradation of environment to be minimized or stopped.

9. Technical Inputs

9.1. Review of Sectors

9.1.1. Existing livestock situation

Bangladesh is a densely populated country and is a nation endowed with enormous potential. Agriculture, including livestock and fisheries, has emerged as a growth driver in the 21st century. The potential of the livestock sub-sector is much higher than generally estimated at present. Bangladesh has serious shortages of milk, as people want to consume it for nutrition of the whole family, not merely the children. Bangladesh however has to depend on imported milk products.

9.1.2. Sizes of dairy farms in Bangladesh

Most of the Dairy farms in the country is belonging to the private sector. These can be categorized into 5 different groups based on local standard.

Dairying for home consumption: Majority of the farm belongs to this category. They keep 1or 2 cows to meet primarily their household demand for milk products, and the surplus are sold in the local market or through home delivery system. .

Rearing of cows for dual purposes (draught and milk): Households depending mainly on draft power for cultivation usually keep 2or 3 cows including both bulls and dairy cows and often have to use their dairy cows for ploughing. They produce milk which is usually sold in the market or through home delivery system

Small-scale dairy farming: The small and medium sized households with financial and technical support from the government, NGOs and cooperatives manage 2-5 cows. They usually sell all their milk in the market or to the ferias/Gosh.

Medium sized commercial dairy farming: The medium sized households receiving cooperative or bank support establish dairy farms where they usually rear 6-20 cows for market sale of milk.

Private large commercial dairy farms: The commercial modern dairy farm operations keep more than 20 cows established mostly with bank support.

In public sector, there are eight government dairy farms throughout the country, basically being used as breeding purposes for supplying of heifers to small-scale farmers. A buffalo development farm at Bagerhat district in the coastal region is also functioning and recently, the DLS and BLRI started joint buffalo improvement program in Public sector.

Buffaloes are managed mainly as draught purpose in household subsistence farming that can give milk to the family in low quantity. About half of the population of buffaloes are reared in coastal region of the Southern part under extensive farming in '*Bathan' (Bathan is a* farming system where a large number of cattle/ buffalos are reared in herds in some isolated areas usually seen in coastal and riverine estuary areas.

Basically a private seed company, Lal Teer Livestock Limited started buffalo development program to create dairy and meat buffalo in the country. Number of dairy cattle and goat farms and self-employment record are shown in Table below:

Table 11 Number of registered dairy farms, goat farms and self-employment records in private sectors

Year	Dairy Farm		Goat Farm	
	Number	Self-Employment	Number	Self-Employment
1979-1980	227	2270	-	-
1997-1998	29,600	296,000	20,900	104,200
2000-2001	32,600	326,000	24,900	125,000
2004-2005	52,000	520,000	26,000	130,000
2009-2010	79,900	98,500	56,200	281,000

Source: DLS -2011 (adopted from M A Hamid and KM Hossain-2014)

9.1.3. Livestock Population

The estimated Livestock and Poultry Population in Bangladesh is about 53.66 million and 307.47 million respectively. Species wise population for the last 3 years is presented below:

Table 12 Livestock and poultry population (in millions)

Species	Approximate Population (in millions)			Remarks.
	2011-12	2012-13	2013-14	
Cows	23.16	23.34	23.44	The figures are up to February 2014 of FY 2013-14.
Buffalos	1.44	1.45	1.45	
Goats	25.12	25.28	25.61	
Sheep	3.08	3.14	3.16	
Total Cattle:	52.70	53.21	53.66	
Chicken	242.87	249.00	259.42	
Ducks	45.70	47.25	48.05	
Others	-	-	-	
Total Poultry:	288.57	296.25	307.47	

Source: Bangladesh Economic Review 2013-14

Cattle: Among the total cattle population**,** about 6 million are dairy cattle of which about 85-90% are indigenous and 10-15% are crossbred. Indigenous cattle consisted of (a) Non-descript Deshi, (b) Red Chittagong cattle, (c) Pabna cattle, etc. The crossbred cattle are mainly derived from crossing local with different exotic breeds, such as; Holstein, Friesian, Sindhi, Shahiwal, Jersey etc. at different level of genetic combinations.

Goat: Black Bengal, the only goat breed comprises 90% of the total population of goats. Some Jamunapari breed and their cross with local variety are also seen.

Buffalo: Buffalos in Bangladesh is mainly indigenous origin and most of them are riverine type and some are swamp type. There are also some cross breed with Murrah, Nili-Ravi, Surti and also Jaffrabadi in south eastern and northern border districts.

The following table illustrates the gradual growth situation of cattle, buffalos and goats in the country:

Table 13 Growth rate of dairy animals in Bangladesh

Year	Cattle		Buffalo		Goat	
	Number (million)	Growth (%)	Number (million)	Growth (%)	Number (million)	Growth (%)
2002-03	22.5	-	1.01	-	17.7	-
2003-04	22.6	0.31	1.06	4.95	18.4	4.07
2004-05	22.7	0.31	1.11	4.72	19.2	4.07
2005-06	22.8	0.57	1.16	4.50	19.9	4.07
2006-07	22.9	0.31	1.21	4.31	20.8	4.06
2007-08	22.9	0.31	1.26	4.13	21.6	3.90
2008-09	22.2	0.33	1.30	3.49	22.4	3.90
2009-10	23.1	0.15	1.35	3.85	23.3	3.91
2010-11	23.1	0.30	1.39	3.26	24.2	3.76
Average (%)		0.32		4.15		3.97

Source: DLS -2012: **(**Adopted from M A Hamid and KM Hossain-2014).

9.1.4. Livestock Products

Milk, Meat and Egg production in Bangladesh for the last 3 years is presented below:

Table 14 Production of Milk, Meat and Eggs in Bangladesh for last 3 years:

Products	Unit	Amount/quantity (in millions)			Remarks
		2011-12	2012-13	2013-14	
Milk	Million Tones	3.436	5.067	3.738	The figures are up to February 2014.
Meat	Million Tones	2.332	3.620	3.021	
Eggs	Million number	73038	7617.380	6745.280	

Sources: Bangladesh Economic Review 2013-14

9.2. Status of Poultry Industry in Bangladesh

Bangladesh has a long history of poultry rearing under traditional and Backyard system. At the beginning commercial poultry farming started on small scale involving the rural women, unemployed youths, semi-urban and urban poultry rearer.

Poultry sector in Bangladesh is a fast growing sector. Private sectors are the driving force to develop this sector and the DLS has been facilitating the entire process of development since 1990s. Since then a significant annual average growth rate in the commercial poultry sector has been achieved. Poultry Industries Association in Bangladesh claims average growth rate in this sector is about 15-20%.

The salient points regarding the poultry sector investment, activities, consumption of poultry product, quality issues, Poultry feed, hatchery operations, etc. have been outlined as per proceedings of 9th WAPSA conference, Dhaka 2015 as follows:

- The poultry Industry is the second largest employment generating Industry in Bangladesh after the Garments Industry. Currently 2 million people are employed in this industry half of which are female.

- The annual per capita chicken consumption in Bangladesh is nearly 3.63 kg, compared to the global health standard of consumption at 18-20 kg.
- FAO recommends annual per capita consumption of eggs at 104. In Bangladesh this number stands only at 45-50 eggs.
- WHO and FAO's joint survey on health standards stipulates annual per capita protein intake at 43.80 kg but in Bangladesh it is 15.23 kg.
- Use of antibiotic in poultry feed is prohibited by regulation and compliance is practiced. Antibiotics are used for safeguarding poultry health only under disease condition as per advice of veterinarians.
- Annual demand of poultry feed presently is 2.7 million MT. Commercial feed mills generate 2.57million MT and local mills are able to produce 0.13 lacs MT.
- 95% of the annual poultry feed requirement for Bangladesh is produced locally under advanced technology. More than 99% of poultry feed production do not use tannery waste.
- Investment size of the poultry industry currently amounts to Tk. 25000 crore which during the eighties decade was Tk. 1,500crore.
- Effective policy and infrastructure of the Government will facilitate poultry industry to grow to Tk. 50,000 crore by 2020.
- Daily demand of chicken currently is at 1700 MT and estimated 2 crore eggs are produced daily.
- Weekly demand of one-day-old chick is at 1 crore 10 lacs.
- Number of Grand Parent Stock farms in operation-6
- Number of listed Breeder farms-140
- Production of Parent stock- 60-70 Thousand per week.
- Production of Broiler Day-old-Chick (DOC) - 11 million per week.

9.3. Status of Dairy and Meat Industry in Bangladesh

Country is producing milk well under the requirement and most of the demand is being met from import of milk powder from the international market. Bangladesh has 23.44million cattle and 1.45million buffalo (Source: DLS). As per Animal Health Companies Association of Bangladesh (AHCAB) about 4.9 million are milking cows and 0.3 million are milking buffalo. **Bangladesh dairy industry is mainly dominated by local breed. Out of 4.9 million milking cows, 4.2 million are local breed and 0.7 million are crossed breed.** This country needs **14.02 million MT** milk calculating 250 ml per head /day. Out of which we produced only **6.09 million MT** and met up our requirement by importing about 52 thousand ton milk power from abroad. However, status of dairy and meat industry can be realized from the following discussion in this report.

9.4. Demand and supply of Livestock Products

The country's demand for milk, meat and eggs for **153.6 million people** is enormous. Demand for milk is **14.02 million MT** (based on 250 ml/person/day), Production is **6.09 million MT.** Thus, there is a production deficit of **7.93 million MT**. Demand for meat is **6.73 million MT** (based on 120 g/person/day or 43.8 kg/year/person), production is **4.52 million MT**, deficit is **2.21 million MT**. Demand for eggs is **15974.4 million** (based on 104 eggs/person/year), production is **10168.00 million**, deficit is **5806.40 million**. (DLS data sheet 2014).

To realize the demand for milk a comparative consumption situation per person per day among the SAARC countries may be taken into consideration. Milk consumption per head per day in Bangladesh is only 91 ml (MoFL claims that production has increased almost double since 2009 and per capita milk consumption has rose at 91 ml from the earlier 38ml), while it is 140 ml in Nepal, 142 ml in Sri Lanka, 188 ml in Maldives, 227 ml in India and 520 ml in Pakistan. Bangladesh has huge potentiality to minimize the shortage of milk and save huge money which is being spent for milk import (BSS report on 'World Milk Day-2013 seminar').

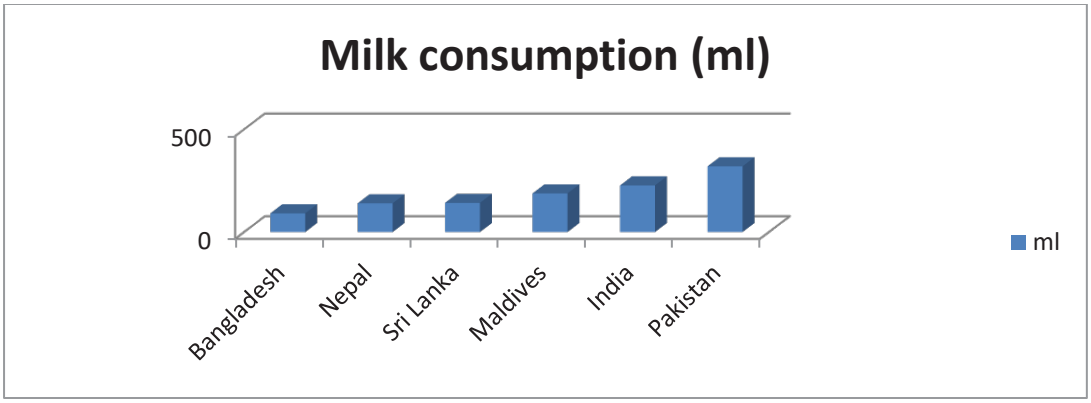


Figure 6 Comparison of milk consumption among SAARC countries.

Among the SAARC countries, Bangladesh is the lowest in consumption of milk per person per day.

Estimation of DLS reveals that existing production of milk, meat and egg against demand is around **43 %, 67% and 64%** respectively. Therefore, a pragmatic livestock policy with immediate, medium and long term action plan to address the situation is necessary.

Demand and supply of livestock Products for its population 153.60 million (As on July 2013) is presented below:

Table 15 Demand, Production and availability of Livestock products

Products	Demand	Production	Availability	Deficit
Milk	14.02 million MT	6.09 million MT	108.66 (ml/day/head)	7.93 million MT
Meat	6.73 million MT	4.52 million MT	80.64 (gm/day/head)	2.21 million MT
Egg	15974.4 million	10168.00 million	66.20 (numbers/year/head)	5806.40 million

Source: DLS- 2013-14

The milk production was increasing slowly up to 2007-08. In the year of 2008-09 and 2009-10 it was decreasing. Thereafter in the year 2009-10 and 2010-11 milk production increased by 25% and 17.3% respectively, which is the highest increment rate during the last ten years. Yearly milk production and its growth rate are shown below:

Table 16 Yearly milk production and its growth rate (%) in Bangladesh

Year	Milk	
	Production (MMT)	Growth rate (%)
2002-03	1.82	-
2003-04	1.99	9.34
2004-05	2.14	7.54
2005-06	2.27	6.06
2006-07	2.28	0.44
2007-08	2.65	16.3
2008-09	2.29	-13.9
2009-10	2.36	3.06
2010-11	2.95	25.0
2011-12	3.46	17.3
Average growth rate for 10 years (%)		7.11

Source: DLS-2013; **(**Adopted from M A Hamid and KM Hossain-2014).

Deficiency of dairy product is largely met by import of milk powder and cream from abroad. The country loses huge amount of foreign currency every year which is about USD 93.4 million (Bangladesh Bank 2012-13).

Table 17 Yearly powdered milk and cream import status of Bangladesh

Years	Amount (MT)	Cost (million USD)
1999-2000	16,000	60
2000-2001	19,000	62
2001-2002	20,000	59
2002-2003	18,600	61
2003-2004	16,250	57
2004-2005	17,600	86
2005-2006	51,500	73
2006-2007	58,500	83
2012-2013	20,000	93.4

Source: Haque (2005); Bangladesh Bank- 2013;

9.5. Long term projection of Demand and supply

Long term projection of demand and supply of livestock products has been shown in the table below. The projection of population growth is as per World Bank/UN estimation. Demand estimation has been calculated based on the DLS-recommendation for milk: 250 ml/day/person (according to the national health strategy); for meat: 120 gm/day/person or 43.8 kg/ year/ person (WHO and FAO's joint survey on health standards) and for eggs: 104 Numbers/year/ person (FAO recommendation).

Table 18 Estimated demand for Milk, Meat and Eggs for the growing Population up to 2100

YEAR	Projected Population (million) (WB/UN)	Demand for Milk (based on 250 ml /person/day), Million MT	Demand for Meat (based on 120 g /person/day) Million MT	Demand for Egg (based on 104 eggs/person /year) Million
2015	160.41	14.64	7.03	16682.74
2020	169.57	15.47	7.43	17634.86
2025	177.89	16.23	7.79	18500.04
2030	185.06	16.89	8.11	19246.66
2035	191.04	17.43	8.37	19868.37
2040	195.86	17.87	8.58	20369.54
2045	199.51	18.21	8.74	20749.46
2050	201.95	18.43	8.85	21002.59
2055	203.34	18.55	8.91	21146.84
2060	203.70	18.59	8.92	21184.90
2065	203.10	18.53	8.90	21122.50
2070	201.59	18.40	8.83	20965.36
2075	199.28	18.18	8.73	20725.33

YEAR	Projected Population (million) (WB/UN)	Demand for Milk (based on 250 ml /person/day), Million MT	Demand for Meat (based on 120 g /person/day) Million MT	Demand for Egg (based on 104 eggs/person /year) Million
2080	196.34	17.92	8.60	20419.05
2085	192.97	17.61	8.45	20068.78
2090	189.37	17.28	8.29	19694.38
2095	185.75	16.95	8.14	19317.48
2100	182.24	16.63	7.98	18952.75

The demand for milk, meat and egg will increase with the population growth.0.44 million MT of milk,0.21 million MT of meat and 45.64 million number of eggs will be required on average in every 5 years period up to 2060. The quantity of demand will start declining after 2060 at an average rate of 0.25 million MT for milk, 0.12 million MT for meat and 25.48 million number of eggs in every 5 years time.

The demand for milk, meat and eggs can be met in two ways:

(1) Through importing the products

(2) Through increasing the productivity of livestock

Importing livestock product must not be recommended because it is a very temporary and risky solution of the problem. It will deprive the nation from employment of millions of people and much more people will lose their livelihood options and means of sustenance. Import will increase dependability and the nutritional situation of the country will be at high risk. With the import of livestock and livestock products, the risk of importing deadly diseases may have to be experienced.

Therefore, measures to increase the domestic productivity are very important and should pay due attention.

Recommendations:

1. Immediate measures need to be taken to increase the livestock productivity to meet the expanding demand of the increasing population.
2. Imposing import tax on livestock product will discourage import and the farmers will be encouraged in rearing livestock.
3. Support to smallholders in livestock rearing is the best way to generate employment opportunities and production.
4. Immediate action is necessary to remove the constraints of smallholders in livestock rearing.
5. Support to small and medium size livestock and poultry unit should be emphasized instead of large business enterprises.
6. Private sector large companies should be encouraged and supported for producing inputs like feed, medicines, vaccines and biological products, genetic stocks and materials for the small and medium size enterprises. All possible support should be extended to them also for processing and exporting livestock products, (large companies must not compete the smallholders and medium entrepreneurs with their products in the domestic markets)
7. Reasonable price for inputs and livestock products need to be ensured.

Poultry industry can grow through vertical expansion and also minimize the requirement of land. Despite many problems viz. Avian Influenza threat, soaring prices of feed, erratic prices of Day old Chicks and other accessories, absence of proper marketing net-work, the sector is moving forward.

9.6. Livestock situation in some Hydrological-Regions of Bangladesh

Bangladesh has been divided into Eight hydrological Regions. Although the people of each of the regions traditionally rear almost all livestock and poultry species, but the people of these regions have been facilitated by the nature for rearing particular species at a large numbers. For example, People of North-East (Haor) region prefers duck rearing due to abundance of natural feed in the water bodies. Not only that, duck facilitate transplantation of rice plants eating up small snails coming in a large volume with the flush flood originating from hill areas of Assam province of Indian territory. Otherwise, it would have been difficult to transplant rice plants in the field of farmers in haor areas. The ducks also help them by weeding of aquatic plants and eating algae from their field. Further, duck droppings in the field is a good source of organic fertilizer, it also controls insects by eating up them. For these reasons, duck raising practice in haor areas are popular. Similarly the buffalos in coastal areas are popular for tillage of muddy soil that the native cows cannot perform properly. Besides, the buffalos are more tolerant to harsh environment of coastal regions than other species of livestock. Buffalos are more productive than indigenous breed of cows.

9.6.1. North-East Region (Haor areas)

Haor areas covering 8 districts located in the North-Eastern part of Bangladesh has been elaborate studied by CEGIS, a public trust organization and a Master plan has been formulated. In the study, it has been found that almost every family has at least 1 cattle or goat and few chicken or ducks. There are few commercial dairy and poultry farms having about 10-50 cattle and 100-1000 chicken. Duck farming is very popular and majority of the people particularly landless and marginal farmers have advantage of rearing ducks in the area. The intensity of duck farming is mostly in three Haor districts- Netrokona, Kishoreganj and Sunamganj. District wise population of livestock resources is presented below:

Table 19 District wise livestock population (2010-2011) in Haor Areas (in thousands)

District	Cattle	Buffalo	Goat	Sheep	Duck	Poultry	Pig	Horse
Sylhet	856	63	157	54	953	3,940	0	-
Moulovi- Bazzar	533	147	133	14	440	1,809	1	0
Habigonj	519	9	143	39	1,165	976	3	2
Sunamgonj	1,345	25	214	44	1,969	1,168	0	-
Netrokona	603	3	230	10	2,811	2,322	4	-
Kishorgonj	667	29	304	25	1,631	3,829	-	-
B. Baria	483	3	111	22	776	2,104	-	-
Total 7 districts:	5,006	279	1,291	208	9,745	16,148	-	-

Source: DLS, Bangladesh.

A large number of livestock are reared in haor areas but constrained by flash flood causing inundation of large areas and crop lands during monsoon. As a result, shortage of feed (crop residues), reduction of grazing facilities seriously affect livestock rearing. Small holders are to depend on water hyacinth and other aquatic plant for their cattle during this season. All of livestock species suffer much during this season.

Large number nomadic types of duck rearer are found in haor areas. During monsoon, they had to transfer their flocks in peripheral areas to avoid getting lost with the water flows, wind driven wave of high magnitude and also due to problems in collecting natural feed particularly small snails (commonly known as "Googly shamuk") coming from the hilly areas of the North. One point of interest to note that a large flock does not have male ducks because it causes split up of the flock into several groups headed by the male ones resulting management problem of the flock and chances of getting lost.

However, a well-planned flood control and irrigation system may save the crops of thousands of acres and also serve as the protection of their livelihood options of rearing livestock.

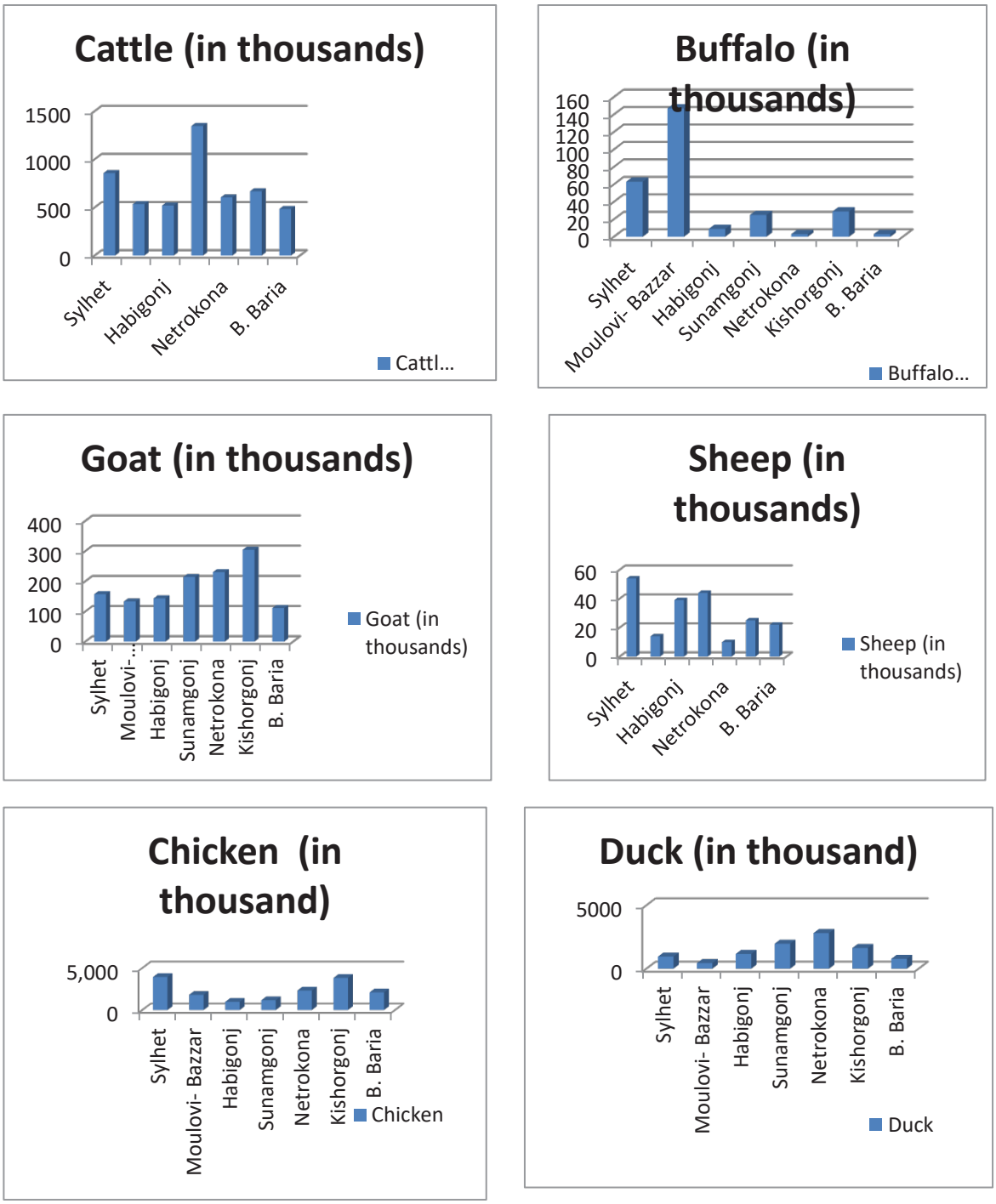


Figure 7 District wise livestock and poultry birds concentration in haor areas

9.6.2. South, South-West and South-East Regions (Coastal areas)

Coast line of Bangladesh is about 710 km. One third of the country is belonging to coastal area. And the population is about 35 million (about one fourth of total population in the country) Coastal zone is rich in many natural and socio-economic resources such as: Agricultural land, Livestock, Forest, Fisheries, etc. Three fourth part of coastal population

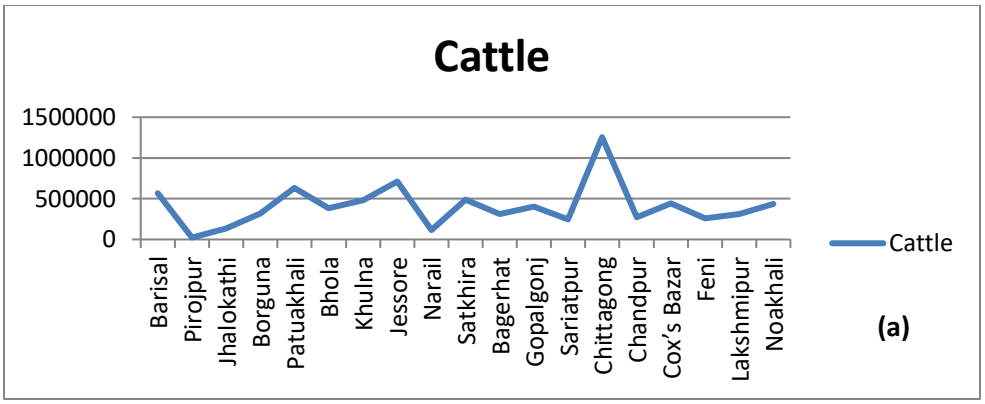
are belonging to poor livelihood. Livelihood is influenced by a number of natural hazard and socio economic factors such as tropical cyclone, storm surge flood, River and sea beach erosion, water logging, intrusion of saline water, soil salinity, etc. Rearing cow/goat/sheep and chicken/ duck/ geese/ pigeon etc. are very common in rural families. District wise population of livestock resources in coastal area is given below:

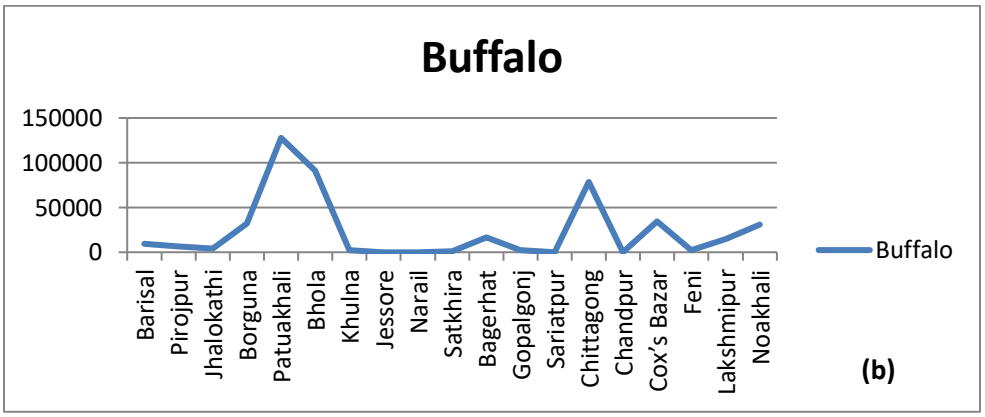
Table 20 District wise livestock population (2011-2012) in Coastal Areas

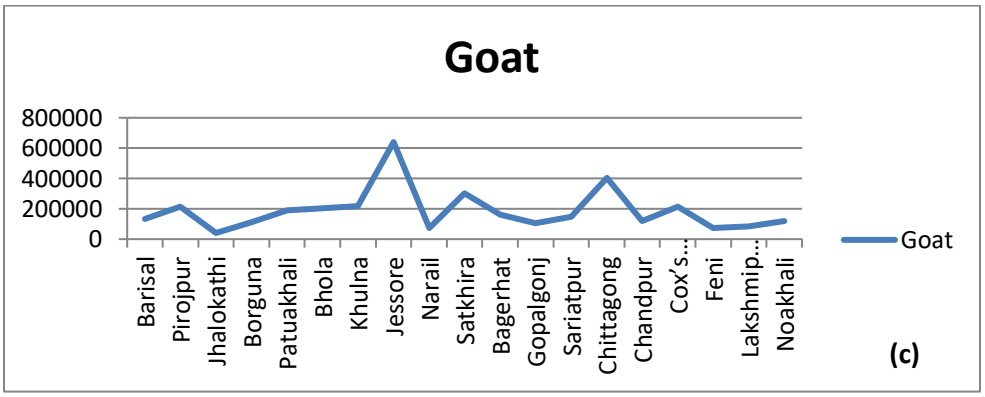
District	Cattle	Buffalo	Goat	Sheep	Pig	Duck	Chicken	Pigeon
Barisal	563422	9556	134616	3132	365	669423	3660318	98171
Pirojpur	22363	6713	212790	10949	0	980161	1341162	39936
Jhalokathi	137887	4165	40756	2648	45	564553	3163574	86678
Borguna	317955	32008	112873	1602	51	436156	1441551	128424
Patuakhali	632618	127774	188268	11330	54	1870914	3749894	88632
Bhola	383934	90827	205030	13405	0	1345646	2179917	245782
Khulna	479006	2561	219153	22926	9000	833005	5002723	103422
Jessore	710440	83	639920	7265	22293	802840	4055388	275758
Narail	115869	98	72944	1777	949	177269	743148	38207
Satkhira	486118	1117	302841	46061	3665	329997	4369188	14000
Bagerhat	312714	16424	161549	1618	3625	445715	3154607	3625
Gopalgonj	405000	2000	105000	3572	171	707000	1767000	26000
Sariatpur	246543	0	149023	717	0	558574	2242616	27847
Chittagong	1254660	78503	404640	50910	1235	562680	7779790	99600
Chandpur	272433	0	118907	1885	55	940170	1507946	34347
Cox's Bazar	445311	34648	215656	20015	62	215400	1740117	11591
Feni	257205	2504	72302	2010	20	728502	2549254	28459
Lakshmipur	308422	14495	85199	3420	0	686774	2346510	74543
Noakhali	438906	31069	119383	15706	60	1928397	3665643	22253
Total: 19 districts	7790806	454545	3560850	220948	41650	14783176	56460346	1447275

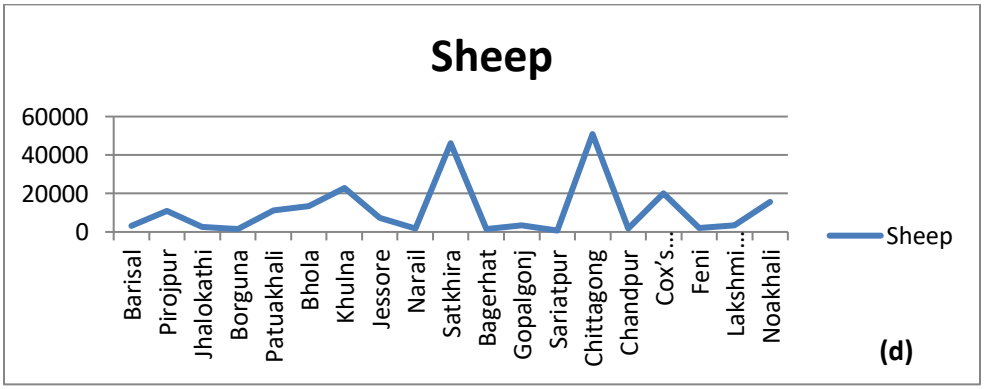
[Source: DLS, Bangladesh]

Coastal areas are very potentials for livestock rearing particularly cattle and buffalos. During early eighties the southern part of Khulna, Bagerhat and Satkhira districts had enough naturally grown grasses inside the polder. The land inside the polder had been cultivated for a single crop in a year. Therefore, there were enough grazing facilities and the rich and middle class farmers had large herd of cattle and buffalos. But the reduction in number started with the intrusion of saline water and logging of saline water inside the polder. Intrusion was due to damage of the polder occurred due to successive cyclone led tidal surges in 1991 and onwards and also induced for shrimp culture by the influential land owners and making the small or subsistence farmers compelled to allow their lands for shrimp culture activities.


Cattle
1500000
1000000
500000
0
Barisal
Pirojpur
Jhalokathi
Borguna
Patuakhali
Bhola
Khulna
Jessore
Narail
Satkhira
Bagerhat
Gopalgonj
Sariatpur
Chittagong
Chandpur
Cox's Bazar
Feni
Lakshmipur
Noakhali
Cattle
(a)


Buffalo
150000
100000
50000
0
Barisal
Pirojpur
Jhalokathi
Borguna
Patuakhali
Bhola
Khulna
Jessore
Narail
Satkhira
Bagerhat
Gopalgonj
Sariatpur
Chittagong
Chandpur
Cox's Bazar
Feni
Lakshmipur
Noakhali
Buffalo
(b)


Goat
800000
600000
400000
200000
0
Barisal
Pirojpur
Jhalokathi
Borguna
Patuakhali
Bhola
Khulna
Jessore
Narail
Satkhira
Bagerhat
Gopalgonj
Sariatpur
Chittagong
Chandpur
Cox's...
Feni
Lakshmip...
Noakhali
Goat
(c)


Sheep
60000
40000
20000
0
Barisal
Pirojpur
Jhalokathi
Borguna
Patuakhali
Bhola
Khulna
Jessore
Narail
Satkhira
Bagerhat
Gopalgonj
Sariatpur
Chittagong
Chandpur
Cox's...
Feni
Lakshmi...
Noakhali
Sheep
(d)

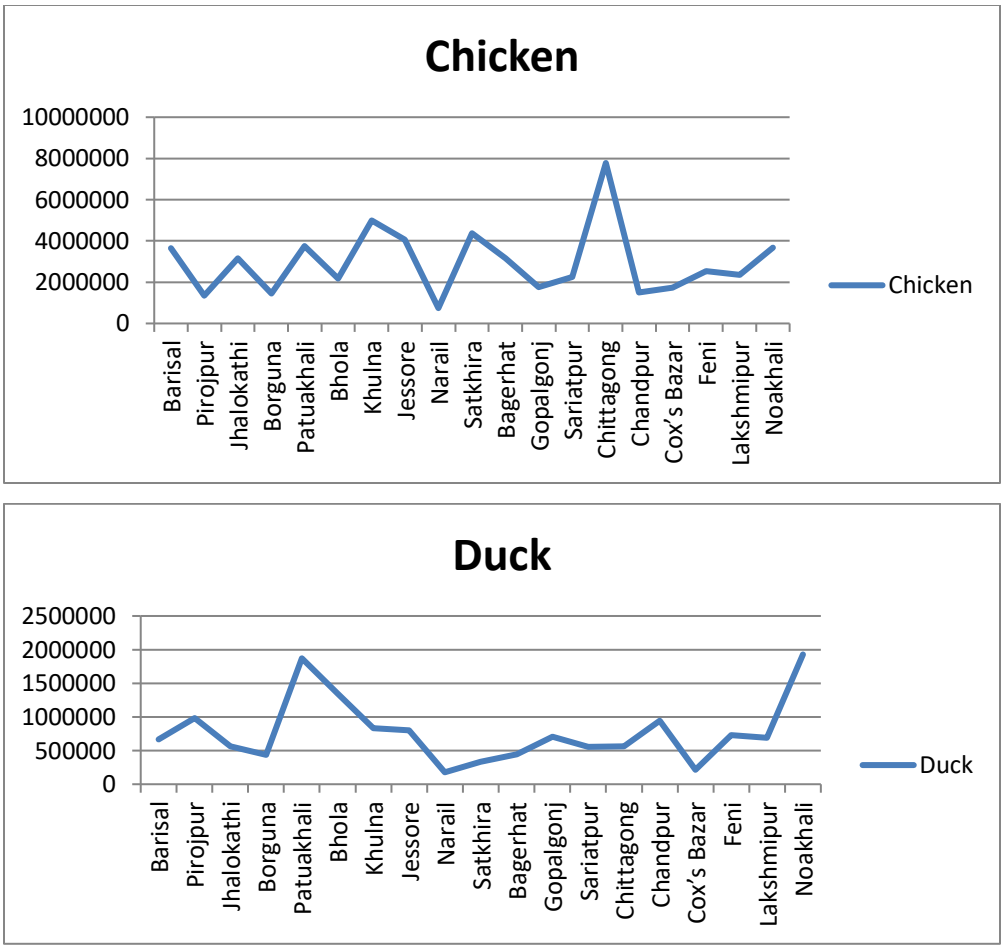


Figure 8 District wise livestock concentration in coastal districts

CHT is a unique zone for the control of Livestock diseases and quite suitable for export oriented livestock and livestock processing industries.

However, alongside the shrimp culture practices, there are great potentials of making the coastal zone as a hub of cattle and buffalo rearing by adopting appropriate policies for creating pasture for grazing of cattle and buffalos inside the polder and in the newly formed char lands because the people of coastal regions of Barisal, Khulna and Chittagong divisions are traditionally habituated in cattle and buffalo rearing. The facilities for livestock rearing will create opportunities of employment for thousands of people in coastal regions in addition to the valuable protein food for the country

9.6.3. Eastern-Hill region (Chittagong Hill Tracts)

Chittagong Hill Tracts (CHT) is a unique area of Bangladesh having an area of 13,295 sq. km with about 1.7 million people. It is rich in biological and cultural diversity. The agricultural practices and livelihood pattern is different from other part of the country.

The present challenges as identified by FAO in CHT are;

1. Land and population pressure
2. Water scarcity in dry season
3. Extreme remoteness
4. Weak market linkage

5. Degradation of natural resources.

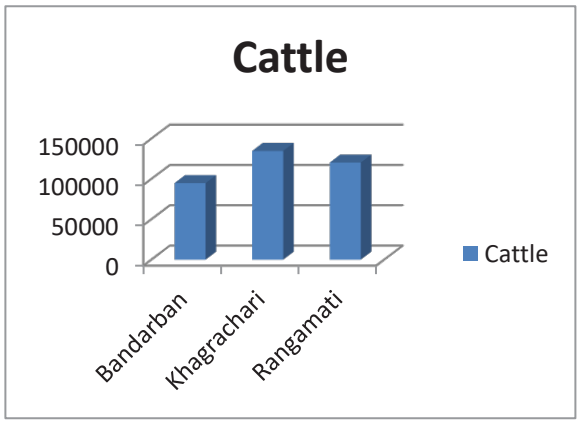
Land and population pressure signifies the need for other option of livelihood in the area. Livestock and poultry farming may be the most suitable option because livestock rearing is very common and traditional among the rural farm families and is an integral part of their agricultural practices and require very little space in comparison to other agricultural activities. The livestock population in the hill districts is presented below:

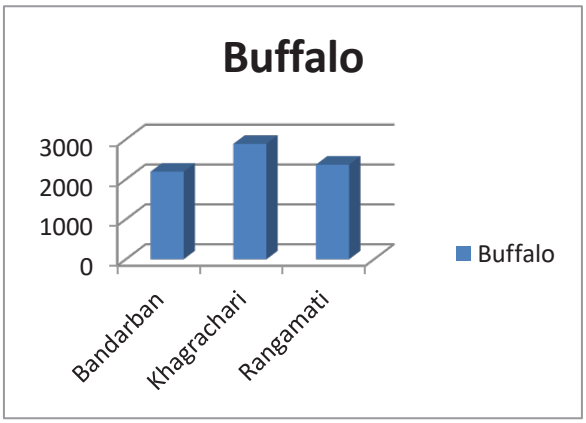
Table 21 Livestock Population in Chittagong Hill Tracts

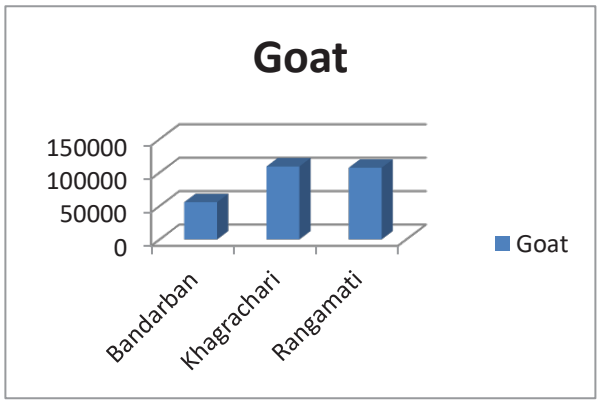
District	Cattle	Buffalo	Goat	Sheep	Chicken	Duck	Pigeon	Pig
Bandarban	94882	2194	55763	1534	468194	26899	9162	-
Khagrachari	134814	2890	109211	3349	851344	69843	13823	-
Rangamati	120388	2370	107250	2797	811108	78319	9167	-
Total:	350084	7454	272224	7680	2130646	175061	32152	-

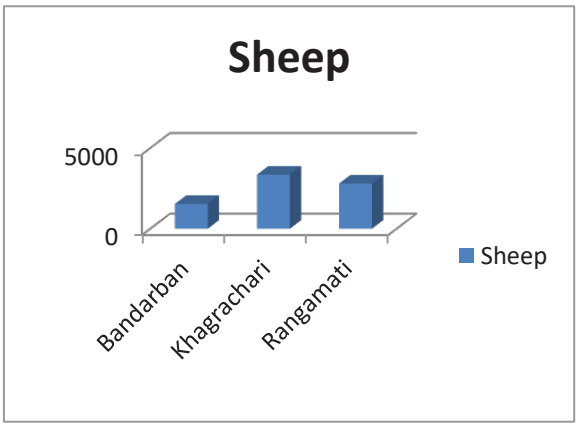
[Source: BBS- Agricultural Census 2008]

The population size of livestock in CHT clearly indicates their demand and necessity of livestock rearing in the area but constrained by adequate rearing knowledge, extension and veterinary services, absence of marketing facilities due to remoteness. A well planned policy to improve the situation will encourage more people to rear cattle, goat, sheep and poultry birds that help improving their livelihood and nutritional status.









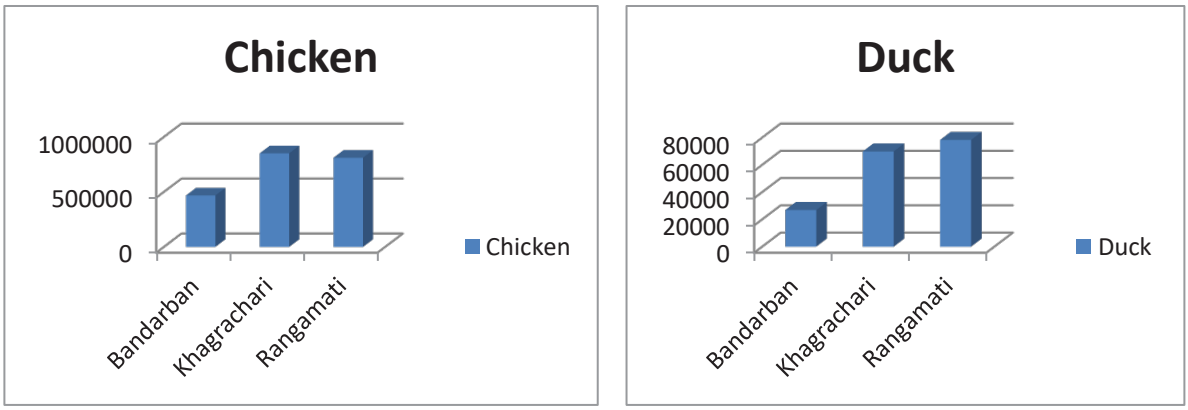


Figure 9 Species wise livestock concentration in CHT districts

9.6.4. A brief account of native livestock species with their genotypic traits

Cattle: Cattle dominate the livestock population in Bangladesh, accounting for about 60% of the total stock. The indigenous (deshi) animal is a small non-descript *Bos indicus* type, with three main types large deshi, small deshi, and Red Chittagong. The mature body weight is between 125-200 kg. The slow growing, shy breeding animals average age at first calving is 45 months and have lactation period of about 7 months, Average milk production is 300-450 litre per lactation (about 1-2. litre in a day) with about 4.5-5.5 percent milk fat. First Calving is about 33 Months to 40 Months. Inter-calving period is about 18-24 months. In areas with the increasing cropping intensity and the greater need for timeliness in land cultivation, the demand for draft power is increasing; to meet the demand cows are being harnessed to the plough. Small local breeds of cattle are preferred because easily housed within the limited homestead space and easily managed by women and children. Despite significant increase in use of power tillers since early nineties, the use of cattle as one of the source of draft power for agricultural operations is still vital.

On the other hand the cross bred cows' produce about 2000-2500 litres per lactation period of 280-305 days. (About 7-8 litres per day; depending on the genetic make-up at F_1 or F_2 generation and also management condition) Inter calving period is 14-16 months; Jersey cross / HF cross Age at first calving 26-28 Months Inter-calving Period 14-16 months Milk fat 3.5-4.5 per cent.

Under these circumstances milk, meat and hides are largely by products of the draft herd. The average daily yield of milk is little over one litre per cow.

Buffalo: Buffalo in Bangladesh is mainly indigenous in origin and most of them are riverine type and some are swamp type in eastern part of the country and have low productivity. There are also some cross breed with Murrah, Nili-Ravi, Surti and also Jaffrabadi in some border districts. They thrive well in marshy and swampy lands. A preferred species as they are better adopted to plough the mud flats, consume coarser roughage that grows in the newly accreting chars and in the forests. They can tolerate more salinity than cows and are more resistant to disease. In the new estuarine chars in coastal region the buffaloes are kept in large herd of 50 to 250 under care of herdsmen. The buffaloes found in the coastal region are Indian water buffalo type, mature body weight is 350-450 kg and are seasonal breeders and come in heat in post monsoon months with the increased availability of fodder in the chars and calve in spring. The average milk yield about 2.5 to 3 kg per day and lactation period is 7 to 8 months.

Buffalo milk contains more fat and solid not fat (SNF) than cow's milk and are preferred by local people for making ghee (Clarified butter) and curd. There is scarcity of quality stud buffalo bulls and very little tangible improved breeding and management practices have been initiated in the country.

Goat: The major breed of goat is the Black Bengal. The breed is famous for its high prolificacy, tender meat and skin quality. The Black Bengal goat is well adapted to hot humid climate and produces twins and triplets even more and have the potential of being developed all over Bangladesh. The average live weight of adult goat is 16 to 18 Kg. Goats are reared by marginal and landless households. Children and women are involved in taking care and it is considered as an important activity in the existing integrated small holder farming system. The marginal and landless households prefer goat rearing for its small capital investment, simple housing, easy management, graze on fallow lands after crop harvest, selectively nibble weeds in weed infested and planted rice crop during mid-stage or are tethered along the road sides and embankments. The goat can survive on tree leaves of different species frequently seen in the estuarine villages. The goats mature at an early age and it has a short gestation period and generation interval. Goat meat sales at higher price than beef and the milk are easily digestible by children and the old due to less fat content. The kids are reared as household pets.

Marginal and landless households with limited access to feed the large ruminants but having opportunity to obtain green grass and palatable leaves round the year and having idle manpower to take care may be promoted for goat rearing to generate the flow of family income. Women groups mainly destitute and widows may be involved to take up goat rearing activity.

Sheep: Sheep found in the coastal area are coarse wool type, small in size about 10-12 kg adult live weight and well adapted to the saline environment. In some households preferred sheep to goats for their selective browsing on the leftovers of cattle and buffalo and considered less menacing than goat. These are reared mainly for meat purposes.

Chicken: Most of the households in Bangladesh rear chicken. Generally they live on a scavenging feeding and seldom receive much supplementary feeds. The local 'deshi' types is poor egg producer and lays 40-50 eggs in a year with a characteristics of pronounced brooding. The indigenous deshi birds are small in body size of about 1-1.5 Kg and well adapted under scavenging condition and more resistant to common diseases than exotic breeds and are better able to protect from predators. The local birds are ideal for natural brooding. However, in a semi scavenging system and balanced feeding practices have shown to increase income of smallholder poultry rearer in some parts of the country.

Duck: Like chicken duck rising is widely practiced by the housewives in the area especially in the village areas, having large member of ditches that favours natural growth of fresh water snails and duck weeds are ideal for duck rising on commercial basis but large flock is not suitable because of the natural feed shortage during the dry months. The fresh water snails do not survive during the post winter salinity and this increase the cost of supplementary feeding. However, a few 'Khaki Campbell' is seen all over the country. The 'Deshi' type produce 100-150 eggs per year and are resistant to many diseases than the chicken.

9.7. Review of Institutions

9.7.1. Department of Livestock Services (DLS)

Department of Livestock Services under the Ministry of Fisheries and livestock is responsible for conservation and development of livestock in Bangladesh for production of valuable protein food for human. Department of livestock Services is one of the oldest department in this country inherited from British India. Over the period of time the country has made remarkable progress in some of the areas, e.g. Crop agriculture and supplementary sectors. But due to age old neglect and low priority, the development of livestock sector was not visible since nineteen nineties. Due to the realization of diversified impact of the importance of sector, in nineties and afterwards, a good number of development programmes have been taken up infra-structure facilities created and the sector has been contributing very significantly in the national economy by producing valuable protein food, milk, meat, eggs for health and nutrition, employment generation for the vulnerable women, unemployed youth and rural poor to reduce poverty. The sector has now transformed from traditional system to a commercially viable one.

Man-power and infrastructural facilities:

Department of Livestock Services is the public sector major player in livestock development in the country having 1,556 officers including 1,471 Doctor of Veterinary Medicine/ Animal Husbandry graduate officers and 6,829 other sub-technical and support staff. Over the years created some infrastructure facilities with its Head Quarter in Dhaka, seven Divisional offices, 64 District and 589 Upazila Livestock Development Complex (ULDC). The department has one Central Disease Investigation Laboratory (CDIL), seven Field Disease Investigation Laboratory (FDIL) and 24 (6 functioning and 18 is underway) quarantine stations. The ULDC is the nearest service delivery window for the rural farmers. The Department also have 61 District Veterinary Hospital. The DLS has one Central Animal Nutrition Laboratory, one Feed Mill. DLS has 2 Veterinary Training Institute (VTI), 2 Livestock Training Institute (LTI), one Officers Training Institute (OTI) and Two Veterinary Colleges, DLS has Two Vaccine Production Institutes /Livestock Research Institute (LRI) producing essential vaccines for ruminant and poultry.

For the Artificial Insemination (AI) Services, DLS manages one Central Bull Station and semen processing laboratory, one Regional Bull Station, 21 District AI centres with liquid semen processing facilities and 466 AI sub centres in the ULDC. The AI sub centres at Upazila headquarters operate 3,151 AI points in the Union level.

In addition, DLS manages two Zoos, 7 Dairy Farms, 5 Goat Farms, one Sheep Farm, one Pig Farm, 31 Poultry Farms, 14 Duck Farms.[Source: DLS 2014]

DLS has started eradication programme on Rinderpest (Cattle Plague) the most formidable killer disease of cattle in early sixties from this country and eradicated successfully and obtained the recognition of World Organization for Animal Health (OIE) in 2010. The sporadic incidence of Anthrax and Black Quarter (BQ) are also partly contained through organizing ring vaccination program. The DLS is currently producing more doses of Anthrax and BQ vaccines for a successful protection. However, production of vaccines against Foot and Mouth Disease (FMD), an economically important disease of ruminant is not enough to cater the total national demand.

9.7.2. Union Parishad Complex

The Union Parishad (UP) Complex belonging to the Ministry of Local Government, Rural Development and Cooperatives (LGRDC) is an important infrastructure facility to meet the demand for services of the rural people; the facility is not proactively utilized by the DLS due to shortage of manpower and budgetary constraints. Considering the importance of extension services, DLS along with DAE and DoF has established 732 Farmer's Information and Advice Centre (FIAC) in 120 Upazila through National Agricultural Technology Project (NATP). These FIACs are attended by 1280 Community Extension Agent for Livestock (CEAL).

Another important area to work of DLS with LGED is the construction of 'Safe shelter' (Killa/Earthen Mound) with each 'Multi-purpose Cyclone Shelter' to protect the animal resources during tropical cyclonic storm and tidal surge. Death of animals in huge number during cyclone led tidal surge has been experienced in the past in the coastal areas and off shore islands. UP complex may be utilized fully and be a focal point for providing services to the rural people.

9.7.3. Bangladesh Livestock Research Institute (BLRI)

This institute was established in 1984 by a Presidential Ordinance. Mandates of the Institute are to: identify livestock and poultry production constraints at the national and farm level, solve those problems through multi and inter-disciplinary and inter-institutional research and to develop technologies to help food and nutrition security for the increasing population, poverty alleviation, employment opportunities, income generation and control of environmental pollution.

This institute is operating its functional activities through the following divisions with their relevant mandates.

1. **Animal Health Research Division:** Mandate of this division is to develop and maintain a rapid diagnostic capacity for key diseases, develop and test new vaccines, conduct research in the area of exotic/ emergent diseases, provide

training in emergent diseases recognition, preparedness and control techniques. Maintain the highest level of microbiological security.

2. Animal Production Research Division with its 3 sections:
   i) Animal Genetics, Breeding and Reproduction.
   ii) Nutrition and Feed Biotechnology,
   iii) Forage Production and Development
3. **Goat and Sheep Production Research Division.**
4. **Poultry Production Research Division.**
5. **Socio-Economic Research Division.**
6. **Farming System Research Division.**
7. **Training Planning and Technology Transfer Division.**

The Division wise approved research projects during 2013-14:

Poultry Production Research Division:

i) Conservation and improvement of Native Chicken.
ii) Conservation and improvement of Quail.
iii) Conservation and improvement of Duck Germplasm of BLRI.
iv) Maintenance and conservation of Shuvra Parent and promotion of Shuvra
v) Field Trial of BLRI Layer-2 (Shorna)
vi) Moringa Leaf meal as natural feed additives on the growth performance and meat quality of commercial Broiler chicken.
vii) Screening and development of vitamin mineral premix suitable for poultry.
viii) Omega-3 enriched chicken eggs through dietary manipulation**.**
ix) Development of two stage Probiotic mixed fermented feather meal and its performance evaluation on chicken.

Animal Production Research Division:

i) Selection of suitable Beef breed(s) and performance evaluation of their crosses with native cattle.
ii) Study on candidate genes for milk production traits of Red Chittagong cattle (RCC)
iii) Study on red meat quality and diversification of value addition technology.
iv) Study on improving feed efficiency of Pubna and RCC bulls.

Animal Health Research Division:

i) Monitoring of HPAI Virus circulation in Bangladesh and in vitro expression of viral protein.
ii) Study on efficacy, Potency and safety of BLRI developed enterotoxaemia toxoid.
iii) A Pilot Project on Peste des petits ruminant (PPR) control in selected areas of Bangladesh.

Farming System Research Division:

i) Accelerating Technology Transfer through farmers training, field demonstration.

Socio-economic Research Division:

i) Impact assessment of different interventions on dairy farming in a selected area of Bangladesh.

Training, Planning and technology Testing Division:

i) Evaluation of Existing Livestock and Poultry Development Policies and provide guideline for development in Bangladesh.
ii) Value chain analysis of processed poultry products (Egg and meat) in some selected areas of Bangladesh.
iii) Livestock marketing in most peripheral areas of Bangladesh- A base line study.

Goat and Sheep production Research Division:

i) Development of Boer x Jamunapari goat.
ii) Selection and Breeding of native sheep and development of lamb production package.
iii) Improvement of Black Bengal goat through selective breeding.

Development Projects of BLRI

1. Buffalo Development Projects
2. Fodder Research and Development Project.
3. Conservation and improvement of native sheep through community farming and commercial farming.
4. Research on FMD and PPR in Bangladesh Project.
5. Strengthening research and on farm trial programme of BLRI Regional station Project

Man-power of BLRI:

As per organogram of the BLRI, the institute comprises 201 Man-power of which Class-I category 90 posts, Class-II category 6 posts, Class-III category 60 posts, and Class-IV category 45 posts.

Class-I category 90 posts are: DG-1, Additional Director-1, Chief Scientific Officer (CSO)-6, Principal Scientific Officer (PSO)-9, Senior Scientific Officer (SSO)- 24, Senior Training Officer (STO)-1, System Analyst-1, Executive Engineer-1, Assistant Engineer-1, Scientific Officer-40, Asst. Director-1, Accounts Officer-1, Publication Officer-1, Information Officer-1, Librarian-1). Class-II, III and IV are mainly support staff (111 posts).

Major Achievements of BLRI:

BLRI has been continuing its effort on different aspect of livestock and poultry research. The institute has a lot of achievements and most of them are yet under field trials. To date, 53 technologies including 17 programmes to improve livestock resources production systems through coordinating of two or more developed technologies have been developed. Some of the major achievement is given below (from Report of MoFL):

Programmes to improve livestock resources production system have been developed based on the research result obtained from epidemiological study of bacterial, viral and parasitic diseases which are widely prevalent in Bangladesh.

Epidemiological study of bacterial, viral and parasitic diseases:

- Development of PPR vaccine for goats;

- Salmonella vaccine of poultry production system; and also

- FMD control system of cattle.

Development of herbal medicine for prevention and control of livestock and poultry diseases:

- A garden of medicinal plant has been established and research is going on to investigate their effectiveness.

Development of Breed technologies for increasing livestock productivity:

- BLRI-Beef-1 breed has been developed through selection of indigenous cattle for increasing meat production.
- Two breed of ducks have been developed through selection from indigenous ducks and now under field trial.
- Most recently developed a promising layer poultry breed “SHORNA” and is now under field trial.

Feeds and Fodder:

- BLRI developed Napier-1, 2 & 3 High yielding green forage
- Silage technology has also been developed for supplying fodder during lean seasons.

10. Public Sector Involvement

Ministry of Fisheries and Livestock is the administrative Ministry for Livestock and fisheries. This Ministry has the control over all public agencies involved in the livestock production, Extension, Research, and livestock related services. Department of Livestock services (DLS) are responsible for all livestock related activities in the country. It is the executing agency and regulatory body to carry out and oversee the livestock related extension services, Veterinary health services, Disease Prevention and curative services, Regulatory services for livestock production activities, Public health issues, Registration and licensing authority of Dairy and Poultry farms, Wild life issues, Training of farmers, Human resource development in livestock sector, Animal Breeding activities, etc.

Bangladesh Livestock Research Institute is responsible for carrying out livestock and poultry related research on their every aspect such as; production, Disease prevention and control, vaccine for animal and poultry diseases, demand led research work, etc.

The Agricultural Universities, Veterinary University, Training institutes, and Govt owned farms are also public sector agencies for Education, Training, Research and livestock input production as well as service providing activities.

Not all, but a lot of other Ministries, public sector organizations/ agencies are also involved directly or indirectly in Livestock development activities through facilitating the process of livestock related activities, such Ministries and agencies are; Ministry of Agriculture, Ministry of Local Government and Cooperatives, , Ministry of Industries, Ministry of Commerce, Ministry of Finance, Ministry of Health, Ministry of Law; Agricultural Universities, University of Science and Technology, Nationalized Commercial Banks and financial institutions, Department of Fisheries, Department of Agricultural Extension, Department of Youth Development , Bangladesh Rural Development Board (BRDB), Department of Agricultural Marketing, financial institutions like PKSF, etc.

10.1. Private sector/ NGOs involvement

NGOs are involved in livestock development activities and are playing the important role through providing micro-credit to small holders, providing extension services and training and input supply. The major player like Char Livelihood Program (CLP) and some others have invested large amount in cattle, goat/sheep/ chicken and duck in terms of direct asset transfer to the extreme poor beneficiaries. Breed development, feed production and supply, providing extension and veterinary services, including vaccination are being performed by the NGOs in addition to the DLS support in these services.

In the private sector, there were 60,669 Dairy farms, 3834 Goat farms, 3473 Sheep farms, 78,171 Poultry Farms have been registered with the Department of livestock Services up to February 2014. (as stated in the provisional report of Bangladesh Economic Review 2014). But practically there are much more remains un-registered due to lack of awareness of the farmer. The stated farms are mostly of very small size having 5-20 dairy cattle, or 10-20 goats or similar numbers of sheep. The poultry farms are small medium and large size as per country's standard specification.

The private sector involvement in different areas of livestock services are mainly: Feed manufacturing; Veterinary medicine and drug manufacturing; Poultry and dairy equipment and appliances manufacturing; private diagnostic services for different diseases; Poultry hatchery operations; maintaining and selling breeding stock of poultry birds; dairy and poultry production; dairy and poultry product processing and marketing; trading (export and import); marketing of feeds and feed ingredients, veterinary medicines, dairy and poultry products, machineries, equipment and appliances, etc.

Around 120 private sector poultry farms and hatcheries produce hybrid day old chicks, broilers and concentrate feed usually to support small-scale commercial poultry farms located in the urban and peri-urban areas.

There are about 25 pharmaceutical companies in Bangladesh. They have expanded their market by 15-20 per cent annually and the quality of vaccines is found to be effective compared to similar vaccines provided by DLS. They either manufacture or import livestock drugs, vaccines, sera, premix and vitamins and the customers are mostly small-scale commercial livestock entrepreneurs and some smallholder farmers. These firms provide farmers in the country with drugs, vitamins and feed pre-mixes within almost all livestock categories.

A few of NGOs and private enterprises are:

Non-Government Organization (**NGO)** having livestock related activities are: BRAC, RDRS, Proshika Concern, Practical Action, Uttaran, Sachetan, Pallisree, Ashray, Help Age, Asha, CCDB, PMUK, UDDIPON, BEES, GUP, HEED, TMSS, PBK, PMK, Swanirvar Bangladesh, VERC, Sajag, SSS, PPSS, ESDO, Coast Trust, VARD and many more have their livestock related programmes.

Private entrepreneurs, animal health companies, poultry breeders, feed millers, individual farmers, farmers organization /cooperatives, producers organizations, meat and milk processors, animal health workers, poultry vaccinators, livestock volunteers, emerging processed meat marketing agencies, electronic and printing media, information technology centres and farm advisory groups, etc.

10.2. Major Private and public industries in Livestock sector

Besides government, there are many private and cooperative enterprises, like Bangladesh Milk Producers' Cooperative Union limited (BMPCUL) known as Milk Vita, Bangladesh Rural Advancement Committee (BRAC), Lal Teer Livestock Limited (LTL), Pran Dairy, Gentech International, EJAB and Grameen Motso O Pashusampad Foundation (GMPF) are working for dairy breed development program and providing technical assistance to the farmers.

Though private sectors is an important part of dairy industry in Bangladesh, there is no documented research studies so far that investigated the role of private sectors in the development of dairy industry.

Milk Vita is the largest commercial milk processors and cooperative organisation in the country which sells about 52% of the processed liquid milk and dairy products of the country. A good number of other private enterprises like BRAC Dairy (Aarong), Pran Dairy, Amo milk, Bikrompur Dairy, Ultra Shelaide Dairy, Aftab Dairy, Grameen, Rangpur Dairy, Akiz Dairy are also collecting and processing milk and milk products in the country. They are also providing various services to the dairy farmers, like milk collection facilities, veterinary and animal health services, artificial insemination services, balance cattle feed, loan for cattle purchase, etc., as a part of their milk production enlargement and milking animal improvement.

10.3. Private enterprises in Cattle Breed development in Bangladesh

Dairy cattle improvement program in Bangladesh was started in 1958 by DLS with artificial insemination program which was strengthened in 1975-76. However, in the absence of following the proper process of improvement like registering, recording and others, the government has not achieved any remarkable progress over this long period of 55 years. The dairy cattle improvement project was undertaken as an annual development project on AI for 5 years and after the completion of the project period, required attention was not given to follow the next steps until a new AI project was initiated. For improvement of buffalo, the government has run a 5 year project named Buffalo Development Project since July 2009 and using Mediterranean Murrah for breed up-gradation.

The price of government semen is presented in Table below. Many private and cooperative enterprises and NGO's are working for development of livestock resources since long time following the government initiated breeding policy.

Government also encourages the private sectors and entrepreneurs to take part in the development process of livestock sector of the country.

Table 22 Price of semen of different dairy breeds available in Bangladesh (BDT)

Source/Suppliers of semen	Breed/Type of animals	Office price, Tk./Dose (Government price)		Farmer's price, Tk. /Dose	
		Frozen	Liquid	Frozen	Liquid
DLS (Government)	Friesian (any blood level)	30	15	200-300	120-200
	Local	30	15	200-300	120-200
	Sahiwal (any blood level)	30	15	200-300	120-200
	Friesian x Sahiwal	30	15	200-300	120-200
	Buffalo (very new)	Free (under project selected area)			
MILK VITA	Friesian	100		only for cooperative farmers	
	Jersey	125			
BRAC	Friesian	125		200-300	
	Sahiwal	140		200-300	
	Red Chittagong	135		200-300	
	Friesian, Imported	550		650	
	Goat	40			
Lal Teer	Friesian	On trial position, yet not in marketing			
	Jersey				
	Buffalo				
Pran Dairy	Holstein Friesian	325		only for Dairy Hub members	
	Jersey	325			
Gentech International	Holstein Friesian	250		300-400	
	Friesian	250		300-400	

Source: Personal contact and Adopted from M A Hamid and KM Hossain- 2014

10.3.1. Milk Vita (Bangladesh Milk Producer's Cooperative Union Limited, BMPCUL)

Milk Vita, the trade name of BMPCUL is the largest dairy cooperative in Bangladesh, started dairy business based on genetic improvement of dairy cattle through AI services of their cooperative farmers in 1972. In addition to semen, BMPCUL has periodically imported Shahiwal bulls from Pakistan (1991) and four Friesian and three Jerseys bulls from Australia (2002). Initially, BMPCUL started to produce and use liquid semen, later they shifted towards producing frozen semen. The BMPCUL artificial insemination service is limited to their cooperative farmers only. They do not sell semen outside farmers. In 2012-13, they produced 91,000 doses frozen semen and inseminated 100,000 cows (including previous frozen semen stock). The price of their semen is presented in Table 9. They have trained employed livestock field assistants (LFA-AI) who serve the cooperative farmers for AI service on call basis by the following distribution channel:

BMPCUL AI Lab. → Cooperative area office → Selected Cooperative farmers

(Through Livestock Field Assistant for AI)

10.3.2. BRAC (Bangladesh Rural Advancement Committee)

Bangladesh Rural Advancement Committee (BRAC), an international NGO started cattle breeding program with AI services using liquid semen from government origin in 1985.They started AI programme at Manikgonj district using trained AI technicians. BRAC has started trial semen production from May, 2000. However, this NGO has established its own bull station and started actual frozen semen production from November, 2000. By now they have trained 2523 AI technicians and operating AI services in 61 districts (440 upazila) out of 64 districts through 89 points. In 2013, they produced 1300000 doses frozen semen and inseminated 1324000 cows (including previous frozen semen stock) throughout the country.

They are also producing frozen semen from goat to develop high milk and meat producing goat in the country. The cost for single doses of BRAC semen is presented in Table- 22. At present, BRAC is in the process to expand more AI services through the country. They are producing and distributing frozen semen to the farmers by the following distribution channel (*Source: BRAC report)*:

Sambugonj→ Central AI Lab	Central Container Area → (65 Nos.)	Union AI-Points→	**Farmers** (Through AI. Worker)

10.3.3. Lal Teer Livestock Limited (LTL)

Lal Teer Livestock is a sister concern of the country's largest seed company 'Lal Teer Seed'. They have started cattle and buffalo improvement program since 2009. They are producing semen from locally produced Tested bull at different blood levels crossing with the imported frozen semen of Holstein, Frisian, Jersey, Shahiwal breed of cattle and Mediterranean buffalos. Distribution/marketing of this enterprise started through artificial insemination for increasing milk and meat production throughout the country. They have buffalo improvement program at household farming, semi-intensive and extensive farming systems in selected regions of the country. It is yet on trial basis, not selling their semen in the market. Their proposed frozen and liquid semen distribution channel is as follows:

Uthura Bull Station→	Central Distribution office	1. Liquid semen to farms around Bull station through Farm AI staff.
		2. Frozen Semen to Farmers through Field Assistant (AI).

Besides**,** Lal Teer Livestock Limited along with the Beijing Genomics Institute has jointly '**Decoded'** the buffalo Genome which was announced at a press briefing on 24January, 2014. This is one of the good examples of private sector's effort in milk and meat production in the country through buffalo breed development. They have jointly sequenced buffalo genome under a three-year project based on Bangladeshi local buffalo stock. It is expected that it will help in increasing the country's milk and meat production capabilities by using the genetic information of local buffalos.

10.3.4. PRAN (Program for Rural Advancement Nationally) Dairy

The Pran Dairy is a private company which started dairy breed improvement program with imported frozen semen and providing AI services. Pran Dairy imports semen from World Wide Sire, USA. The price of their semen is presented in Table- 22. They have selected Dairy Hub where they distribute frozen semen and AI services within their Hub member's farmers by the following distribution channel:

Semen import from USA→	Storing centre at Head office→	Selected Dairy Hubs

10.3.5. Gentech International

The Gentech International is a private company that started dairy breed improvement program with frozen semen also being imported from World Wide Sire, USA. They have started training of local AI workers. The price of the semen is presented in Table- 22. They help the farmers by selling frozen semen and providing AI services by the following distribution channel:

Import from USA→	Storage at Head office→	Local agents/ Practitioners→	Farmer (through local AI workers)

10.3.6. EJAB

EJAB is a private company had started dairy breed improvement program through semen production and marketing. The company is reported to have suspended semen production due to low quality of semen and unscientific process. The price of their semen is presented in Table- 22.

Besides these, Community Livestock and Dairy Development project of Grameen Motso O Pashusampad Foundation (GMPF) also working on breed development program with technical assistance from FAO.

Bangladesh Agricultural University is also involved in AI services to the farmers in and around the University areas. The frozen semen is originated from the government AI laboratory while liquid semen is produced from their stud-bulls.

10.4. Private enterprises involved in Animal Feed manufacturing

A lot of animal and poultry feed manufacturing companies are now available in the country. Some of the leading companies are: Aftab Bahumukhi Farms Ltd; Paragon Poultry Ltd; CP Bangladesh Ltd.; Quality Feed Ltd; Phoenix Feed Mills Ltd., BRAC-RENATA Agro Inds. Ltd, Usha poultry feed Ltd, Holy Poulty & Fish Feed Industries Ltd. Etc.

11. National Plans

11.1. The Sixth Five Year Plan (2011-2015)

The main goal of development initiative is a part of 'Vision 2021'. The livestock sub-sector has to contribute to achieve the goals of the vision through reducing unemployment and meet the demand for standard nutrition of 85% of the population. The livestock sub-sector has to have initiatives for

- Promoting sustainable productivity of milk, meat and egg including processing and value addition
- Promoting nutrition and employment for the landless, small and marginal farmers
- Promoting private sector participation and investments in livestock production, livestock services, development and export of livestock products and by-products.

The Sixth Five Year Plan identifies a wide gap between total requirement of livestock products like milk, meat and eggs and their current level of production. The gap between production and requirement will further widen due to population growth and rapid increase in per capita income. With the increase in income the demand for livestock and poultry products increases.

Despite urgent need to increase livestock products, the animal and poultry production is constrained by inadequate feeds and fodder production and high prevalence of animal and poultry diseases and poor genetic potential of the stock. Growing scarcity of grazing land and green grass, restricted stall feeding with crop residues alone reduces expression of inherent potential of local stock. Improved animals perform even less under nutritional stress.

The research institute initiatives to increase fodder production and to improve digestibility of crop residue is yet to be mass popularized, the farmers apparently are not used to cumbersome process recommended by the researchers. This need rethought and simplification of the process.

The livestock sub sector did not receive priority in resource allocation from the government, whatever resources are made available need to be devoted mainly to produce technical inputs essential for the farmers. The under-utilized infrastructures (Dairy, Goat, Sheep, Pig, Poultry, Duck farms) need to be adequately funded to ensure their sustainable and profitable use or **may be decided for public-private partnership approach.** Similarly, the idle Veterinary Training Institute (VTI), Livestock Training Institutes (LTI) need to plan their round the year capacity utilization through organizing farmer training, Livestock Field Workers training, Artificial Inseminators training, and training of rural agricultural farmers.

Animal diseases like, **Anthrax, Hemorrhagic Septicaemia (HS)**, **Foot and Mouth Disease (FMD)** are endemic and often appear in epidemic form. **New Castle Disease** in chicken causes heavy losses, **Gambaro disease** is also fatal to chicken and no vaccine is produced in the country. Avian Influenza (H5N1 strain) suspected to emerge as a major threat to commercial farms. Fortunately **Rinderpest,** a deadly disease of cattle has already been eradicated from the country and obtained OIE recognitions.

Besides diseases there are location specific constraints in many parts of the country – In the coastal zones high salinity in drinking water becomes harmful for the animals and are often compelled to drink saline water. In arsenic contaminated area, the tube well water is also unsafe for men and animals. However, the effect of arsenic in animals remains unexplored. Rain water harvesting facilities designed for providing drinking water for animals particularly during dry months (November-March) is essential to undertake any development project in the salinity intruded areas.

To mitigate the identified constraints regarding feeds it is necessary to ensure quality feeds and fodder supply through vigorously maize cultivation in less-fertile lands and as an intercrop. As an intercrop with food and cash crop maize is rarely practiced by large or medium farmers. The prospect of growing other HYV fodder crop like Napier, Para, German, etc. appears feasible by the landless livestock rearer groups to produce in roadsides, embankment slopes and other fellow lands. With the availability of green grass and crop residues, the farmers may be interested to rear more and more cross breed cows with higher milk production capacity.

The other major constraint identified are the livestock diseases for which the department needs to take up elaborate program, though improving its own comprehensive vaccine production and mass inoculation. In that case the non-formal livestock field workers need to be technically trained by DLS and use their services at cost sharing basis.

Breed up-gradation through Artificial Insemination, progeny testing of local breeds should be undertaken to conserve indigenous cattle, Black Bengal Goats and local variety of sheep through improving disease management, feeds and fodder availability and reducing kid mortality.

In chicken, egg production largely dominated by the private sector. It is the fastest growing sector with a growth rate over 5%. However, dependency on imported baby chick, imported feed items and absence of proper regulatory function on quality control is a threat to commercially sustaining development of this sector. This sector has shown growth over 5% followed by sheep and goat at 4%.

Gaps:

- Collaboration under SAARC Framework mainly in animal disease surveillance, cooperation in vaccine production and utilization has not been included in the plan.
- Country's tannery industries are under the control of Ministry of Industries (MoI), No strategic plan or directives or targeted effort for exporting finished leather instead of crushed or Blue-wet has been ignored in the plan.
- No planning to provide the grazing facilities and feeds and fodder production in the country has been included for livestock sector development.

- Disease investigation and diagnostic services, continuous disease surveillance and monitoring, appropriate health care services are to be developed.
- DLS capacity is to be developed and strengthened many folds to combat the situation. Present organizational set-up, infrastructure and human resources in DLS is hardly in a position to achieve the goal.

Despite many constraints, the DLS has extended its effort to achieve the target of the 6th 5-year plan. The evaluation of Achievement is under process.

11.2. Annual Development Plan

Annual Development Plan (ADP) of DLS consists of a number of Projects on Dairy, Goat, Sheep, Poultry, institutional and infrastructural development. Some of the important on-going projects are listed below:

On-going Projects: Department of Livestock Services.

Sl. No	Name of the Project & Duration of Implementation	Project Code	Project Cost (PA)
1	2	3	4
1	Modernization of Vaccine Production Technology & Extension of Laboratory Facilities Project (1/7/08-30/6/2016)	6410	5687.00
	Buffalo Development Project (Component-A). (01/01/2010-30/06/2017	7053	1932.00
3	Small Scale Dairy and Poultry Farmers Support Services in Selected 22 District (01/10/2010-30/06/2015)	7040	1962.00
4	National Agricultural Technology Project (DLS Component)(01/07/2007-31/12/2014)	5700	7534.56 (6691.00)
5	Establishment of the Regional Duck Breeding Farm Along with Hatchery (3rd Phase) (01/07/2011-30/06/2015)	5150	17703.99 (-)
6	Integrated Agricultural productivity project(IAPP)(DLS Component)(01/07/2011-30/06/2016)	5140	3524.60 (3193.48)
7	Upazila Livestock Development Centre(ULDC) Project (3rd Phases)(01/07/2011-30/06/2016)	5170	8093.48 (-)
8	Conservation & Improvement of Native Sheep through Community Farming & Commercial Farming Project " Component-B" (2nd Phase) (01/07/12-30/06/17)	5023	2873.86
9	Livestock Disease Prevention and Control Project (01/07/2012-31/12/2014)	5024	5044.78 (-)
10	Establishment of National Institute of Livestock & Poultry Management and Disease Diagnostic Laboratory Project (30/06/2012- 30/06/2015)	5025	2785.32 (-)
11	Establishment of Serajganj Govt. Veterinary College(01/01/2013-31/12/2015)	5015	5420.01
12	Beef Cattle Development Project (01/07/2013-30/06/2016)	5026	2556.76 (-)
13	Establishment of Jhenaidah Govt Veterinary College(2nd Phase) (01/07/2004-30/06/2017)	5036	1485.00 (-)
14	Breed Up-gradation Through Progeny Test Project (2nd Phase) (01/07/2014-30/06/2019)	5037	4413.00 (-)
15	Establishment of Institute of Livestock Science and Technology Project (01/07/2014-30/06/2019)	5038	20737.64 (-)
	Total (DLS)		

12. Water for Livestock

12.1. Water requirement

Life is impossible without water. Livestock require drinking water like any other biological beings. Water constitutes 60 to 70 percent of the body of livestock. An animal losing almost all its fat and 50% of its body protein survives for several days. But the loss of 10% of body water can be fatal (Lance Brown- 2006). A good supply of water (both quantity and quality) is required for an animal to maximize the food intake and production.

Water requirements of livestock are influenced by several factors. These factors are the animal's rate of gain, pregnancy and lactation, the animal's activity level, type of diet, feed intake, and environmental temperatures.

Water helps in absorption and conveys the nutrients in the body. Water constitutes about 87% of blood. Maintaining water balance is critical for survival, it is closely linked to digestion and Thermoregulation.

Animals should have access to all the water they can drink. Livestock get a portion of the water needed daily from the forage they consume but this will vary according to forages conditions and other environmental factors. Consumption varies on physiological condition and stages. In our condition,cow needs about 4-8 gallons of water daily. In General, cattle that are milking need 5 times as much water as the volume of milk they produce.

In Bangladesh, water is available to livestock in two ways:

- ✓ Water that is contained in feeds and fodder consumed.
- ✓ Free access to water from natural sources or water troughs

Quantity of water consumed by an animal depends on many factors and therefore it is very important to consider the factors particularly the environmental factors in planning to make fresh water available for livestock in different hydrological regions of the country. Water consumption depends on:

- **Kind and size of animal**.
- **Physiological condition of animal;**
  - Lactating animal require 0.86 litre of water per kg of milk.
  - Pregnant cows or growing animals require 30-50% extra.
- **Animal's activity**: More active requirement of water is more.
- **Types of feed and dry matter intake:**
  - Dry diet (straw/ hey or bran) require more water than moist diet (green grass or silage)
  - Dry matter intake increases water consumption. Limiting water intake will limit feed intake
  - 1 pound of Dry Matter intake requires 7 pound of water (F. Fluharty et al- 2011)
- **Water quality:** Palatability and salt content affects water intake.
- **Water temperature:** 10°C is desirable; limit should not exceed 4°C- 18°C.
- **Air temperature:** Temperature is directly correlated with consumption.

Thumb Rule:

- ***4 litres per 45 kg Body weight at temp. below 15 °C (winter temp. in Bangladesh)***

- ***8 litres per 45 kg Body weight at temp. above 25 °C (summer temp. In Bangladesh)***

Black Bengal goat and Bengal sheep requires roughly about 1/2 to 1 gallon of water per head per day. This varies according to the environmental conditions, weather, feed intake, activity level, etc.

Poultry birds require about 10-20 litre of water per hundred birds per day.

Fresh water requirement for livestock resources in Bangladesh has been estimated (gross estimation) to be as follows:

Table 23 water requirement for livestock

Species of Livestock	Approximate consumption requirements on average per head/day (in Litre)	Livestock Population (in Millions)	Total requirement for consumption (million Litres per day)
Cow (Zebo type-cattle)	20-30 Litres	23.44	468.8
Buffalo (water buffalo)	25- 40 Litres	1.45	43.5
Goat (Black-Bengal)	2-4 Litres	25.61	76.8
Sheep (Bengal Sheep)	3-5 Litres	3.16	12.6
Chicken (Native + Exotic)	10-20 Litres /100 birds	259.42	51.9
Ducks (Native + Exotic)	20-25 Litres/ 100 birds	48.05	12.0
Total:			665.6

Drinking water intake depends largely on: Production level, Dry matter intake and Ration water intake. Our cattle are mainly depending on crop residues (straw/ hey, rice or wheat bran, etc.) which contains 10-15% moisture only. Therefore, water requirement is certainly higher than the grazing herds.

Bangladesh is in humid tropical region and cattle are mainly Zebu cattle type. Average weight is about 160 kg. The estimated water requirement for cow is about 20 litres per head per day. Water buffalos require about 25 litres per head per day and Goat and sheep requires 4 litres per head per day. Chicken and duck needs 20 litres/day/100 birds. Therefore, total consumption per day is estimated to be around 665.6 million Litres. The evaporated water, spillage, water for fodder production, washing of cattle requirements, farm equipment and livestock products (hides and skins, meats.) has not been included in the calculation. In haor areas the daily requirement of drinking water for livestock has been estimated to be 118.84 million litres, for coastal region 196.00 million litres and that for Chittagong Hill Tracts is 8.54 million litres. In these three hydrological regions scarcity of fresh drinking water prevails during dry winter and summer seasons, when water requirement for livestock becomes highest of their need.

Therefore, a large quantity of fresh water sources is required for livestock in Bangladesh every day which should be ensured for a sustainable food and nutrition security in the country.

12.2. Water quality for livestock

Water quality counts much for livestock and poultry. Coastal region covers 19 districts (almost one third of the country). Salinity intrusion is a great problem for livestock rearing in this region. Increased salinity level due to climatic change is remaining a potential threat to livestock resource and subsequently on the livelihood option of landless poor families. Increase in salinity in coastal area may seriously affect food and nutritional security of millions of people. Good quality water is essential for livestock and poultry birds. Water content of Sodium (Na), alkalinity, Sulphate (So_4), Nitrate (No_3), hardness etc. are the factors that determine the suitability of water for livestock. Salinity of water adversely affects the livestock. Salts such as sodium-chloride change the electrolyte balance and intracellular pressure in the body, producing a form of dehydration. Salts also place a strain on the kidneys. Excess fluoride causes degeneration of the teeth. Therefore, high level of salinity is not suitable for livestock rearing.

The tolerance of animals to salts in water depends on factors such as water requirements, species, age and physiological condition, season of the year and salt content of the total diet as well as the water. South Dakota State University, USA in a publication on "Interpretation of water analysis for livestock suitability" indicated that the electrical conductivity (EC) determines the suitability of saline water for livestock. Conductivity values of more than 6000 micro-ohms indicate high total dissolved solids.

The following table (**Table 24**) indicated the recommended level:

Water quality, as well as quantity, may affect feed intake and animal health since low quality water will normally result in reduced water and feed intake. Chemically pure water is not found in nature and actually de-ionized-distilled (pure) water is undesirable for livestock. Certain salts and gases in solution make water more palatable but excess may cause serious problems. Animals, however, have the ability to adapt to saline water quite well, but abrupt changes from waters of low salts to waters of high salts concentrations may cause harm. But animals can adapt well if gradual changes occur.

Table 24 recommended salinity level of water for livestock

Water Salinity (EC- level in micro-ohms)	**Suitability level**
< 1000	This is relatively low level of salinity. Excellent for all classes of livestock & poultry.
1000- 2999	Very satisfactory for all classes of livestock &poultry. May cause temporary and mild form of diarrhoea in livestock not accustom to such water. Watery droppings in poultry may be seen.
3000- 4999	Satisfactory level for livestock but may cause temporary diarrhoea and may refuse to intake by the animals not accustom to such water. Watery droppings in poultry, increased mortality and decreased growth may occur.
5000- 6999	Can be used with reasonable safety measure in dairy and beef cattle (including buffalos), sheep, swine and horse. Must be avoided for Pregnant and lactating animals. **Goats must not be allowed this level of salinity.**
7000- 10,000	**Totally unfit for swine and poultry birds.** Considerable risk in using for Pregnant and lactating cattle in confinement, sheep and horse. Young of these species must be avoided. In general, this level of salinity must be avoided.
>10,000	Risk of using this high level of saline water is so great that it cannot be recommended to use for livestock and poultry under any conditions.

In coastal region of Bangladesh, salinity varies from seasons to seasons. The danger of salinity is not only for intake of water but for other implications such as, reduction of pasture land, destroys the natural growth of grass causing serious shortage of feed, outbreak of diseases, etc. A well planned livelihood programme with saline water protection measure is therefore, necessary to ensure food and nutrition security of millions of people.

Recommendation:

1) Water Management programme in coastal region through polder projects should be intensified.
2) Fresh drinking water for human and animals to be ensured.
3) Salinity level should be monitored regularly to ensure sustainability of agricultural productivity.
4) Pasture for large and small ruminants should be created in the char lands in coastal regions to protect the livelihood options of livestock for the millions of people.

13. Linkage with other studies

This study is a part of an effort to provide information regarding livestock resources to ensure food and nutritional security. Water management is for human consumption, animal rearing, increasing agricultural productivity, protecting

the people from getting loss of their assets of sustenance and also for other economic purposes. Therefore, this study may be linked with many other studies particularly with water sector management, agriculture, and livelihood related issues.

13.1. Linkage with Water Management

Water requirement for livestock and poultry rearing is an important issue related with the water management. Fresh water consumption by livestock has been estimated to be around 665.6 million Litres per day or about 63267 million gallons per year excluding the evaporated water, water spillage, water for fodder production, washing of cattle requirement, farm equipment's and livestock products such as hides and skins, meats, etc. The requirement of water for livestock purposes will be many folds higher if these purposes are considered all together. Water sector management therefore, must need to include this enormous amount of fresh water to make available all over the country in their estimation of national water requirements. The hydrological regions particularly the North-East (Haor area), South, South-East and South-west (Coastal regions) and Eastern-Hill (Chittagong Hill Tracts) are potential zones for livestock rearing. Haor areas are famous for duck rearing due to availability of natural feed for ducks in natural large water bodies. Almost every family is rearing ducks. A symbiotic process between ducks and the local inhabitants has developed in haor areas. Similarly the buffalos in coastal areas are popular for tillage of muddy soil that the cows cannot perform properly. Besides, the buffalos are more tolerant to harsh environment of coastal regions than other species of livestock. For this reason, the concentration of ducks in haor areas and buffalos in coastal areas are noticeable. These hydrological regions are the critical and important area for water sector management issues too. Water quality is also a management concern of water sector. Polder projects in coastal areas are important for protecting saline water intrusion in the project areas to improve drinking water quality, agricultural productivity, livelihood and food and nutrition security, human and livestock health issues, etc. Drinking water of the people is important and equally important for livestock rearing also. It is important for fodder cultivation and fresh water requirement for livestock where salinity (EC) is more than 6000 micro-ohms. FAO has identified water scarcity in dry season is one of the major challenges of CHT development which needs to be addressed to enhance agricultural productivity to ascertain livelihood and food security.

Therefore, water management in hydrological regions will improve the livelihood and food security of the people of these regions where livestock and poultry rearing is playing an important role on their livelihood and nutrition.

13.2. Linkage with Agriculture

Agriculture (crop production) and livestock is closely related and interdependent. Cattle are used for tillage to about 50% of the croplands, cattle provides valuable organic fertilizer for vegetable and crop production, transportation after harvesting and threshing of the crop. It provides nutrition to the farm families and also provides ready cash to them; On the other hand, Livestock depends mainly on the crop residues and forage grown in the crop fields.

This baseline study has, therefore, a close linkage with many other studies particularly with water sector, Agriculture, and livelihood issues. Chicken and duck lives on the scattered grains by scavenging and provides ready cash and family nutrition to the farm families. Therefore, the livestock and agriculture is closely related and interdependent.

14. Knowledge gap identification

Identification of knowledge gap in livestock sub-sector is very important for its long term development planning process. Knowledge gap poses constraints to implementation of any programme. Livestock is an essential component of the rural economy of Bangladesh. Cattle, goat and poultry rearing are the major components of animal agriculture and part of mixed farming system in Bangladesh. Research gaps may be realized from the following unresolved issues:

A lot of unresolved question may be taken forward for identification of knowledge gaps in livestock sector research, particularly relating to integrated agriculture:

Bangladesh being one of the highest cattle populated countries has to import milk and milk products. The country loses huge amount of foreign currency every year which is about USD 93.4 million (Bangladesh Bank 2012-13). No reliable information and statistics are available on actual requirement and availability of milk powder in the country. Knowledge gap in this regard is the constraints for adopting appropriate measure for a pragmatic solution.

Impacts of imported livestock and their products on livestock development process and the socio-economic implication should be studied to know the extent and nature of problem that may arise from stopping import of cattle and milk-powder.

What is the implication of livestock development for providing financial incentives to the small holders has not been studied. The nation has provided cash incentives to the dairy farmers two times in last decades. The instant positive results were experienced but the sustainability was questionable. So, detailed and unbiased study on input and expected outcome is necessary for taking such programmes in future. This is also an example of knowledge gap in livestock sector development.

Whether technology development and diffusion for livestock development are properly outlined with the integrated agricultural interventions is an important question to stakeholders involved in livestock sector development and research, particularly relating to the integrated mixed farming system in Bangladesh.

Knowledge gap in different technological aspects is a reality in Bangladesh. Interventions with demand led, sustainable and appropriate/suitable technology is lacking in our mixed agricultural farming system. For example; Cattle contribute in tillage, post-harvest threshing, transportation, provides organic fertilizer, etc. but we are not aware of their nutritional needs. They are provided crop residues with very little or no green forage due to lack of such facilities. Therefore, Technological intervention is needed to improve the nutritional value of Crop residues.

For genetic improvement of indigenous buffalo, Lal Teer Livestock Limited along with the Beijing Genomics Institute has jointly '**Decoded'** the buffalo Genome. They have jointly sequenced buffalo genome studying on Bangladeshi local buffalo stock. It is expected that it will help in increasing the country's milk and meat production capabilities by using the genetic information of local buffalos. But for the genetic improvement of our local cows, particularly the red Chittagong variety is equally or much more important for sequencing genome. Perhaps, this is a knowledge gap on breed development effort in the country.

A lot of factors for livestock development activities need to be addressed particularly relating to the integrated agriculture or mixed farming system research in the country. A few of these factors are: Nutritional factors, animal health factors, Management, production, processing and marketing factors, etc. These factors should be researched and adopted with sustainable and appropriate technological interventions and with economically permissible manner of the integrated poor farm families. A very little research and technological achievement is in the focus of the relevant institutions and therefore, diffusion of such technologies in the integrated farming system is almost absent in the rural community.

14.1. Adaptation of climate change

At present context of climate change related consequences in the country; climate change adaptation is important to incorporate with long term economic planning process. The Sixth 5-year plan has already recognized the importance of adaptation measures and investment supports from development partners in Bangladesh. Such investments are:

1. **Food management scheme** in order to increase agricultural productivity in low lying areas and protect them from severe flood.
2. **Flood protection and drainage scheme** to protect urban areas from rain water logging and river flooding during monsoon seasons.

3. **Coastal embankment projects** to increase agricultural productivity by preventing tidal flooding and intrusion of saline water.
4. **Cyclone shelter** to protect lives and assets from tropical cyclone and tidal surges.
5. **Comprehensive disaster management project** for early warning system for cyclone and tidal surges and also its community based programmes.
6. **Irrigation scheme** to support farmers for dry season rice and other crop production.
7. **Agricultural Research Programmes** to develop saline, drought and flood tolerant rice and other crop incorporating traditional varieties.
8. Coastal green belt projects.
9. **Institutional capacity building** to implement the mandates of the respective institutions through regular programmes efficiently and effectively to combat climate change related consequences.
10. Integrated approach of different ministries, agencies, civil societies and development sector is needed to address the climate change.

However, almost all of the above mentioned investment in the climate change adaptation process is also appropriate for livestock sector. For example: Food management scheme for agricultural productivity in low lying areas is also necessary for protecting livestock resources; Flood protection and drainage scheme will help protecting livestock resources; Coastal embankment projects will help protecting livestock resources and help producing fodders in the region. Govt. has also recognized the necessity of cyclone shelter for livestock resources. The 'Earthen-Killa' (Earthen platform/ village platform) programme is the best example of cyclone shelter for livestock resources. Comprehensive Disaster Management Programme and early warning system of natural disasters will help protecting the livestock resources and community based programme on livestock is also necessary. Irrigation scheme will help fodder production during dry seasons. Research programme for livestock sector, Institutional capacity building in livestock sector is also important.

In sixth Five-year plan, initial studies for ideas on adaptation have been targeted. Very little experience on adaptation process in livestock sector has been identified as benchmark in the plan.

14.2. Technology Diffusion and Adoption

From the Agricultural extension point of view, 'Diffusion' is the process by which an innovative technology is communicated through certain channels over times among the members of a social system. Diffusion generally occurs in five stages such as; awareness, interest, evaluation, trial, and adoption. In other words, the five stages are: knowledge, persuasion, decision, implementation, and confirmation. Extension procedures like training of farmers, motivation, individual or mass contact, demonstration, etc. to be followed for adoption of new technologies.

Technology development to cope with the adverse effect of climate change is essential in Bangladesh particularly in coastal region and also in drought prone northern part and flood prone areas including haor areas of the country. Cattle have the ability to adapt saline water quite well, but abrupt changes from waters of low salts to waters of high salts concentrations may cause harm. But animals can adapt well if gradual changes occur. Therefore, rearing of different cattle species is possible but their feeds and fodder problems, prevalence of emerging and re-emerging diseases, etc. are of great concern. Therefore, research on these issues is very much essential to cope with the situations.

Research on salinity and draught tolerant variety of fodder is of great importance. Disease investigation and research is essential. Besides, integrated farming system, improved and hygienic management practices, improvement of genetic resources, nutritional aspects of animals, marketing system of products, etc should be priority area for research work.

14.3. Gender Issues

Women in Livestock Sector:

About 45% of world's Population depends on agriculture, fisheries, livestock, Forestry and the women constitutes about 43 percent of agricultural labour force worldwide (FAO). Gender Equality and Empowerment of Women has been endorsed by the govt. of the peoples' Republic of Bangladesh and reflected in different policies

The Bangladesh Government, international and multilateral agencies and especially the Donor Partners in development process of the country recognized the need to address gender issues and promote gender mainstreaming, formulating own gender policy. In this context, Ministry of Fisheries and Livestock (MoFL) has adopted few policies to promote and encourage women's involvement in its development process.

Women's access to livestock production system and generating income is significantly important. The rural women are the economic driving force in livestock rearing activities. In livestock sub-sector, backyard Chicken, ducks, goat and sheep rearing are the important economic activities mainly performed by the rural women. Gender discrimination and disparity prevalence among women exists in the country. They have very limited access to power exercise and in decision making in most families. They face discrimination in wages in rural labour market; they are engaged in work either part time, seasonal or in low paying hard jobs. These are the social realities in Bangladesh like many other countries worldwide.

In Bangladesh, the National agriculture policies have outlined the gender issues but the National Livestock Development policy 2007 and the National Poultry Development Policy 2008 have not addressed adequately this issue. Neither the directives nor the strategic action plan on gender issues has been outlined in the National Livestock Development Policy 2007 and the National Poultry Development Policy-2008. However the National Livestock Extension policy 2013 (Draft) have included the gender issues.

Female headed households without excess to land (landless) unemployed youths (female) and destitute women are probably the most vulnerable group to food and nutrition security in the country. The women in the country have very limited or no access to productive assets, inputs and services including land, agricultural labour, financial services, etc. causing reduction in their productivity, diminishing their contribution to the agricultural sector and affecting their well-being in terms of their food and nutrition security.

However, Bangladesh government has ratified the UN convention of eliminating all forms of gender disparity in 1984 and therefore, has adopted the policies and plans to empower the women. Contribution of women in family nutrition and family income through kitchen gardening, chicken, ducks and small ruminant rearing activities are most common and suitable practices in Bangladesh. Therefore, their contribution should be recognized and incorporated almost in all the future national policies accordingly.

15. Conclusion

Bangladesh is a nation endowed with enormous potential. To explore this potential, the BDP 2100 formulation project is conducting this baseline study to determine the overall situation of the livestock sector and to have the necessary inputs for the future agricultural policy issues.

Livestock is the sustenance of landless people, livelihood options for the rural poor families and is potentially important for poverty reduction. Income generation, contribution to food and nutrition security, employment generation, land cultivation, post harvest threshing, draft power for transportation, fuel for cooking, manure for crop and vegetables, export earning, cultural and religious uses etc. are some of the contribution of livestock. Therefore, it deserves necessary attention to develop through exploiting potentialities and removing the constraints.

Increased livestock production will depend ultimately on the adoption of appropriate technology, improved support services, market access and infrastructural development to stimulate increased productivity. However, there must be a framework of coherent policies and development strategies that facilitate such development and ensure that the full potential of livestock is exploited.

Hydrological regions are very potential area for rearing livestock. Haor and coastal areas covers about half of the country (27 districts). Among the Hydrological regions, the cattle population in the northern region is relatively better than the coastal and Haor region. People of coastal and haor areas are relatively poor. Crop production in coastal area is constrains by the salinity and natural hazards, and the haor area is constrained by the flash flood. Therefore, special programmes on livestock particularly on Buffalo (in coastal region) and Duck (in haor region) in this area will improve the production situation of the country and will create employment opportunity of millions of people.

In haor areas duck rearing with zero feed cost is an age old practice. Full potential of this may be exploited with appropriate plan/ program. Similarly raising of buffalo and sheep in the coastal areas has enormous potentialities and may be considered as a thrust area.

Since the Livestock is performing a multifarious function including livelihood option for millions of people, needs adequate attention to provide them access to fresh water sources particularly in coastal regions where water quality is a serious problem for human and livestock consumption.

Demand for milk, meat and eggs will increase with the population growth. Immediate attention is, therefore, required to address the constraints and explore the potentialities. Land use for pasture, free access to fresh water sources, environmental and public safety issues, etc must be taken into consideration in formulating a long term perspective policy frame work for livestock development.

16. References

Asaduzzaman 2000 Livestock sector, economic development and poverty alleviation in Bangladesh. In: Mandal MAS (Ed), Changing rural economy of Bangladesh. Bangladesh Economic Association, Dhaka, Bangladesh. pp 1-20.

Dave *et el* : 2008 : Dave German, Nancy Thiex, Cody Wright : 2008 South Dakota State University, USA. a publication on "Interpretation of water analysis for livestock suitability"

F. Fluharty, J. Mc. Cutcheon, R. Lewandowski, S. Smith and J. Grimes: 2011; Innovations in feeding the Cow herd: Maximizing Productivity through forage processing.

Haque S A M A 2005 Prospects and constraints of dairy development in Bangladesh, Paper presented at training program for the small scale dairy sector, December 26, Dhaka, Bangladesh.

Lance Brown (2006): Engineering Technologist, Ministry of Agriculture and lands: British Columbia: Livestock Watering Requirements

M A Hamid and KM Hossain-2014.*;* Role of private sector in the development of dairy industry in Bangladesh; Authors are from the School of Agriculture and Rural Development, Bangladesh Open University, Board Bazar, Gazipur-1705, Bangladesh; and Biotechnology and Genetic Engineering Discipline, Khulna University, Khulna-9208, Bangladesh.

Omore A, Mulindo J C, Islam S M F, Nurah G, Khan M I, Staal S and Dugdill B T 2002 Employment generation through small scale dairy marketing and processing: Experiences from Kenya,

Bangladesh and Ghana. FAO, Rome, Italy

Raha S K 2009 Status of Dairy Production and Marketing in Bangladesh – Milk marketing system. Handbook of Dairy Nutrition-Bangladesh. Edited by Peter H. Robinson and U. Krishnamoorthy. Published by American Soybean Association (ASA), International Marketing, New Delhi, India.

Sarker N R, Huque K S and Khaleduzzaman A B M 2012 Feeds, Fodder and Feeding Challenges for Bangladesh. Paper presented in the Seminar and Reception: Animal Husbandry Education and Profession in Bangladesh-A journey of 50 years organized by Bangladesh Animal Husbandry Association, Dhaka, Bangladesh. pp 51-61.

Stephen Boyles: Email: sboyles@mail.utexas.edu

Susmita Dasgupta, Lead Environmental Economist, Development Research Group, World Bank

BASELINE STUDY: 18

Forest and Biodiversity

Author

Neaz Ahmed Siddiqui[1]

[1] Neaz Ahmed Siddiqui, Ex. Chief Research Officer, Bangladesh Forest Research Institute (BFRI)

Executive Summary : Study 18

During the past 100 years or so, there has been great deterioration of forests and biodiversity in the territory now comprising Bangladesh. So, a baseline study was necessary to ascertain the present status of natural resources and causes of their degradation with a view to develop a long-term sustainable management for forest ecosystems and biodiversity.

The report is primarily based on literature review, internet browsing, collection of information from different organizations and discussion with relevant specialists. It has been prepared for the Planning Commission, Government of the People's Republic of Bangladesh under Bangladesh Delta Plan 2100 Formulation Project.

This baseline study report reveals the status and distribution of forests and biodiversity, their management, people's participation in forestry, causes and magnitude of degradation of natural resources, trade and industries, forest policy and acts, services from forest ecosystems, problems and challenges, prospects of eco-tourism and other aspects.

Bangladesh is represented by six natural forest types and plantations in the villages, road/embankment sides and forest land with indigenous and exotic plants. There are 5,000 species of angiosperms belonging to 15% trees, 35% shrubs and 50% herbs and four gymnosperms. Many valuable tree species are greatly reduced in proportion and endangered.

As regards wildlife, 120 species of mammals, 700 birds, 150 reptiles and 40 amphibians exist in Bangladesh. In recent decades, 15 mammals, 6 birds and 2 reptilian species became extinct. Considerable numbers of wildlife species are endangered and restricted to limited areas from previous wider range of distribution.

The forest land accounts for 17% (2.56 million hectares) of Bangladesh covering hill forest, sal forest, village forest, mangrove forest and coastal plantation. Yearly wood production from government forests is low being 0.5-2.5 m3/ha, however in homestead forests 7-9m3/ha. About 70% of round wood and 80% of bamboo come from private own village grooves.

The NWFP in Bangladesh is quite diversified and includes bamboo, rattan, sungrass, golpata, hantal, patipata, mushroom, honey and wax, medicinal plants, etc. Some medicinal plants are endangered according to IUCN Red Data Book and status of valuable NWFP reduced. Adequate attention is needed for the conservation and cultivation of medicinal plants.

The report discusses the history of forests management from commercial exploitation to conservation of forest resource. Currently, there has been emphasis on sustainable management of forest ecosystems and participatory management approach in order to ensure protection, increase forest cover and wood productivity.

The history of introduction of exotic plants, teak and rubber in particular has been described and the impact of exotic plants on wildlife discussed. Need for conservation and restoration of natural habitats as required for a healthy wildlife population has been emphasized.

Forestry sector provides huge direct and indirect employments. In 2013-14, the contribution of forestry sector to GDP was 1.63%. The contribution would be higher if the services from forest ecosystems could be taken into account. There are seven categories of industries and 157 small scale industries based on forest produce.

The Protected Area covers 10.72% of total forest area. There are 17 National Parks and 20 Wildlife Sanctuaries. Bangladesh Wildlife (Preservation) Order was promulgated in 1973. In 2012, Wildlife (Conservation and Security) was promulgated for the conservation and extending security to the biodiversity, forests and Wildlife.

High biodiversity is the characteristics of wetland ecosystems which have undergone degradation in many areas of the country. The fauna, flora and the wetland itself need to be conserved. Multi-sectoral integrated management should be initiated to restore and protect the biodiversity of the wetlands.

The Forest Act of 1927 is the key law regulating forest resources. The current forest policy, introduced in 1994, represents some shift. In the past, there was commercialization of forest use for revenue. Now emphasis is given on sustainable management of resources, conservation of forests and biodiversity, services from forest ecosystems and people's participation in forestry practices.

The Ministry of Environment and Forest (MoEF) looks after various concerned departments. Organizations involved are Forest Department, Department of Environment, Bangladesh Forest Research Institute, Bangladesh National Herbarium, Bangladesh Forest Industries Development Corporation and Bangladesh Climate Change Trust.

Both Forest Department and Forest Research Institute are running short of trained manpower to address the newly emerging problems in the forestry sector. Development of trained managers and researchers and improvement of infrastructure are essential for the advancement of forestry sector.

The report discusses the services of forests in relation to storm surges, stability of environment, development of healthy microclimate, watershed management and eco-tourism. It suggested evaluation of intangible benefits to ascertain the actual contribution of the forest ecosystems.

Forests provide immense services in relation to storm surges, stability of environment, reduce earth quake, develop of healthy microclimate, watershed management and eco-tourism. In recent years, there has been growing demand for eco-tourism although adequate facilities could not be developed. Number of recorded tourists became double between 2001 and 2009 in the Sundarbans. Intangible benefits need to be estimated and recorded to ascertain the actual contribution of the forest ecosystems to mankind and GDP.

Problems, opportunities and challenges in relation to forests and biodiversity have been pin-pointed. The report presents lists of 19 on-going and 12 completed projects. Goal-oriented research studies and efficient technology transfer to the users have been suggested.

1. Introduction

1.1. Background

Forest is an important renewable resource of the nature. It provides material like timber, pulp, pole, fuel wood, food and medicine, habitat for wildlife and primary base for biodiversity. Forest ecosystem also provides oxygen, controls or reduces the intensity of the cyclones and tidal surges in the coastal areas of Bangladesh, influences the rainfall, and sustained water yield in the river systems and other services. Besides, forest is a place for recreation and nature based tourism. Now a day, eco-tourism is the preferred type of tourism and it is widely believed that eco-tourism could be an alternative mechanism for environmentally sustainable development without depleting the forest resources, its habitats and biodiversity. The majority of the territorial biodiversity is found in forests and most of that in tropics. The carbon stored in the forests and the other ecosystem services they provide are of local, regional and global concern. Considering all these, forests and consequently forest management and biodiversity conservation are gaining importance all over the world including Bangladesh.

Globally, forest covers 31% of total land area and primary forests account for 36% of the forest area. Livelihood of over 1.6 billion people including more than 2000 indigenous culture depends on forest environment. Forests support 80 percent of the terrestrial biodiversity and home to 300 million people around the world. Besides, services from the forest ecosystems to mankind and environment are multifarious and enormous (Khan 2015).

In Bangladesh, there has been great depletion of forests and biodiversity in recent years due to human pressure, agricultural expansion, over exploitation of forest resources and encroachment of forest land. Goal of management for securing higher yield of wood per unit area from the forests led to establishment of mono-specific plantations through conversion of biodiversity rich natural forests. Throughout the world, the forestry operations especially from silvicultural treatments have substantial impact on the biodiversity. Thus compatible management of various resources in the forest ecosystems is important.

During the past 100 years, considerable loss of natural forests and biodiversity occurred in Bangladesh. Many forest plants are greatly reduced in proportion, a good number of important animals have become extinct and many more are endangered. There has been shrinkage of forest areas primarily because of improper management, increasing human pressure and ruthless exploitation of resources. The overall productivity from the forest ecosystems has declined in recent years. So, a baseline study in relation to different aspects of forests and biodiversity, identify the causes for the degradation of ecosystems, develop their proper management practices and prepare long-term planning for ensuring sustainable natural resources was felt essential. Accordingly, this baseline study has been undertaken with a view to gather information and to formulate a plan for the management of long-term forestry resources.

1.2. Forest Types in Bangladesh

A forest type is a unit of vegetation which possesses characteristics in physiognomy and structure sufficiently pronounced to permit of its differentiation from other such units. The type of vegetation in a locality depends primarily on climate and soil and past treatment (Champion *et al*. 1965). Bangladesh possesses five natural forest types. Through further studies, forest types for Bangladesh were presented by Das (1990) and Das and Alam (2001).

Phytogeographically the forests of Bangladesh fall under Indian, Indo-Chinese and eastern Asiatic regions. Floristically, the vegetation of hill forests is related to Indo-China than other part of Indian subcontinent. The flora also shows a considerable admixture of Cachar and Khasia elements. Forests of Bangladesh are generally uneven aged and multi-storeyed. According to height of trees, the floristic composition is divided into top canopy/storey, middle canopy and the species growing on the forest floor as undergrowth (Das and Alam 2001).

Ecologically, Bangladesh delta is represented by five broad natural forest types: (1) tropical wet evergreen on eastern and north-eastern hills (2) tropical semi-evergreen on eastern hills, (3) tropical moist deciduous/sal forests on central and north western terraces, (4) mangrove forests facing the sea and (5) freshwater swamp forests in low lying areas of Sylhet. In addition, there are planted homestead forests, rubber plantation, and embankment/roadside plantations (Das 1990, Siddiqi 1996, Hossain and Haque 2013). In Bangladesh, the forests are distributed on the eastern hills, central and north western terraces and the mangroves facing the Bay of Bengal (Fig.1).

The natural forest types with rich flora and fauna are under tremendous human pressure. Heavy logging, irrational management and introduction of plantation forestry caused colossal damage to natural forests. Their range of distribution and coverage are greatly reduced specially in hilly regions. There has been expansion of plantation forestry at the expense of natural vegetation leading to the reduction of floral and faunal diversity.

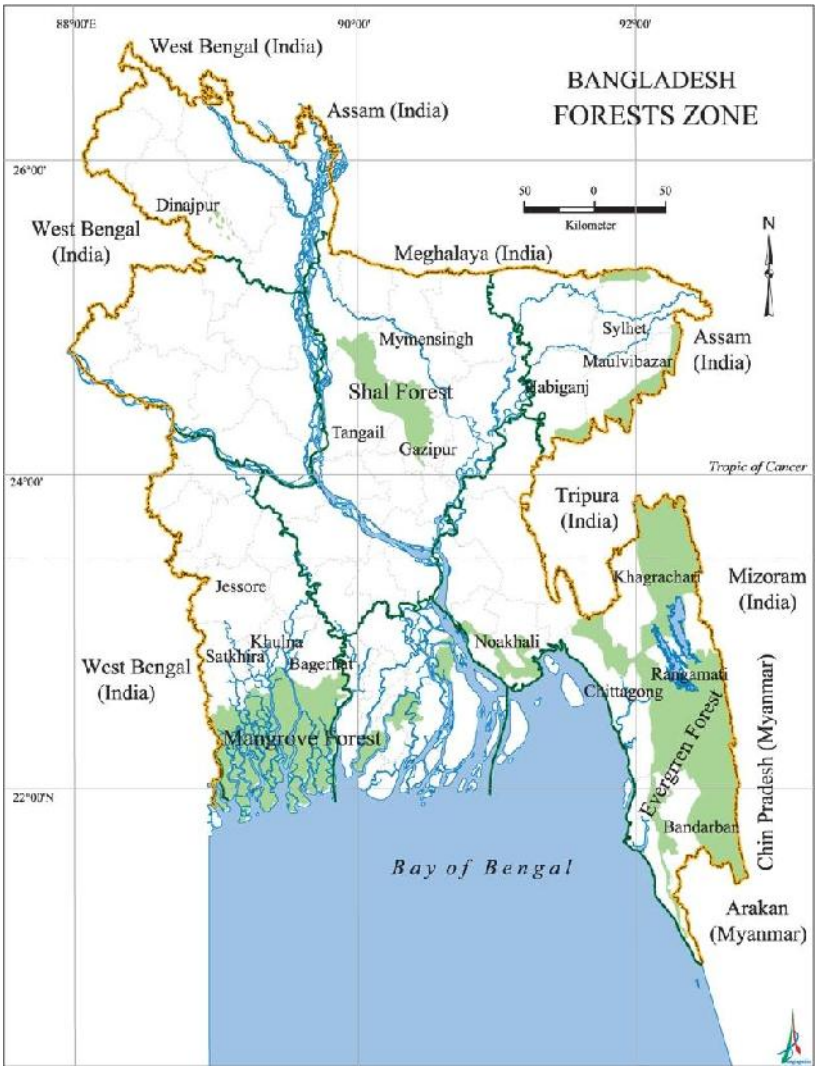


Figure 1 Map of Bangladesh showing the distribution of forests

1.3. Biodiversity in Bangladesh

The term 'biodiversity' is most commonly used to replace the more clearly defined and long established terms, species diversity and species richness. Biologists often define biodiversity as totality of genes, species and ecosystem of a region. Presently unified view of this traditional three levels at which biological diversity has been identified is species diversity, ecosystem diversity and genetic diversity.

Considerable work on species and ecosystems diversity has been undertaken in Bangladesh and literatures are available. However, for want of regular and systematic studies, it is difficult to exactly focus on the declining trends of different plants and animals in the nature. In Bangladesh 5,000 species of angiosperm are reported to occur (IUCN 2003). Studies in relation to genetic diversity are limited for forestry. Because of geographical settings and climatic conditions, Bangladesh is rich in floral and faunal diversity although occupying small territory. However, the ecological condition of the country is similar to the neighbouring countries. Consequently, it is unlikely to have any ecologically adapted species at higher levels in the country. Thus, there is little scope for the existence of endemic species.

In Bangladesh, almost 80% of terrestrial biodiversity finds refuge in forests (NSDS 2013).This report will be confined to discussing only the species diversity of plants and animals in the natural habitats. Under animal diversity, wildlife covering amphibians, reptilians, birds and mammals will be described.

2. Floral Diversity

2.1. History of Floral Exploration

Survey of plants has a long history for this region. William Roxburgh is the pioneer of Botanical exploration in the undivided Bengal. He was appointed Superintendent of Calcutta (Kolkata) Botanical Garden in 1793. His follower Buchanan-Hamilton and N. Wallich also laid down the foundation of Botany for the greater Bengal. Joseph Dalton Hooker and Tomson made their journey to Sylhet and Silchar in 1850 through the Megna and Surma River and collected botanical samples. Many other British explorers collected samples from the areas now comprising Bangladesh. Notable among them are: Clarke, King, Kurz, Griffith, Lister, Gamble and Prain.

Chapters on the History of Botany of India by I.H. Burkill (1965) give a good overview of the botanical exploration of India. Many British colonial civil and army personnel also collected samples from present Bangladesh. The British Foresters contributed to the Botany of Bengal. Most of these collected samples are housed in Kew and Edinburgh herbaria.

Local Botanists initiated sample collection in 1930 and the samples are housed in the Botany Department of the University of Dhaka. Notable samples of the forest flora are collected and preserved at BFRI Botanical Herbarium since 1960. Bangladesh National Herbarium was established in 1975 for floral exploration throughout the country. Since 1980, the foresters of the University of Chittagong are engaged in the exploration of forest flora of Chittagong and Chittagong Hill Tracts.

2.2. Distribution and Floral Diversity

In recent years, many species of plants including herbs, shrubs and trees in their natural habitats have greatly declined in their proportion and distribution. Human pressure, over-exploitation, irrational forest management practices and introduction of exotic species have negative impact on floral diversity. In absence of regular systematic survey, it is difficult to ascertain the magnitude of degradation of floral diversity.

2.2.1. Hill Forests

Wet evergreen and semi-evergreen forests occur in hilly areas of Bangladesh. Hilly forest extends from Teknaf peninsula, north along the Myanmar border to Chittagong hills and Chittagong Hill Tracts (CHT), and low hills in the district of Habiganj, Moulvibazar and Sylhet.

2.2.2. Wet Evergreen Forests

Wet evergreen forests are magnificent dense forests and support a diversified and rich in biodiversity. The trees in the top canopy attain a height of about 45-60m. A few semi-evergreen species may occur but they do not affect the evergreen nature of the forests. The floral diversity is rich with epiphytes, orchids, and woody and non-woody climbers, ferns, mosses, aroids and palms particularly in shady moist places. Herbs and grasses are abundant and the undergrowth is a tangle mass of shrubs, bamboo and rattans. These forests occur in shady areas of CHT, Chittagong, Cox's Bazar, Habigonj, Moulvibazzar and Sylhet (Das 1990, Hossain and Hoque 2013). Major dominant tree species are boilam (Anisoptera scaphula), chapalish (Artocarpus chama), garjan (Dipterocarpus turbinatus, D. alatus, D. costatus), telsur (Hopea odorata), champa (Michelia champaca), narikeli (Pterygota alata), civit (Swintonia floribunda), etc. About 700 species of flowering plants grow in this forest type (Pasha, Banglapedia). Bamboo is abundant throughout the hilly areas and Alam (1982) recorded 18 bamboo species from Bangladesh.

2.2.3. Semi-Evergreen Forests

Semi-evergreen forests occur in CHT, Cox's Bazar, Chittagong and Sylhet in more exposed dry areas. Trees in the top canopy reach a height of about 25-55m. In this forest type, the evergreen species predominate but there are many deciduous species. As many of evergreen forest species occur here, only during winter these forests are distinguishable from evergreen forests. Over 800 species of flowering plants have been recorded in this forest type (Pasha, Banglapedia).

2.2.4. Moist Deciduous Forests

They are known as sal (*Shorea robusta*) forests. Sal growing areas of Bangladesh fall within Indian region. They are deciduous in nature except a few patches along the foot hills of Garo hill which are semi-evergreen type. In Bangladesh, sal forests are found in Dhaka, Gazipur,Tangail, Mymensingh, Sherpur, Jamalpur, Netrokona, Dinajpur, Rajshahi, Panchagar, Rangpur, Naogaon and a small patch in Comilla (Chowdhury 1994).

Sal is the dominant species in this forest type and usually form 75-100% of the upper canopy but may be absent locally over large patches. The associates are other species but they vary in different localities. The trees are 10-25m in height. Associate species are palas *(Butea monoserma),* haldu *(Adina cordifolia),* sildha jarul *(Lagerstroemia parviflora),* kumbi *(Careya arborea),* hargaza *(Dillenia pentagyna),* bhela *(Semecarpus anacardium),* koroi *(Albizia procera),* gandhi gazari *(Miliusa velutina),* menda *(Lisea monopetala),* chapalish *(Artocarpus chama),* bahera *(Terminalia bellirica),* hortiki *(Terminaria chebula),* amloki *(Phyllanthus emblica),* etc. Undergrowth includes sungrass and other grasses. Among the palms, only rattans are found along the outskirts. Bamboo is not seen in sal forests.

2.2.5. Mangrove Forests

The mangroves are found in the form of natural and planted forests in Bangladesh. The natural ones are the Sundarbans is on the western part of coastline under Khulna Division and the Chakoria Sundarbans in Chittagong District on the eastern part. Mangrove plantations have been raised along the shoreline and near shore islands of Bangladesh during the last 50 years (Siddiqi 2001). Sundri *(Heritiera fomes)* and gewa *(Excoecaria agallocha)* are the dominant species of the Sundarbans. Other commercially important trees include kankra (*Bruguiera sexangula*), goran *(Ceriops decandra),* shingra *(Cynometra ramiflora),* kripa *(Lumnitzera racemosa),* keora *(Sonneratia apetala),* passur *(Xylocarpus mekongensis), etc.* The palms include golpata *(Nypa fruticans)* and hantal *(Phoenix paludosa)*. Tree canopy is seldom above 10m. Much of the forest is two-storied with scattered trees attaining up to 20m. In some places,

there is profuse growth of sedges and grasses along the canal and river bank. Depending on the level of salinity, the forest height decreases from 15m in east to 4m in west. There are about 70 species in the Sundarbans including 28 true mangrove species while others are mangrove associates (Chaffey and sandom1985, Siddiqi and Khan 2004).

Initial vegetation of the Chokoria Sundarbans included 53 species (Cowan 1926). The forests consisted mainly of *Ceriops decandra* and *Avicennia officinalis*. A notable feature of the forest is complete absence of *Nypa fruticans*, although this species grows naturally further south. The forests disappeared completely some 30 years ago due to human pressure and government policy of converting the area to shrimp farms (Siddiqi and Alam 2006).

2.2.6. Coastal Afforestation

Creation of mangrove plantation along the coast is in progress since 1966 with primary objective to protect the human lives and properties against cyclones and tidal surges. In fact, Bangladesh is the pioneer country in coastal plantation in the world. Keora (*Sonneratia apetala*) and baen (*Avicennia officinalis*) are the main planting species. On suitable sites, growth of trees is quite fast and survival satisfactory (Siddiqi and Khan 1990). Up to 2013, an area of 196,000 ha has been planted with mangroves. A considerable proportion is lost through erosion and encroachment of forest land. Net plantation area is 132,000 ha (BFD 2014) Other valuable species (*Heritiera fomes, Xylocarpus makongensis, Ceriops decandra, Bruguiera sexangula, Phoenix paludosa* and *Nypa fruticans*) are also being tried in less inundated areas for developing second rotation crops (Siddiqi et al. 1992). In recent years, mesophytes have been successfully established by planting the seedlings on excavated heaps in relatively matured coastal land not frequently inundated by tidal water (Siddiqi 1993, 1996).

2.2.7. Fresh Water Swamp Forest

This occurs in low lying areas (haor) of Sylhet Division. Large area of swamp forest is covered with grasses namely *Erianthus ravennae, Saccharum spontaneum* and *Phragmites karka*. These three species grow mixed together but P. karka over the other two species near the streams. In the depression where water is stagnant almost throughout the year, *Barringtonia acutangula* forms a pure crop. The undergrowth of *B. acutangula* is Calamus tenuis. In the elevated grassland, *Albizia procera, Bombax ceiba, Cordial dichotoma* and *Lagerstroemia speciosa* are found growing scattered. Species observed along the river bank and near the villages are: *Pongamia pinnata, Trewia nudiflora, Crataeva magna* and *Salix tetrasperma.* This is a highly productive ecosystem and supports plenty of fish and an ideal habitat for the migratory birds.

2.2.8. Homestead Forests

Planting trees near homesteads is a traditional land use system in Bangladesh. They form small scattered groves in different stories around villages through ecological and anthropogenic selections. The village forests comprise 10% of the total forests areas of the country but they contribute to substantial wood production, almost 80 percent. Homestead flora includes annual herbs to woody perennial indigenous and exotic species of multiple uses. Trees are dominant and common features of homesteads (Alam and Masum 2005). This forest consists of mixed fruits, fuelwood, shade and other multipurpose trees and bamboos (Khan and Alam 1996). Village trees in Bangladesh are represented by 183 species (excluding bamboo) covering 136 genera under 48 families. Floristic elements of village tree flora consist of native, African and New World texa. About 50 species are exotic and many of them have been naturalized (Alam et al. 1996).

Common trees of upper stratum are Albizia procera, A. lebbeck, Aphanamixis polystachya, Artocarpus heterophyllus, Artocarpus lacucha, Polyalthia longifolia, Aalstonia scholaris, Azadirachta indica,Dillenia indica, Mangfera indica, Cordial dichotoma, Elaeocarpus floribudus, Bombax ceiba, Syzygium cumini, Albizia saman, Swietenia macrophylla, Tamarindus indica, Toona cialiata, Acacia nilotica, Lagerstroemia speciosa, Ficus bengalensis, F . religiosa, F. racemosa, Anthoceprhalus chinensis, eucaluptus camaldulensis, Areca catechu, Borassus flobellifer, Cocos nucifera, Gmelina

arborea, etc (Khan and Alam 1996).The mid stratum is dominated by medium to small trees and bamboos. Plants of medicinal value, fruit trees and rattans are also found.

3. Endangered Plant Species

Inventory of wild plant resources is a continuous process but yet to be explored in details for all the forest areas of Bangladesh. It is reported that 5,000 angiosperms exist in Bangladesh (Table 1). Of these, 15% belong to trees, 35% shrubs to woody climbers and 50% herb species. There are about 700-800 tree species and 300 fresh water wetland species in Bangladesh (BARC 2012). There are species whose disappearance would significantly decrease the biodiversity of an area or their presence would help the stability of very existence of an ecosystem (Heywood 1992). A dependable report on the endangered species is lacking. Red Data Book of Threatened Vascular Plants of Bangladesh reported 106 species but more species were suspected to be in danger (Hossain 2014).

There are four gymnosperm species (Cycas pectinata, Gnetum scandens, G. funiculare and Podocarpus neriifolia) in Bangladesh and all are becoming rare (Khan et al. 2001). Besides, from ocular observations, it is apparent that a good number of naturally occurring species including rattans and medicinal plants are greatly reduced in density all over the country. According to Encyclopedia of Flora and Fauna of Bangladesh (2007-2009), 36 pteridophyte, 1 gymnosperm and 449 angiosperm species are threatened in the country. Alam (Pers.Com) mentioned of danger of many tree species in the natural forest of Bangladesh (Table 2).

Table 1 Extent of Floral Biodiversity in Bangladesh

Category	Total Number of Species
Flora	
Angiosperms	5,000
Gymnosperms	4
Algae/Seaweed	168

Source: MoEF 2002, Arannayk 2014.

Table 2 List of some Threatened Forest Tree species

Sl No.	Threatened Tree Species
1	Anisoptera scaphula
2	Aquilaria agallocha
3	Bombax insigne
4	Buchanania lancifolia
5	Canarium bengalense
6	Canarium resiniferum
7	Cycas pectinata
8	Elaeocarpus acuminatus
10	Homalium schlichii
11	Hydnocarpus kurzii
12	Knema bengalensis
13	Lithocarpus acuminata
14	Magnolia pterocarpa
15	Swintonia floribunda
16	Podocarpus neriifolius
17	Terminalia citrina
18	Pterospermum semisagittatum
19	Myristica linifolia

20	Michelia manii
21	Anogeissus sericea
22	Careya arorea
23	Dendrocalamus hamitonii

4. Plantation Forestry

4.1. Raising Plantation

Forest Department has moved to raising plantations over sizable area in different places for higher wood production. Due to homogeneity of vegetation, ecological niches are greatly reduced. Besides, the forest is clear-felled at maturity of the trees and replanted with single species. Thus it is not an ideal practice for habitats of indigenous plants and animals. Besides, exotic species are also introduced because of higher survival and fast growth.

4.2. History of Exotic Plants

Exotic trees have been introduced in Bangladesh during the past three centuries. Plantation of exotic species was raised by removing the natural forests or on denuded areas. Exotic species are aggressive in nature and in many cases they establish themselves by eliminating the indigenous ones.

Plantation forestry started in Bangladesh from 1871 with teak (*Tectona grandis*) from Myanmar. Teak was major planting species until the mid-1960s, along with indigenous species like *Dipterocarpus turbinatus, Shorea robusta, Artocarpus chaplasha* and *Syzygium grande*. More than 130 exotic tree species have been tried so far in the plantation programmes. The exotics that proved successful in trials are: *Tectona grandis, Paraserianthes falcataria, Hevea brasiliensis, Dalbergia sissoo,Swietenia macrophylla, Acacia nilotica, Eucalyptus camaldulensis, E. tereticornis, Pinus caribaea, Xylia kerrii, Leucaena leucocephala, Acacia mangium, A. auriculiformis* and *Gliricidia sepium*. Rubber (*Hevea brasilensis*) was introduced in 1961 Chittagong and Sylhet hilly region for commercial latex production (Hossain 2003).

Conversion of natural forests, particularly the evergreen and semi-evergreen hill forests of high biological diversity relies on the rational forest management. However, some of the successful species namely, *Eucalyptus camaldulensis, Acacia mangium* and *A. auriculiformis* have already been discarded from large-scale plantation programmes in the natural forest areas due to controversy about their suitability or bad effects on the ecosystem.

4.3. Performance of Exotics

Eucalyptus camaldulensis, E. tereticornis and *E. brassiana* emerged as the best species from Australia. Finally, *E. camaldulensis*, petford-1 provenance was found suitable and promising. *Eucalyptus camaldulensis* showed the highest height and diameter increment of their coppices. Superiority of *E. camaldulensis* was noticed in Chittagong.

Acacia mangium and *A. auriculiformis* have shown promising growth in poor sites. Provenance trials of *Pinus caribaea* var. *hondurensis* were established in 1983 and 1984 at Keochia, Chittagong and it grew well. *Pinus caribaea* var. *hondurensis* is doing better in comparison with *Pinus oocarpa*.

4.4. Introduction of Exotic Species

In recent years, a good number of exotic tree species have been introduced in Bangladesh by the Forest Department. Some of these species including *Eucalyptus camaldulensis*, *Acacia auriculiformis*, *A. mangium* and *Hevea brasiliensis* show good performance. Because of their fast increment, they became popular planting species. *Eucalyptus camaldulensis* is still planted by the villagers although it is declared banned for planting in the forest area. These

species have little to provide to the wildlife, birds and mammals in particular. Exotic species is problem for a sustainable wildlife management and their conservation.

4.5. Risks with Exotic Species

Invasion of exotics may cause major loss of biodiversity and indigenous species extinction either due to direct replacement by exotics or indirect effects on the ecosystem. Concern also exists on the degradation of the environment. There are also risks of the decline of growth and yield of the introduced species in second and successive rotations, or the infestation of pests and diseases.

4.6. Strip Plantation

Strip plantation was initiated about 25 years ago. Under Social Forestry programme, unused patches on the sides of roads, canal bank, embankment and railway track have been put to planting by Forest Department and different NGOs with people's involvement on profit sharing basis. On maturity and harvest of trees which vary from 10 to 20 years, 40-75% of the income passes to people involved (Bangladesh Gazette 2010). Even raising plantations on forest land by private persons is allowed. Social forestry also includes block plantations. Different indigenous or naturalized species including mahagony and sissoo are given priority. However, people's preferred species are *Eucalyptus camaldulensis* and *Acacia auricularformis* for fast growth in short rotation. And they constitute considerable proportion of the planted and surviving trees.

Initially plantation on coastal embankment has not taken place on a formal scale. *Samanea saman, Phoenix sylvestris, Acacia nilotica, A. auriculiformis, A. mangium, Dalbergia sissoo, Cocos, nucifera,* etc are success species on embankment. However, depending upon the locations from east to west of the shoreline and on the slope from top to bottom, species selection is important (Nandy *et al.* 2002, Siddiqi and Sayed 2012).

4.7. Prospects of Plantation Forestry

In Bangladesh, plantation programme is gaining movement steadily and the exotic species are getting preferences over the indigenous ones often at the expense of natural forest or homestead vegetation. With deforestation, many degraded sites are available for plantation, though very little is known about how to manage such sites economically. Conversion of healthy prospective natural forests to plantations of alien species must be strongly discouraged. Productive plantations on previously deforested or non-forested sites may offer important options for conservation of natural forests and arresting the further deforestation activities.

Another option of mixed species plantations of both the indigenous and exotics may also be able to contribute as an effective mechanism for sustainable resource management. Through the increase of productivity, pressures can be reduced on remaining natural forests but emphasis must focus on existing plantations, and new plantations on degraded or denuded land, agroforestry and community forestry programmes rather than on natural forest.

4.8. Rubber Plantations

Rubber plant (*Hevea brasiliensis*) was introduced to Bangladesh from Malaysia. The planting activity was initiated in 1960 and now it extends to greater districts of Chittagong, CHT, Mymensingh and Sylhet. Annual yield of latex from a hectare is 500 kg or 2 kg per tree. Currently both latex and wood are extracted from rubber plantations. Up to 2013, an area of about 40,000ha was brought under rubber plantation by BFIDC, Private Sector, CHT Board and small-scale planters. Yearly yield of latex was about 15,000 M.T. (BFIDC 2013).

5. Faunal Diversity

5.1. History of Faunal Exploration

Traditionally wildlife refers to non-domesticated vertebrates including mammals, birds, reptiles and amphibians, but has come to broadly reference to all wild plants, animals and other organisms. In other words, it includes animals and vegetation, especially animals living in a natural and undomesticated. Domesticating wild plants and animal species has occurred many times over the planet, and has a major impact on the environment, both positive and negative. Work in relation to faunal diversity of this region was initiated about 150 years ago during the time of British India. So, specific information was not available for the area now comprising Bangladesh. Some more elaborate studies were made in recent decades although not on regular basis to ascertain the trend of wildlife. However, most animals being visible by direct observations or through indices, their declining trend is understandable (Siddiqi 1996). Old literatures relevant to Bangladesh for mammals were by Pocock (1939, 1941), Jerdon (1874) and Blandford (1888). Baker (1830-1930), Whitsler (1949), Ripley (1961), and Ali and Ripley (1986-1974) worked on the birds of the Indian sub-continent. Rashid (1967) published list of birds of East Pakistan. As regards reptiles, catalogue was published by Theobald (1864), Smith (1943), Gunther (1876) and Whitarker (1978). About the amphibians, Smith (1943) and Boulenger (1980) initiated studies.

In recent years, substantial contribution has been made to determine the status and distribution of different animals, usually by the university teachers and students in absence of a zoological survey department. Husain (1974) put forward the first book highlighting the species composition and distribution exclusively for Bangladesh territory. Checklist of wildlife was published by Khan (1982) and Sarker and Sarker (1988) mostly based on primary data. A good number of dedicated persons from the universities and other organizations enlisted amphibians, reptiles, birds and mammals. The IUCN (2010) published red list of animals showing extinct and threatened species. Usually, information on different aspects of wildlife are scattered and need compilation. There is no plan as yet for a Zoological Survey Department in Bangladesh for regular faunal exploration.

5.2. Faunal (Wildlife) Status and Distribution

Bangladesh is represented by about 1010 species of wildlife. The amphibians comprise roughly 40 species (belonging to 7 families), reptilians 150 species (belonging to 20 families), birds 700 species (belonging to 71 families) and the mammalians 120 species under 33 families. Species wise, it looks rich and impressive over a small territory. However, there is considerable decline of population size of most of the animals in recent years. During the last century, many important animals have disappeared from the territory of Bangladesh for good, their distribution has become limited and population density reduced (Table 6).

5.3. The Mammals

Bangladesh is represented by about 1010 species of wildlife. The amphibians comprise roughly 40 species (belonging to 7 families), reptilians 150 species (belonging to 20 families), birds 700 species (belonging to 71 families) and the mammalians 120 species under 33 families. Species wise, it looks rich and impressive over a small territory. However, there is considerable decline of population size of most of the animals in recent years. During the last century, many important animals have disappeared from the territory of Bangladesh for good, their distribution has become limited and population density reduced (Table 6).

5.3.1. Primates

There are 10 Primates. Slow Loris (*Nyeticebus coucang*) is a rare one. It occurs in the forests of Sylhet, Chittagong and Chittagong Hill-Tracts (CHT). Rhesus Macaque (*Macaca mulatta*) is commonest and widely distributed. It occurs in villages, outskirts of towns and forest areas. Langoor (*Presbytis entellus*) is only found in the villages of Jessore while

the Capped Monkey (*P. pileatus*) and Leaf Monkey (*P. phayrii*) in the forest Sylhet, Chittagong and CHT. Pigtailed Macaque (*Macaca nemestrina*), Assamese Macaque (*Macaca assamensis*) and Stumptailed Macaque (*Macaca arctoides*) occur in hill forests. A small population of Crabeating Macaque (Macaca fasicularis) is found in mangrove patches under Teknaf Range. Out of four Apes in the world, Bangladesh is represented by White-browed Gibbon (*Hylobates hoolock*). Gibbon is found in Sylhet, Chittagong and CHT.

5.3.2. Carnivores

There are big cats and small cats. Tiger (*Panthera tigris*) was widely distributed in the 19th and 20th century. It is now confined to the Sundarbans with a big population size. The other big cat, leopard (*Panthera pardus*), once found all over, is virtually vanished from the territory of Bangladesh.

The small cats include Jungle Ca (*Felis chaus*), Leopard Cat (*F. bengalensis*), Fishing Cat (*F. viverrina*), etc. The extinct cat is provided in Table 3.The Asiatic Jackal (*Canis aureus*) and the Bengal Fox (*Vulpes bengalensis*) are widely distributed throughout Bangladesh. Wolf (*Canis lupus*) is extinct from Bangladesh.

5.3.3. Bears

Bear is represented by three species. The Asiatic Black Bear (*Selenarctos thibetanus*) is few in number and two others are fairly common. All the species including Black Bear, Malayan Sun Bear (*Helarctos malayanus*) and the Sloth Bear (*Melursus ursinus*) occur in the forests of Sylhet, Chittagong and CHT.

5.3.4. Civets and Mongoose

At least six species occurs in Bangladesh. The large Civet (*Viverra zibetha*) and the Small Civet (*Paradoxurus hermaphrodites*) are widely distributed. Two species of mongoose, the Small Indian Mongoose (*Herpestes auropunctatus*) and the Common Mongoose (*H. edwardsi*) are found.

5.3.5. Hoofed Mammals

There were five species of deer but three species exist. The Sambar (*Cervus unicolor*) is found in Sylhet, Chittagong and CHT. The Spotted Deer (*Axis axis*) is found in the Sundarbans, Sylhet, Chittagong and CHT. The Barking Deer (*Muntiacus muntjak*) is quite common and still has a wide range of distribution.

The Wild Boar (*Sus scrofa*) occurs in all the forest areas. In the Sundarbans, it forms prey for the predator, tiger. As overwhelm population of Bangladesh is Muslims, there is no human pressure on wild boars except in the Sundarbans, where they comprise food for the tigers.

5.3.6. Elephant

The Asiatic Elephant (*Elephas maximus*) is found in the forests of Chittagong, CHT and Sylhet. It has regular migration between Bangladesh and Myanmar or India. About 150 years ago, the elephant was a nuisance in the Madhupur Jungles but it does not exist anymore.

5.3.7. Aquatic Mammals

The Cetaceans are adapted to aquatic habitat. In Bangladesh, about 10 species of aquatic mammals occur. The most common is the Gangetic Dolphin (*Platanista gangtica*). None is known to have vanished but heavy pollution of river water has been restricting to wider distribution of aquatic mammals.

5.4. Extinct Mammals

A good number of mammals are extinct from Bangladesh. Besides, a few do not have a viable population. Species (Table 3) that disappeared from Bangladesh territory include:

Table 3 List of Extinct Mammals of Bangladesh

Sl No.	Common name	Scientific Name
1	Great One-horned Rhinoceros	Rhinoeros unicornis
2	Javan One-horned Rhinoceros	Rhinoeros sandaicus
3	Asiatic Two-horn Rhinoceros	Rhinoceros sumatrensis
4	Clouded Leopard	Neofelis nebulosa
5	Marbled Cat	Felis marmorata
6	Golden Cat	F. temmincki
7	Wolf	Canis lupus
8	Gaur	Bos gaurus
9	Blue Bull	Boselaphus tragocamelus
10	Water Buffalo	Bubalus bubalis
11	Banteng	Bos banting
12	Serow	Capricornis sumatraensis
13	Black Buck	Antilope cervicapra
14	Swamp Deer	Cervus duvauceli
15	Hog Deer	Axis porcinus

5.5. The Birds

The birds of Bangladesh are many to deal with. Against 8,600 species in the world and 1500 in India, the small territory of Bangladesh supports about 700 species of birds belonging to 71 families. Roughly 450 birds are resident and the rest are migratory. Some interesting birds include Red Jungle Fowl (*Gallas gallus*), Peacock Pheasant (*Polyplectron bicalcaratum*) and other pheasants. Among the pigeons and doves, Blue Rock Pigeon (*Columba livia*), Yellow-footed Green Pigeon (*Treron phoenicoptera*), Spotted Dove (*Streptopelia chinensis*), Red Turtle Dove (*S. tranquebarica*), Rufous Turtle Dove (*S. orientalis*), Ring Dove (*S. decaocto*) and Emarald Dove (*Chalcophaps indica*) are common. In the forest areas, there are Pin-tailed Green Pigeon, Grey-fronted Green Pigeon, Wedge-tailed Green Pigeon, Thickbilled Green Pigeon, Orangebrested Green Pigeon, Imperial Pigeon, Brown Dove and a few others. The number of forest dwelling pigeon and dove has considerably declined. Of the total available species, 358 species are non-passerine and 274 passerine. About 25 species of waterfowls are known to occur in Bangladesh. Of them four are resident and the rest winter migrants. The Lesser Whistling Teal (*Dendrocygna javanica*), Large Whistling Teal (*D. bicolor*), Spotbill (*Anas poecilorhyncha*) and the Cotton Teal (*Nettapus coromandelianus*) are resident. The migrants which occur widely during winter include Bar Headed Goose (*Anser indicus*) , Common Teal (*A. erecca*) , Graylag Goose (*A. anser*), Brahminy Duck (*Tadorna ferruginea*), Common Sheld-Duck (*T. tadorna*), Pintail (*Anas acuta*), Gardwall (*A. strepera*), Gargany (*A. querquedula*), Shoveller (*A.clypeata*), Wigeon (*A. Penelope*) , Redcreasted Pochard (*Netta rufina*), Tufted Duck (*Aythya fuligula*), Common Pochard (*A. ferina*), Mallard (*Anus platyrhynchos*), etc. Only a few decades back, thousands of these ducks created fantastic sights in the rivers and haor of Sylhet, Mymensingh and Pabna. Now they visit in lower number due to shrinkage of undisturbed ground.

Bangladesh has many species of parakeets, cuckoos, storks, kingfishers, raptors, hornbills, owls, woodpeckers, drongos, mynas, bulbuls, sunbirds, flowerpeckers and other birds. There are about 25 waterfowls winter visitors from the north. In recent years, some resident species have disappeared and some including the vultures are threatened

with extinction. Habitats for the birds all over the country are badly damaged particularly through harvest of tall trees and decline of tree cover. These result in reduction of bird population and disappearance of some species (Table 4).

Table 4 List of Noticeable Extinct Birds of Bangladesh

Sl No.	Common name	Scientific Name
1	Bengal Florican	Eupodotis bengalensis
2	Pink-head Duck	Rhodonessa carryophyllacea
3	White winged Wood Duck	Cairina scutulata
4	Common Peafowl	Pavo cristatus
5	Greater Adjutant	Leploptilos dubius
6	King Vulture	Gyps bengalensis

5.6. The Reptiles

As regards reptiles, Salt Water Crodiles (*Crocodylus porosus*) are not uncommon and now well protected in the Sundarbans. The Marsh Crocodiles (*C. palustris*) is extinct and the Gavial (*Gavialis gangeticus*) is approaching the same path with no viable population anywhere or already extinct. Following construction of Farakka barrage and diversion of normal water flow, the species lost its natural habitat.

Fresh water and marine turtles are plentiful. As regards turtle and tortoise, there are five marine and 25 freshwater species. As of 2002, the IUCN classified Bostami turtle (*Trionyx nigricans*) as extinct in the wild. However, it is found in fresh water in Assam and in a pond of the shrine of Hazarat Bayazid Bastami. About lizards, the Bengal Monitor (*Varanus bengalensis*) is widely distributed and the Ringed Lizard (*V. salvator*) is quite common in the Sundarbans. There are about 100 species of snakes in Bangladesh, although over a dozen of these have not been reported during the last few decades. Of existing snakes, about 32 species are venomous. The common snakes of the country are:

Checkered Keelback(*Xenochropis piscator),* Striped Keelback (*Amphiesma stolata),* Banded Wolf Snake (*Lycodon aulicus),*Black-barred Kukri Snake(*Oligodon cinereus)* Copperhead (*Colelognatha radiates),* Eastern Cat Snake (*Boiga gokool),* Smooth Water Snake (*Enhydris enhydris)* Rat Snake (*Ptyas* spp.), Python (*Python* spp.), Cobra (*Naja* spp.), King cobra (*Ophiophagus hannah*), Kraits (*Bungarus* spp.) and Sea Snakes (*Hydrophis* spp.) and others.

5.7. The Amphibians

The Amphibians include three species of toads and 47 species of frogs. Export of frog leg has been banned about two decades back and since then the population of the animals appears to be more or less stable. However, shrinkage of the habitats might have affected the frog population. Common Toad (*Bufo melanostictus*), Green Frog (*Euphlyctis hexadactylus*), Skipper Frog (*Euphlyctis canophlyctis*), Bull Frog (*Hoplobatrachus tigrerinus*), Cricket Frog (*Limnonectes limnocharis*) and Large Tree Frog (*Rhacophorus maximus*) are commonly seen.

Other than wildlife, extent of faunal diversity is mentioned in Table 5, although it needs revision with further studies. Present status of wildlife species composition and endangered species are mentioned in Table 6.

6. Endangered Wildlife

The status of wildlife with regard to species may look impressive but the population size and the range of distribution of important animals have declined considerably in recent decades. Many species are endangered or threatened with extinction. Reduction of human pressure on animals and maintenance of wildlife natural habitats will play a vital role for the management and conservation of vulnerable plants and animals. However, wildlife can be protected and conserved by developing awareness of the people about the importance of natural heritage.

Table 5 Extent of Faunal Diversity in Bangladesh

Fauna	
Sponge	3
Corals	66
Mollusks	362
Marine	336
Freshwater	26
Insects	2,493
Mites	19
Shrimp/prawns	56
Crabs	15
Marine	11
Freshwater	4

Table 6 Status of Wildlife (mammals, birds, reptiles, amphibians) and Endangered Species in Bangladesh

Class	No. of Species	No. of Genus	No. of Extinct Species	No. of threatened Species	% of Extinct Species	% of Species Threatened
Mammalia	120	89	15	43	12.5	36
Aves	700	334	06	47	01	07
Reptalia	150	87	02	63	1.5	42
Amphibia	40	24	00	o8	00	20
Total	1010	534	23	161	161	105

Source: Husain (1974), Khan (2010), Hossain (2014).

7. Forest Soils of Bangladesh

Major factors that regulate the properties of forest soil, like other soil types, are the relief, elevation, texture, moisture and temperature regimes of a region. Of course the landuse type, particularly the forest coverage of a region, has much influence on soil properties viz colour of topsoil, organic matter content, bio-turbation and structure formation, etc (Hassan 2013).

Time during the pedogenic past, the world was covered with forests of some kind or the other. The natural forest cover was broken over the historical past to claim land for agriculture. With the advancement of civilization and increasing human population, the natural forests throughout the world got reduced due to other conflicting landuses, e.g., agriculture, urbanization, infrastructure development and industrial development. Consequently, the forests now exist only in region that are subjected to severe limitations for other landuses. Under this context, the forest soils of Bangladesh in different forest types have been described as below:-

7.1. Littoral Forest Regions

This includes the Sundarbans, planted coastal forests and the Chokoria Sundarbans. Soils are generally in very poor drainage condition and clayey to fine loamy texture. The soils of the Sundarbans are grey to dark grey, slightly to moderately calcareous, slightly alkaline clays. Soils of the coastal region, where plantation is undertaken, are loamy to

clayey, calcareous and poorly drained. Calcareousness decreases from west towards east while the silt content of soils decreases both towards the east and the west of Bhola district.

Soils of the coastal plain are tidally inundated. These soils along the eastern coast line are grey non-calcareous clayey or fine loamy. The soils of the Chokoria Sundarbans, occupying the delta of the Matamuhuri, are unlike the Sundarbans as being more leached and contain least amount of weatherable minerals. On drainage improvement, acidity of these soils might reach very low (pH <3.5) locally due to oxidation of sulphide carried with tidal saline water to sulphuric acid and become unsuitable for agricultural use.

7.2. Soils of Freshwater Swamps

Forests of freshwater swamps occupy the beels and haors of greater Khulna, Faridpur, Dhaka, Mymensingh and Sylhet districts. Soils of these forests are very poorly drained, grey to dark grey clays that become strongly acid when dry. The soils of Khulna and Faridpur are dark grey, calcareous and alkaline clay. These soils are under the influence of seasonal inundation up to six months each year. Because of very deep seasonal inundation the soils though quite rich in mineral content have limited agricultural use. Clearing of the swamp land forests in the northern part of Bangladesh caused rapid siltation and gradual reduction of the perennial water area, degradation of wetland habitat and biodiversity. Occasionally high flood may occur in the downstream regions.

7.3. Soils of Deciduous Forests and Barind Tracts

These forests are depleted due to felling of sal (*Shorea robusta*) and encroachment of forestland for cultivation over the past several decades. The area includes brown terrace soils, grey terrace soils and grey valley soils. Sal forests occur in brow hill soils while the other two types under mainly agriculture. Brown forest soils are well drained, acidic and have clayey to fine loamy texture. The depth ranges from 50cm in shallowly weathered terraces to several meters in deeply weathered terraces both in Bhawal-Madhupur and Barind tracts. The soil contains concretionary mottlings or indurated concretions in the subsoil and substratum.

The upland terrace soils are called 'chala' and the valley soils are called 'baid' locally. The imperfectly drained level upland and the valley soils are used for paddy cultivation by holding rainwater. The brown well drained chala soils, because of their rapid permeability, were considered unsuitable for paddy cultivation and hence left under sal forests. The chala soils with their moderate to high nutrient content are suitable for horticultural crops with or without periodic irrigation.

The hill soils belonging to the Dupi Tila series are well drained, brown, fine to coarse loamy and acidic throughout the profile. Soils of Dihing series are similar to that of the Dupi tila soils except that these contain large volume of pebbles and boulders impregnated within the finer soil mass. Stones are commercially collected for building construction material.

7.4. Soils of Hill Forests

These forests grow in Sylhet, Chittagong and CHT. This landform covers area of about 18100 sq km. The hills comprise the Tipam-Surma (50%) and Dupi tila series (40%). The remainder is occupied by alluvial soils. The poorly drained valleys and the level river alluvium are used for paddy cultivation. The high hill soils of the Tipam-Surma series are shallow (35%) slope should be best placed under managed natural forests.

7.5. Soils of Homestead and Community Forests

In total an area of 2.10 million hectares are covered by anthropogenic soils in Bangladesh. This includes man-made land (0.10m ha), miscellaneous types (2.0 m ha) covering 200,000 km roads, 7,000 km river embankment and 6,000 km

coastal embankments. Additionally, on the bank of innumerable irrigation and drainage channels, sporadic tree planting is undertaken. A considerable portion of man-made land has been brought under community forests.

Man-made soils and miscellaneous land types occur on all geophysical parent material units. Hence these soils have heterogeneous physic-chemical characteristics related to landform, geology and physiographic condition to which they belong. However, the drainage conditions of these soils are freer in the floodplain region. In the upland region, the anthropogenic soils occur on more level land compared to adjacent areas and are richer in their organic matter and phosphorus content. The homestead soils are mostly fertile, intensively managed and highly productive compared to lands that occur in the adjacent regions.

8. Forest Areas and Wood Production

8.1. Forest Areas of Bangladesh

Of the total area of Bangladesh, agricultural land makes up 65% of its geographic surface, forest lands account for almost 17%, while urban areas are 8%. Water and other landuse comprise the remaining 10%. The total forestland includes classified and unclassified state lands and homestead forests and tea/rubber gardens. Actually about 8.37% of the total land is found with tree cover. Of this, about 6.5% belongs to the state owned Forest Department, and the rest 1.87% is privately owned village groves scattered throughout the whole country (Akhtaruzzaman 2006). For various reasons, there has been much degradation of forests, especially the natural ones. Hassan (2001) reported that the forest cover declined to only 6% during the past 50 years from previously dense vegetation of 20% in 1947.

Of the 2.54 million hectares Forest Land, Forest Department manages 1.54 million hectares which includes Reserved, Protected and Acquired forest and the Mangroves on the newly accreted land in estuaries of major rivers. The remaining 0.73 million hectares of land designated as Unclassed State Forest (USF) are under the control of Ministry of Land. Village forests (homestead land) form the most productive tree resource base in the country and accounts for 0.27 million hectares (Table 7, Fig.2).

Table 7 Area and percentage under different categories of forest in Bangladesh

Forest Category	Area (Million ha)	% of Total Forest Areas
Hill Forest Under FD	0.67	26.38%
Hill Forest under USF	0.73	28.74%
Sal Forest	0.12	4.73%
Village Forest	0.27	10.63%
Mangrove Forest	0.60	23.62%
Coastal Plantation	0.15	5.90%
Total	2.54	100.00

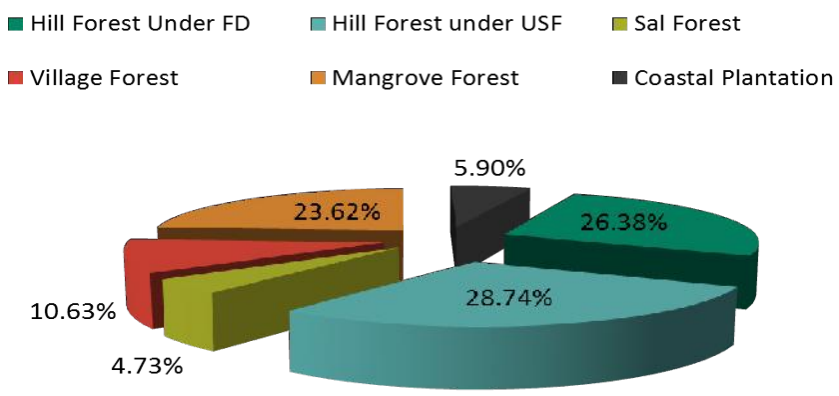


Figure 2 Percentage under different categories of forests in Bangladesh

About 70% of the total round wood and 80% of bamboo are supplied from the private own village grove. The existing yields from Forest Department are only 10% of the fuel wood, 20% of saw logs and 20% bamboo (BFRI 1999, Akhtaruzzaman 2010). With this scenario, there has already been an estimated deficit of 7.2 million m^3 total wood in 2003. This deficit is estimated to grow further to 14.44 million m^3 in 2020. As regard bamboo, there has been an estimated deficit of 59.72 million culms in 2003 and this will lead to 390.78 million culms in 2020.

The productivity of wood is about 0.5-2.5 m^3/ha/year in the government forest while it is about 7-9 m^3/ha/year in the homestead forest (Ahmed 1995). As the village homesteads are meeting the major demand of the resources and homestead forestry is a popular practice, there is a large potential to make the village groves more productive. This thrust is also important the requirement of rural population.

8.2. Status of Forest and Productivity

According to the information of Forest Department (FD), the total forest area in Bangladesh including hill forest, sal forest, village forest and mangrove forest is 2.54 million hectare in 2007 (Choudhury and Hossain 2009). Out of 2.54 million hectares of forests area in Bangladesh, FD manages 1.54 million hectares. The 1.53 million hectares of land, under the management and direct control of the FD, is legally defined as forestland; but all do not necessarily carry tree cover. Only 8.37% of the land, including 1.87% of village forest, is under forest cover (Akhtaruzzaman 2006). Of the total land in hilly areas, 0.67 million ha under FD and 0.73 million ha under USF. Besides, there exists 0.02 million ha under FD 0.6 million ha in Sundarbans and 0.15 million ha under mangrove afforestation (Kibria *et al.*2000). The tree cover amounts to 48.8% of the forest land. This means that 51.2% of forest land remains denuded and degraded. The forest area comprises 17% of land of the country. About 10% area of the country is under the control of Forest Department. However, only 6% of this land is under closed canopy forest cover.

As regards wood volume or growing stock in Bangladesh, it is difficult to give accurate information. However, in Table 8 an estimate is given of growing stock of wood in the country.

Table 8 Estimated growing stock of wood in different types of forests in Bangladesh.

Forest type	Growing stock of wood, million m^3		
	1990	2000	2005
Hill forest*	19.34	17.26	16.03
Plain land forest*	2.07	1.98	1.97
Littoral forest*(Mangroves)	13.14	11.97	12.00
Village forest**	69.16	89.58	101.94

** Data from FAO 2005*

***Hammermaster (1981)*

It is observed from the table that village forest is the largest contributor of wood resources. The condition of state owned forests is very disappointing. The main factors undermining the production and sustainability of the state forests may be due(i) poor management,(ii) scarcity of fund to materialize of the long-term visions and commitments, (iii) serious manpower shortage both in forest administration and research, (iv) disparity of FD with general administrative setup and poor linkage of research with FD, (v) poor monitoring and evaluation**, (**vi) land dispute,(vii) low acceptance of FD personnel to community at large, viii) corruption and policing behaviour amongst of FD personnel, etc.

Choudhury and Hossain (2009) collected data of Reserved Forest, Protected Forest, Acquired Forest and Un-classed State Forest from 1975 to 2001 from the Year Books of BBS. According to their regression analysis, Reserved Forest, Protected Forest, Acquired Forest and Un-classed Sate Forest in the country is estimated as 1.738 million ha in 2020, and those in 2040 as 1.462 million ha. The data do not include village forest area.

The main causes for change of forest area in the Asia-Pacific regions has been analysed by FAO (FAO 2009). Accordingly, expansion of large-scale commercial crops will be the most important driver of deforestation to meet the food grain prices rise. In addition, in the more populous countries, especially those in South Asia, forest degradation will stem from unsustainable collection of wood and non-wood forest products and from grazing. The situation is no different in Bangladesh.

8.3. Wood Production

Wood usually means fuel wood and timber. It is well recognized that wood production declined seriously since 1972. This is mostly because of imposition of moratorium on the extraction of wood till about 2001, when the felling of the plantations was started. The production of wood since then is increasing. This increase will depend largely on the availability of fund for new social forestry plantations involving private participants. Beside these, over 10 million homesteads in about 88 thousand villages across the country possess a large quantity of trees. These homesteads are the major suppliers of wood for the nation. The role of the homesteads in growing stock is shown in Table 9. Choudhury and Hossain (2009), Aktaruzzamanm (2010) estimated production of timber and fuel wood till 2020.The total estimated wood production till 2020 is given in Table 9.

Table 9 Estimated wood production till 2020 in Bangladesh.

Year	Wood production (Gov't forest), million m^3	Village wood production, million m^3	Total wood production, million m^3
1990	0.87	4.01	4.88
2000	0.18	6.07	6.25
2010	1.10	7.86	8.96
2020	3.62	10.62	14.24

Table 9 shows that the rate of production of wood grows at a faster rate in the village groves than in the forest. The community people have become more conscious of their wood requirement, especially fuel wood. This has encouraged them to utilize their homesteads more effectively. There is further opportunity in boosting the production by using modern technology, appropriate selection of species and strengthening management practices. The demand - supply gap will culminate in illicit felling of trees and force to imports. Hence production of wood must be augmented through utilization of modern technology generated by aggressive research, intensive management practices, enhanced investment in the forestry sector, etc. Figure 3 shows the trend in import of wood is to meet the demand. It is observed from the figure that the import of wood is growing sharply with a slope of 9.44 thousand ton/year. The import of wood in 2020 is estimated as 265,000 m^3. The figure in 2030 becomes 359,400 m^3 against the import of only 9,500 m^3 in 1990.

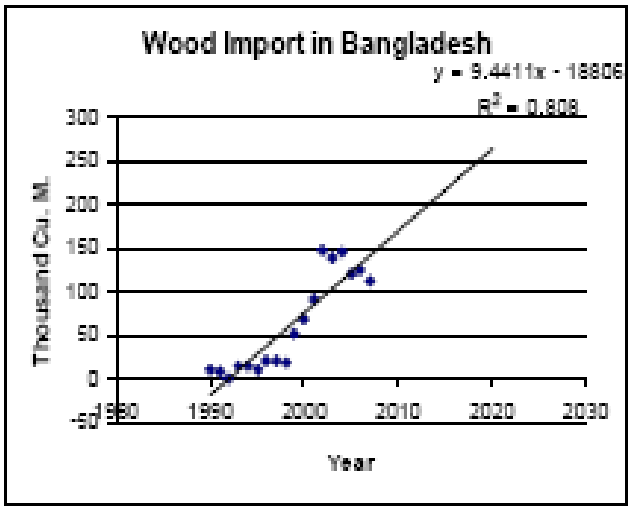


Figure 3 Projected import of wood in Bangladesh (Choudhury and Hussain 2011)

8.4. Demand and Supply of Bamboo

The database on bamboo production and human demand is very scarce. It is more limited for village grown bamboo. However, Banik (2000) made an estimate of supply and demand of total bamboo, i.e., bamboo produced in the forest and the village. Thus, data recorded by him was used for making further projection till 2040 as given in Table 10.

Table 10 Demand and supply of total bamboo (forest + village), data up to 2013

	1993	1998	2003	2008	2013	2020	2040
Demand	706.29	761.12	815.52	868.11	901.50	981.80	1252.75
Supply	656.2	679.8	755.8	637.8	576.9	591.02	633..29

In making the projection for the demand, annual growth was calculated using the data in the table from 1993 to 2013. The computed growth rate was 1.226%/per year. The situation with the supply estimate is rather complex. An abnormally large supply was anticipated in 2003. According to Banik (2000), this is due to availability of additional bamboo as a result of gregarious flowering of muli bamboo *(Melocana baccifera)*. The flowering of muli bamboo declined the supply of bamboo in 2008 and 2013. However, following this natural phenomenon, the bamboo production will be gradually rising. Thus, the supply growth rate was calculated from the data of 2010 and 2020 in Table 10.

It was found to be 0.346%/per year, and was used to work out the estimated supply of bamboo in 2020 and 2040 in Table 10. The table shows that the demand of bamboo is gradually increasing. But the supply remains almost the same. Unless the tremendous demand-supply gap is narrowed down, 80% population living in the villages will face employment problem for want of raw material.

A report by the BARC (2012) summaries the following main problems of the forestry sectors:

- Low forest productivity
- Flash flood and siltation of river basin
- Shortage of bamboo and other NWFP
- Lack of importance on medicinal plants
- Uneven forest distribution
- Loss of biodiversity
- Inadequate availability, reliability and quality of data
- Post-harvest loss
- Scarcity of industrial raw material
- Climate change
- Poor technology transfer

9. Non-Wood Forest Produce

Forest and forest products have been providing food, shelter, clothing and many necessities of life to the forest dwellers and rural poor since prehistoric days. As the economy of Bangladesh is predominantly agricultural and about 90 percent of the population live in rural areas, forests play an important role in supplying fuelwood for cooking and timber for house construction, agricultural implements, boats, carts, furniture, etc. Besides fuelwood and timber, non-wood forest produces (NWFP) provide many vital forest resources such as food, medicine, honey, essential oil, spice, resin, gum, latex, fiber and floss, bamboo and rattan, golpata, hantal, broom-grass, sun-grass, mushroom, tamarind, silk cocoon, lac, khoer (catechu), etc. These play a crucial role in the daily life and economy of the rural population in providing off-farm employment and income and are linked to the problem of poverty and subsistence. The forest foods supplement what is obtained from agriculture, thus increasing food security. NWFPs also create new opportunities for entrepreneurship development and their collecting and process in provide considerable employment opportunities to the poor rural population. Besides the subsistence role, NWFPs also have commercial importance in supporting small-scale industries through which value-added products are developed. Many of the participants in the community forestry development are including income generation activities by using NWFPs, and are trying to improve the returns from their forest resources. Various income-generating activities from NWFPs in the community forestry involve bamboo and rattan and their products, golpata for thatching, hantal as house posts, medicinal plants, spices, lac, silk cocoon, dye, betel nut, betel leaf, ginger, turmeric, calocasia, arum, fruit, vegetable, flower, honey, etc.

In a developing country like Bangladesh, non-wood forest products play a vital role in the economic and socio-political arenas of the country. Though branded as "minor forest products" in old forestry literature and departmental records, they are certainly not "minor" products in the context of the feeble Bangladeshi economy. They deserve to be given due attention in their own right (Khan 1992). NWFP gained greater importance following moratorium on wood extraction from the natural forests. Resources other than timber and fuelwood are considered NWFP in Bangladesh. Major NWFPs from different types of forests are discussed in this report.

9.1. Bamboo

Bamboo is the fastest growing plant in the world, and grows well on a variety of sites. Bamboos grow throughout Bangladesh with the exception of the Sundarbans. They are divided into two groups; that are the Forest (Hill Tracts) bamboos and the village Bamboos. Natural regeneration occurs in Hill Tracts bamboo. Planting does take place in village bamboo. Exact number of bamboo species is not available for Bangladesh. Over 20 species of bamboo grow in Bangladesh's natural forests and village homesteads. Bangladesh Forest Research Institute (BFRI) identified 33 species of bamboo and conserved them at the arboretum of BFRI Campus (Table 12). The most common bamboo species of Bangladesh are *Bambusa balcooa, Bambusa nutans, Bambusa tulda* and *Bambusa vulgaris*.

There are many impressive lists of the uses to which bamboos are put, these tend to obscure their most important purpose, at least in Bangladesh, namely housing. Over 90% of each year's harvest is used for either structural support of the house or partitions and walls. The first type we call the POLE bamboo (e.g. *Bambusa balcooa)* and the second type SPLIT bamboos (e.g. Muli or *Melocanna baccifera*). The POLE types have generally thick walls and short internodes; the SPLIT bamboo has walls and long internodes. Most POLE bamboos come from the villages and most SPLIT bamboos from the Hill Tracts. Besides this, bamboos are also used as tools of agricultural works thatching materials and in cottage industry for making walking stick, basket, mat, bag, fishing trap, novelty items etc. Young bamboo shoots are eaten as vegetables. Bamboo is also used as a component of herbal medicine (Banik 1997.) and in paper mills for paper making. Common bamboo species of Bangladesh are *Bambusa balcooa, B. vulgaris, B. tulda,* etc.

Table 11 Bamboo species preserved at bamboo arboretum of BFRI, Chittagong

Serial No.	Scientific Name
01	Bambusa balcooa
02.	Bambusa bambos
03.	Bambusa bambos var.spinosa
04.	Bambusa burmanica
05.	Bambusa cacharensis
06.	Bambusa comillensis
07.	Bambusa jaintica
08.	Bambusa multiplex
09.	Bambusa nutans
10.	Bambusa polymorpha
11.	Bambusa salarkhanii
12.	Bambusa tulda
13.	Bambusa vulgaris
14.	Bambusa vulgaris var striata
15.	Bambusa ventricosa
16.	Bambusa sp.
17.	Dendrocalamus brabdisii
18.	Dendrocalamus giganteus
19.	Dendrocalamus hamiltonii
20.	Dendrocalamus longispathus
21.	Dendrocalamus membranaceus
22.	Dendrocalamus strictus
23.	Gigantochloa andarmanica
24.	Gigantochloa apus

Serial No.	Scientific Name
25.	Gigantochloa atroviolacea
26.	Melocalamus compactiflorus
27.	Melocanna baccifera
28.	Schizostachyum dullooa
29.	Thyrsostachys siamensis
30.	Thyrsostachys oliveri
31.	Bambusa longispaculata
32.	Dendrocalamus latiflorus
33.	Thyrsostachys sp.

9.2. Rattan cane

Rattan cane is a climbing plant, mostly grown in homesteads and the low-lying areas of reserved forests. Canes are used for domestic purposes by the rural population, and for sophisticated furniture and luxury souvenirs suitable for export. Rattan is an important NWFP of Bangladesh and represented by two genera. Recent investigation provided a list of 10 rattan species occurring in Bangladesh (Ara 2005, 2006). These are *Calamus acanthospathus, C. erectus, C. gracilis, C. guruba, C. latifolius, C. longisetus, C. tenuis, C. travencoricus and C. viminalis var fasciculatus* and *Daemonorops. Jenkinsiana.*

All recorded rattan species of Bangladesh are forest dwelling except *C. tenui* and *C. guruba that* have been domesticated and are usually found to grow at the edge of water and marshy places in village groves. Forest dwelling rattans mostly grow in evergreen and semi-evergreen forests except *C. viminalis* which also grows in the outskirt of mixed deciduous forests. Generally rattan is not available in mangrove forest but *C. tenuis* grows along mangrove fringe.

Common species of rattan in Bangladesh are karak bet *(Calamus viminalis), golla bet (Daemonorops. Jenkinsiana)* and Jali bet *(Calamus tenuis).*Rattan is in use in this country since date back as binding material, weaving strip for making furniture, furniture frame, walking stick, broom handle, carpet, stick, fish trap, bird case, hanging bridge and novelty items of aesthetic value. In addition to its use in furniture making, split canes are used for hanging bridge and novelty items of aesthetic value. In addition to its use in furniture making, split canes are used for handicraft and cottage industries to make basket, mat, bag and host of other products of everyday uses. Large diameter rattans (*C. latifolius, C. longisetus, C. viminalis var fasciculatus* and *D. jenkinsiana)* are used for furniture framing and small diameter rattans *(C. gracilis, C. guruba, and C. tenuis*) are used for weaving. Stem of largest diameter rattan *(C. erectus)* of Bangladesh is used as pole for making house. Rattans are also used as cordage for tying binding. Young shoots of rattan are used as vegetables. Ripen fruits are eaten by children and tribal people. Tender leaves of rattans are used for treating biliousness and dyspepsia.

9.3. Sungrass (Imperata spp)

Sungrass (*Imperata* spp.) is the most common roofing and thatching material for temporary low-cost housing in the villages. Sungrass grows naturally, especially in the forests of low-lying areas, or around the denuded and barren hills unfit for growing high-quality timber trees.

9.4. Stone

Stone is one of the most important NWFPs, available only in some areas of Bangladesh, such as Sylhet, Hill Tracts, and Dinajpur. Stone is required for construction of highways, buildings and other infrastructural needs.

9.5. Golpata (Nipa fruticans)

Golpata (*Nipa fruticans*) is one of the most abundant NWFPs in Bangladesh, growing naturally throughout the Sundarbans mangroves and scattered along the coast line. Villagers in the coastal areas also grow nipa in small scale to meet their need. Plantation of golpata can be established from raised seedlings (Siddiqi 1995, 1999) Leaves of nipa palm are used for thatching and roofing. It provides considerable revenue for the Forest Department and direct and indirect employment opportunity for many people. Harvesting is allowed once a year. Small quantity of molasses is prepared from nipa sap.

9.6. Hantal (Phoenix paludosa)

Hantal *(Phoenix paludosa),* another palm species of mangroves is well distributed on relatively raised land of the Sundarbans. It was also plentiful in Chokoria Sundarbans (Siddiqi *et al.* 1994). Harvesting is undertaken at 2/3 years intervals. The stem of hantal is light but strong and durable. They are used for house posts and trusses.

9.7. Patipata (Schumannianthus dichotoma)

Patipata (*Schumannianthus dichotoma)* grows well in marshy places**.** The plant is shrubby with cylindrical blackish stems. Five main patipata growing areas in Bangladesh are Chittagong, Noakhali, Tangail, Sylhet and Barisal. Patipata is a valuable plant for the cottage Industry. It is used as a raw material for making shitalpati, mats, busket, etc. from ancient times. Shitalpati and decorative mats are traditional products of Bangladesh. They have potential markets at home and abroad. Different types of handicrafts are prepared from patipata. In glossary shop, it is used as a binder of goods. Patipata made products are used for decoration of office, drawing-room and show-room of business centre, in conference room or any gathering and so on. A good number rural people remain employed in patipata based shops.

9.8. Mushroom

Common edible mushroom belongs to some species of *Agaricus* and *Pleurotis*. Edible mushrooms provide a good addition to the diet in the form of proteins, carbohydrates, valuable salts and vitamins, immediate between meat and vegetables. Due to high protein and mineral contents and low caloric value, it is recommended to heart patients. Mushroom is a very tasty vegetable having nutritional and medicinal value. About 20 mushroom species grow wild in Bangladesh, of which 5-6 are poisonous. Some mushrooms grown wild are eaten by the tribals of Chittagong Hill Tracts. Mushroom from the nature are also marketed in hilly areas. Very recently 1980s, some small-scale farms are cultivating mushroom mostly at Savar area of Dhaka for human consumption. Most common type of eatable mushroom is *Pleurotus ostreatus*. The cultivation and uses of mushroom have become popular because of favourable climatic and environmental condition of Bangladesh.

9.9. Honey and Wax

Honey is used as food, drink, and medicine. It is produced naturally in the beehives of the Sundarbans forest where it is collected in large quantities every year. Honey is also grown in the forest regions of Chittagong, Sylhet, Cox's Bazar, and Mymensingh. Recently, apiculture (artificial bee-keeping) has been introduced in some areas of North Bengal and Mymensingh district with considerable success. Honey is a promising NWFP in Bangladesh in terms of export potential. It is gaining popularity and importance.

In the Sundarbans, honey and wax are harvested every year. The honey bee (*Apis dorsata*) produces them. Approximately 150,000 kg of honey and 40,000 kg of wax are harvested between April and June annually (Helalsiddiqui 1999, Siddiqi 2001). About 50 plants have been recorded that are linked to honey production. *Apis*

dorsata has never been domesticated but *A. indica* produces in the wild as well as domestication. The Sundarbans accounts for 20% of the total honey production of the country (Imran 2011).

9.10. Shells, Conch Shells, Oysters

Shells, Conch Shells, Oysters, etc. are collected in large quantity in the coastal forest sea beach of Cox's Bazar, Teknaf, Moheskhali, Barisal, Patuakhali, and Sundarbans. This activity provides income to local inhabitants who sell them to the tourists as souvenirs. Some are also exported. Although the Forest Department has no effective control on processing and export of these products, it is indirectly supporting the growth and expansion of this cottage industry. If the Government promotes it with proper incentives, this industry has considerable export potential. No statistics are available for these products.

9.11. Medicinal Plants

Once a rich and diverse medicinal plants grew in the forests, plain lands, crop fields, roadsides, home gardens and wastelands. More than 500 species of medicinal plants have been enlisted in Bangladesh (Ghani 1998). BFRI made an inventory and enlisted 220 medicinal and aromatic plants. Their habitat, distribution, flowering time and healing ailment have been documented (Rashid. *et al.* 1990). In the BFRI campus 108 species of medicinal plants have been conserved. Bangladesh Council of Scientific and Industrial Research (BCSIR) identified 747 medicinal plants (Yusuf. *et al.* 1994). IUCN made a comprehensive survey on selected medicinal plant of Chittagong Hill tracts and listed 31 species that are regularly used by the tribal people (Motaleb, 2011). Khisa, (1996) recorded more than 500 plants species used by traditional practitioner for medical purpose, out of which 135 species are taxonomically identified.

According to IUCN Red Data Book, 106 species of plants in Bangladesh are endangered. Among them eight species have medicinal values. These are *Andrographis peniculata, Rouwolfia serpentina, Terminalia citrina, Cycas pectinata, Dioscorea prazeri, Cymbidium aloifollium, Amomum costatum* and *Zingiber roseum*. Leaves, bark and fruits"Kurus pata'' Holarrhena antidysenterica is very popular for medicinal use. Horitaki (*Terminalia chebula*), amlaki (*Phyllanthus emblica*) and bohera (*Terminalia belerica*) popularly called "Trifala" (Myrabolum) are used as medicine in the country. List of commercially important medicinal species are mentioned in table 12.

Table 12 Commercially Important Medicinal Plants of Bangladesh.

Sl. No.	Local name	Scientific name	Local name	Scientific name
1	Aswaganda	*Withania somnifera*		
2	Basak	Adhatoda vasica		
3	Tulsi	Ocimum tenuiflorum		
4	Satamuli	*Asparagus resimosus*		
5	kalomegh	Andrographis paniculata		
6	Pipul	*Piper longum*		
7	Amloki	*Emblica officinalis*		
8	Sarpagantha	*Rauvolfia serpentine*		
9	Brahmi shak	*Becopa monniera*		

9.12. Market potential of Medicinal plant

Since ancient time plants have been used to heal and cure diseases and to improve health and wellbeing of human. Medicinal and aromatic plants (MAPs) play a significant role in meeting the demands of the traditional medicine market which are found both domestically in the producing and in overseas markets. Bangladesh herbal medicine internal market is valued at Tk. 330 crore (approximately US$ 60 million) as trade price. Table 13 exhibits discipline wise medicinal plants value and volume requirement as raw material.

Table 13 Sector wise MAP raw material usage in terms of value and quantity

Sector	Local supply		Import		Total	
	Tk. million	US $ Million	Tk. Million	US $ million	Tk. Million	US $ million
Unani	127	2.20	127	2.20	254	4.40
Ayurvedic	82	1.40	100	1.75	182	3.15
Herbal Doctors	45	0.80	54	0.95	99	1.75
Self Treatment	76	1.30	200	3.50	276	4.80
Total	330	5.70	481	8.40	811	14.10
Raw Material	12,500 Ton		5,000 Ton		17,500 Ton	

Source: SEDF/IC, 2003

Helvetas, Swiss inter cooperation reported that 60,000 producers are involved in cultivating five commercially important MAPs like *Withania somnifera* (Aswaganda), *Ocimum tenuiflorum* (Tulsi), *Asparagus resimosus* (Satamuli), *Adhatoda vasica* (Basak), and *Andrographis paniculata* (kalomegh) (SEDF/IC, 2003).

10. Forest Management in Bangladesh

Territory comprising Bangladesh has a long history of forest management. Forests of this region have undergone manifold changes both on the aspect of administration and management. Services, in other words, intangible benefits from the forest ecosystems started gaining importance from initial revenue collection oriented management. At the time of partition in 1947, human population of Bangladesh was roughly 40 million, in 1971 during independence it was 70 million and in 2012, the population was 152 million. Bangladesh, covering an area of 147,570 Km2, is an over populated country and so there is a big gap between demand and supply of forest produce. In order to meet the need of growing population, greater emphasis has been given on increasing the timber yield, often ignoring the environmental issues. Forests provide important renewable resources like timber, fuelwood, bamboo, non-timber forest products and habitat for wildlife. It also provides oxygen, controls or reduces the intensity of the cyclones and tidal surges in the coastal areas of Bangladesh, influences the rainfall, and sustained water yield in the river systems, etc. Now-a-days, eco-tourism is the more attractive type of tourism, which could be an alternative mechanism for environmentally sustainable development without depleting the forest resources, habitats and biodiversity.

10.1. History of ancient and medieval period

Based on literature survey and analysis Ahmed (2007) put forward a vivid description in changes of silviculture and forest from management practices from ancient time. The existence of a regular Forest Department in India could be traced back to the *Maurya* era. *Kautilaya's Arthoshastra* a manual for administrators written by Chanakya, the Prime Minister of Chandra Gupta Maurya (321 B.C.) provided elaborate description of the Forest Department at the time (Dwivedi, 1980). This Department was headed by a Superintendent of forests or `*Kupyadhkyaksha*' who was assisted in discharging his duties by a number of Forest Guards or `*Vanapalas*'. Forest management practice was quite advanced

for the time and fairly similar to practices carried out in the recent past. The forests during *Maurya* era were classified into 3 categories namely, Reserved Forests, Forest donated to eminent Brahmins and Forest for the people.

For the king, some of the reserve forests were set aside only for recreational purposes. Rest of the reserved forests were managed by the Kupyadhyaksha. Forest regulations aiming at protection of forests were enforced. Illegal felling of trees or setting of fire to forest was considered punishable offences. The Forest Department was also responsible for the protection of animals and some animals were brought under the protection of the state and any trapping or killing of such animals were punishable. At that time, afforestation for specific end uses was also undertaken.

Little is known about the state of management of forest in ancient India after the fall of Mauryas. There are a number of reports about the existence of large tracts of dense forests in India at that time. However, it is generally believed that after the fall of Gupta dynasty around 800 A.D., India got divided into a large number of smaller states. When these states were continuously fighting for supremacy over each other, large tracts of forests were cut to meet the demand of timber for fighting these wars.

Existence of dense forests during the Mughals has been recorded. However, during the Mughal period, emphasis was given on expansion of agricultural land which resulted in deforestation of large areas. Large tracts of forests were also sold for revenue (Curtis 1933). They had utilization and aesthetic approach towards forest without any comprehensive outlook to problems of forestry including preservation, propagation, protection management or improvement (Dwivedi, 1980).

Scientific forest management in the Indian sub-continent was initiated during the British rule by the appointment of Sir D. Brandis as the Inspector General of Forest in 1865. A Conservator, Mr. T.M. Anderson was appointed for Bengal, Assam and Bihar. Subsequently, a separate forest Department was created for Bengal in 1876. Chittagong was the first Forest Division in Bangladesh which was created around 1872. Sundarban Forest Division (India and Bangladesh) was constituted in 1879. Reservation of forest areas under the Indian Forest Act started in Bangladesh with the reservation of some forest land in the Sundarbans in 1875. Large scale reservation of forest land in Bangladesh took place in early decades of the century.

For quite a long period after the establishment of Forest Department in India, forestry activities were confined to the realisation of revenue for trees. Before the establishment of the Forest Department, Revenue Department and Collectors were responsible for the disposal of forest produce and realisation of revenue. This practice still continues in the Unclassed State Forest of Chittagong Hill Tracts where management of whatever little resource is left is confined only to realisation of revenue for sold trees. The management of forests in different regions of the country was taken up at different times. Even though the Forest Department was created about 125 years ago, it exists in present shape for about 40 years. Even though Chittagong Forest Division was created in 1872 first major management plan for the forest was not written till 1923. However, this plan which prescribed a clear felling cum-artificial regeneration system of management could not be executed properly because of lack of demand for the local trees.

Situations, however, were better in case of Sundarban forests where the first management plan written by Mr. R.L. Heinig came into operation in 1883-84. Before this plan came into operation forest produce from Sundarbans was sold unsystematically on realisation of revenue by weight of produce exported. The exploitation of Sundarbans forest dates back to late Mughal days when forest mahals in Sundarbans were leased out and entire crops were extracted. The reservation process was started in Sylhet in 1914, the first management plan came into operation in 1938.

Dhaka-Mymensingh forests were owned by big landlords and in 1925 the management of these forests were vested with the Forest Department. A Forest Division was created in Dhaka for the management of these forests. Forest Department continued to manage these forests till they were acquired by the Government under the East Bengal State Acquisition and Tenancy Act in 1950.

The forests in Dinajpur were managed by the big landlords till their acquisition in 1950. A Forest Division was created in Dinajpur for the management of forest in the northern districts in 1952. The First management plan for these forests came into operation in 1960 (Ahmed, 1960).

- Management of forests on a sustained basis.
- Ensuring supply of forest products to the population.
- Carry out operations to improve the quality of forest stock.
- To bring all poorly stocked and denuded forest areas under tree cover.
- To replace the existing trees with more valuable tree species (in case of hill forests).
- To maintain adequate forest cover for maintenance of an ecological balance and improved environmental condition.
- In consistence with the above objectives to derive the maximum economic benefit out of these forests.
- To provide forest cover for preservation and propagation of wildlife.

10.2. Management System

From early days of management, the forests of Chittagong (Chittagong, Cox's Bazar and Chittagong Hill Tracts) region were worked under a clear felling system. Based on the demand for the produce and in the absence of growth data an arbitrary period of conversion of natural forest to plantation were assumed and based on this assumption an annual coupe or felling and was decided. This area would normally be scattered over different centre within the forest. The land was restocked with artificial plantations of most valuable species. In Sylhet, the first management plan prescribed a selection-cum-improvement system of management which trees above a certain diameter were removed followed by an improvement felling of dead, dying and suppressed trees on a 20-year cycle. However, after the expiry of this plan the forests of Sylhet have been managed under the same system as in Chittagong. Most of the early plans prescribed for establishment of plantations for timber production. However, from sixties an awareness about the necessity of creating: supply sources for fuelwood and industrial raw materials have been felt and consequent attentions have been given gradually to the establishment of plantations production of fuelwood and industrial raw materials.

For the last few years specific end-use oriented plantations have been raising in Chittagong, Sylhet, Cox's Bazar. The Chittagong Hill Tracts, the coastal regions and the northern districts. These include fuelwood, pole, timber and industrial plantations. Different species both local and exotic have been identified and planted in different end-use oriented plantations.

The management of bamboo forests has been treated separately in all management plans. However, the management prescriptions have been confined to regulation of the felling and little effort has so far been made any improvement of the quality of the stock.

In the Sundarban Division, forests have been worked on a selection system where exploitable sizes for important species were fixed in the management plan and trees above certain diameters were extracted. In the early days, there was no regulation for felling trees of less important species. The selection system of management is still in practice in Sundarban forests. The system in now known as selection-cum-improvement, as, in addition to felling of trees above a certain exploitable diameter, improvement felling for removal of diseased dead, suppressed tree together with removal of some healthy trees for removing any congestion is carried out. However, improvement felling is not undertaken for practical problems.

The management of plain land sal forests of Dhaka, Mymensingh and Dinajpur was originally in the hand of a number of landlords. General practice in those days was to lease out forests in big chunks, often mouza by mouza for 5 years and the lease was allowed to cut all trees over 1 foot 6 inches in girth 3 feet from the ground. This resulted in serious depletion of the crop. These forests have been worked under clear felling system with either coppice or artificial

regeneration. However, because of serious degeneration of the forest during and after the 1971 war, a moratorium on felling of trees in the sal forest has been in force since 1972.

10.3. Present Forest Management

In the light of degrading condition of the environment and forests, new approaches in management came into being. The protective role and intangible benefit of forest environment including conservation of wildlife and biodiversity has been taken into consideration. Consequently, activities in the forestry sector like (i) plantation forestry for higher yield, (iii) introduction of fast growing exotic species, (iv) roadside plantation, (v) development of community forestry, (vi) participatory forestry approaches, (vii) coastal afforestation, (viii) eco-tourism and (ix) wildlife management have been initiated with a view to increase forest productivity and conserve the environment (Siddiqi 2002). Some of these approaches are conflicting for natural resource management and conserving wildlife. So, methods are to be evolved for a compatible management of forests and wildlife habitats. Communication and awareness will play an important role in this respect for people's motivation and implementing forest policy.

There is a fundamental difference between past and present forest management in Bangladesh. It depends on its objectives and philosophy. Present forest management objectives are not only to produce timber only but also to provide clean air, clean water and healthy habitat for wildlife and to act as a major source of biodiversity and nature-based tourism. The present approach of forest management is to involve people in the management and create an environment so that people can feel that they have also some stakes on trees growing on the forestland and to improve living standard of the people residing in the vicinity of the forests.

10.4. Present Management Objectives

Through the assistances of ADB, UNDP and FAO, present forest management plan is established under the guidance of Forestry Master Plan (FMP) in 1993. The objectives of present forest management are the following:

1. To enhance environment preservation and conservation.

2. To introduce rational forestland use.

3. To increase public participation and benefit from the forest.

4. To create forests on marginal and private lands.

5. To setup institutional strengthening.

6. To improve management practices.

7. To Improve efficient resource utilization.

10.5. History of Sundarbans Management

In the 16th century, the Sundarbans forests were the property of the local king or Zamindar who imposed levy on the extraction on wood from the forest. During the British period, the Crown assumed the proprietary right over the forest. Forests were leased under the ACT in 1830 to Europeans. This resulted in the progressive conversion of forests into agricultural land that continued up to 1875. A number of prominent British foresters visited the Sundarbans within 1863 to 1874 and succeeded in raising awareness in the colonial administration about the value of the forests. Their recommendations resulted in the introduction of a set of guidelines initiating the first conservation activities. Leasing out of forests land was thus stopped in 1875 and the remaining unleashed forest was declared as Reserve Forests under the Forest Act of 1876. A Forest Management Division was established in 1879 at Khulna that regulated export of timber and was in charge of management. The Boundary of the Bangladesh portion of the forest has

remained mostly unchanged for the last 125 years. The conservation effort received a boost when in 1977 the government set aside 139,700 hectares for three wildlife sanctuaries under the Wildlife Act of 1973.

10.6. Impact of Management

In the past, clear felling system was in practice for evergreen, semi-evergreen and deciduous forests. At the moment, tree harvesting is banned. In the mangroves, selection system was in practice which means only the bigger trees above prescribed diameter used to be harvested. The forest remained virtually virgin with little or no deterioration of wildlife habitat. Rather sometimes, removal of larger trees helped penetration of sunlight to the forest floor allowing growth of grass and understory vegetation, food for the herbivores on which the carnivores depend. So, selection system never degraded the wildlife habitats for food and shelter. The selection system is still followed in the Sundarbans but the forest is under human pressure for resource exploitation legally or illegally.

10.7. Sustainable Forest Management

In the context of the lessons learnt, the sustainability of the forest is discussed below. Since most of the forest and biodiversity resources are in a degraded state, protection and conservation of these resources are the main focus in this area (Planning Commission 2013). The key elements of the sustainability include:

- protection and expansion of forests and forest resources
- retaining the integrity of hill ecosystems that sustain plant and animal biodiversity
- enhancing forest biodiversity and wildlife conservation through expanding protected area expansion of social forestry and agroforestry
- adopting co-management approach with community participation for protecting the forest and biodiversity conservation
- restoring ecosystems and rehabilitating endangered species
- plantation of the wet land with special emphasis on maintaining the integrity of wetland ecosystems
- further development of coastal green belt and promoting people's ownership of social forestry
- stopping expansion of shrimp culture
- stopping use of forest land for urbanization, industrialization and conversion to agricultural land

10.8. Co-management for Biodiversity Conservation

Co-management is usually applicable to the peripheral areas of reserved forests or protected areas for the conservation of habitats and wildlife. It was initiated under the project IPAC which focuses on building a foundation of sustainable co-management. People are expected to be involved in different activities including raising plantations for income generation and to protect the biodiversity. Social forestry must be anchored on felt needs and problems of target beneficiaries. People's participation in the activities is the key principle of social forestry. For the success of social forestry an effective awareness program has to be launched and participatory forestry or co-management of forest resources has to be undertaken in a wider scale. It is a multi-sectoral approach led by the Forest Department and other technical agencies involved in the conservation of biodiversity and management of protected areas in the terrestrial and aquatic ecosystems of Bangladesh. For the success of social forestry an effective awareness program has to be launched and participatory forestry or co-management of forest resources has to be undertaken in a wider scale (Bangladesh Gazette 2009).

If these are done the following will unfold one after the other in the sequence as mentioned below:

- The people in general and the people living nearby the forests in particular, will be fully aware of the environmental values of the forests and shall understand its role not only at local level but also at national level.
- Once they acquire this awareness they will oppose the illegal felling from the forests.

- As the local people will become participants of forests and forestry, they will start receiving substantial gain. Thus they will get into the ownership. Once that is there, they will look for its sustainability.
- At this stage they will not only remain passive supporters of conservation but will also become vocal opponent to any destruction or illegal felling.
- This will stop all sorts of illegal felling from the forests of the country and the existing strength (number of manpower) FD personnel will be able to protect the forest.

Bangladesh has bright prospects to increase production of forest resources through intensive practice of social forestry**.** The ball is already rolling. To this end, Government should earnestly promote co-management practices of natural resources. The co-management is a collaborative management approach used by government technical agencies to collaborate with local communities and other stakeholders in the conservation of forest lands, wetlands and other natural resources. To implement this approach, co-managers engage local stakeholders through a participatory approach that empowers them with a voice as well as defined role in decision making and provides sufficient economic incentives to engage their interest in the successful of agreed upon natural resources management objectives.

The co-management approach under implementation has some limitations:

- It is operating by virtue of a gazette notification by the Ministry of MoEF. It does not have the legal framework which is an urgent need. In absence of legal provisions and policy directives, truly co-management may be jeopardized. The legal framework should also address utilization of revenues generated by the activities as a means of long term sustainability of the management programme;
- At present the forest officials are observed as managers of forest that are to be cut and sold. This mind set must be transformed for conservation management of the of the resources in partnership with other stakeholders and local communities;
- There are chances that the co-management councils and committees are represented and dominated by the local elite setting aside the true beneficiaries of the communities;
- No success will accrue if the implementing community members are not involved from planning, implementation and monitoring;
- There are inadequate incentives for income generation ;
- There are chances that the community members do not get appropriate share of the entry fee earned due to misappropriation, etc.

With a view to make the programme successful for the benefit of the people at large and the country in particular, the above shortcomings must be addressed forthwith. In addition, strong scientific back up with demand-led knowledge and information is a key to bring rapid and sustainable success. With delineation of the Protected Area (PA), things are changing towards greening and conservation of the resources. Hence, social forestry activity with co-management of forest through participation of local people is a bright hope in covering up a vast majority of the denuded and degraded forest.

It is too early to access the success of co-management. There are constraints. The attitude of the implementing officers for revenue collection needs to be changed. Frequent transfer of offers affects efficient execution of project activities. The real beneficiaries are the influential people of the locality instead of directly involved villagers. The officers for co-management practices have to be adequately trained up. A sustainable or revolving fund needs to be developed for smooth functioning. In a densely populated country, it is nearly impossible to conserve natural resources without direct participation of the people. Accordingly, social forest management and co-management practices are likely to play an effective role in the long-term forest management planning. Lesson learnt in the neighboring countries on similar socio-economic and environmental conditions can be taken into consideration.

11. Impact of Exotics

11.1. Ecological Impact of Exotics

Probably the single most important factor a plantation has on the local environment is the site where the plantation is established. If natural forest is cleared for a planted forests then a reduction in biodiversity loss of habitat will likely result. If a plantation is established on abandoned agricultural land, or highly degraded land, it can result in improvement of both habitat and biodiversity. Plantations harvested on longer rotation periods (30 years or more) can sometimes provide similar benefits to a naturally regenerated forest managed for wood production, on a similar rotation for the wildlife. This is especially true if native species are used.

11.2. Impact of Invasive Trees on Wildlife

In Bangladesh, substantial barren lands are there in hilly areas, plain lands and new coastal accretions. These areas are not inhabited by a rich wildlife fauna. Introduction of any species, local or exotic, will not affect the fauna. However, indigenous tree species will attract the surrounding animals and they should get priority in planting programme with a view to rehabilitate and conserve wildlife. A mixture of indigenous and exotic trees can also be undertaken for plantation success and economic return which will reduce the adverse effect on the wildlife.Natural forests in Bangladesh occupy small areas compared to previous status but support many important animals and diversified flora. These virgin forests must be maintained undisturbed. Plantation forestry inside the natural forests should be discouraged and exotic plants controlled. Plantation forestry over night destroys and reduces various ecological niches for the animals causing reduction of species composition and population size of animals. This scenario is common all over Bangladesh.

11.3. Invasive Species Control

The main objective of the exotic trees are maximum production, meet the growing need of the people and higher income in a short time. Rotation is short, in other words, the areas is harvested at a shorter interval, not allowing the animals to settle. Sustainable wildlife management at a short rotation is not feasible. The policy makers and the government are convinced of the adverse effect of the exotic trees. Destruction of natural forests and planting of some exotic species have been banned. Besides, *Eucalyptus* is no more raised in public nurseries. However, other fast growing exotic trees including *A. auricilaformis, A. mangium* and hybrid *Acacia* are planted specially under social forestry. Rubber plantations have established over 40,000 hectare in hilly areas affecting negatively the indigenous vegetation and the wildlife.

11.4. Invasive Tree Control at Private Level

This will be a difficult task. In recent years some exotic trees have been planted based on research studies. They grow faster, produce good quality timber and ensure higher economic return. However, the impact of these species on wildlife and environment was not considered. These species have become popular by private owners and the villagers. Without an alternative, the rural people will continue to plant exotic trees.

11.5. Motivation against Invasive Plants

People, Government and NGOs need to be aware of the negative effects of exotic species on wildlife and environment. It took several years for nature lovers to develop people's awareness against hunting and poaching of animals and conserve natural environment. Unfortunately, forest management was shaped to increase wood productivity completely in disregard of conserving natural flora and wildlife habitat. Research on the improvement of local species did not get adequate attention rather greater emphasis was given on exotic species. Moreover, there has

been exploitation of plant resource all over Bangladesh to meet the people's demand. Control of exotic plants may be possible through motivation of the people.

12. Wildlife Conservation

12.1. Threats to Wildlife Richness

Bangladesh being a small and over populated country, threats to wildlife is enormous and from various angles. Still the country possesses a rich wildlife fauna in respect of species composition. Technically there is ample scope for the management and conservation of the wildlife but there are constraints too. To take a pragmatic view the following points need to be taken into account:

1. The forests will continue to shrink gradually due to increasing human pressure and agricultural expansion.
2. Every part of the forests is getting approachable to common people due to improvement of communication system through the forests.
3. Poaching and hunting pressure are there since the forests are in the vicinity of human habitation. However, due to motivation and awareness, direct human pressure is much reduced.
4. With the increasing demand for the forest produce, the management policy is turning towards more intensive use of forest land by introducing fast growing and short rotation crops.
5. Expansion of clear-felling system with artificial regeneration in the forests which overnight destroys wildlife habitats.
6. Practice of monoculture, in other words, raising plantations with sing species reduces the ecological niches which adversely affects the richness of the fauna.
7. Plantations with exotic species like Teak (*Tectona grandis*), Pine (*Pinus*) and Rubber (*Hevea brasiensis*) have been established in place of natural forests. Other fast growing short rotation species (*Eucalyptus, Acacia auriculariformis, A. mangium,* etc) are planted in different places even by the rural people.
8. Short rotation implies that the forest will be harvested at shorter intervals and the wildlife habitat will be more frequently damaged. Naturally occurring vegetation on the forest floor that provides food and shelter to animals will be suppressed.
9. The virgin forests with heterogeneous flora will hardly be available in time to come unless strict measures are adopted without delay.
10. The vast wet lands provide shelter and habitats for fishes and migratory water fowls. The ecosystems are increasingly affected by environmental pollution and human activities.

12.2. Fruit Trees for Wildlife

In the natural forests many trees provide food and shelter to animals. In fact, the figs of all the Ficus spp. are food for animals, birds in particular. So, during a plantation programme, plants comparable to wildlife need attention. The following are some trees suitable for animals in table 14.

Table 14 List of some fruit trees in the forests.

Sl.		**Sl.**	
01.	Antidesma ghaesembilla	14.	Garcinia cowa
02.	Artocarpus chama	15	G. xanthochymus
03.	Artocarpus lucucha	16	Garuga pinnata
04	Baccaurea ramiflora	17	Grewia glabra
05	Dillenia pentagyna	18	Parkia roxburghii
06	Diospyros pilosula	19	Pithecellobium dulce

Sl.		Sl.	
07	Elaeocarpus floribundus	20	Suregada multiflora
08	E. robustus	21	Syzygium fruticosun
09	E. rugosus	22	S. syzygioides
10	Erioglossum rubiginosum	23	S. oprculatum
11	Ficus auriculata	24	Phyllanthus emblica
12	Ficus racemosa	25	Sonneratia apetala
13	Ficus semicordata		

Source: Dr. M.K.Alam (Pers.com)

12.3. Need for Wildlife Conservation

Wildlife conservation is a practice of protecting endangered plant and animal species and their habitats. Under Bangladesh context, the wildlife generally includes the mammals, birds, reptiles and amphibians. Among the goals of wildlife conservation are to ensure that nature will around for the future generation to enjoy and recognize the importance of wildlife and wilderness lands to humans. Wildlife conservation has become an increasingly importance due to negative effects of human activity on wildlife. An endangered species is defined as a population of living being that is at the danger of becoming extinct because of several reasons. Either they are few in number or are threatened by the varying environmental or predation parameters. Naturally the endangered species are supposed to get priority from conservation point of view.

12.4. Natural Habitat loss

Fewer natural wildlife habitat areas remain each year. Moreover, that remains has often been degraded to bear little resemblance to the wild areas which existed in the past. This is a great problem for maintaining a sustainable population of wildlife round the world and Bangladesh in particular with increasing human population. Subsistence farming is responsible for 48% of deforestation, commercial agriculture for 32%, logging for 14% and fuel wood removals make up to 5% of deforestation. Primary causes for habitat destruction and degradation are population increase, growing demand for forest produce, fuel wood, and forestland to agriculture, industrialization, urbanization, infrastructure development for transportation, energy production and so on. In Bangladesh, between 990 and 2005, forest loss is about 1.3%. Large scale use of toxic chemicals, industrial waste to water bodies and other factors caused further degradation of wildlife habitat.

13. Degradation of Forests

13.1. Causes for Degradation

A number of factors are responsible for the denudation or degradation of forests ecosystems. The main causes are pin pointed below:

- Conversion of lands to agriculture/ cash crops
- Urbanization and Industrialization
- Firewood / Fuelwood collection
- Human Settlement inside Forest Land
- Shifting / Jhum cultivation
- Illicit felling of trees
- Encroachments of Forest Land
- Hill cutting and Settlement etc.

- Exotic Rubber plantation
- Non-sustainable Forest Management
- Lack of Policy for Conserving habitats
- Greater Importance on Productive Role
- Intangible benefit of Forests not Accounted
- Inadequate Step for Biodiversity Conservation
- Expansion of Shrimp Farming
- Extension of Salt Production Area
- Ship Breaking Industries

13.2. Wildlife Habitat Degradation

The forest area comprises 17% of Bangladesh. Forest Department controls 10% however, only 6% of the land is under closed canopy cover. The Protected Area covers 10.72% of effective control of the Forest Department. Broadly speaking, the country is represented by three forest types – semi-evergreen forests on the eastern hills, deciduous sal (*Shorea robusta*) on the central and north western terraces and the mangrove forests facing the Bay of Bengal.

Additionally, there is natural or raised vegetation in the homesteads, sides of road/rail/embankment and in wet land. In a country like Bangladesh where one third of all area can be termed as wetlands, the haor basin is an important wetland ecosystem for the resident and migratory animals. Migratory birds come in August-September and return during February-March. Maximum concentration is noticed in December-January. All over the country tall trees which were supported some selected bird species are greatly reduced. In recent decades, there has been much degradation natural habitat of wildlife leading the animals to an uncertain future.

14. Forest Industry

14.1. Wood and wood products

Wood products fall far below the demand of the people. The products from forest lands are of various types such as timber, fuel wood, poles, bamboo, cane, thatch leaves, fish, honey, wax, etc. (Choudhury and Hossain 2011). For the purpose of this report, timber, fuel wood and poles are treated as 'wood'. Wood production has declined seriously since 1972 due to over-exploitation and with the imposition of a moratorium on the extraction of wood till about 2001, when the felling of plantations was started. The production of wood since then has been increasing, but this increase will depend largely on the availability of funds for new social forestry plantations involving participants. Over 15.4 million households in about 88,000 villages across the country possess a huge quantity of tree growth and this is the major supplier of wood for the nation.

14.2. Forest industries

In general the following major categories of forest products based industries are found in Bangladesh:

1. Sawmills
2. Manufacture of wood products including furniture
3. Production of hardboards, particleboards, chipboards, etc.
4. Manufacture of pulp, paper, newsprint and paper products
5. Match factories
6. Manufacturing of packaging paper
7. Production of various products from wood, bamboo, cane, patipata, etc. as handicrafts by the cottage industries

Information about the number of the forest product based industries in Bangladesh are inadequate. Most of the industries are Government owned and run through corporations such as BFIDC and Bangladesh Chemical Industries Corporation (BCIC). Recently (as of September 2007) the privatization commission was looking for buyers to sell out the following forest product based industries:

1. Chittagong Board Mills, Chittagong
2. Chittagong Cabinet Manufacturing Unit, Chittagong
3. Chittagong Chemical Complex, Patenga, Chittagong
4. Dhaka Cabinet Manufacturing Unit, Dhaka
5. Eastern Wood Works
6. Fidco Furniture Complex, Chittagong.
7. Karnaphuli Rayon & Chemicals Ltd., Kaptai, Rangamati
8. Karnaphuli Timber Extraction Unit
9. Khulna Cabinet Manufacturing Unit, Khulna
10. Khulna Hardboard Mills Ltd., Khulna
11. Khulna Newsprint Mills Ltd., Khulna
12. Lumber Processing Complex
13. North Bengal Paper Mills Ltd., Pakshi, Pabna
14. Particle Board Veneering Plant
15. Sangu Matamuhuri Timber Extraction Unit
16. Sangu Velly Timber Industries
17. Sylhet Pulp and Paper Mills Ltd., Sylhet
18. Wood Treating Unit, Chittagong
19. Wood Treating Unit, Khulna

Those industries were sick and that might be due to poor management under Government ownership. Local private entrepreneurs are emerging to establish new industries in pulp and paper, composite wood, etc mostly based on recycling of the paper and small wood from rural homesteads (Choudhury and Husain 2011). Sawmills are the principal wood user. Though furniture making has the highest number of establishments (over 34,000); there are about 10,000 sawmills, including pit saws (Forestry Master Plan 1993). The major wood based industries recorded in the Statistical Year Book 2004 were 1,642 in 1995–96. It appeared that the small rural carpenters were not taken into account.

14.3. Small-Scale Forest Industries in Community

Small-scale forest industries constitute an important part of the forestry sector in Bangladesh, contributing significantly to the development of both the sectors of the rural and industrial economies. Being small, such enterprises are able to utilize local valuable but scattered forest resources, which might otherwise be unproductive. The rural people benefit from such enterprises in a short time. Moreover, the enterprises are characterized by small size, technological simplicity of operation, low capital intensity, heavy reliance on entrepreneurs, seasonality of activities, etc. The Small and Cottage Industries Corporation of Bangladesh (BSCIC) listed 157 types under small and cottage industries (BSCIC 1983). The following types of small and cottage industries are located in or nearest to the community forestry projects which are based on the raw materials from the community forests (Table 15).

Table 15 List of community forestry-based small-scale industries in Bangladesh

1. Sericulture	19. Bidi and cheroot
2. Lac culture	20. Brick manufacturing
3. Apiculture	21. Candle making
4. Mushroom culture	22. Chanachur making
5. Catechu/khoer production	23. Chira (flaked rice) and mori (puffed rice)
6. Gur (molasses)	24. Dairy products (sana and sweetmeat)
7. Charcoal production	25.Lime manufacturing
8. Furniture from wood	26. Metal working/foundries
9. Cane and bamboo furniture	27. Oil extraction
10. Basketry from cane and bamboo	28. Paddy parboiling
11. Novelties from wood, cane, bamboo and	29. Pottery other NTFPs 30.Soap
12. Broom-making	31. Dying (rug and cloth)
13. Agricultural tools,	32. Fish smoking/drying
14. Cart (wheel and body)	33. Ginger and turmeric drying and grinding
15. Musical instrument	34. Goldsmith
16. Handicrafts	35. Tile making
17. Bakery and confectionery	36. Tobacco curing
18. Blacksmith	37. Herbal medicine

15. Wetland Biodiversity and Management

Wetlands are the most productive low lying ecosystems on the earth surface covering marsh, fen, bog, floodplain, and shallow coastal areas. Most of the world's wild plant and animal species depend on the wetlands for their survival and in many places they are under acute stress as a result of changes made by human beings. The wetlands are found to be most degraded mainly due to lack of understanding about their beneficial role and consequently faulty utilization practices. Bangladesh is rich in wetland habitats but their conditions are not satisfactory specially for increasing human population and unplanned development.

15.1. Wetlands of Bangladesh

The wetlands may be natural or artificial. The man-made wetlands include aquaculture ponds (brackish and freshwater), irrigated land and irrigation channels, salt pans and hydro-dam, eg., Kaptai Lake. The country possesses enormous area of wetlands including rivers and streams, freshwater lakes and marshes, haors, baors, beels, water storage reservoirs, fish ponds, flooded cultivated fields and estuarine systems with extensive mangrove swamps. Freshwater marshes are more or less shallow water bodies lying at the back-slope of floodplains. In most cases, these are old or abandoned river courses, having tall reeds and grasses mixed with thickets of floating vegetation. Lakes are deeper perennial water bodies. Swamp forests develop along the margins of beels, marshes and lakes. Typical trees are Hizal (*Barringtonia acutangula*), Tamal (*Diospyros cordifolia*), Barun (*Crataeva nurvala*), Madar (*Erythrina variegata*), Gab (*Diospyros peregrina*), Dumur (*Ficus hispida*), Chalta (*Dillenia indica*) and Dehua (*Artocarpus lacucha*).

15.2. Importance of Wetlands

The wetlands have a wide range of ecological, socio-cultural, economic and commercial values in Bangladesh. These are important habitats for a large variety of flora and fauna of local, national and regional significance. In the freshwater wetlands the floral composition includes trees, herbs, shrubs and aquatic vegetation. Wetlands are critically

important in Bangladesh for human settlements, high biodiversity, shelter for migratory birds, fisheries, agricultural diversity, navigation, communication and ecotourism. Freshwater capture fishery is an important source of employment in the fishery sector and a supply source of animal protein.

Development activities over the last three decades, massive physical infrastructures in the form of rural road and flood embankment have been developed in the wetlands including floodplains and haor areas. Many of these infrastructures disregarded local topographic condition and natural water flow direction, which has often resulted in poor drainage or water logging and impacted on the local surface water regime. The critical point of such development activities in the wetlands led the transformation very rapidly at a massive scale. In the southwest brackish water coastal plains of Bangladesh farmers used to have a paddy crop only during monsoon season when surface saline layer is depleted due to rainfall and for rest of the months the field is left for grazing. This cultural practice was established for centuries. However, in the last two decades this has been abandoned for more profitable shrimp farming practice. As a result, local ecosystems are threatened because of changed water exchange system, rapid siltation of the channels and continuous inundation of land with saline water.

In the haor areas, largescale settlement was initiated at the mid-20th century from surrounding densely populated regions and since then the resources of the haor basins are being exploited at an increasing rate causing adverse effects. Continuous exploitation of aquatic vegetation has caused serious degradation of the quantity and quality of the habitat required for fish and migratory birds of the haor areas. Similarly, embankments reduce floodplains and obstruct fish movement and migration from rivers as well as beels to the remaining floodplains for feeding and breeding. As a result, many fishermen have lost their livelihood. This has led to an enhanced marketing infrastructure and relatively easy access to social and other services. Conversely, the navigation system has been either closed or substantially reduced. As a whole, degradation of wetlands has caused several problems including extinction and reduction of wildlife, extinction of many indigenous wild and domesticated rice varieties, loss of many indigenous aquatic plants, herbs, shrubs and weeds, loss of natural soil nutrients, loss of natural water reservoirs and of their resultant benefits, increase in the occurrence of flooding and degeneration of wetland based ecosystems, occupations, socio-economic institutions and cultures.

15.3. Resident and Migratory birds

About 210 species of birds covering resident (62.5%) and migratory are found in the fresh water wetlands of Bangladesh. Of them, 30% are waterfowls, 26% waders, 20% bush and herb land birds and the rest are grassland, air hawking prey. Open sales of wild and migratory birds in the cities are all too flagrant. Guest birds trapped in Sylhet's haors are held captive in Srimangal town for sale in other cities. The poachers take advantage of the people's lack of awareness of the importance of migratory birds. While poaching, killing of birds and their open sale in towns continues, safe places are also available. In Kanglar haor in Sunamganj, guest birds are neither shot nor caught. The local panchayet in the village banned the killing of birds in 2001.

In the winter, Bangladesh has been hosting thousands of ducks and other birds from Europe, Siberia or the Himalayas, but the scenario is changing due to loss and reduction of undisturbed wetlands. Some 500,000 birds, mainly ducks, travel to Bangladesh each winter for food and shelter. Poaching and the loss of water bodies are major reasons for the decrease in the numbers of visitors but loss of habitat is more important. Mere declaration of some Protected Areas is not enough for the conservation of biodiversity. For the enforcement of laws, there is need to develop people's awareness about the importance of wildlife, resident and migratory birds in particular and benefits of wetland ecosystems.

15.4. Fish Resources

Bangladesh is rich in aquatic resources with extensive seasonal and perennial water bodies throughout the country. In the past, the expansive floodplains, oxbow lakes, beels, and haors were home to a vast range of fish species. Of the

260 fishes found in the inland waters of Bangladesh, 150 grow to a small size (maximum length of about 25 cm), and these are found in the wetlands. The re-establishment of these species in wetland areas through stock enhancement can increase fish production and provide micronutrients to local communities living in the floodplains and the population at large. Over time, a significant number of these species have declined. Yet 30% of total fish production comes from these water bodies and supply vital income and food for the country's rural poor.

Fishing is the second largest livelihood activities. The majority of rural population depends on fishing there. The available information indicate that this sector employs about 2 million people who remain fully engaged in fishing, handling, packaging, transporting, distribution and marketing of fish. An estimate showed that about 10 million people are engaged as part-time fishermen to supplement their income or to live on fishing in some part of the year. About ten per cent of the population depend on fisheries for their livelihoods in Bangladesh.

15.5. Management of Wetland Biodiversity

Community based resource management in wetlands has to be emphasized for effective and sustainable utilization and conservation of wetlands. This approach is gaining impetus in recent years in the wetland areas particularly in Sylhet region, rich in low lying ecosystems. Some agencies under the initiative of the Government are engaged in co-management in Sylhet haor areas. The Sundarban is the biggest wetland ecosystem in estuarine area. Its resource management, biodiversity conservation and ecotourism are under the direct control of the Forest Department. All over Bangladesh, considerable areas have become degraded due to human pressure, irrigational utilization of resources and unplanned development activities.

For the conservation, the hotspot areas with high biodiversity are to be identified through systematic surveys. As many disciplines are involved in wetlands, multi-sector integrated approach should be adopted for the management of wetlands. The degraded wetlands and wetland-based resources, also considered as "Common Property Resources" are found wide spread in the country due to lack of scientific management and unwise consumption patterns. Valuable wetland biodiversity needs to be addressed adequately and managed with greater emphasis.

16. Trade, Employment and Wood Energy

16.1. Forest Trade and Employment

The major forest products traded in Bangladesh are timber and poles, fuel-wood, bamboo, thatch grasses, nipa palm, hantal, rattan, medicinal plants etc. Regarding trade of forest products generally three tiers of people, namely primary collectors/growers, intermediaries and mohajans are involved. In the Sundarbans alone, 300,000 people work in various seasons of the year inside the forest. The probable direct employment offered by the Sundarbans is between 500,000 and 600,000 people for at least half of the year (Husain and Karim 1994). It is reported that over 0.2million people are involved as primary workers in the hill forest areas of Chittagong Hill Tracts, Chittagong and Sylhet. Roughly 0.075 million people are working as primary workers in the plain land Sal forest areas of the country, either as participants or as intruders. At least 0.4 million people are involved with the trade of forest produce in some form or the other. The big investors are few in number.

Though quality woods such as teak, garjan, sundari, etc. come from the Government forests, the majority of the wood is of rural origin (Choudhury and Hossain 2011).The trade is directly related to the use of the forest products. With the increase of demand, import of timber has become a regular feature now. Since there was a moratorium on the harvest of wood from 1971 the import of timber has been increasing. From 2003 a slight decline is being noticed because harvest of wood was started in participatory plantations under the FSP. Besides wood, bamboo, designated as "poor-men's timber", is the second most important forest product used for trade. It is mostly transported by river and thus, with a few exceptions, the flow of its trade also follows stream flow, up-stream to down-stream. Bamboo is also a very important raw material for pulp making. Enhanced production of bamboo will reduce the import of pulp.

16.2. Wood as Energy

The major areas where wood energy is used in Bangladesh are: Domestic Cooking, Agro-Based Industries, Non-Agro-Based Industries and Commercial business.

ADB (Forestry Master Plan 1993) divided the fuel into (i) fuelwood and (ii) Residues. Douglas (1981) considered fuel types as (i) fuelwood, (ii) other tree fuel and (iii) agricultural residues and bamboo.

Most of the wood energy is used for domestic cooking. Use of fuelwood for cooking is almost four times higher in urban area than in the rural area. The total use of residues is more than six times than that of fuel-wood. In 1981 the total energy consumption in Bangladesh was 574.8 PJ16 which increased to 687.6 PJ in 1990. There has been an annual increase of about 2%. The use of commercial fuel has become double during this period. Agricultural residue remains the highest contributor towards biomass energy. It has been observed that the increase of fuelwood supply reduces the use of dung as fuel (ADB 1993, Choudhury and Hussain 2011). According to the FD, 65% of forest products are consumed as fuel wood.

In fact there is no wood energy policy in the country. Fuelwood was the most common and major energy source for brick burning in Bangladesh. Huge quantity of wood was used to burn every year in brick field. In 1989, Government promulgated the "Brick Burning (Control) Act, 1989" to conserve forest resources and maintain ecological balance. The Act firmly prohibits the use of fuelwood in brick burning. Coal has been suggested to be used in lieu of wood. But since the price is high and the availability of coal is low, the brickfield owners still use fuel-wood. Implementation of the Act was not at all satisfactory. Hardly 22% of the coal requirement is available (ADB 1993). Unless coal is made available at a reasonable price, there is very little hope for improvement of the situation.

17. Protected Areas and Wildlife Legislation

There is no legal definition of wildlife so far. However, wild animal means different types and species of animals or different stages of their life cycle, whose source is considered as wild. Under the Wildlife (Protection) Act, 1972 of India, the wildlife includes any animal, aquatic or land vegetation which forms a part of any habitat. And wild animal means animals found wild in nature.

17.1. Protected Areas

Protected Areas are generally understood to be those in which human occupation or at least the exploitation of resources is limited. Widely accepted definition across regional and global frameworks definition that has been provided by the International Union for Conservation of Nature (IUCN) in its categorization guidelines for protected areas says, "A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values." Bangladesh got its first comprehensive wildlife law in the form of The Bangladesh Wildlife (Preservation) Order, 1973. Until then, matters related to wildlife were regulated under the Forest Act 1927, which prohibited certain acts, including hunting, in the reserve and protected forests, without official permission.

17.2. History of Wildlife Law

Before 1947, i.e., prior to partition, many Indian states promulgated their own legislations but none of these instruments dealt with the subject holistically. For example: The Wild Birds and Animals Protection Act, 1912 (8 of 1912), The Madhya Pradesh Game Act, 1935, Indore Game Act, 1907 etc. All these laws and rules provided for hunting regulations but none provided for the regulation of trade and transit of wild animals and animal products. The 1973 order for the first time provide a comprehensive framework for regulating hunting, transit and trade of wild animals and their products, while making provisions for creating protected areas for their conservation.

Bangladesh Wildlife (Preservation) Order was promulgated in 1973. Under this Order a large number of endangered or nearly endangered species of animals have been given legal and total protection against killing, trapping or harm in any other way inside the country. There was provision to declare certain areas reserved for wildlife. In 2012, Wildlife (Conservation and Security) was promulgated in suppression of prevailing rules for the conservation and extending security to the biodiversity, forests and wildlife. Some of the elements of the act include (a) Notification of the Protected Areas, (2) Nature of offences and penalties, (3) Authorities empowered to implement the laws, (4) System of getting permits/license for hunting, owning, purchasing, breeding, etc (5) Schedule of protected plants and animals, and others.

17.3. Importance of Wildlife Law

The basic function of wildlife law is to defend the wild animals from evils – that is, those who would intend to harm them. Having a comprehensive law for protecting natural resources, especially wildlife, is critical because strict protection of habitats as well as controls on removal, possession and trade of wild animals and their products can be done only with the help of proper legal provisions. The law provides direction to the implementing authorities as well as gives them the power to take action against the violators of the law. The law defines what the government is required to do and what interface can the citizens have with natural resources. The law defines how public can use natural resources and how they can possess, transfer, transport or trade the products which are regulated by law. The law also prescribes the penalties for various violations of the law. As the country has a huge population, the demands for more space and wildlife products are growing. The law allows the state to place restrictions on people's use of these items, and modify their behaviour, to make the use of these commodities more sustainable. Without a strong and comprehensive law governing the administration of natural resources such as wildlife, there is a risk of over-exploitation of rare and threatened elements of the biodiversity which may result into a permanent loss to the society.

17.4. Protected Areas of Bangladesh

Under the existing rules, there are 17 National Parks and 20 Wildlife Sanctuaries (Figure 3). The National Parks comprise an area of 45,745 hectares and Wildlife Sanctuaries 2, 20,250 hectares. Thus the Protected Areas cover an area of 265,996 hectares, in other words, 10.72% of the total forest areas are under Protected Areas (Table 17, 18).

17.5. National Park

National Park means comparatively large areas of outstanding scenic and natural beauty with the primary object of protection and preservation of scenery, flora and fauna in the natural state to which access for public recreation and education and research may be allowed.

17.6. Wildlife Sanctuary

Wildlife Sanctuary means an area closed to hunting, shooting or trapping of wild animals and declared as such by the government as undisturbed breeding ground primarily for the protection of wildlife inclusive of all natural resources such as vegetation soil and water.

17.7. Sundarbans - The World Heritage Site

Sundarban, the World Heritage site is composed of three wildlife sanctuaries such as (i) Sundarbans East Wildlife Sanctuary, (ii) Sundarbans South Wildlife Sanctuary and (iii) Sundarbans West Wildlife Sanctuary. The total area of World Heritage Site is 1400 km2 out of which 910 km2 is land area and 490 km2 is water area. The three sanctuaries are intersected by a complex network of tidal waterways, mudflats and small islands of salt tolerant mangrove forest. The area has been recognized globally for its importance as a reservoir of biodiversity. This mangrove supports a unique assemblage of flora and fauna, including charismatic megafauna like the Royal Bengal Tiger, Estuarine

Crocodile and the Ganges River Dolphin. The Sundri (*Heritiera fomes*) tree, for which the Sundarbans is named, is an endemic species of this forest. It has virtually disappeared from previously occurring forests of the Chokoria Sundarbans and mangroves of Myanmar. The Sundarbans mangrove forests, particularly the three wildlife sanctuaries, act as good nurseries and potential breeding ground for shrimps, prawns and many edible fishes. For outstanding natural value, the World Heritage committee of UNESCO inscribed the Sundarbans of Bangladesh in the World Heritage list in 1997 and accordingly, Bangladesh Government declared the Sundarbans as World Heritage Site in 1999 (FD Website).

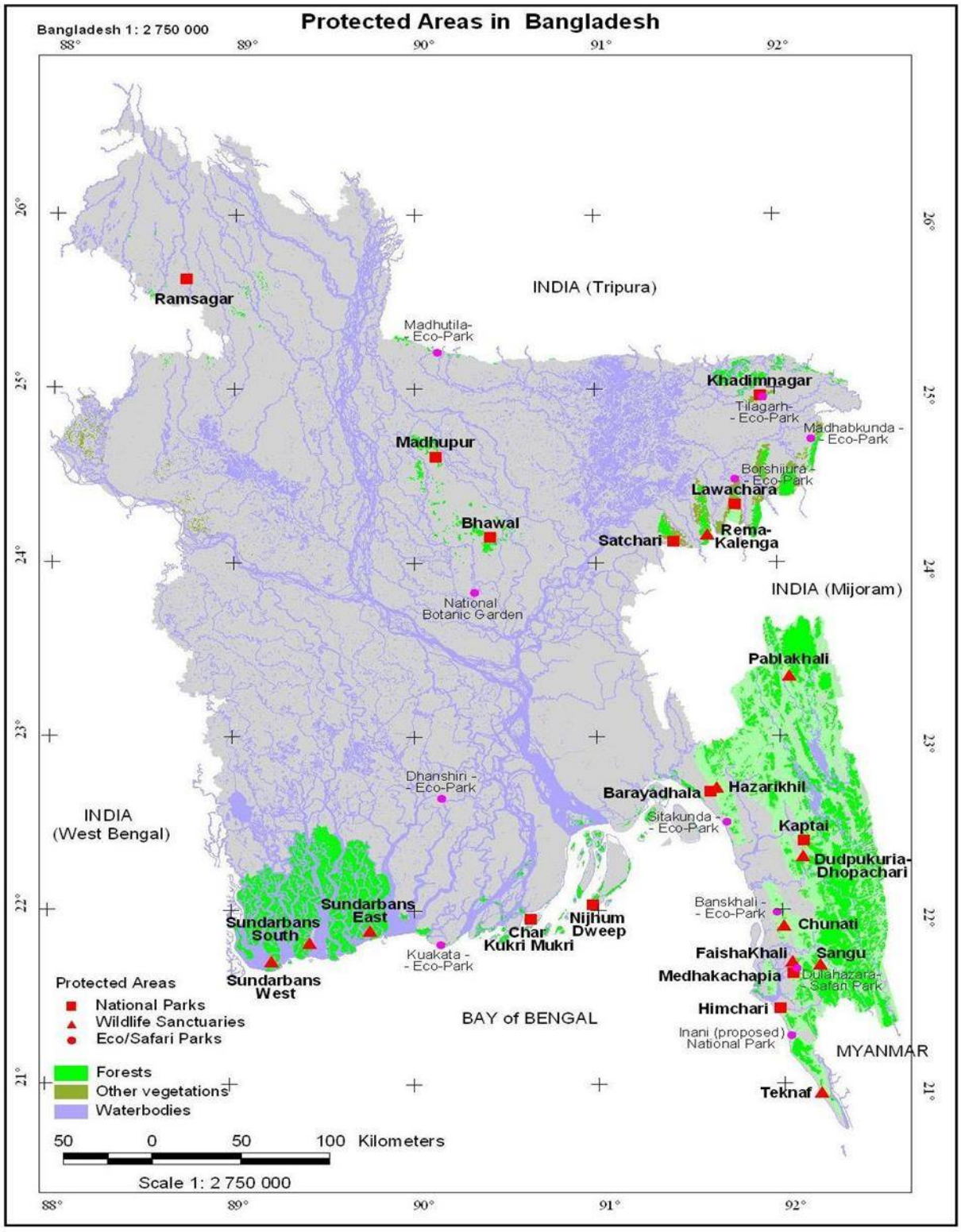


Figure 4 Map showing Protected Areas in Bangladesh

Table 16 Notified Protected Areas of Bangladesh

Sl.	National Parks	Location	Area (ha)	Established
1	Bhawal National Park	Gazipur	5022	11-5-1982
2	Madhupur National Park	Tangail/ Mymensingh	8436	24-2-1982
3	Ramsagar National Park	Dinajpur	27.75	30-4-2001
4	Himchari National Park	Cox's Bazar	1729	15-2-1980
5	Lawachara National Park	Moulavibazar	1250	7-7-1996
6	Kaptai National Park	Chittagong Hill Tracts	5464	9-9-1999
7	Nijhum Dweep National Park	Noakhali	16352.23	8-4-2001
8	Medhakachhapia National Park	Cox's Bazar	395.92	8-8-2008
9	Satchari National Park	Habigonj	242.91	15-10-2005
10	Khadimnagar National Park	Sylhet	678.80	13-04-2006
11	Baroiyadhala National Park	Chittagong	2933.61	06-04-2010
12	Kuakata National Park	Patuakhali	1613	24-10-2010
13	Nababgonj National Park	Dinajpur	517.61	24-10-2010
14	Singra National Park	Dinajpur	305.69	24-10-2010
15	Kadigarh National Park	Mymensingh	344.13	24-10-2010
16	Altadighi National Park	Naogaon	264.12	24-12-2011
17	Birgonj National Park	Dinajpur	168.56	24-12-2011

B) Wildlife Sanctuaries :

Sl.	• Wildlife Sanctuaries	Location	• Area (ha.)	• Established
18	Rema-Kalenga Wildlife Sanctuary	Hobigonj	1795.54	7-7-1996
19	Char Kukri-Mukri Wildlife Sanctuary	Bhola	40	19-12-1981
20	Sundarban (East) Wildlife Sanctuary	Bagerhat	31226.94	6-4-1996
21	Sundarban (West) Wildlife Sanctuary	Satkhira	71502.10	6-4-1996
22	Sundarban (South) Wildlife Sanctuary	Khulna	36970.45	6-4-1996
23	Pablakhali Wildlife Sanctuary	Chittagong Hill Tracts	42087	20-9-1983
24	Chunati Wildlife Sanctuary	Chittagong	7763.97	18-3-1986
25	Fashiakhali Wildlife Sanctuary	Cox's Bazar	1302.43	11-4-2007
26	Dudpukuria-Dhopachari Wildlife Sanctuary	Chittagong	4716.57	6-4-2010
27	Hajarikhil Wildlife Sanctuary	Chittagong	1177.53	6-4-2010
28	Sangu Wildlife Sanctuary	Bandarban	2331.98	6-4-2010
29	Teknaf Wildlife Sanctuary	Cox's Bazar	11615	24-03-2010
30	Tengragiri Wildlife Sanctuary	Barguna	4048.58	24-10-2010

31	Dudhmukhi Wildlife Sanctuary	Bagerhat	170	29-01-2012
32	Chadpai Wildlife Sanctuary	Bagerhat	560	29-01-2012
33	Dhangmari Wildlife Sanctuary	Bagerhat	340	29-01-2012
34	Sonarchar Wildlife Sanctuary	Patuakhali	2026.48	24-12-2011
35	Nazirganj Wildlife (Dolphin) Sanctuary	Pabna	146.00	01-12-2013
36	Shilanda-Nagdemra Wildlife (Dolphin) Sanctuary	Pabna	24.17	01-12-2013
37	Nagarbari-Mohanganj Dolphin Sanctuary	Pabna	408.11	01-12-2013

**Protected Area Covers 10.72% of Total Forest Area

Table 17 Other Conservation Sites in Bangladesh

SL	Name	Location	Area (ha.)	Established
1	National Botanical Garden	Dhaka	84.21	1961
2	Baldha Garden	Dhaka	1.37	1909
3	Madhabkunda Eco-Park	Moulavibazar	265.68	2001
4	Sitakunda Botanical Garden and Eco-park	Chittagong	808	1998
5	Dulahazara Safari Parks	Cox's Bazar	600	1999
6	Modhutila Eco-Park	Sherpur	100	1999
7	Banshkhali Eco-Park	Chittagong	1200	2003
8	Kuakata Eco-Park	Patuakhali	5661	2005
9	Tilagar Eco-Park	Sylhet	45.34	2006
10	Borshijora Eco-Park	Moulavibazar	326.07	2006

18. Social Forestry/Participatory Forestry

18.1. Social Forestry Programmes

Social Forestry programmes have been initiated with a view to meet the forest product requirements of local population and to reverse the process of ecological and climatic degradation through proper soil and water conservation and to improve the socio-economic condition of the rural people. Bangladesh has made commendable success in social forestry. It calls for greater importance in the core theme of forestry planning. However, the existing rules and regulations need careful review for scientifically acceptable management system. Social Forestry programs have following objectives:

1. To meet the needs for fuelwood, small timber, bamboo, fodder and other minor forest produces on sustained basis.
2. To provide employment opportunities to the rural population.
3. To develop cottage industries in rural areas.
4. To utilize the available land to the best advantage according to its production capacity.
5. To provide efficient soil and water conservation.
6. To improve aesthetic value of the area and to meet the recreational needs of the population.

18.2. Social Forestry Achievements

From 1981 to 2003 under Social Forestry Programs are summarized which are as follows:

During last 22 years Woodlot / Block plantation work is done in 32,640 ha of land. Agroforestry plantation work is done in 8,778 ha of lands. Strip plantation works is done in 86,338 km (including WFP assisted part) roads, Rehabilitation of Jhumias are approximately 6,321 families, Village afforestation was done among 7,282 villages of the country. 168 million nos. of Institutional planting & Seedling distribution / sale is done. Establishment of SFNTC (Social Forestry Nursery and Training Center) is 98 Nos. Establishment of SFPC (Social Forestry Plantation Center) is 345 Nos. 1, 77,261 persons got Training on Social Forestry works. Addition to that in every upazila, there is a Forest Department's Nursery center. Moreover 12,000 private nurseries have been established throughout the country. The benefit-sharing ratio for Social forestry plantations.

1. **For Agroforestry and Woodlot Plantations:** The benefit-sharing ratio is Forest Dept.-45%, Participants-45% and Tree Farming Fund-10% of the total benefits.
2. **For Linear Strip Plantations:** The benefit-sharing ratio is Forest Dept.-10%, Participants-55%, Tree Farming Fund-10%, Land owning agency-20% and Local Union Parishad 5% of the total benefits.
3. **For Sal coppices:** The benefit-sharing ratio is Forest Dept.-65%, Participants-25% and Tree Farming Fund-10% of the total benefits.

19. Participatory Forestry and Agro Forestry

As a concept, Agroforestry is not new in forestry practice. Forest Department has been practicing this in the name of Taungya in the hill forest for last 100 years. But as a science for natural resource management, it is new. Agroforestry as the name implies is the practice of growing agriculture and forestry on the same land at same time to optimize the land utilization. In the plain land forest i.e. in Sal Forest, Forest Department is practicing this system for decades together on a participatory approach to replant the barren forestland and after harvest; a share will go to the participating members. This is a multipurpose approach to replant barren land with the help of participants and protect it by them to build up forest resources. At the end of the rotation, the shares of the harvested forest produces are distributed to the participants in accordance to an agreement with the participants.

This concept is doing well in the 'Sal Forest' of Dhaka, Tangail, Mymensing, Rajshahi, Rangpur and Dinajpur. New programs of agroforestry have been incorporated in the ADB aided Forestry Sector Project launched by the Forest Department. In this project 6450 hectare of new plantations will be raised on the degraded Sal Forest and another 5400 hectare will be raised on the harvested land of old Agroforestry plantations.

19.1. Betagi-Pomora Agroforestry Experience

Advances in Bangladesh, the experiences gained in the two hilly villages of Rangunia Thana, Chittagong district are invariably mentioned. The Betagi-Pomora project aimed at achieving three goals:

1. To regenerate denuded hills by planting trees
2. To rehabilitate the landless farmers and
3. To protect the forest from the illegal felling with the help of the settlers.

The project began functioning at Betagi with 82 landless families in 1979; later in 1980 with another 144 families, settled at Pomora. The Betagi-Pomora project has been widely acclaimed in a number of studies as a success story of social forestry.

19.2. Jhum Cultivation

Jhum cultivation is the most common form of farming practice by the tribal people in growing food in the hilly areas. This, however, causes denudation of vegetation, loss of top soil and degraded environment as a whole. On the contrary, it is claimed that burning of the shrubs during the process of Jhum cultivation increases N, P, K, Ca, Mg and Na in top soil (Rahman and Dhar 2008). The authors also reported that burning drives away harmful insects and makes the ground warm accelerating the emergence of naturally fallen seeds of forest plants. Notwithstanding the dispute, jhum cultivation will remain to meet food security of the hilly people. In such a situation, modified hill farming systems through agroforestry must be used such that the soil is disturbed to a minimum extent.

19.3. Participatory Forestry

There has been a gradual shift in the forest management approach custodian role of Forest Department to a more participatory approach. Accordingly, the provision of people's participation in protecting the natural forest and afforesting the degraded and encroached forestland with benefit sharing mechanism has been developed .Through benefit sharing of the yield, people's participation has been ensured in seven northern districts from 1981to 1987 under ADB ADB funded Community Forestry Project. Following this other ADB funded project named 'Thana afforestation and nursery development project', 'Green Belt project' were implemented and now 'Forestry sector project' is being implemented throughout the country. Major components of this project are: Woodlot, Agro forestry and Strip plantations etc.

ation of NTFPs. But restriction on collection of NTFPs is mostly non-existent; there is no effective management system and little recognition goes to replenishing the resources. However, the present 'clear-cutting followed by artificial regeneration' with monoculture is highly discouraged and mixed plantation is getting preference over monoplantation. Again, cultivation of rattans and medicinal plants along with tree plantations is getting preference in the management plan. Cultivation of bamboo and patipata (*Tenogyne dichotoma*) is also being emphasized. The targeted NTFPs plantation area developed in the Forestry Master Plan (1993).

19.4. Betagi-Pomora Model

The model has the following characteristics:

- integration of poor landless farmers with degraded forest land (land areas of Betagi and Pomora were Forest Department's and Khas land respectively);
- homogeneous characteristics of the participants (farmers);
- 1.62-ha land allocation to each family;
- tenurial security ensured to both husband and wife;
- adoption of agrisilvicultural production system on the basis of farmers' needs for food, fuelwood, timber, cash and other products;
- inclusion of short-term, mid-term and long-term crops with emphasis on fruit trees (60 percent);
- adoption of indigenous technology;
- self-help ideology;
- decentralized decision-making process;
- solidarity and existence of strong organization (Bhumiheen Samity);
- technical and financial assistance;
- strong patronage from state and local elite;
- linkage with middlemen for marketing the products and to ensure fair price;
- Ecologically sound and economically sustainable land use.

19.5. Chittagong Hill Tracts Rehabilitation Model

The model has the following characteristics:

- is based on participation of nomadic shifting cultivators;
- 2.0 ha of land allotted for each family, of which 0.20 ha is for homestead and kitchen garden and 1.82 ha for agrosilvihorticultural garden with short-, mid- and long-term crops;
- setting up cluster villages in convenient locations so as to afford all social and community facilities like water supply, health care, education, access road and product marketing;
- financial assistance for land development, housing and subsistence grant for the first year until the agricultural crops are harvested. The farmer families work in their own holdings but are paid for their wages;
- extension services provided by the FD and the health, education, local government and co-operative departments extended community services;
- engaged in block plantations on participatory concept with the FD and the farmers get wages for their work and practised taungya cultivation in the new plantation areas.

19.6. Community Forestry Project (North Bengal)

The model has the following characteristics:

- is based on participation of local landless farming community, especially the forest encroachers;
- practised in the denuded (in many cases encroached) plain land sal (Shorea robusta) forest areas of northern districts;
- motivation by the local FD officers and staff;
- allotment of 1.2 ha land for a period of one year by offering usufructory rights under a lease agreement which is extendable up to the rotation period of trees subject to satisfactory performance of the participants;
- introduction of specially designed alley-cropping agroforestry models;
- fast-growing short rotation exotic and indigenous tree species planted with agricultural crops;
- first-year agricultural inputs such as seeds, fertilizers, insecticides given to the farmers as free grants of the project;
- the entire agricultural produce of the holdings belongs to the farmers free of costs; 50 percent of the timber or its sale proceeds at harvest also granted to the farmers through bilateral agreement between the FD and the individual farmer. Besides, the fallen trees, leaves, twigs and branches from the pruning also given to the farmers free of costs;
- training provided to the farmers and during training they are given a money incentive fairer than their daily wages.

19.7. Strip-Plantation in Roads and Highways

This takes the following characteristics:

- the FD takes the allotment of strips of land from the Authority of Roads and Highways, the Bangladesh Water Development Board and the Bangladesh Railway Board;
- motivation of local landless people and formation of groups (10-15 participants per group);
- allocation of strip lands among the groups;
- plantation establishment and cultivation of agricultural crops (intercrops) by the groups on the strip land under the guidance of the FD;
- the FD provides seeds, seedlings, fertilizers and daily wages to the groups at the time of planting;
- responsibility given to the groups for post planting maintenance, management and supervision;

- the participants receive 100 percent of the agricultural crops and pruning materials from the trees;
- a bilateral agreement between the groups and the FD is that the final yield of the tree crop would be shared with the participants: 65 percent to the farmer groups, 20 percent to the FD, 10 percent to the agency owning the land and 5 percent to the Union Council. In the case of Union Council road, 80 percent of the harvest goes to the groups and 20 percent to the Council.

Kanwal (1982) reported that there are about 75 000 bamboo and cane units in Bangladesh. According to Abdullah (1979), there are only 45 000 small-scale industries and 425 000 cottage industries in Bangladesh. But Sirajuddin (1986) stated that there are 3.22 million cottage industries in Bangladesh that are able to produce 160 items and employ approximately 9.18 million people.

19.8. Conclusion and Recommendations

Community forestry (now well known as social forestry), which is an appealing land-use strategy by local poor landless community, has been in practice in Bangladesh for more than twenty years. It has become a highly attractive and acceptable programme to the rural people, especially the landless and small farmers. It has generated sufficient resources and income to raise the rural poor above subsistence level and proved that community forestry can play a significant role in rural poverty alleviation in Bangladesh. Apart from the creation of resources, employment and income, community forestry is playing a vital role in preserving the environment, which also helps alleviate rural poverty.

The efforts of the last twenty-year's activities have resulted in the emergence of community forestry as a rural institution. This is perhaps the most significant achievement. Motivation and awareness creation of communities towards tree plantation in marginal lands, degraded forest lands and community lands is also a great achievement. The participants have already obtained their share as per participatory benefit sharing agreements and now strongly believe that community forestry can reduce poverty.

The incomes of community forestry participants have increased. But there are still many constraints that need to be overcome for smooth functioning and sustainable management of community forestry programmes.

Some recommendations are made below to alleviate the major constraints and improve community forestry programmes in Bangladesh:

1) Ensure true participation. Joining the community forestry programmes and getting a share from the sale of products do not mean true participation. All decisions are still taken by the higher authorities of the government and NGOs without involving the target clientele. From the programme planning stage to implementation and evaluation, decision must be taken in consultation with the local communities.
2) Ensure tenurial security of both land and tree. Medium- and long-term leasing of land should be introduced. Letters of agreement or deeds must be given to the participants/clientele. Tenure should be given jointly to both the husband and wife of a household.
3) Integration of multifarious production systems. Agrisilvicultural, agrisilvipastural, agrisilvipiscicultural production systems along with apiculture, sericulture, lac culture, mushroom culture, poultry rearing and livestock rearing should be integrated in the CF programmes, especially in the homesteads. Homesteads should be utilized as a production unit with all available and site suitable production systems.
4) Integrate small and cottage industries in the homesteads or develop community-base enterprises. Processing of food or other raw materials and product development (e.g. handicrafts) should be done with indigenous or advanced technologies.
5) Provide participant farmers with collateral-free credits to carry out the CF programmes and equip the farmers with technology.

6) Develop marketing infrastructure to sell the products. Linkages should be developed among producers (participants), village traders, retailers and consumers.
7) Develop marketing information system so that farmers get information about demand and prices of the products.
8) Create/format community organizations. Local organizations should be created or strengthened to foster self-reliance and to encourage people to mobilize their own resources in managing a CF programme. The Krishak Samabay Semite (Farmers Co-operative Association) and the Bhumiheen Samabsy Semite (Landless Farmers Association) could be best utilized in participation.
9) Obtain strong patronage from state, political leaders, government officials, local elite and community organizations.
10) Provide training and extension.

20. Urban Forestry

An urban forest is a collection of trees that grow within a city, town or a suburb. In a wider sense it may include any kind of woody plant vegetation growing in and around human settlements. In a narrower sense (also called forest park) it describes areas whose ecosystems are inherited from wilderness leftovers or remnants. Care and management of urban forests is called urban forestry i.e., tree populations in urban settings for the purpose of improving the urban environment. Urban forestry advocates the role of trees as a critical part of the urban infrastructure.

Urban forests play an important role in ecology of human habitats in many ways: they filter air, water, sunlight, provide shelter to animals and recreational areas for people.

20.1. Urban Forestry in Bangladesh

The green resources in Dhaka are overwhelmed by a number of limitation inherent to the exceptional mode of urban development, rapid increase of urban population, transformation of green and other open spaces into other types of land use, lack of proper planning and implementation and management restrictions as well. Nevertheless, there are ample opportunities yet remain to promote urban forestry in and around Dhaka and other cities. The possible opportunities are to the protection of existing green areas such as parks, garden, play grounds etc., increase roadside, avenue plantation and rooftop gardening, introduce afforestation and nursery activities in newly developing areas, promote homestead gardening and social or community forestry. However, several recurrent obstacles must be overcome in the way of the planning and execution of more green areas in urban landscapes. Co-ordination amongst concerned ministries and governmental departments, patronization of private-sector, NGOs participation and contribution, enhancement of green awareness of citizen and ensuring their active participation and collaboration with donor agencies can accelerate the greening process in Dhaka and cities of Bangladesh.

Dhaka city has 21.57% open space including 0.89% city parks, 0.02% urban forestry, 0.90% gardens and 12.12% agriculture. The green space is shrinking at the expense of building construction. An ideal city needs 20% area covered by trees but only 8% area in Dhaka was covered by vegetation about a decade back. The urban heat has sharply increased in recent decades. Air pollutants levels in Dhaka city are about 4 to 5 times higher than the Air Quality Standard due to lack of tree coverage. Drinking water resource is being lost for reduction of woodland and trees.

20.2. Benefits of Urban Forestry

The benefits of urban trees and shrubs are many, including beautification, reduction of the urban heat island effect, reduction of storm water runoff, reduction of air pollution, reduction of energy costs through increased shade over

buildings, enhancement of property values, improved wildlife habitat, and mitigation of overall urban environmental impact. Urban forestry helps enrichment of biodiversity.

20.3. Constraints for Urban Forestry

- Loss of green space is continuous as cities expand; available growing space is limited in city centres. This problem is compounded by pressure to convert green space, parks, etc. into building sites.
- Inadequate space is allowed for the root system.
- Poor soil is used when planting specimens.
- Incorrect and neglected staking leads to bark damage.
- Larger, more mature trees are often used to provide scale and a sense of establishment to a scheme. These trees grow more slowly and do not thrive in alien soils whilst smaller specimens can adapt more readily to existing conditions.
- Lack of information on the tolerances of urban tree cultivars to environmental constraints.
- Poor tree selection which leads to problems in the future
- Poor nursery stock and failure of post-care
- Limited genetic diversity
- Too few communities have working tree inventories and very few have urban forest management plans.
- Lack of public awareness about the benefits of healthy urban forests.
- Poor tree care practices by citizens.

20.4. Future of Urban Forestry

The cities in Bangladesh are over-populated and congested. So, it is not easy to initiate well-planned and successful urban forestry programme. Apart from technical aspects involved, people's interest and awareness are vital. Research studies need to be carried out in relation to urban forestry including selection of suitable plant species for the execution of urban forestry activities. Urban forestry is likely to play a substantial role in maintaining a healthy environment and some wildlife including birds. Accordingly, the declining biodiversity can be protected to some extent apart from bringing the expected vacant areas under green cover.

21. Forest Act, Policy and Rules

Bangladesh has a low forest cover, but those forests are diverse in nature and of significant importance for the national economy and local people's livelihood. For forest degradation and depletion like in many other developing countries, the existing national forest policy was announced in 1994 after exactly one hundred years of the first forest policy announcement in 1894. The earlier versions of forest policy were characterized by commercialization of forest use for maximization of state revenue. The current policy is significantly departed from its previous versions and recognized the importance of people's participation in forest management (Alam 2009). Emphasis has also been given on modernization of management different resources, habitat protection and wildlife conservation (BFD 2013) .

21.1. The Forest Act, 1927

The Forest Act provides for the constitution of Reserved Forests, Village Forests, Protected Forests, and the control over forest land which is not the property of Government. It provides for the collection of duties on timber and other forest products, control on the transportation of these products, collection of drift and stranded timber, penalties and procedures, and the role of forestry officers.

The Forest Act of 1927 is the key law regulating forest resources in Bangladesh. This Act encompasses the provisions for conservation and protection of Government-owned forests, and also of some private forests. This Act stipulates

the provisions for establishing Reserved Forests and Protected Forests and assigns responsibility to the Forest Department for managing forests with these designations. Moreover, the Act provides scope for participatory management approaches in the context of joint management and establishment of village forests.

21.2. National Forestry Policy, 1994

The first National Forest Policy was adopted in 1979 with the objective of greater protection and conservation of the country's forest assets while developing its rural and industrial economies. The current forest policy, introduced in 1994, represents the first shift towards recognition of the importance of people's participation in forestry and sustainable development. The new Forestry Sector Master Plan (FSMP), 1993 and the corresponding Forestry Policy, 1994, are primarily aimed at raising the total forest cover of the country to 20% by the year 2015 through '*Social/Participatory Forestry' (SPF)*. This has been defined in the FSMP as "programmes implemented on private land, encroached Sal forest land or on underused land under the jurisdiction of government departments other than the Forest Department." It suggests afforestation, tree plantation and nursery establishment, development, maintenance and preservation through involving, encouraging and extending co-operation to the people. It further suggested that all State owned forests of natural origin and the plantations of the Hills and Sal forest will be used for producing forest resources keeping aside the areas earmarked for conserving soil and water resources, and maintaining biodiversity.

21.3. Other Rules

Other rules include:

- Social Forestry Rules, 2004 (Modified up to May, 2011)
- Bangladesh Wildlife (Preservation) Order, 1973 (as amended up to 1974)
- Bangladesh Spotted Deer Rearing Policy-2009]
- Compensation Policy for Causalities Caused by Wildlife]
- Brick Burning (Control) (Amendment) Act, 2013
- Prime Minister's National Award on Tree Plantation
- Transit Rule for Bangladesh- 2011
- Saw-mill (License) Rules, 2012

21.4. Forest Policy for Future

In recent years, forest policy of Bangladesh is shifted from exploitation of resources to conservation and sustainable management of ecosystems. Lower forests land (13%) is unable to meet the demand of the growing human population. Moreover, only 6% is under closed canopy cover. So, the approach towards increase of forest resource per unit area, wood in particular, has to be maintained for coming decades. Under projected increasing population, it will not be possible to extend the forest area. However, participatory of forestry will help protect the trees from illicit felling and encourage the people to increase income and improve vegetation cover. A strong motivation of the people living in the vicinity of the forests and Protected Areas will be required to implement the government policy of conserving the natural habitats, wildlife and biodiversity. Aggressive research will be necessary to increase the productivity of forest with indigenous plants and discourage the exotic species. Thus a compatible management of forest ecosystems needs to be developed where production and protection can be ensured. Besides, long-term programme has to be initiated for developing trained man power required for the conservation of forests and biodiversity including maintenance of the Protected Areas and natural habitats.

The policy of greater thrush for deriving the indirect benefits of forests including ecotourism has to be effectively continued. Area of towns is expanding all over Bangladesh but urban forestry is virtually lacking. In order to maintain a healthy and beautiful environment, urban forestry needs to be introduced and strengthened.

People's awareness is still lacking towards the importance of forests and biodiversity. Even to many educated people, the role of wildlife in an ecosystem is unknown. Mass education is required to motivate the people for the protection and conservation of forests and renewable resources. The on-going coastal afforestation activities need to be continued for land reclamation, wood production and protection from the frequently occurring storm surges and possible occurrence of tsunami. With the transformation of forest policy, forest management has been reshaped and under continuous revision. This requires new rules and laws for effective implementation of changing policy. Wildlife Act has been promulgated but that again needs improvement. Additional new laws should be considered to protect trees outside the forests and in the ecologically critical areas. New guideline and policy for the emerging ecotourism industry are needed for optimal utilization of nature without affecting the ecosystems. At present there is no rule or scope for the management and conservation of common pool resources. But sustainable management of natural resources is essential. For the successful management and implementation of new projects adequate rules are necessary.

Research findings should get priority in coming decades for sustainable yield and management of the forest ecosystems. With the transformation of forest policy, forest management has been reshaped and under continuous revision. This requires new rules and laws for effective implementation of changing policy. Wildlife Act has been promulgated but that again needs improvement. Additional new laws should be considered to protect trees outside the forests and in the ecologically critical areas. New guideline and policy for the emerging ecotourism industry are needed for optimal utilization of nature without affecting the ecosystems. At present there is no rule or scope for the management and conservation of common pool resources. But sustainable management of natural resources is essential. For the successful management and implementation of new projects adequate rules are necessary.

22. Organizations in Forestry Sector

22.1. Bangladesh Forest Department

Before partition of Indian sub-continent in 1947, Bangladesh forests were administered under Forest Circles of the Bengal and Assam Forest Departments. From 1947 to 1962, the Provincial Forest Department was the authority with a Conservator of Forests, and subsequently until 1971 by a Chief Conservator of Forests. With the formation of Bangladesh in 1971, reserved and proposed reserve forests passed to the Bangladesh Forest Department (BFD). From 1971 to 1989, BFD fell under the Ministry of Agriculture and subsequently under the Ministry of Environment and Forest. At present, BFD has nine Circles headed by Conservator of Forests and 44 Divisions headed by Divisional Forest Officers. The Department of Environment (DoE) established in 1977 under the Environment Pollution Control Ordinance, 1977 still functions under the ECA.

With the formation of the new Ministry of Environment and Forests, in 1989, both the departments were transferred to this new Ministry. The DoE has been placed under the MoEF as its technical wing and is statutorily responsible for the implementation of the Environment Conservation Act, 1995 (MoEF Website 2014).

Besides these two departments, MoEF look after the Bangladesh Forest Industries Development Corporation (BFIDC), Bangladesh Forest Research Institute (BFRI), Bangladesh National Herbarium (BNH) and Bangladesh Climate Change Trust (BCCT).

The principal activities undertaken by Ministry of Environment & Forests consist of conservation & survey of flora, fauna, forests and wildlife, prevention & control of pollution, forestation & regeneration of degraded areas and protection of environment, in the framework of legislations. The main tools utilized for this include surveys, impact assessment, control of pollution, regeneration programmes, support to organizations, research to solve solutions and training to augment the requisite manpower, collection and dissemination of environmental information and creation of environmental awareness among all sectors of the country's population. The organizational structure of the

ministry covers a number of divisions, directorate, board, subordinate offices, autonomous institutions and public sector undertakings. In short, MoEF has the following major functions:

- Management of environment and ecology.
- Matters relating to environment pollution control.
- Conservation of forests and development of forest resources (government and private), forest inventory, grading and quality control of forest products.
- Forestation and regeneration of forest extraction of forest produce.
- Plantation of exotic cinchona and rubber.
- Botanical gardens and botanical surveys.
- Tree plantation.
- Planning cell is responsible for preparation of schemes and coordination in respect of forest.
- Research and training in forestry.
- Mechanized forestry operations.
- Protection of wild birds and animals and establishment of sanctuaries.
- Matters relating to marketing of forest produce.
- Liaison with international organizations and matters relating to treaties and agreements with other countries and world bodies relating to subjects allotted to this Ministry.

Apart form two major departments, i.e., Department of Environment and Department of Forest, working under this ministry, there are three others:

22.2. Bangladesh Forest Research Institute (BFRI)

Bangladesh Forest Research Institute (BFRI) was established in 1955 and mandated to provide research support to the Forestry sub-sector of the country, including Forest Department, Bangladesh Forest Industries Development Corporation, NGOs and other private enterprises. BFRI's research activities aim to develop appropriate technologies to maintain sustainable productivity of forest land and of forest industries without resource depletion.

22.3. Bangladesh National Herbarium (BNH)

Bangladesh National Herbarium is a plant survey, collection, identification and conservation organization. It documents the plant biological diversity of the country and its collections are accessible samples of natural population. The collection of the herbarium is a national property that goes down to the posterity through generation for hundreds of years and work as reference materials on the flora of the country. The National Herbarium serves as repository of technical information on plant genetic resources and advises the Government on technical aspects of question dealt with by the herbarium. It also provides direction required in the implementation of policies laid down by the Government in relation to plant biodiversity conservation.

22.4. Bangladesh Forest Industries Development Corporation

Bangladesh Forest Industries Development Corporation (BFIDC) is mandated to rubber plantation, processing and to extract timber from inaccessible Forest areas. After sawing, seasoning and treatments, these timbers are used in wood based industries for production of quality furniture, electric poles, anchor logs, cross arms, railway slippers, doors & windows, woodtex, tea chest and plywood etc. In addition to this, BFIDC have been raising Rubber plantation in the district of greater chittagong, Sylhet, Mymensingh and Tangail since 1961 in order to increase the productivity of the fellow forest land through producing row rubber in the country. BFIDC so far has raised 32,625 acres of started plantation in its 15 (fifteen) Rubber Estates in greater Chittagong, Sylhet, Tangail and Mymensingh districts and 10 (ten) acres experimental rubber plantation in Barind tract (Rangpur distict) to test the viability of rubber plantation. Besides, about 33,000 acres rubber plantation has been raised in private sector with technical assistance of BFIDC.

- To extract timber/rubber wood & other Forest produces from forest land & BFIDC's rubber garden.
- To establish Industries/Factories for Commercial use of forest produces & rubber wood.
- Treating, Seasoning of wooden extracted/collected timber and manufacturing of office and household furniture, dunnage, railway slipper, etc.
- Cultivation of Rubber/ raising of Rubber garden on commercial basis in the forest land leased out by the Govt. in favour of BFIDC.
- Promoting Rubber cultivation in Bangladesh through Private Sector/Multinational companies in the Govt. khas and protected land of Hilly areas.

22.5. Bangladesh Climate Change Trust

Bangladesh Climate Change Trust (BCCT) is a statutory body formed under Climate Change Trust Act, 2010 to administer Climate Change Trust Fund (CCTF). The CCTF is a self-financing mechanism of the Government of Bangladesh to address the adverse impacts of climate change. It is an annual block allocation from the revenue budget of the Government. It should not be confused with Bangladesh Climate Change Resilience Fund (BCCRF), a coordinated financing mechanism by the Government of Bangladesh, development partners and the World Bank.

BCCT is entrusted with the overall management of Climate Change Trust Fund (CCTF) including the release of funds for the projects approved by the Trustee Board. It coordinates with the Climate Change Focal Points of different ministries/divisions, communicates with concerned stakeholders including civil society, NGO, private sector and international agencies. It also monitors and evaluates the projects approved under CCTF.

22.6. Arannayk Foundation

The governments of the USA and Bangladesh support tropical forest conservation programmes on the basis of Tropical Forest Conservation Act (TFCA) of 1998. The programme is implemented by The Arannayk Foundation (AF) – a not-for-profit company established in July 2003 under the Bangladesh Companies Act of 1994. The activities of the Arannayk Foundation include

(www.usaid.gov/bd/programs/environ_response.html):

- the establishment, restoration, protection and maintenance of protected areas and reserves;
- the development and implementation of scientifically sound systems of natural resources management;
- training programs to increase scientific, technical and managerial capacities of individuals and organization involved in forest conservation;
- the restoration, protection or sustainable use of diverse animal and plant species;
- research and identification of medicinal uses of tropical forest plant life; and
- the development and support of the livelihoods of individuals living in or near a tropical forest in a manner consistent with protecting such a tropical forest.

The entities in Bangladesh which are eligible to receive grants from Arannayk Foundation fund are: non-governmental environmental, forestry, conservation, development and indigenous people organizations; scientific, academic and professional organizations related to forests; other appropriate forest related entities active in the country; and exceptionally, agencies of the Government of Bangladesh. Since 2003, the Arannayk Foundation has approved 39 projects.

23. Administration, Education and Research

23.1. Forest Administration

Responsibility for forestry was passed to the Bangladesh Forest Department after the independence of Bangladesh in 1971.Bangladesh Senior Forest Service were renamed as Bangladesh Civil Service (Forest) Cadre under Bangladesh Civil Service Cadre Rules, 1980.There were 7385 revenue posts in the Forest Department, which have been increased to 8681 with the reorganization of the Forest Department in the year 1999 (FD 2011). The reorganization of the Department with the enhancement of the posts shall facilitate to implement the objectives set in the National Forestry Policy. The Government of Bangladesh formulated Forestry Sector Master Plan (FSMP) in 1993. The administrative head of Forest Department is the Chief Conservator of Forest (CCF). The Forest Department is divided into four wings (Forest Management, Social Forestry, Planning, Education and Training) considering magnitude of the works and line of jurisdiction. Each wing is administered by a Deputy Chief Conservator of Forest (DCCF).

There are nine Circles (5- Forest Management, 3-Social Forest, 1-Wildlife and Nature Conservation, 13-Social Forest, 4-Wildlife Management and Nature Conservation) in the Forest Department, each circle is headed by a Conservator of Forest (CF).Similarly there are 44 Forest Divisions (24-Forest Management, 3-Management Plan, each division is headed by a Divisional Forest officer (DFO) / (DCF).

Forest Department has to cover wide range of activities from resource protection, management and rendering services. However, it is operated under serious constraints. Scarcity of finance is threatening to hinder implementation of forestry activities scheduled under normal development programme. There is shortage of infrastructure and transport facilities for efficient functioning of the Department. However, the most serious of all is the shortage of trained manpower at all levels, professional, technical and vocational.

23.2. Forestry Education & Training

23.2.1. Forestry Education

The history of forestry education in Bangladesh began in 1978. Greater attention is given on traditional forest management. Forestry is a dynamic discipline. Forestry education need to be modernized Forestry education need to be modernized. There are three universities in Bangladesh where a student can enroll for degree in forestry. Among them the Institute of Forestry and Environmental Sciences under Chittagong University offers undergraduate and graduate degrees both in Forestry and in Environmental Sciences. This is the premier institute for Forestry education in Bangladesh. The three universities of Bangladesh offering undergraduate degree in Forestry are:

Name of the University	**District**	**Courses Available**
1.Chittagong University	Chittagong	B.Sc/M.Sc/PhD
2.Shahjalal University of Science and Technology	Sylhet	B.Sc/M.Sc
3.Khulna University	Khulna	B.Sc/M.Sc

23.2.2. Forestry Training

1. **Forest Academy, Chittagong, Bangladesh:** Established in 1964. Administered by an officer in the rank of Conservator of Forest, who is designated as Director of the institute. The academy conducts long and short courses for the Cadre officers as well as Forest Rangers.

2. **Forest School Chittagong, Bangladesh:** Established in 1995. Administered by an officer in the rank of Deputy Conservator of Forest, who is designated as Director of the institute. The school conducts Diploma Course in Forestry.
3. **Bangladesh Forest School, Sylhet, Bangladesh**: Established in 1948. Administered by an officer in the rank of Deputy Conservator of Forest, who is designated as Director of the school. The school conducts Diploma course for the Foresters and short courses for the Foresters, Forest Guards and Plantation Malis.
4. **Social Forestry School, Rajshahi, Bangladesh:** Established in 1985. Administered by an officer in the rank of Deputy Conservator of Forest, who is designated as Director of the school. The school conducts Diploma course for the Foresters and short courses for Foresters, Plantation malis and NGO staffs.
5. **The Forest Development and Training Centre, Kaptai, Bangladesh:** Established in 1979. Administered by an officer in the rank of a Deputy Conservator of Forest, who is designated as Director of the institute. The center conducts training Courses for the forest staffs, BFIDC staffs, saw mill employees and NGO staffs.

23.3. Forestry Research

In 1955, the Bangladesh Forest Research Institute (BFRI) in Chittagong was set up as a Forest Products Research Laboratory. In 1968, the Forest Management Research Branch was created and was reorganized as BFRI. In 1985, the BFRI was separated from the Forest Department, and placed under the administrative control went under the Ministry, now known as the Ministry of Environment and Forest (MoEF).

BFRI is headed by a Director (NPS Grade-II), has two research Branches (Forest Management and Forest Products). The Branch is headed by a Chief Research Officer (CRO). The Forest Products Branch has 06 research Divisions and the Forest Management Branch has 11 research Divisions each headed by a Divisional Officer (DO). There are over 100 positions of scientists (BFRI 2013). Research on scientific and efficient utilization of forest produces are the responsibilities of the Forest Products Branch. Research in the Forest Management Branch is aimed at increasing the productivity of forest land through improved management, conservation of soil and water, protection of trees from pests and diseases, tree improvement through biotechnology & genetic engineering, etc. and coastal afforestation. An internationality abstracted journal "Bangladesh Journal of Forest Sciences" is regularly published showing the research findings in the field of forestry and natural science.

The vision of BFRI is to achieve self-sufficiency in forest and forest resources and it mission is proper utilization of forest resources and dissemination of developed technologies to the end users. BFRI aims at maintaining sustainable productivity of forest land and forest industries without resource depletion and provide research supports to the FD, BFIDC, NGOs, end-users and others in performing the forestry activities. The broad objective is to reduce the demand-supply gap of forest resources. Still Bangladesh Forest Research Institute is engaged in traditional research activities. With the changing scenario of the country and forestry sector, emerging problems need to be identified and addressed. Advanced research has to be initiated in the light of forest research in other parts of the world and to support the current development in the forestry sector. BFRI lacks adequate infrastructure and greatly lacks adequate and trained researchers. Manpower development should be the top priority of BFRI for conducting advanced forestry research.

24. Climate Change and Forest

24.1. Climate Change on Forest and Biodiversity

Because many types of plants and animals have specific habitat requirements, climate change could cause disastrous loss of wildlife species. A slight drop or rise of average rainfall will translate into large seasonal changes. Hibernating mammals, reptiles, amphibians and insects are harmed and disturbed. Plants and wildlife are sensitive to moisture

change. So, they will be harmed by any change in moisture level. Climate change may cause sea level rise and salt water intrusion in coastal region of Bangladesh and thereby affect the flora and fauna especially the aquatic ones.

Almost one fourth of the total population of the country live in the coastal areas of Bangladesh, where majority of the population are somehow affected (directly or indirectly) by tidal surges, river-bank erosion, salinity increase, tropical cyclones etc. With the rise of Sea-level up to one meter only, Bangladesh could lose up to 15% of its land area under the Sea water and around 30 million people living in the coastal areas of Bangladesh could become refugees because of the impact of climate change. Agriculture, industry, infrastructure (school, hospitals, roads, bridges and culverts etc.), livelihoods, marine resources, forestry, biodiversity, livestock, human health and other utility services will suffer severely because of the same. Salinity intrusion from the Bay of Bengal already penetrates 100 kilometers inside the country during the dry season and the climate change in its gradual process is likely to deteriorate the existing scenario to a great extent. Since most of the country is less than 10 meters above Sea level and almost 10% of the population of the country is living below 1 meter elevation - the whole coastal area is Highly Vulnerable to High Tides and Storm Surges. Moreover, the Bay of Bengal is located at the tip of the north Indian Ocean, where severe Cyclonic storms as well as long Tidal waves are frequently generated and hit the coast line with severe impacts because of the Shallow as well as Conical shape of the Bay near Bangladesh.

Data on sea level rise for the southern hemisphere are meagre and it is risky to draw any conclusion (Islam 1999). In case 45cm rise of sea level, the southern part of Bangladesh will suffer most. Predicted rise may inundate 75% of the Sundarbans and greater portion of the coastal plantation will vanish (Anon 1994). Highly specialized plants and animals will migrate to north or disappear while less specialized organisms may be in a position to adapt in newly created environment (Siddiqi 2008). Additionally, possibility of sea level rise will make irreparable damage to the environment in the south and socio-economic condition of the people. The direct and indirect impact of climate of climate change over Bangladesh is likely to increase frequency of flooding, storm surges, salinity level, soil erosion and sedimentation.

24.2. Impacts on Forest Growth and Productivity

Many aspects of projected climate change will likely affect forest growth and productivity. There may be occurrence of (i) increases in carbon dioxide (CO_2), (ii) increases in temperature, and (iii) changes in precipitation (EPA 2013).

- Carbon dioxide is required for photosynthesis, the process by which green plants use sunlight to grow. Given sufficient water and nutrients, increases in atmospheric CO_2 may enable trees to be more productive. Higher future CO_2 levels could benefit forests with fertile soils in the Northeast. However, increased CO_2 may not be as effective in promoting growth in the West and Southeast, where water is limited.
- Warming temperatures could increase the length of the growing season. However, warming could also shift the geographic ranges of some tree species. Habitats of some types of trees are likely to move northward or to higher altitudes. Other species may be at risk locally or regionally if conditions in their current geographic range are no longer suitable. For example, species that currently exist only on mountaintops in some regions may die out as the climate warms since they cannot shift to a higher altitude.
- Climate change will likely increase the risk of drought in some areas and the risk of extreme precipitation and flooding in others. Increased temperatures would alter the timing of snowmelt, affecting the seasonal availability of water. Although many trees are resilient to some degree of drought, increases in temperature could make future droughts more damaging than those experienced in the past. In addition, drought increases wildfire risk, since dry trees and shrubs provide fuel to fires. Drought also reduces trees' ability to produce sap, which protects them from destructive insects such as pine beetles.

25. Intangible Benefit of Forests

Only tangible benefits of forests i.e., through sale of forest produce are taken into account. Thus enormous positive role of forest ecosystems towards mankind and environment remains neglected. Actual income of forestry sector will be much greater if estimate is made adding direct and indirect benefits of forest ecosystems. Change in land use patterns, encroachment of forest land, forest fires, uncontrolled and wasteful commercial logging, illegal felling of trees, turning forestland into grazing fields and collecting fuel wood are considered major reasons for rapid deforestation. In order to obtain higher level of goods services from the forest ecosystems, special attention is needed to arrest further degradation and improve vegetation cover.

25.1. Establishment of a Healthy Microclimate

Microclimate is the suite of climatic conditions measured in localized areas near the earth's surface. Forest vegetation causes development of a microclimate of local climate which influences the surrounding areas. A dense cover allows only a small portion of solar radiation to the ground. Thus temperature of ground surface is lower than at the surface of the vegetation. The forest affects microclimate through its effects on solar radiation, temperature, humidity and wind velocity. The microclimate is a determinant of ecological patterns in both plant and animal communities and a driver of such processes as the growth and mortality of organisms. The importance of microclimate in influencing ecological processes such as plant regeneration and growth, soil respiration, nutrient cycling, and wildlife habitat selection has become an essential component of current ecological research. Forests help develop a more suitable environment for man, livestock, wildlife and other organisms.

25.2. Stability of Environment

Forests acts for the regulation of water regimes by intercepting rainfall and regulating its flow through the hydrological system. Afforestation in hilly areas improves soil stability, thus reducing the risk of landslides and erosion. The role of forests in sustaining water supplies, in protecting soils of watersheds and in minimizing the effects of catastrophic floods and landslides has long been known. Benefits of the forest ecosystems have been concluded and emphasis is suggested on reforestation and forest protection. Thus there is need to bring about the denuded hills of Chittagong and Chittagong Hill Tracts under vegetation and forest cover. Forests act as giant 'sponges' soaking up water during heavy rainfall and releasing fresh water slowly when most needed during dry season. Forested watersheds are exceptionally stable hydrological system. Forests maintain soil quality and the provision of organic materials through leaf and branch fall, limiting erosion and protection of soil from the direct impact of rainfall.

Areas with better vegetation covers suffer less during earthquake. Forest lands are effective in reducing earthquake. Deforestation is also a major challenge in the hilly areas of Bangladesh, contributing along with heavy rainfall to serious landslides. During the 2007 landslide in Bangladesh's second-largest city, Chittagong, deforestation aggravated the impact, causing nearly 900,000 houses to collapse. Forest ecosystem plays a role against flood, soil erosion and ensures perennial flow of water. Government has taken the initiative to improve forestry coverage in hilly areas for better soil stability and watershed management.

25.3. Forest as Defence against Climate Hazard

The Bay of Bengal is an ideal breeding ground of tropical cyclones. About 90% of all cyclonic casualties in Bangladesh are due to storm surges (Tarafdar 1977). The coastal areas may also be susceptible to Tsunami. In 2004, the earthquake was in north-south orientation and so wave propagation was in east-west direction. Had the orientation been in east-west direction, the country would be badly hit. Observing the role played by the natural mangroves against the cyclones and storm surges, coastal plantations have been established alone the shoreline and near shore

islands of Bangladesh to minimize the disastrous effects and protect human lives and properties (Siddiqi 2006). Subsequently, other countries also raised mangrove plantations and this got movement following recent Tsunami.

25.3.1. Role of Trees against Cyclone and Storm Surges

- Thick forests can reduce wind velocity and storm surges. Thick vegetation diminishes the tidal height, thus arresting the magnitude of devastation. Not only mangrove afforestation, social forestry can also be important in cyclone mitigation.
- In case of Bangladesh, it is necessary to make green belt of 3 to 4 km width depending upon the position and configuration of the coast for protective purpose.
- The height of the embankment is not consistent with the maximum height attainable by storm surges. Coastal embankment can be raised to adequate height with massive plantation programme with mangrove and mesophytic species on both sides of the embankment to prevent sea water intrusion.
- The Sundarbans with a width of 80-100km from the sea can very effectively minimize the intensity of cyclone speed before reaching human habitation. In many instances, colossal damage to plants and animals of the forests occurred.
- The Chokoria Sundarbans in the east has been completely cleared for shrimp farming. In 1991, about 40,000 people died due to cyclone. Had there been a vegetation barrier, the loss could be much lower.
- In April 1991, a cyclone ravaged the Chittagong coastal belt. But the people of Mirsrai and Sitakunda suffered least casualties primarily due to protection provided by 1-2 km wide plantations alone the shore. This proved the effectiveness of coastal plantations against cyclones and storm surges.
- In coastal areas, foreshore afforestation is a proven cost-effective method to dissipate wave energy and reduce floods on embankments during storm surges. This was also evident during the 2007 Sidr and 2009 Aila cyclones. Even scattered and unplanned afforestation on the embankments affected by the cyclone Sidr substantially broke the storm surge velocity, reducing damages and losses.

25.4. Watershed Management in Hilly Areas

Forest causes greater infiltration of rain water and reduce run-off. Perennial supply of water and soil fertility is ensured and siltation in water channels is reduced. In recent years, watershed in hilly areas of Bangladesh is degraded due to various human activities. The key issues and problems of watershed management are mentioned below:

- 27.3.1 Jhum and its impact on watershed conservation and people's livelihood
- Traditionally, the communities practice a farming method called jhum which basically involves
- cultivation of food crops in forest land through clearing and burning of undergrowth in the dryseason usually leaving a certain fallow period (3-15 years) between the two successive crops in
- the same piece of land. However, population pressure necessitated a higher production from an ever shrinking land base for jhum (due to inclusion of jhum land into reserved forest) that has resulted into a gradually shortened fallow period to as low as 2 or 1 year to date contributing to a sharp decline in jhum productivity and deterioration of forest ecosystem.

25.5. Monoculture plantation versus mixed cropping and their impact on watershed

- The successive governments had leased out big chunks of forest lands to often wealthy
- individuals for cultivation of monoculture crops such as rubber and other horticultural species on the basis of economic considerations only, and thereby ignoring people's traditional user rights and values. Also land parcels were distributed to ethnic communities to encourage monoculture based farming strategy.

Unsystematic tillage in the hill slopes for establishment of monoculture based plantations has led to serious land degradation.

25.6. Natural resources use affecting watershed conservation and peoples' livelihood

The extent and intensity of exploitation of natural resources in the hilly landscape is an important controlling factor in the conservation of watershed as well for sustainable livelihood. Seasonality of resource extraction or harvesting of forest produces affects food security of the inhabitants as well as plays a key role in controlling soil and water quality in the watersheds.

25.7. Cultural Operations and Plantation Establishment Techniques

- In the clear-felled natural forests, land preparation prior to establishment of plantation involves
- Uprooting of tree stumps and burning of debris in the forest floor that leads to serious soil erosion and depletion in soil moisture. The most serious problem with regard to gardening of particularly pineapple and citrus fruits, and some root crops such as ginger and turmeric, is the direct exposure of soil surface to heavy downpour and surface run-off resulting into top soil 6 erosion which not only leads to gradually diminishing harvest of the concerned crops, but also ultimately renders the land virtually useless for cultivation or plantation purposes.

25.8. Cultural Operations and Plantation Establishment Techniques

Bangladesh has lagged behind its neighbours in the promotion of watershed management largely because the subject failed to receive adequate attention from the relevant policy makers as well as the major international development partners. The reported increase in sedimentation and soil erosion in the CHTs, however, has significantly increased the level of concern in the Government. Forest Department is planning to introduce participatory agroforestry in the degraded land through adopting cropping models that would involve cultivation of agricultural crops by exposure of surface soil in between rows of trees which too may pose the indigenous communities to further environmental problems.

25.9. Apathy of the Government Agencies Regarding the Gravity of the Problem

Bangladesh has lagged behind its neighbours in the promotion of watershed management largely because the subject failed to receive adequate attention from the relevant policy makers as well as the major international development partners. The reported increase in sedimentation and soil erosion in the CHTs, however, has significantly increased the level of concern in the Government. Forest Department is planning to introduce participatory agroforestry in the degraded land through adopting cropping models that would involve cultivation of agricultural crops by exposure of surface soil in between rows of trees which too may pose the indigenous communities to further environmental problems.

26. Forests for Eco-tourism

Eco-tourism is responsible travel in natural areas that conserves the environment and improves the well-beings of the local people. This is a new concept in the country though it has developed in the last 15 years in different countries of the world. The marketing of eco-tourism in the world today has reached maximum sophistication and supply of goods and services has exceeded than its present demand. Now a day more and more people want to spend leisure time for nature, so it is an important window of the hospitality Industry. The eco-tourism creates opportunities in areas having unique features or attributes in natural scenic beauty, wildlife and wilderness. Local communities have

maximum opportunities to be benefited from the eco-tourism, which shall generate income for them that shall also help to conserve the nature. So it is believed that eco-tourism is a sustainable hospitality industry that shall benefit the nature and the community as well. Bangladesh has great potentialities for the development of eco-tourism opportunities in the country, as there are many sites of interest for levels of people. Some Potential Eco-tourism Sites are:

- National Botanical Garden, Dhaka
- Dhaka Zoo
- Baldah Garden
- Bhawal National Park
- Madhupur National Park
- Ramsagar National park
- Kaptai National Park
- Himchari National Park
- Teknaf Game Reserve
- Dulahazara Safari Park
- Sitakunda Botanical Garden and Eco-park
- Madhabkunda Eco-park
- Katka
- Kochikhali
- Nilkamal
- Dublar Char
- Kuakata
- Tanguar Haor

Ecotourism is expanding steadily against many constraints. The sundarban for example does not ensure proper facilities for the tourists. But over years, it has been gaining popularity as a tourist destiny. The number of recorded tourists has been double from 60,000 to 120,000 between 2001 and 2009. The entire forests including the wildlife sanctuaries are open to visitors. Most visitors do not follow the norms associated with ecotourism (IUCN 2014). Wildlife management and ecotourism should get due importance. Unplanned and unmanaged ecotourism will lead to degradation of natural ecosystems and wildlife habitats.

27. Problems and Opportunity Related to Forest and Biodiversity

27.1. Problems and Challenges for Forestry

- Growing population pressure causes shrinkage of forests and the forest area in Bangladesh is reduced by 13,000 ha annually.
- There is a big gap between demand of the increasing human population and supply of recourses from the forest ecosystems.
- Low wood productivity (0.5-2.5m3/ha/yr in Government forests and 7-9m3/ha/yr from homestead) is a great challenge to meet requirement of the people.
- Due to heavy on forest ecosystems and scarcity of land for human habitation and agriculture, occurrence of over-exploitation and encroachment of natural forests and plantations is quite common.

- Non-wood Forest Produce (NWFP) like bamboo, rattan, nipa palm and medicinal plants are valuable. Following moratorium of timber harvest from the natural forest, the importance of NWFP is augmented. However, attention paid to the management on NWFP for higher yield is inadequate.
- In the past, ruthless exploitation of natural forests over vast areas took place. About 50% of the forest lands are denuded or degraded for higher yield of wood per unit area. Only 6% areas of the country are under close canopy cover.
- Role played by the forest is unknown to common people. They are ignorant about various services provided by the forest ecosystem to mankind and natural environment. Thus illicit felling of trees due to heavy demand and lack of people's awareness commonly occurs throughout the country.
- Old system of forest management Forest is still in practice for higher revenue. Management often is not compatible to political/ social changes and conservation of nature. In many cases, sustainable yield in an area cannot be ensured for several reasons.
- It is quite difficult to develop a complementary management of various resources in a forest. Emphasis on higher wood production may affect biodiversity conservation. So, management of various resources can be conflicting and it is not easy o evolve a compatible management systems of the available resources.
- Considerable proportion of hill forests is barren due to harvesting and subsequently not bringing the under vegetation cover. Denudation causes soil erosion, flood from runoff, siltation of river bed, management of watershed, and other services. Services from the forest ecosystems are greatly reduced.
- Source of exotic rubber plants is from Malaysia. Latex yield from the rubber plantation is low being 0.5 ton/ha while in India it is ton3/ha. Appropriate use of seeds and management are likely to considerably increase the yield of latex.
- In order to meet the growing need of wood, there has been introduction of exotic species. Survival and growth of some exotic species are satisfactory. However, the exotic plants have a destructive impact on natural habitats and wildlife population.
- Intangible benefit from forest ecosystems is enormous and if this is added to direct benefit, the real contribution of the forestry sector to the GDP could be ascertain. Still inadequate importance is given on services from the forest ecosystem.
- Goal-oriented research studies have been undertaken in addition to basic research. Considerable research findings are available which can help improve management of forests and increase production of the ecosystems. Technology transfer and execution of research findings for higher return need to be ensured. At the moment, there is no organization responsible for the extension of research achievement from BFRI to the users.

27.2. Problems and Challenges for Biodiversity

01. There is need to extensively study floral and faunal diversity of different forest types. During the past century, great depletion and degradation of biodiversity occurred due to over-exploitation, improper management, poor protection and lack of people's awareness.
02. Large-scale destruction and loss of natural habitat even by Government organizations had been a common phenomenon all over the country. The concept of wildlife conservation and habitat management came into being only 40 years. Still the concept is under the process of popularization among the greater mass of the people.
03. Both terrestrial and aquatic animals suffer from environmental pollution. Indiscriminate use of chemical for agriculture and drainage of sewerage from cities to water bodies causes heavy water pollution resulting in the decline of many valuable organisms. Even sea water nearby ship breaking industries in Chittagong are polluted for living organisms.

04. There is demand for outdoor recreation local by the local and foreign tourists. Bangladesh has some unique places for attracting tourists if proper facilities are extended. Efforts needs to be made to develop forest based eco-tourism for mutual benefits of human being and natural environment.
05. It is not possible to conserve wildlife and biodiversity only by promulgating some rules. Implementation of rule for protecting the animals and protected area management will not be possible without the cooperation of the people. So, motivating the people and develop their awareness are essential for the conservation of wildlife and biodiversity, and protected area management.
06. Primary attention is paid to the establishment of tree crops for commercial harvest. Other potentials the forests including goods services remained unmanaged and underutilized. Proper initiative for maximizing multiple benefits from forests is necessary.
07. Population size of many plants and animals has declined. To ensure viable population, deterioration has to be arrested. Declining trends of important plants and animals density is a serious threat for the survival of the species and has to be addressed.

27.3. Opportunities for Forest and Biodiversity

01. Popularizing People's Participation in Forest Development Activities.
02. Develop Awareness of People for Protection of Plantation and Natural Forests.
03. Greater Emphasis on Social/Agro-Forestry for Higher Yield and Green Cover.
04. Strengthen Coastal Afforestation for Protection against Storm Surges and for Wood Production.
05. Improve nursery and management techniques for optimal utilization of land.
06. Use of Superior Quality of Seeds from Plus Tree/Orchard for Higher Yield and Quality Timber.
07. Pest and Disease Control and Selection of Suitable Site Specific Species.
08. Planned Management of NWFP including Bamboo, Rattan and Medicinal Plants.
09. Application of Proper Management to Increase Forest Productivity.
10. Economic Utilization of Forest Produce and Reduce Pressure on Harvesting.
11. Adequate Measures to obtain Greater Services from Forest Ecosystems.
12. Greater Emphasis on Afforestion/Reforestion to Increase Forest Canopy Cover.
13. Management of Protected Areas for Conservation of Wildlife and Natural Habitats.
14. Implementation of Wildlife Law to Stop, Hunting, Poaching, Illegal Trade, etc.
15. Create Avenues for Eco-tourism and Nature Conservation and Employment Opportunities.
16. Little attention is paid to urban forestry. The urban areas are steadily expanding and so there is scope for planting those to conserve biodiversity.
17. Care and Measures to Save the Endangered Plants and Animals.
18. Protection, Habitat Management and Reintroducing of Extinct Species.
19. Strengthen Research, Technology Transfer and Execution of Research Findings.
20. Develop Compatible Management of Various Resources in Ecosystems.

28. Completed and On-going Projects

28.1. List of on-going Projects

- Biodiversity Conservation and Ecotourism Development in Bangladesh (July, 2011 to June, 2015).
- Strengthening Regional Cooperation for Wildlife Protection Project (July, 2011 to June, 2016).
- Development and Extension of Bangabandhu Sheikh Mujib Safari Park, Cox's Bazar (July, 2012 to June, 2015).
- Bangabandhu Sheikh Mujib Safari Park, Gazipur (2nd Phase) ((March, 2010 to June, 2016).
- Establishment of Sheikh Russell Aviary and Ecopark at Rangunia, Chittagong (2nd Revised) (July, 2010 to June, 2015).

- Sundarban Environmental And Livelihoods Security (SEALS) (1st Revised)

(October, 2010 to December, 2014).

28.2. Approved Projects under Climate Change Trust Fund

Community Based Adaptation to Climate Change through Coastal Afforestation in Bangladesh (July, 2009 to June, 2016).

Char Development and Settlement Project-IV (FD Component) (January, 2011 to December, 2016).

Climate Resilient Participatory Afforestation and Reforestation Project (CRPARP) (July, 2012 to June, 2016).

Sustainable Development and Biodiversity Conservation in Coastal (Protection) Forests (SDBC - Sundarbans) (July 2012 to June 2015).

- Developing Carbon Sink through Reforestation in Kaptai Area (November 2012 to June 2015).
- Revegetation of Madhupur Forests through Rehabilitation of Forest Depended Local and Ethnic Communities ((Phase-2) (July, 2013 to June, 2015).
- Biodiversity Conservation and Increasing Ecotourism Facilities in Laldia Reserved Forest (February 2013 to June 2015).

Reduction of Carbon Emission through Establishment of Sonaichari Botanical Garden, Bhatiary, Chittagong. (1st Revised) (July, 2011 to June, 2015).

- Eco-restoration of Hill Forests, Cox's Bazar (July, 2012 to June, 2015).

Development of Land and Maintenance of Environmental Balance in the Char Areas of Bhandaria Upazila near Charkhali Ferrighat to Mitigate the Adverse Effects of Climate Change through Afforestation (April 2014 to June 2016).

28.3. Approved/Current Programmes

Establishment of Wildlife Conservation Centre in Sylhet (November, 2013 to June, 2016).

28.4. List of some completed Projects

- Bamboo, Cane and Murta Plantation Project (2nd Phase) (1st Revised) (July, 2009 to June, 2014).
- Restoration and Conservation of Biodiversity in the Denuded Hills of Sitakunda, Mirsharai, Banskhali, Inani Forest Area, Barind Dhamuer Hat Sal Forest and Singra Sal Forest (July, 2011 to June, 2014).
- Poverty Alleviation through Social Forestry - (March, 2010 to December, 2013).
- Integrated Protected Area Co-Management (IPAC)-Nishorgo (July, 2010 to June, 2013).
- Afforestation in the Denuded Hill Areas of Chittagong North Forest Division (2nd Phase) (1st Revised) (July, 2008 to June, 2013).
- Biodiversity Conservation and Poverty Alleviation in the Greater Rajshahi and Kushtia Districts (July, 2008 to June, 2013).
- Forest Information Generation and Networking System Project (January, 2011 to March, 2013).
- Coastal Charland Afforestation Project (2005-06 to 2009-10).
- Establishment of Botanical Garden and Eco-park at Sitakunda, Chittagong (2005-06 to 2009-10).
- Management Support Project for Sundarban Reserved Forest (2005-06 to 2009-2010).
- Initiation Phase of the Shamol Bangladesh: Greening Initiative for Sustainable of Rural Poor and Biodiversity Conservation Project.
- Forestry Sector Project (1997-98 to 2005-06).
- Development of Kaptai National Park (1999-2000 to 2005-06).

- Strengthening Capacity to Generate Quality Information on Forest Resource (2004-05 to 2006-07).
- -Nishorgo Support Project (1999-2000 to 2008-09).

28.5. Past Major Social Forestry Activities under development projects

- Sundarbans Biodiversity Conservation Project (Currently suspended Loan No. 1643-BAN[SF]; EA: FD; Duration 1999-2006).
- Forestry Sector Project (ADB Loan No. 1468-BAN[SF]; Duration: 1998-2004, EA: FD).
- Forest Resources Management Project: Forest Directorate Component (IDA Grant and WFP Assistance Duration: 1992-2001 EA: FD)
- Coastal Green Belt Project: (ADB Loan No.1353-BAN[SF]; EA: FD; Duration 1995-2002)
- Upazila Afforestation and Nursery Development Project (ADB Loan No.0956-BAN [SF]; EA: FD; Duration 1989-1996)
- Community Forestry Project (ADB Loan No. 555-BAN; EA:FD; Duration 1981-1988).

29. References

Abdullah, M.M. 1979. *Rural development in Bangladesh*. Dhaka - 7. p. 44.

Ahmed, F.U., 1995, Homestead Agroforestry of Bangladesh, M.Sc. Thesis, Universsity of Wales, Bangor,UK

Ahmed, F. U. 2007. Forest Resources of Bangladesh: Problems and Prospects. Arannayk Foundation. (Mimeographed).

Ahmed, F.U. and Akhtaruzzaman, A.F.M. 2010. A vision for Agricultural Research in Bangladesh (Forestry Component – 2030). BARC, Farmgate, Dhaka.

Akhtaruzzaman, A.F.M.2010. National Medium Term Priority Framework (NMTPF) 2010-2015 for Bangladesh: Sector Paper- Forestry. FAO, Bangladesh.

Akhtaruzzaman, A.F.M., 2006, Priority Setting in Forestry Research in Bangladesh, Paper presented at the national workshop on Planning and Priority Setting of Forestry Research in Bangladesh, , 17 May 2006

Alam, M. 2009.Evolution of forest policies in Bangladesh: A critical analysis. *International Journal of Social Forestry*. 2(2): 149-166.

Alam, M.K., Mohiuddin, M. and Basak, S.R. 1996. Village trees of Bangladesh: Diversity and economic aspects. *Bangladesh Journal of Forest Science*. 25(1&2):21-36.

Ali, S. Pipley, S.D. 1964-1974. Handbook of the Birds of India Pakistan. Bombay. Oxford University Press.

Anon. 1994. Climate Change in Asia: Bangladesh Country Report, Regional Study on Global Environmental Issue. Asia Development Bank. 80pp.

Anon. 2014. Urban forestry status at Dhaka in Bangladesh. *Omni Bangla* (from website).

Anon. 2014. Urban Forestry for Green City. *Wikipedia.* 30 June 2014.

Ara, R. 2006. *Biology, propagation and Conservation of Rattans of Bangladesh*. Ph.D Thesis, Department of Botany, Dhaka University, Dhaka.251pp.

Ara, R. 2005. Occurrence of *C. gracilis* Rox. In Sylhet district of Bangladesh. *Indian Forester* 131(9): 1238-1240.

BARC. 2012. Agricultural Research Vision 2030 and Beyond. National Agricultural Technology Project. Phase -I. Bangladesh Agricultural Research Council. Farmgate, Dhaka.

Bangladesh Gazette. 2010. Social Forestry Rule Amendment. Ministry of Forest and Environment.

Bangladesh Gazette 2009. Co-management. 5 January. Ministry of Environment and Forest.

Banik, R. L..1997. Bamboo cultivation and management in Bangladesh (in Bangla). Bulletin1, Bangladesh Forest Research Institute, Chittagong. 4-5 pp.

BCCRF. 2013. Forest as first line of defence against climate change. Bangladesh Climate Change Resilience Fund (from website).

BFD. 2014. Website of Bangladesh Forest Department. 14 December, 2014

BFIDC. 2013. Rubber Statistic. Bangladesh Forest Industries Development Corporation (from website).

BFRI. 1999. Master Plan for 2000-2005, Bangladesh Forest Research Institute, Chittagong.

Blanford, W.T. 1888. *The Fauna of British India (Mammals).* London: Taylor & Francis.

Chaffey, D.R. and Samdom, J.H. 1985. The Sundarbans Forestry Poject. A Glossary of Vernacular Plant Names and a Field Keys to the Trees. Overseas Development Administration England. 23pp.

Champion, H.G., Seth, S.K. and Khattak, G.M. 1965. *Forest Types of Pakistan*. Pakistan Forest Institute, Peshawar. 238pp.

Choudhury, J.K. and Hossain, M.A.A. 2011. Bangldesh Forestry Outlook. Asia-Pacific Forestry Outlook Study II. Working Paper No. APFSOS II/WP/2011/33. 101pp.

Coudhury, J.K. and Hossain, A. 2009. Asia Pacific Forestry Sector Outlook Studies, Bangladesh Country Report. Department of Forest, Government of Bangladesh.

Cowan, J.I. 1926. The Flora of the Chakaria Sundarbans. Records of the Botanical Survey of India, Calcutta. 197-226pp.

Das, D.K., 1990. *Forest Types of Bangladesh*, Bangladesh Forest Research Institute, Chittagong, Bangladesh, Bulletin 6, Plant Taxonomy Series. 9pp.

Das, D.K. and Alam, M.K. 2001. *Trees of Bangladesh*. Bangladesh Forest Research Institute, Chittagong. ……..pp.

Dwivedi, A.P. 1980. Forestry in India. Jugol Kishore and Company. Dehradun, India.

FAO, 2009, Regional Outlook - Asia Pacific.

FAO, 2005, Global Forest Resources Assessment, Country Reports – Bangladesh, FRA 2005/141, Rome

Ghani, A. 1998. Medicinal Plants of Bangladesh. Chemical Constituents and Uses. Asiatic Society of Bangladesh, Dhaka-1000, 460 pp.

Gunther, F.B.I. 1876. *The Reptiles of India*. Ray Soc. London.

Imran, M. 2011. Honey of Sundarbans. *Look Bangladesh*. 16 July, 2011

Hammermaster,E.T. 1981. Village Forest Inventory of Bangladesh. UNDP/FAO Project BGD/78/020. 59pp.

Hassan, M.M. 2001. The declining forest and causes of deforestation in Bangladesh. *The Bangladesh Observer*. 6 May.

Hassan, M.M. 2013. Forest Soil. Banglapedia – Encyclopedia of Bangladesh

Helalsiddiqui, A.S.M. 1999. Minor forest products in the Sundarbans of Bangladesh. *Journal of Non-timber Forest Products*. 6(1&2): 19-25.

Hossain, M.L. 2014. Lecture Note Wildlife of Bangladesh. Strengthening Regional Cooperation for Wildlife Protection Project. Forest Department, Dhaka.

Hossain, M.K. 2003. Growth performance and critics of exotics in plantation forestry of Bangladesh. World Forestry Congress. Quebec City. Canada.

Hossain, M.K. and Haque,A.T.M.R. 2013. *Eucalyptus Dilemma in Bangladesh*. IFES, University of Chittagong.

Hussain, M.K. 2014. Vanishing forest genetic resources of Bangladesh and the strategy of their conservation. Arannayk, Dhaka.

Husain, K.Z. 1992. *An Introduction to Wildlife of Bangladesh*. Book Promotion Press. Dhaka. 84pp.

Irfanullah, H.M. 2011. Conserving threatened plants of Bangladesh: Miles to go before we start? *Bangladesh Journal of Plant Taxonomy*. 18(1):81-91.

Islam, M.S. 1999. Somotal Paribartan ebong Bangladesh Prekkhit. *Bhugal Patrika* 18: 71-86.

IUCN. 2003. Bio- ecological Zones of Bangladesh. IUCN- The World Conservation Union, Bangladesh Country Office. Dhaka.

IUCN, Dhaka, 2002, Impact of Climate Variability and Flora and Forest of Bangladesh, Report submitted at the Third World Water Forum, cited in (Choudhury and Hossain 2009).

IUCN. 2014. Bangladesh Sundarbad Delta Vision 2050. Internation Union for Conservation of Nature.. Dhaka. 23pp.

Jerdon, B.F.1974. *The Mmammals of India.* London: Jhon Wheldon.

Kanwal, A.S. 1982. *Cane and bamboo craft*. Bangladesh DRI, UNDP & ILO Project.

Khan M.A.R. 2010. Wildlife of Bangladesh from Amphibia to Mammalia a Check List. Shahitya Prakash. 112pp.

Khan, M .A.R. 1982. *Wildlife of Bangladesh.* University of Dhaka. 173pp.

Khan, S.A. 1992. Non-wood Forest Products of Bangladesh: An overview. *Aranya*. BCS(Forest) Association, Dhaka. 1(1): 11-16.

Khan, N.A. 2015. Seminar on international day of forests 2015 (Forest-Climate-Change). Presented at Forest Directorate, Dhaka.

Khisa, B. 1996.Chakma Talik Chikista (tradional Medicine by Chakma in Bangla). Herbal Medicine Centre Committee, Rangamati, Bangladesh.136 p.

Kibria,M.G, Sarker,D.C.,Hossain, M.A.T.,Mannan, M.A..,Motaleb, M.A. and Islam,S.S., 2000, Forest Statistic of Bangladesh, Bulletin 4, Forest Economics Division, Bangladesh Forest Research Institute, Chittagong.

Misbahuzzaman, K. (website 2014) Problems and Prospects of the Hilly Watersheds in Bangladesh, Priorities for their Conservation. Institute of Forestry and Environmental Sciences, Chittagong University.

MoEF, 2009, Bangladesh Climate Change Strategy and Action Plan 2009, Ministry of Environment and Forests, Government of the People's Republic of Bangladesh.

Motaleb, M. A. 2011. Selected Medicinal plants of Chittagong Hill Tracts. IUCN (International Union for Conservation of Nature), Dhaka Bangladesh, 116 p.

Mustafa, M.M., 2002, Policy Trend Report, 114 - 121.

Nandy, P. *et al*. 2002. Growth of 37 species raised on embankments from eastern, central and western coastal belt of Bangladesh. Coastal Green Belt Project Forest Department, Bangladesh. 41pp.

NSDS. 2013. National Development Strategy 2010-21. GED. Planning Commission. Bangladesh Government.

Pasha, M.K. 2013. Mushroom. Banglapedia.

Pocock, R.I. 1939, 1941. The Fauna of British India including Ceylon and Burma. *Mammalia*. Vols 1&2. London: Taylor & Francis.

Rahman, A.K.M.A. and Dhar, M. 2008. Hill Farming Practices in Chittagong- Its Constraints and Opportunities. Proceedings of the National Workshop on Hill Farming Practices in Bangladesh – Constraints and Opportunities. ARC. March 2008.

Rahman, M. Z. and Siddiquee, S.A. 2014. *The Daily Star*. 6 December, 2014.

Rashid, H. M., Mohiuddin, M. Ara, R. and Alam, M. J. 1990. Medicinal Plants and their Cultivation (in Bengali). Bulletin-4. Minor Forest Products Series. Bangladesh Forest Research Institute, Chittagong. 17 p.

Ripley, S.D. 1961. A Synopsis of Birds of India and Pakistan. Bombay Nat. Hist. Soc.

Sarker, M.S.U. and Sarker, N. J. 1988. *Wildlife of Bangladesh.* Rico printers, Dhaka. 59pp.

SEDF/IC, 2003. Medicinal Plants Marketing in Bangladesh SEDF/Inter -corporation –a Swiss Development Foundation study, 2003, 76 p.

Siddiqi, N.A. and Hasan Sayed, A.K.M. 2012. Agroforestry practices in newly accreted coastal areas of Banglades. Pp 59-66. In: Shahjahan, M. *et al* (eds). *Proceeding of the workshop on "Constraints and Opportunities of Agroforestry Practices in Newly Accreted Char Land of Bangladesh.* Bangladesh Agricultural Research Council, Dhaka.

Siddiqi, N.A. and Hasan Sayed, A.K.M. 2012. Agroforestry practices in newly accreted coastal areas of Banglades. Pp 59-666. In: Shahjahan, M. *et al* (eds). *Proceeding of the workshop on "Constraints and Opportunities of Agroforestry Practices in Newly Accreted Char Land of Bangladesh.* Bangladesh Agricultural Research Council, Dhaka.

Siddiqi, N.A. 2011. Changing trends in biodiversity of the mangroves of Bangladesh.Pp.77-82. *In:*Roskaft, E. and Chivers,D.J.(Eds). *Proceedings of the International Conference on Biodiversity – Present State, Problems and Prospects of its Conservation.* Norwegian University of Science and Technology, Trondheim, Norway.

Siddiqi, N.A. and Alam, M.J. 2006. Impact of shrimp farming and salt production practices on mangrove forests destruction in Bangladesh. *Indian Forester* 132(12): 1570-1580.

Siddiqi, N.A. 2008. Mangrove Afforestation in Bangladesh: Experience and Lessons for the future. Pp 258-271. In: Tan, KH, Ong, JE and Prima Vara JH (eds) Proceedings of the International Conference and Exhibition on Mangroves of Indian and Western Pacific Oceans (21-24 August 2006), Maritime Institute of Malaysia, Kuala Lumpur.

Siddiqi, N.A. 2008. Probable impact of climate of climate change and sea level rise onmangrove forests and biodiversity of Bangladesh. *Bangladesh Journal of Forest Science.* 31(1&2):1-15.

Siddiqi, N.A., 2008 Probable impact of climate change and sea level rise on mangrove forests and biodiversity of Bangladesh". *Bangladesh Journal of Forest Science* 31(1&2): 1-15

Siddiqi, N.A. and Khan, M.A.S. 2004. Human-induced succession of vegetation on new accretions in the coastal areas of Bangladesh. Journal of Tropical Forest Science 16(2): 187-198.

Siddiqi, N.A. 2002. Development and sustainable management of coastal plantations in Bangladesh. *Journal of Asiatic Society of Bangladesh, Science* 28(2): 144-166.

Siddiqi, N.A. 2001. *Mangrove Forestry in Bangladesh*. Institute of Forestry & Environmental Science, University of Chittagong, Chittagong. 201pp.

Siddiqi, N.A. 1999. Raising plantation of nipa palm on new accretions along the coast line of Bangladesh. *Journal of Non-timber Forest Products.* 6(1&2):52-56.

Siddiqi, N.A. 1996. Country Report for Assessment of Faunal Biodiversity in Bangladesh. South-Asia Cooperative Environmental Programme, Colombo. (mimeographed).

Siddiqi, N.A. 1995. Site suitability for raising *Nypa fruticans* in the Sundarbans Mangroves. *Journal of tropical Forest Science.* 7(30): 405-411.

Siddiqi, N.A., Khan, M.A.S., Islam, M.R. and Hoque, A.K.F. 1992. Underplanting - a means to ensure sustainable mangrove plantations in Bangladesh. Bangladesh Journal of Forest Science 21(1&2):1-6.

Sirajuddin, M. 1986. *Cottage industry*. Dhaka, Bangla Academy. (in Bengali).

Smith, M. A. 1964. The Fauna of British India (Reptiles and Amphibian). London: Taylor & Francis.

Tarafdar, M.R. 1977. Hydrology and storm surges associated with tropical cyclones in Bangladesh.WWO/ESCAP Panel on Tropical Cyclones (April 12-18), Dhaka.

Theobald, 1964. Descriptive catalogue of reptiles of India, Calcutta.

Whistler, H. 1949. *Popular Handbookof Indian Birds*. London: Gurney & Jackson

Yusuf, M., Chowdhury, J. U., Wahab, M. A. and Begum, J. 1994. Medicinal Plants of Bangladesh. Bangladesh Council of Scientific and Industrial Research, Dhaka. 340 p.

List of Notable Publications By General Economics Division (GED) Bangladesh Planning Commission since 2009

1. Policy Study on Financing Growth and Poverty Reduction: Policy Challenges and Options in Bangladesh (May 2009)
2. Policy Study on Responding to the Millennium Development Challenge Through Private Sectors Involvement in Bangladesh (May 2009)
3. Policy Study on The Probable Impacts of Climate Change on Poverty and Economic Growth and the Options of Coping with Adverse Effect of Climate Change in Bangladesh (May 2009)
4. Steps Towards Change: National Strategy for Accelerated Poverty Reduction II (Revised) FY 2009-11 (December 2009)
5. Millennium Development Goals: Bangladesh Progress Report 2009 (2009)
6. Millennium Development Goals: Needs Assessment and Costing 2009-2015 Bangladesh (July 2009)
7. এমডিজি কর্ম-পরিকল্পনা (৫১টি উপজেলা) (জানুয়ারি-জুন-২০১০)
8. MDG Action Plan (51 Upazillas) (January 2011)
9. MDG Financing Strategy for Bangladesh (April 2011)
10. SAARC Development Goals: Bangladesh Progress Report 2011 (August 2011)
11. Background Papers of the Sixth Five Year Plan (Volume 1-4) (September 2011)
12. 6th Five Year Plan (FY 2011-FY 2015) (December 2011)
13. Millennium Development Goals: Bangladesh Progress Report-2011 (February 2012)
14. Perspective Plan of Bangladesh 2010-2021: Making Vision 2021 a Reality (April 2012)
15. Public Expenditure for Climate Change: Bangladesh Climate Public Expenditure and Institutional Review (October 2012)
16. Development of Results Framework for Private Sectors Development in Bangladesh (2012)
17. ষষ্ঠ পঞ্চবার্ষিক পরিকল্পনা (২০১১-১৫) [মূল ইংরেজি থেকে বাংলায় অনুদিত] (অক্টোবর ২০১২)
18. Climate Fiscal Framework (October 2012)
19. Public Expenditure for Climate Change: Bangladesh CPEIR 2012
20. First Implementation Review of the Sixth Five year Plan -2012 (January 2013)
21. বাংলাদেশের প্রথম প্রেক্ষিত পরিকল্পনা (২০১০-২০২১) রূপকল্প ২০২১ বাস্তবে রূপায়ণ (ফেব্রুয়ারি ২০১৩)
22. National Sustainable Development Strategy (2010-2021) (May 2013)
23. জাতীয় টেকসই উন্নয়ন কৌশলপত্র (২০১০-২০২১) [মূল ইংরেজি থেকে বাংলায় অনুদিত] (মে ২০১৩)
24. Millennium Development Goals: Bangladesh Progress Report 2012 (June 2013)
25. Post 2015 Development Agenda: Bangladesh Proposal to UN (June 2013)
26. National Policy Dialogue on Population Dynamics, Demographic Dividend, Ageing Population & Capacity Building of GED [UNFPA Supported GED Project Output 1] (December 2013)
27. Capacity Building Strategy for Climate Mainstreaming: A Strategy for Public Sector Planning Professionals (2013)
28. Revealing Changes: An Impact Assessment of Training on Poverty-Environment Climate-Disaster Nexus (January 2014)
29. Towards Resilient Development: Scope for Mainstreaming Poverty, Environment, Climate Change and Disaster in Development Projects (January 2014)
30. An Indicator Framework for Inclusive and Resilient Development (January 2014)
31. Manual of Instructions for Preparation of Development Project Proposal/Proforma Part-1 & Part 2 (March 2014)
32. SAARC Development Goals: Bangladesh Progress Report-2013 (June 2014)
33. The Mid Term-Implementation Review of the Sixth Five Year Plan 2014 (July 2014)
34. Millennium Development Goals: Bangladesh Progress Report 2013 (August 2014)
35. Population Management Issues: Monograph-2 (March 2015)
36. GED Policy Papers and Manuals (Volume 1-4) (June 2015)

37. National Social Security Strategy (NSSS) of Bangladesh (July 2015)
38. MDGs to Sustainable Development Transforming our World: SDG Agenda for Global Action (2015-2030)- A Brief for Bangladesh Delegation UNGA 70th Session, 2015) (September 2015)
39. 7th Five Year Plan (2015/16-2019/20) (December 2015)
40. সপ্তম পঞ্চবার্ষিক পরিকল্পনা ২০১৫/১৬-২০১৯/২০ [মূল ইংরেজি থেকে বাংলা অনূদিত] (অক্টোবর ২০১৬)
41. জাতীয় সামাজিক নিরাপত্তা কৌশলপত্র [মূল ইংরেজি থেকে বাংলা অনূদিত] (অক্টোবর ২০১৬)
42. Population Management Issues: Monograph-3 (March 2016)
43. Bangladesh ICPD 1994-2014 Country Report (March 2016)
44. Policy Coherence: Mainstreaming SDGs into National Plan and Implementation (Prepared for Bangladesh Delegation to 71st UNGA session, 2016) (September 2016)
45. Millennium Development Goals: End- period Stocktaking and Final Evaluation Report (2000-2015) (September 2016)
46. A Handbook on Mapping of Ministries by Targets in the implementation of SDGs aligning with 7th Five Year Plan (2016-20) (September 2016)
47. Data Gap Analysis for Sustainable Development Goals (SDGs): Bangladesh Perspective (January 2017)
48. Environment and Climate Change Policy Gap Analysis in Haor Areas (February 2017)
49. Integration of Sustainable Development Goals into the 7th Five Year Plan (February 2017)
50. Banking ATLAS (February 2017)
51. টেকসই উন্নয়ন অভীষ্ট, লক্ষ্যমাত্রা ও সূচকসমূহ [মূল ইংরেজি থেকে বাংলায় অনুদিত] (এপ্রিল ২০১৭)।
52. Exploring the Evidence: Background Research Papers for Preparing the National Social Security Strategy of Bangladesh (June 2017)
53. Bangladesh Voluntary National Review (VNR) 2017: Eradicating poverty and promoting prosperity in a changing world, (June 2017)
54. SDGs Financing Strategy: Bangladesh Perspective (June 2017)
55. A Training Handbook on Implementation of the 7th Five Year Plan (June 2017)
56. 7th Five Year Plan (FY 2015/16-FY 2019/20): Background Papers Volume 01: Macro Economic Management & Poverty Issues (June 2017)
57. 7th Five Year Plan (FY 2015/16-FY 2019/20): Background Papers Volume 02: Socio-Economic Issues (June 2017)
58. 7th Five Year Plan (FY 2015/16-FY 2019/20): Background Papers Volume 03: Infrastructure, Manufacturing & Service Sector (June 2017)
59. 7th Five Year Plan (FY 2015/16-FY 2019/20): Background Papers Volume 04: Agriculture, Water & Climate Change (June 2017)
60. 7th Five Year Plan (FY 2015/16-FY 2019/20): Background Papers Volume 05: Governance, Gender & Urban Development (June 2017)
61. Education Sector Strategy and Actions for Implementation of the 7th Five Year Plan (FY2016-20)
62. GED Policy Study: Effective Use of Human Resources for Inclusive Economic Growth and Income Distribution-An Application of National Transfer Accounts (February 2018)
63. Monitoring and Evaluation Framework of Sustainable Development Goals (SDGs): Bangladesh Perspective (March 2018)
64. National Action Plan of Ministries/Divisions by Targets for the Implementation of Sustainable Development Goals (June 2018)
65. Bangladesh Delta Plan 2100: Baseline Studies: Volume 1: Water Resources Management (June 2018)
66. Bangladesh Delta Plan 2100: Baseline Studies: Volume 2: Disaster and Environmental Management (June 2018)
67. Bangladesh Delta Plan 2100: Baseline Studies: Volume 3: Land Use and Infrastructure Development (June 2018)
68. Bangladesh Delta Plan 2100: Baseline Studies: Volume 4: Agriculture Food Security and Nutrition (June 2018)

General Economics Division

Bangladesh Planning Commission, Ministry of Planning

Government of the People's Republic of Bangladesh