Background Studies for the Second Perspective Plan of Bangladesh (2021-2041)

Volume-5

Editor:
Dr. Shamsul Alam

General Economics Division (GED)
Bangladesh Planning Commission
Ministry of Planning
Government of the People's Republic of Bangladesh
October 2019

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Published and Cover Designed by:
General Economics Division (GED)
Bangladesh Planning Commission
Government of the People's Republic of Bangladesh
Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh
Website: www.plancomm.gov.bd

First Published: June 2019

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Printed By:
Inteshar Printers
217/A, Fakirapool (1st Lane), C/A, Dhaka. Bangladesh
Cell: +88 01921-440444

Copies Printed: 300

M.A. Mannan, MP
Minister
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Message

It gives me immense pleasure to learn that the General Economics Division (GED) of Bangladesh Planning Commission is going to publish 16 background papers in six volumes which have been used as the inputs for preparing the country's Second Perspective Plan (2021-2041). The background papers of the Second Perspective Plan is the culmination of macroeconomic and sectoral issues of Bangladesh for future intervention that GED has pursued with various eminent economists, social scientists, researchers, and academicians at the national level.

My thanks are done to the Member (Senior Secretary) and the officials in the General Economics Division (GED) for their perseverance in shaping this document. I believe background papers will be helpful for policy-planners, development practitioners, researchers, academicians and students as well. I believe that officials working in government ministries and agencies will be immensely benefited from these background papers for upgrading and updating their knowledge and professional competences. Finally, I appriciate GED leadership for undertaking this endeavour for printing background papers of the Second Perspective Plan in book volumes for much wider use. I earnestly wish their success.

(M. A. Mannan, MP)

Dr. Shamsul Alam
Member (Senior Secretary)
General Economics Division (GED)
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Foreword

Following the 2009 National Election that reinstated democracy in Bangladesh, two major changes ensued in the planning landscape of the country. First, Bangladesh returned to its five-year planning system discontinuing the PRSPs. The country, then, decided to synergize its short- and medium-term planning intervention introducing a long-term perspective plan. The efforts culminated into the preparation of first ever Perspective Plan of Bangladesh (2010-2021). The Plan, in fact, was an elaboration of the Vision 2021 announced by the Hon'ble Prime Minister Sheikh Hasina. It provided a roadmap for accelerated growth and laid down broad approaches for the eradication of poverty, inequality, and human deprivation. Most importantly, it provided the broader context in which the Sixth and the Seventh Five Year Plan would be implemented.

Embracing the Perspective Plan's creed, the 6th Five Year Plan (2011-2015) has completed its tenure and the 7th Five Year Plan (2016-2020) has crossed the halfway of its intended period of implementation approaching the end. The preparatory activities of the 8th Five Year Plan are expected to begin in 2019. However, like the two preceding plans, it needs a longer-term perspective plan to set the context and create the policy pathway. Moreover, in the meantime, Bangladesh has gone through some major socioeconomic transformation—it crossed the lower-middle income threshold of World Bank country classification in 2015 and qualified for the first time to graduate into a developing country in 2018. Based on her presentiment that such changes are imminent, the Hon'ble Prime Minister directed GED to initiate Second Perspective Plan (2021-2041) formulation process in the National Economic Council (NEC) meeting held on 20 October 2015.

And following that instruction the process of preparing the Second Perspective Plan has been initiated by General Economics Division at the end of 2016. The process formally started with preparation of a 'Concept Paper'. In addition, Planning Commission constituted a high level "Panel of Experts" for guiding the process of formulating the Plan within a participatory framework. For developing the Plan strategies and indicating the desirable development path that would lead to fulfilling its objectives, sixteen different

background studies covering different socio-economic sectors and sub-sectors, and a technical framework for macroeconomic projection for 2021-2041 were prepared. These background papers were undertaken for generating quantitative/qualitative benchmark values and targets for relevant indicators of the Plan and fill in critical knowledge gaps. Renowned economists, academicians, researchers and development practitioners in the relevant fields with a long-standing flair were assigned to conduct the studies within the stipulated timeframe. Later, the final drafts of the background papers were reviewed by relevant experts in the government as well as from professional and academic community. Based on such elaborate feedback, the drafts were modified and finalised by the author(s) under the overall supervision and guidance of General Economics Division (GED).

These background studies provided valuable information/inputs which significantly contributed towards drafting the Second Perspective Plan. These studies are rich in contents and, if made available, will enrich the knowledge base relating to development challenges and development options facing Bangladesh. In view of the importance of these studies, it has been decided that GED will publish these studies for making these available to interested readers, researchers and academia.

The background papers have been published in six separate volumes. It is expected that these volumes will help the readers to understand the rational for the choice of the specific domain underlying the Plan and the design of the policy package adapted for the Plan for reconciling the goals of efficiency with those of equity. The studies attempted to spell out a reform strategy and agenda for agriculture, food security, industrialisation, poverty reduction, social inclusion, transportation, quality infrastructure, sustainable management of natural resources, and other development issues like governance, gender, urban development, service sector development, health and population management, human development, ICT and information highway, employment and labour market in the light of current conditions as well as past experience trends.

Now, I would like to take the opportunity to convey my gratitude to the people behind this splendid task. First and foremost, I will recall the diligent contribution from the relevant officials of GED for their untiring support and cooperation in managing all the studies. Finally, the publication will be a success only when it served the purpose of the readers that intended to.

I believe, this book of background papers prepared to help formulate the Second Perspective Plan of Bangladesh would be considered as one of the valuable knowledge products of GED.

(Professor Shamsul Alam, M.A. Econs., PhD)

Acknowledgements

As the General Economics Division (GED) is going to publish the background studies as a collection of 16 papers in 6 volumes, it likes to exert its gratitude to all the actors involved.

First and foremost, GED likes to express its humble gratefulness to the Hon'ble Prime Minister Sheikh Hasina for her visionary leadership. Perceiving in advance the changing socioeconomic landscape of the country, she first felt the need of a second perspective plan to be formulated. In the National Economic Council (NEC) meeting of the 20th October 2015, she provided a clear guidance in this regard. Hence began the ensuing activities.

GED acknowledges the guidance and timely direction provided by the Hon'ble Minister for Planning Mr. Abdul Mannan, MP, gave valuable time and precious guidance. GED is indebted to him.

GED, gratefully recalls the valuable contribution of the Panel of Experts headed by Dr. Wahiduddin Mahmud for his suggestions and advices all through. The reviewers' (members of technical committee) contribution to the background papers are also acknowledged herewith.

GED is indebted to the outstanding leadership of Dr. Shamsul Alam for this endeavor. In his eleven years tenure, he has raised GED, the policy-planning hub of the country, into the highest level of excellence. He is the person who reviewed and edited the background papers and transformed them into one interlinked document that ultimately culminated into the Second Perspective Plan (2021-2041).

Md. Mafidul Islam, not only as the Chief, GED also as the Project Director of Mid-Term Review of the Perspective Plan and Formulation of Bangladesh Vision 2041 coordinated all the administrative and financial procedures. Mr. Md. Forhad Siddique, Deputy Chief and Deputy Project Director seconded his with his ubiquitous involvement in all the activities. Ms. Josefa Yesmin, Assistant Chief, as the Assistant Project Director exerted her best to make the initiative a success story. Preparing the project proposal, concept paper and other relevant documents as well as providing data support, Mr. Sheikh Moinul Islam Moin, Senior Assistant Chief, played his role in the process. Ms. Shifat Anwar Tumpa, Assistant Chief also provided constant support in the process of preparation of these background papers.

Last but not the least, many officials from the General Economics Division (GED), Bangladesh Planning Commission, Ministry of Planning and other Ministries of the government graced with their presence to project-related meetings and discussions.

We gratefully acknowledge the efforts by all concerned in the Bangladesh Planning Commission.

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Part-1

Addressing Climate Change, Green Growth, Environment, and Water Resources for Sustaining Shared Prosperity

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Addressing Climate Change, Green Growth, Environment, and Water Resources for Sustaining Shared Prosperity

1. Introduction

1.1 Background

The economic cost of climate change is most acutely felt in developing countries like Bangladesh, one of the world's densest nations and also one of the most vulnerable to climate change. Bangladesh has achieved recent gains in the area of economic growth (growing consistently by 6% since 1996) that could be halted due to climate change. However, a 2010 World Bank study in partnership with the Government of Bangladesh (GoB) finds that climate related disasters continue to result in large economic losses — reducing economic growth and slowing progress in reducing poverty. The report highlights that over the past decade, approximately 0.5 – 1% of GDP has been lost to damages in infrastructure, livelihoods, and from forgone production.

Rising sea-levels, floods and extreme storms, which are increasing in frequency in Bangladesh, often result in the destruction of essential infrastructure and housing. The cost of recovery and rebuilding is likely to intensify in the future with the increased frequency and ferocity of climatic events, further exacerbated by high population density and an underdeveloped infrastructure. With an increased threat of climatic events, the GoB will need to redirect resources away from development projects into mitigation and adaptive measures, for example, by building early warning systems and adding emergency responders to cope with extreme events.

Disruptions in daily life related to climate change can mean lost work and school days and harm trade, transportation, agriculture, fisheries, energy production, and tourism. Severe rainfall events can delay planting and harvesting, cause power outages, snarl traffic, delay air travel, and otherwise make it difficult for people to go about their daily lives. These sectors are particularly vulnerable to climate change and any disruptions will have a direct impact on the national GDP and trade balance.

Climate-related health risks also reduce productivity, such as when extreme heat curtails construction, or when flooding prevents employees from getting to work. Higher temperatures might cause propagation of new pests and disease vectors, while common diseases such as dengue, malaria, and water borne diseases (such as cholera) will take a significant toll on human health conditions.

In 2015, the Government of Bangladesh estimated that five major disasters since 1998 have caused damage equal to roughly 15 percent of GDP with an average of 2.7 percent per event (Planning Commission 2015). In an interview with The Guardian, Prime Minister Sheikh Hasina of Bangladesh, highlighted how a 1°C rise in temperature resulted in 10 percent productivity loss in farming, amounting to US$2.5 billion or 2 percent of the national GDP (Harvey 2012). If the damages to property and other associated losses are factored in, it equates to about 3 to 4 percent of GDP, thereby hampering economic growth.

In additional to economic damages, climate change has the potential to create significant social impact, with direct and immediate effects from damaged infrastructure and loss of livelihoods, to far reaching effects such as poverty, migration, and health impacts.

Climate induced damages and losses in Bangladesh generally tend to be concentrated in rural and coastal areas that also have higher concentrations of poor populations, affecting them disproportionately. A 2010 World Bank study explains, "they live in thatch or tin houses that are more susceptible to direct damages from cyclones, storm surges, and floods."

For the thirty-year period between 1980 and 2010, approximately 191,836 people were killed and it is estimated that over 323 million people were affected by disaster the majority below the poverty line (Majumder 2013). Furthermore, the livelihoods of most rural and underprivileged households depend largely on agriculture, which is vulnerable to climate change and extreme weather events. The loss of their assets and livelihoods leaves the poor with a limited capacity to recover.

Climate change will also lead to "climate refugees"—people who are forced to leave their homes because of climate change-related factors. In Bangladesh, this is likely to translate to a mass migration into urban centers and major urban corridors, leading to a hasty urbanization process, and further complicating living conditions including sanitation, housing, and health (Planning Commission 2015). Rapid, unplanned urban migration can also exacerbate urban unemployment and drive up prices of commodities in specific areas.

1.2 Geographic Vulnerability

Bangladesh is one of the most disaster-prone countries in the world, experiencing floods, tropical cyclones, storm surges, and droughts. It has most recently been rated 6th most vulnerable on the Climate Risk Index. Losses due to disaster continues to increase due to increased intensity, economic growth, increases in assets, population growth, and urbanization.

Bangladesh's hydro-geological features significantly contribute to its high vulnerability to disasters and climate change. Approximately 88 percent of the country's landmass consists of a floodplain, located in the world's largest delta. Additionally, because of the position of the Ganges-Brahmaputra-Meghna (GBM) river basin, this region must drain over 92 percent of the monsoon rainfall runoff generated in the combined catchment, within a period of only 4 and a half months (June to mid-October) (Planning Commission 2012). During the peak of the monsoon, neap tides are high enough to penetrate coastal plains, even those that are protected by embankments, leaving entire areas inundated with saline water (Ahmed 2006). Finally, owing to an inverted funnel-shaped shoreline, and in the path of storms and surges from the Indian Ocean, the country is highly vulnerable to cyclonic disasters (Ali 1999).

Bangladesh is flat and low-lying, with most of the country less than 10 meters about sea level, apart from hilly regions in the north- and south-east corners (MoEF, 2012). The coastal belt is even more low-lying, with most of the coast only 2 meters, and some areas at one 1 meter above sea level. The low-lying topography of the coastal zone and its dynamic morphology contribute to its vulnerability to sea level rise. Finally, following the monsoon season, a lack of rainfall and evaporation also leads to aridity (Ahmed 2006).

2. The past and present

2.1 Climate Change

2.1.1 Vulnerability to Climate Change

As one of the world's most vulnerable nations, Bangladesh is already experiencing the impacts of a changing climate with the countries' most disadvantaged population bearing the burden of adapting to initial shifts in the weather. Many of the impacts of climate change in Bangladesh will look similar to the seasonal challenges it has dealt with for years: flooding, cyclones, erosion, and saltwater contaminating land. However, change in the climate will make these challenges more frequent, more intense and less predictable than they have been in the past. For this reason, it is crucial that national leaders become aware of its effects and work to maximize the country's resilience.

Scientific projections of climate change indicate that the Earth's average temperature may increase within a 3 to 6°C range by 2100. In addition to raising global average temperatures, surface warming also contributes to a rise in sea surface temperatures. This leads to the oceanic expansion of water volume, as well as the melting of permafrost in Arctic and Antarctic regions, contributing to a net rise in sea level around the world. The Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report confirms that sea level rise is actually occurring much faster than was previously projected, and these changes challenge economic progress and human resilience, especially in coastal areas.

Higher temperatures and vaporization in ocean waters will increase total rainfall across the globe. Rainfall patterns will also be destabilized due to an imbalance in seasonal temperatures, adversely affecting systems of food production and straining the capacity of smallholder farmers. Increases in surface temperature and a shrinking drinking water supply will also adversely impact the health of humans and livestock.

Bangladesh has been repeatedly listed as the country that is most vulnerable to climate change, due to is location in the tropics, dominance of floodplains, low elevation, high population density, and low economic and technological capacity. The IPCC's Fifth Assessment Report projected the following climate change impacts for Bangladesh:

i. Temperature rise will be slightly lower than the global average and sea level rise will be close to the global average, with population at risk of sea level rise predicted to grow to 27 million by 2050.

ii. Though frequency of tropical cyclones may remain unchanged, they will likely become more intense, and will be combined with higher storm surges and sea level extremes.

iii. Precipitation on average will increase, monsoon season could become longer, and rivers will likely experience increased flow from added rain and melting glaciers in the Himalayas.

iv. More flooding is expected, with protective coastal mangroves facing greater risk from sea level rise and increased salinity of storms.

Almost every part of Bangladesh is already suffering changes in micro-climates, with local communities dealing with the effects of erratic rainfall and temperature fluctuations. These are leading to damages to agricultural productivity as well as constraints on the availability of fresh water.

Bangladesh has already been experiencing increasing temperature trends, with average temperatures increasing by 0.64oC during the period of 1948-2011. In addition, winter, pre-monsoon, monsoon, and post-monsoon precipitation has shown to have increased significantly at a rate of about 4.0mm per year, a total of 8.6 percent during this period. There is also evidence that sea surface temperature is increasing at a rate of 0.094°C per decade, which may enhance tropical cyclogenesis in the Bay of Bengal during the months of October and November (Quadir and Iqbal 2008). Models of climate change suggest higher than average monsoon rainfall in the future, with modelling data for three timelines outlined in Table 1 (Agrawala et al. 2003). While winter months will become warmer and drier, monsoon months will become warmer and wetter.

Table 1: Temperature and precipitation scenarios (Source: Ahmed et al. 2015)

Timeline	Mean Temperature Change (°C)			Mean Precipitation Change (%)			Sea Level Rise (cm)
	Annual	DJF	JJA	Annual	DJF	JJA	
2030	1.0	1.1	0.8	5	-2	6	14
2050	1.4	1.6	1.1	6	-5	8	32
2100	2.4	2.7	1.9	10	-10	12	88

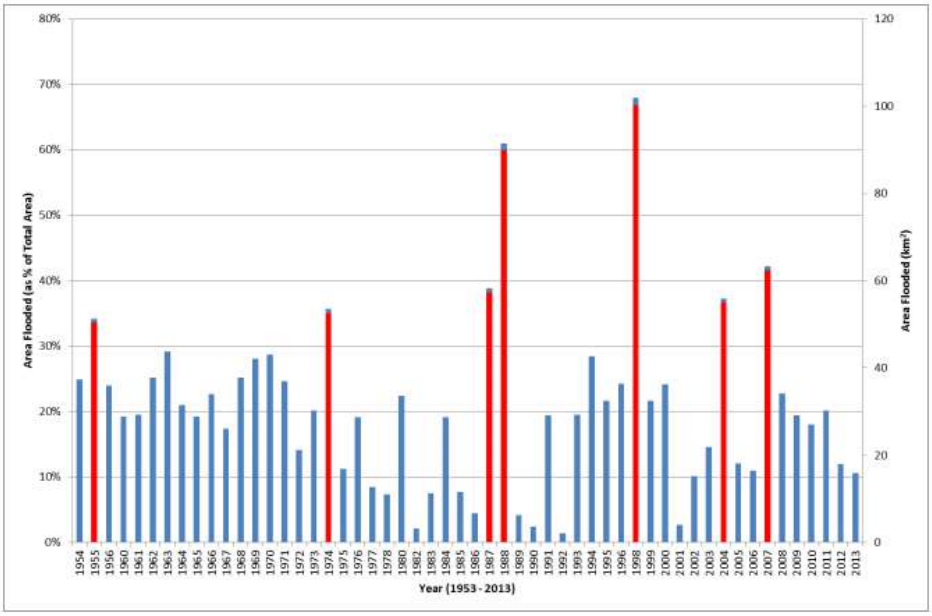
Note: DJF indicates dry season, comprised of December, January and February, while JJA indicates peak monsoon, comprised of June, July and August months **(Agrawala et al. 2003; MOEF-UNDP 2005)**.

Increases in pre-monsoon precipitation may indicate early onset of monsoon activity. This has already made the country more vulnerable to flooding during the month of May. Furthermore, increases in monsoon precipitation during the past 50 years have also increased the country's vulnerability to severe floods (Jain et al. 2012). The unprecedented floods of 1974, 1987, 1988, and 1998, and severe floods of 2004 and 2007 are examples of increased severity of flooding due to greater precipitation over Bangladesh and in the upper catchments.

Bangladesh is already considered a global hotspot for natural disasters (World Bank 2005; World Risk Report 2016), and has been ranked fifth globally in terms of disaster risk. This includes risks from floods, cyclones, sea level rise, salinity intrusion, drought, and landslides.

Floods are nearly annual extreme events in Bangladesh and can be devastating to the socio-economic condition of the country. On average, about a quarter of Bangladesh is inundated with floods annually, and once every 4 to 5 years, severe floods inundate about 60 percent of the country. While most of the country is susceptible to river and rainwater flooding, low-lying coastal areas are also vulnerable to tidal flooding. Figure 1 illustrates extreme flooding events between 1954 and 2013. Additionally, sharp rainfall episodes greatly aggravate urban drainage congestion that, combined with the filling of urban wetlands and ponds, will significantly accentuate water logging and urban flooding.

Figure 1: Inundation area (in percentage) by major historical floods since 1950s



(Source: Flood Forecasting and Warning Centre, BWDB)

Riverbank erosion, a secondary consequence of floods, is also endemic to Bangladesh, with about 1200km of riverbanks currently experiencing erosion. Greater rainfall can cause increased runoff through floodplains, increasing the potential for riverbank erosion. High wave activity will also erode land along the sea coast.

Flood modelling has demonstrated that the total flood-affected area will increase between 2020 and 2050 (Hassan et al. 2010). The inundation area due to climate change will increase by 6 percent in the decade following 2030, and 14 percent in the decade following 2050, compared to a base year of 2005 (Hassan et al. 2010).

In addition to floods, coastal areas of Bangladesh are frequently hit by cyclones formed in the Bay of Bengal, with severe cyclones hitting the country every three years. The primary damage from cyclones is from storm surge flooding. If cyclones make landfall during high tide, surges are higher, penetrate deeper inland and are deadlier. Unnikrishnan et al. (2006) argue that there will be a significant increase in the frequency of high storm surges in the Bay of Bengal due to climate change, though it is possible that overall frequency of storm surges may not increase. Emanuel (2005) also projects increased intensity of tropical storms by 2100 for the North Indian Ocean. Combined with expected rises in sea-level, these higher intensity cyclones are predicted to cause increased tidal surge heights.

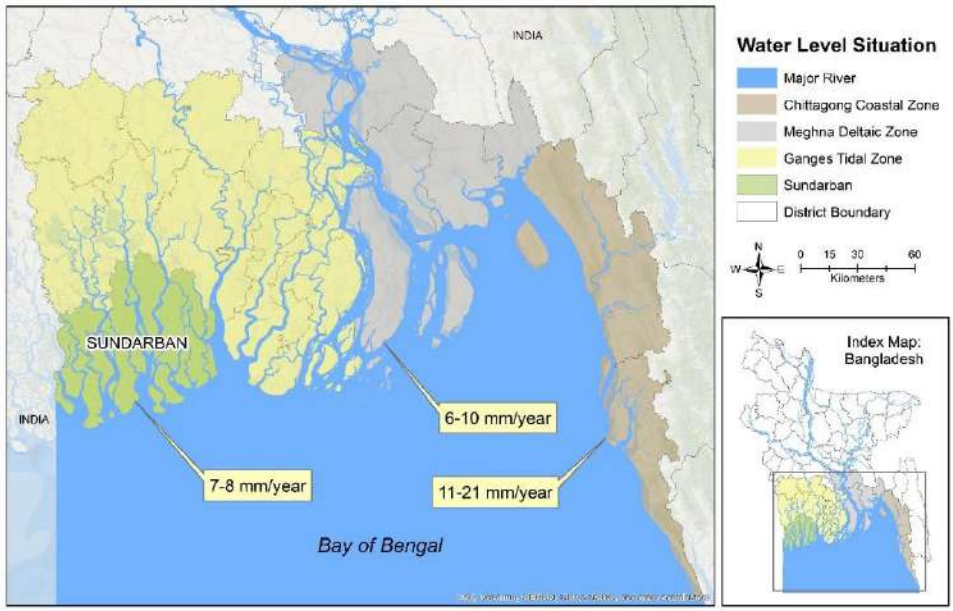
Dasgupta et al. (2014) modelled cyclone storm surge impacts under a changing climate scenario, in order to determine potential future inundation zones by 2050. Table 2 contains their results. Additionally, most recently, in June of 2017, landslides led to over 100 deaths in Rangamati and Bandarban, as well as the destruction of homes and property. As storms and monsoons become more intense and more frequent, these devastating landslides are also likely to increase in frequency.

Table 2: Vulnerable Area Estimates (sq. km)

Inundation Depth	2050 Without Climate Change (sq. km)	2050 with Climate Change (sq. km)	% Change
More than 1m	20,876	23,764	+ 14%
More than 3m	10,163	17,193	+ 69%

CCC (2016), in an effort to assess the historical change of sea level rise along Bangladesh's coast, assessed data from 15 monitoring stations and analyzed changes between 1980 and 2012. They found that sea level rise has increased in the coastal zone by 6 to 21mm per year. According to the Ministry of Environment and Forests, the country can expect to experience sea level rise of 14cm, 32cm, and 88cm by the years 2030, 2050, and 2100, respectively. Both historical increases in sea level and projected increases due to climate change are expected to have significant impacts, including increased salinization of freshwater sources.

Figure 2. Water level trends for the coastal sub zone of Bangladesh based on the data of the last 30 years (from CCC 2016)

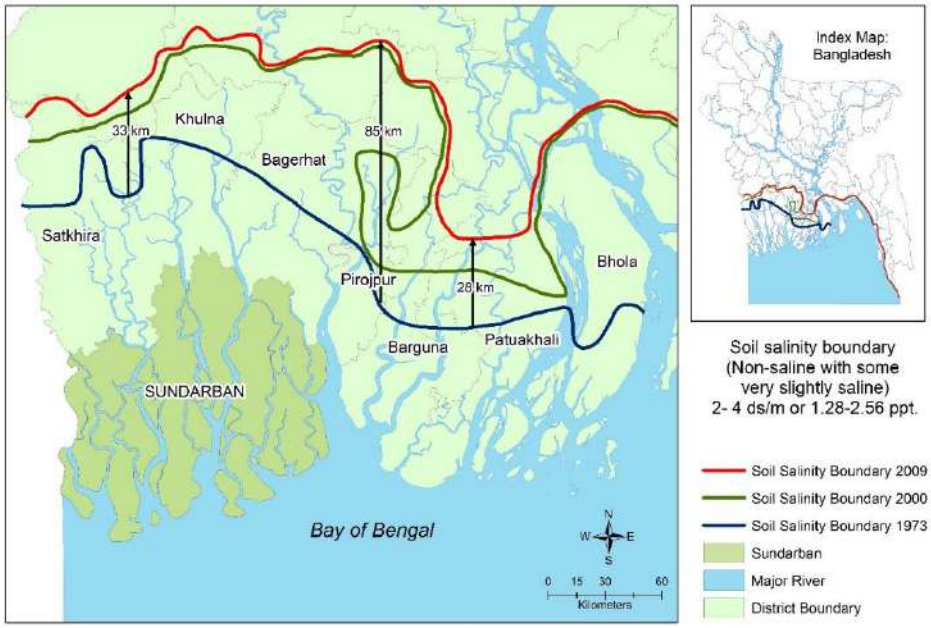


As sea levels rise, issues with salinity intrusion become an even greater problem in the coastal zone of Bangladesh. Multiple studies show evidence that the saline areas in coastal districts and soil salinity are already increasing and moving further inland, illustrated in Table 3 and Figure 3 (Miah et al. 2010; Dasgupta et al. 2015).

Table 3: Increase of soil salinity affected area over the years (1973-2009)

Year	Salinity class and area (000'ha)				
	Non-saline with some very slight saline (S1) **1.28-2.56 ppt**	Very slightly saline with some slight saline (S2) **2.62-5.12 ppt**	Moderate to some strongly saline (S3) **5.18-10.24 ppt**	Very Strongly saline with some strongly saline (S4) **>10.24 ppt**	Total Salt affected area
1973	246.67	397.83	71.75	34.7	750.95
2000	244.65	264.74	320.78	85.17	915.34
2009	269.32	241.4	339.9	100.16	950.78

Figure 3. Movement of the Salinity Front between 1973 and 2009; Salinity boundary was set at 2.0-4.0 dS/m (or 1.28-2.56 ppt)



Increases in surface and river water salinity have also been found in coastal rivers. Saline river water accumulates more than 150km inland in the west part of the country and 50km inland in the east part of the country during the dry season. Under a scenario of 30cm sea level rise, the surface water salinity pattern will change significantly. The dry season saline line is projected to move 30 to 70km north, affecting most of the Khulna, Barisal, Patuakhali, and Nohakali Districts.

Groundwater salinity from connate salts and tidal flooding is also a key challenge for the coastal region in terms of drinking water and irrigation. Nearly 6 million people are already exposed to high salinity, but because of climate change the number is expected to increase to 13.6 million by 2050 and 14.8 million by 2080. A study conducted in Khulna, Bagerhat, and Satkhira projects that a sea level rise of 32cm could reduce the suitable area for Aman rice cultivation to 60 percent, and to only 12 percent with a sea level rise of 88cm.

Along with the challenge of too much water, long-term data indicates that Bangladesh experiences a major drought once every 5 years on average, having suffered from 20 severe drought conditions over the past 50 years. By 2030, a temperature increase of 0.5°C and annual rainfall reduction of 5 percent could reduce runoff into the Ganges, Brahmaputra and Meghna Rivers by 14 percent, 11 percent, and 8 percent, respectively. With a 12 percent reduction in runoff, the population living in severe drought prone areas would increase from 4 percent to 9 percent under moderate climate change scenarios.

Finally, climate change poses a significant challenge to the health of the population of Bangladesh. Globally, the impact of climate change on health and wellbeing will be profound. According to the Lancet Commission, "climate change is the biggest global health threat of the 21st century" (Costello et al. 2009). The World Health Organization (WHO) estimates that the increasing trend in warming and precipitation due to climate change in the past 30 years has already claimed over 150,000 lives annually (McMichael et al 2003). Populations in low-income countries will bear a disproportionate burden of adverse health consequences

Climate change may cause health impacts through multiple pathways (Figure 4), and directly or indirectly (Figure 5). The direct effects of climate change include increased heat stress, floods, drought, and increased frequency of intense storms while population health may be indirectly threatened through changes in air pollution, spread of disease vectors, food and water insecurity, under-nutrition, displacement and mental ill-health. Such impacts will affect most populations, especially the poor and marginalized section of the society, disproportionately. Climate change also amplifies existing inequalities, reinforcing gender inequities between women and men in their vulnerability to and capacity to cope with the impacts of climate change (Mitchell et al 2007).

In Bangladesh weather and extreme weather were found to be associated with mortality (Alam et al. 2012). Public health consequences associated with cyclones include storm related mortality, injury, infectious diseases, psycho-social effects, displacement, damage to health care infrastructure, disruption of public health service, transformation of ecosystems, social dislocation, loss of jobs, livelihoods and economic crisis (Shultz et al. 2005). For temperature extremes, strong heat effects have been linked to different causes of death for different sub-populations and age groups (Burkart et al. 2014). It has also been found that those living in urban areas are more vulnerable than those living in rural areas (Burkart et al. 2011). Vector borne diseases such as malaria, dengue fever, Kala-azar are expected to become more widespread and possibly more severe among non-immune populations as temperatures rise (Hunter 2003; Hossain et al. 2011). Cholera risk may also be amplified by local flooding (Rodó et al. 2002). Finally, Recent studies suggested that drinking water salinity has been associated with pre-eclampsia and gestational hypertension during pregnancy, causing increased cardio-vascular diseases and strokes risk (Khan et al. 2011).

Figure 4: Climate change and health: pathway from driving forces through exposures to potential health impacts. Arrows under research needs represent input required by the health sector [Adapted from Macmicel et al. 2003]

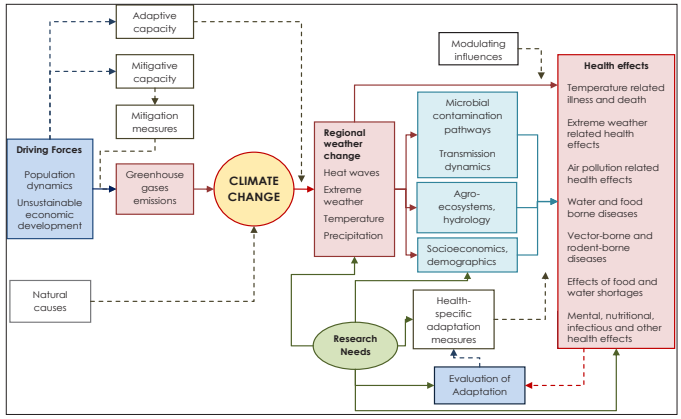
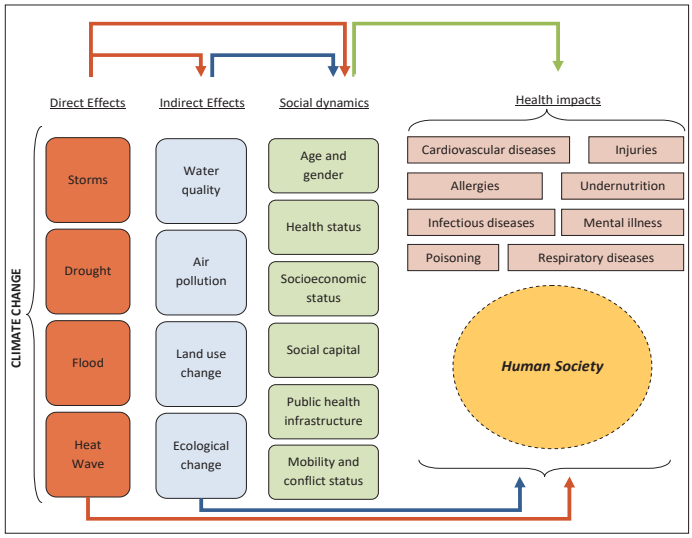


Figure 5: The direct and indirect effects of climate change on health and wellbeing (adapted from Watts, N., et al 2015)



2.1.2 National Policies on Climate Change

Bangladesh has been active in international efforts to address climate change and its impacts since the United Nations Framework Convention on Climate Change (UNFCCC) was signed in 1992 and ratified in 1994. The country also ratified the Kyoto Protocol in October 2001. The government of Bangladesh submitted its Initial National Communication (INC) to the UNFCCC in October of 2002 and its second national communication in October of 2012. It has additionally adopted the Hyogo Framework for Action on disaster resilience and committee to its five areas of priority action and guiding principles.

The government has been active in establishing various policy and institutional initiatives to integrate climate change into its national planning. In particular, the Ministry of Environment and Forests has been set up as the UNFCCC focal point, and has taken the lead in discussing, planning and developing policy programs on climate change. This includes the development of the National Adaptation Programme of Action (NAPA), the 2009 Bangladesh Climate Change Strategy Action Plan (BCCSAP), the establishment of the Climate Change Unit (CCU) to strengthen government coordination and management on adaptation and mitigation projects, as well as the creation of the Climate Change Trust Fund and Resilience Fund.

Table 4: National legislation and policy frameworks related to climate change

Policy documents	Description
7th Five Year Plan, 2016	Climate Change Management and Resilience (comprised of adaptation and mitigation)
National Women Development Policy, 2011	Takes measures to increase the overall safety and security of women and children, with special attention to disabled women, particularly in helping them deal with extreme climate events and disasters.
Disaster Management Act, 2012	Aims to make disaster management activities coordinated, object-oriented, and strong in formulating rules to build infrastructure for resilience.
Coastal Zone Policy, 2005	Acknowledges the importance of ecosystems and biodiversity conservation on the coasts and supports coastal people in developing sustainable livelihoods.
National Plan for Disaster Management, 2008-2015	Calls for comprehensively addressing DRR and CAA in all development plans, programs, and policies through assessing climate change risk, emphasizing community-based programs, building public awareness, improving early warning systems, and strengthening communication facilities and emergency response.
Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009	Recognizes the need for adaptation action and highlights the GoB's willingness to follow a low-carbon development pathway. Acts as the reference for mainstreaming climate change across sectors, via six thematic areas, 44 programs, and 145 actions.
National Adaptation Program of Action, 2005	Identifies 15 priority activities for adaptation action, including general awareness raising, capacity building, and project implementation in vulnerable regions, with a focus on agriculture and water resources.
Standing Order on Disasters, 2010	Works to make relevant persons understand and perform their duties and responsibilities regarding disaster management at all levels.
Climate Change and Gender Action Plan, 2013	Focuses on the transformative potential of gender-focused climate change interventions, potentially enhancing the effectiveness and efficiency of socioeconomic responses.

Several institutions have been established by the GoB to address climate change, particularly following the BCCSAP (Ahmed et al. 2015). The paragraphs below give a brief account of these institutions. The Ministry of Planning has also worked to integrate climate change into the national development processes in a coordinated manner. The General Economics Division (GED) formed an inter-ministerial body to review and recommend changes to the development project proposal process, in order to fill gaps that could better integrate climate change issues along with gender, environmental, and poverty issues.

The GoB is committed to promoting a whole of government approach to address climate risk. Climate change has been highlighted in its own chapter since the Sixth Five Year Plan. Furthermore, GED has developed the handbook "Mapping of Ministries by Targets in the Implementation of SDGs in aligning with the Seventh Five Year Plan (7FYP)," the document "Data Gap Analysis for Sustainable Development Goals (SDGs): Bangladesh Perspective," and the "SDGs Needs Assessment and Financing Strategy: Bangladesh Perspective. These and other documents work to ensure that targets will be achieved and that goals will be implemented.

Table 5: Institutions related to deal with the adverse impact of climate change

Institution	Description
Climate Change Trust	Assists the Ministry of Environment and Forests with implementation of the BCCSAP and provides secretariat support services for the BCCTF.
Bangladesh Climate Change Trust Fund (BCCTF)	A fund established by the GoB and managed by the Ministry of Environment and Forests for projects that fall under the main pillars of the BCCSAP. A Trustee Board works to examine project requests and make decisions on eligible projects.
Bangladesh Climate Change Resilience Fund (BCCRF)	A multi-donor grant fund set up jointly by the GoB and bilateral development partners that allows for donor-funded support for the implementation of the BCCSAP. The World Bank manages the fund and assesses projects, though 10 percent is controlled by Palli Karma Sansthan Foundation (PKSF) as an NGO-window for small-scale community-based projects.
Designated Authority	An individual nominated by the MoEF to work with the National Implementing Authority (NIE) to seek funds through the Adaptation Fund (AF). However, NIE accreditation has not yet been successful.
National Designated Authority	The Ministry of Finance has been identified as the National Designated Authority (NDA) for Bangladesh to deal with matters related to the Green Climate Fund (GCF), such as identifying fund-worthy projects and implementing them.

The GoB has also financed over 300 projects adaptation and mitigation projects, using about 60 percent of the BCCTF (MOEF 2014). Through World Bank Funding and the BCCTRF, GoB has also identified and implemented 7 projects totaling approximately US$190 million. Although the trust fund is being utilized in sync with the development priorities of the BCCSAP, there has been a strong and uneven preference for specific themes and practices. Generally, the projects are adaptation- rather than mitigation-focused, a few projects have actually been implemented (Ahmed et al. 2015). The funding has gone primarily to water infrastructure (20.21 percent); followed by food security, social protections, and health (8.05 percent); comprehensive disaster management (5.83 percent); research and knowledge management (3 percent); and capacity building and institutional strengthening (3 percent). Though the BCCSAP is meant to encourage the integration of climate actions across ministries, in reality it mainly funds the activities in a few ministries and departments. For example, the Bangladesh Water Development Board (BWDB) received the largest amount of funding from the BCCTF at 45 percent (Rai et al., 2014).

As of September 2013, donor agencies had contributed US$188.2 million to the BCCRF, which was disbursed to 13 projects. BCCRF supports a comprehensive program of work with a balanced combination of adaptation approaches, including infrastructure, research, and knowledge management. The Resilience Fund has scaled up construction of

multipurpose shelters and early warning systems, which have played a vital role in housing people during recent cyclones. Early warning systems have also been funded through public-private partnership models, bringing together the government and mobile providers to provide early warning information through text messages (ICAI 2011).

GoB has also worked to implement that top-most priority project outlined in Bangladesh's NAPA, to promote adaptation in the coastal zone with a strong community orientation. This project received the UNFCCC Best Practices Award on Adaptation (Ahmed et al. 2015). In a Climate Public Expenditure and Institutional Review, it was found that GoB typically spends about 6-7 percent of its combined development and non-development budget on climate sensitive activities. This amount was estimated at about US$1 billion per year (GED 2012). GoB has also considered a coastal green belt project, and has supported strip plantation along embankments and roads as part of its participatory afforestation program in the past (MOEF 2012). A new major afforestation programme all along the coastal areas of the country can also be considered.

Apart from the GoB, Bangladeshi communities must consider a variety of responses to resist climate hazards and disaster, and the majority of national efforts are comprised of autonomous efforts. Development partners also often come forward to implement resilience-building, disaster relief, and rehabilitation projects. On flood-management specifically, one-fifth of all support provided to stakeholders is contributed by development partners, with direct involvement from humanitarian NGOs. For example, the Cyclone Preparedness Program (CPP) would not have been implemented had it not been for the Bangladesh Red Crescent Society and its thousands of volunteers.

Non-government stakeholders have taken the lead in many initiatives, highlighted in brief below:

- Creating a knowledge base of vulnerability and adaptation assessments, especially in using disaster risk reduction (DRR) techniques to build community-based adaptation (CBA).
- GoB makes use of the recommendations in the Asia Least Cost Greenhouse Gas Abatement Strategy (ALGAS)
- Multiple donors - including UNDP, UKAid, AusAid, DFID, EU, Norwegian Embassy, and SIDA – have given support on the second phase of the Department of Disaster Management's Comprehensive Disaster Management Program (CDMP).
- The EU's DIPECHO program brought six INGOs together to work on DRR and humanitarian assistance under the NARRI Consortium.
- UNDP has developed a unique set of resources to assist high-risk countries like Bangladesh in gender-sensitive DRR and recovery planning, including awareness and advocacy.
- The Bangladesh Red Crescent Society, Oxfam GB, CARE Bangladesh, ActionAid, IUCN, and others have long worked on disasters in Bangladesh, including community disaster preparedness and community-based development initiatives.
- UN Women has taken climate change challenges as an opportunity to reduce women's particular vulnerability, and advocate for more gender-sensitive climate change policy.

Despite the many important initiatives to promote climate action that have already been undertaken in Bangladesh, there are still a plethora of challenges that inhibit the effective implementation of climate change-related policies and activities. Some of the key challenges are highlighted below. The problems especially lie within the GoB and are the reason that non-government agencies have been so crucial to the country's climate action so far. While these problems are not unique to the issue of climate change, it is important to understand how they impact the production and implementation of climate-related policies if Bangladesh wants to become self-reliant and truly resilient. They include issues with capacity, coordination, institutional and policy arrangements, a lack of an inclusive process, and corruption.

First, agencies in Bangladesh are fraught with capacity constraints, both in terms of technical knowledge and human resources. This is particularly true for lower tier institutions. Officials have a general lack of understanding about climate change and its effects. Both the MoEF and the DoE lack technical expertise, trained staff, baseline information, and strong information management systems (ADB 2004). Furthermore, abrupt changes in ministry personnel leads to a lack of institutional memory, and incurs additional costs for designing and implementing climate change policies (Alam 2007).

Climate change impacts cut across several sectors and therefore overlap with the responsibilities of a wide range of ministries. This leads us to the second issue that strong coordination is necessary among ministries, something which is currently lacking. At the community level, there is an absence of strong mechanisms and administrative infrastructure to facilitate interaction between the central government and local level stakeholders. Additionally, there are no specific strategies or rules that work as a coordination mechanism across the different local level government departments.

Third, though the BCCSAP outlines activities and priorities for climate action, it remains more of a "knowledge strategy" in that it does not contain details for implementation. Furthermore, the incorporation of climate change policies in institutional development planning processes is often inadequate and poorly defined. The current institutional arrangement generally does not sufficiently provide an enabling and encouraging environment for actors and agencies to work in a concerted was to tackle climate change.

Fourth, the policy- and strategy-making process in Bangladesh is overwhelmingly top-down, driven by experts and bureaucrats and excluding the poor and vulnerable. The same is true for the preparation of specific projects, where public participation is very limited, leading to poor outcomes. A lack of gender sensitivity further exacerbates exclusivity, not only in an absence of women involved in planning, but also in a lack of attention to gender issues in policy documents (Huq et al. 2015).

Finally, fifth, there are shortcomings in the oversight and control of corruption within institutions, often allowing it to go unchecked. There is no ombudsman system in Bangladesh, and there are concerns regarding the capacity and independence of the Anti-Corruption Commission to handle cases of corruption and fraud in the delivery of climate finance from both international and national sources (TIB 2013). The national climate funds have both been criticized for allocating resources based on nepotism and partisan politics rather than on vulnerability, thus preventing funds from reaching those most in need of support.

2.2 State of Environment and Pollution

In addition to the challenges posed by climate change, there are also numerous environmental challenges that the country is facing that must be addressed. These include the impacts of a growing population, land use and degradation, industrialization and urbanization, unsustainable agricultural practices, forest degradation, and biodiversity loss.

The population in Bangladesh currently stands at around 152.52 million people (BBS 2012), and is expected to grow to 200 million people by 2050 (UNDESA 2010). Moreover, icddr,b (2010) has shown that, relative to 1900, there may be a 10-fold growth in population by 2100. Such a growing population leads to high population density and pressure, a major driving force for environmental change. Urbanization and industrialization that accompanies this population growth also causes serious strain on environmental quality and natural resources, including air, water, and soil pollution. This threatens ecosystems and public health as well as economic growth, therefore addressing pollution is increasingly a priority in the country's development goals.

Changes in land use patterns and land degradation are also problems for Bangladesh. Bangladesh's total land surface is about 14.85 million hectares, of which about 9.23 million are used for agriculture (BBS 2010). The net cultivable area was calculated to be about 62 percent as of 2009-10, a decrease of about 3 percent from 1980-81 measurements. As the population grows, the per capita share of land shrinks, making the resource base for agriculture, forests, and wetlands more vulnerable, as demands for food water and shelter challenge the country's resource capacity. Land degradation is occurring through loss of soil fertility, loss of organic matter in the soil, erosion sue to surface runoff, soil acidification, river bank erosion, soil salinization, and ground water table depletion. Furthermore, every year over 80,000 hectares of agricultural land is being converted to non-agricultural uses (Planning Commission 2009).

There are also large numbers of people migrating from rural to urban areas due to environmental stresses, consequently increasing pressure on land, housing, education, sanitation, and infrastructure. This trend demands planned growth in the nation's cities, especially with regard to environmental considerations. Running parallel to this change, increases in industrialization to support growing populations and facilitate Bangladesh's participation in global markets produce huge quantities of wastes, which are discharged or poorly disposed of. This also leads to soil degradation.

Brick kilns in particular are degrading land quality. Khan et al., (2007) reported that vast areas of agricultural lands have been degraded because of the construction and operation of brick kilns, which cover about 6,500 hectares of land nationally. As topsoil is removed for clay in the making of bricks, almost three-quarters of the soil fertility is reduced. Furthermore, the firing of the soil in the process of brick-making also emits pollutants that are harmful to the atmosphere and contribute to climate change.

Agricultural practices are another important environmental consideration for the country. Bangladesh has the highest percentage of land dedicated to agriculture (70 percent) and the highest degree of intensification of agriculture (Alauddin and Quiggin 2007). The intensification of land use for food production, including the use of chemical fertilizers and

high yield crop varieties, have contributed to the degradation of much of the arable land in Bangladesh (Ali 2004). Groundwater use has also increased to meet the demand from the rapid expansion of irrigated agriculture.

In the Chittagong Hill Tracts, deforestation has led to soil erosion and landslides, causing sedimentation in the drainage channels. Additionally, cultivation (Jhum cultivation) has intensified to maximize harvest, which also degrades land productivity. Similar instances of land erosion are also occurring in the northern piedmont areas, and at the foothills of the Sylhet and Comilla districts. Increased loss of topsoil in these hilly regions causes the slopes to lose their integrity, increasing the frequency of landslides and lives lost because of them.

Finally, Bangladesh faces significant threats of forest degradation and biodiversity loss. Bangladesh supports a rich diversity of plants and animals, with approximately 5,000 species of flora and 1,600 species of fauna in its small geographic boundary. The diverse array of ecosystems and biodiversity in the country plays a significant role in its socio-economic development in the fishing, forestry, agricultural, and tourism industries. The most significant causes of biodiversity loss in Bangladesh are habitat destruction and the overexploitation of biological resources. Climate change exacerbates the effects of population pressure, poverty, land-use change, intensification of agriculture, pollution, and the introduction of invasive species.

Worsening salinization due to political as well as climatic factors along the coast is having a negative impact on the Sundarbans mangrove forest. The Farakka barrage, built by India in 1975 along the Ganges River has caused a decrease in water discharge. As a result, salinity levels in the south-eastern part of the Sundarbans has increased and the natural re-vegetation of the Sundari tree, the main species in the forest, is decreasing (Islam and Gnauck 2008; Islam and Gnauck 2009).

2.2.1 Environmental pollution

Ultimately, the state of environment of the country is under pressure of unsustainable development, anthropogenic activities, and the changing climate. Severe air, water, soil and noise pollutions are threatening human health, ecosystems and economic growth. Air pollution is exacerbated by population growth, burning fossil fuels, industrialization, and motorization. The surface water in Bangladesh is polluted due to industrial discharge. The groundwater in different parts of the country has been contaminated by arsenic. Soil quality is highly degraded by uncontrolled use of chemical fertilizer and polythene. Finally, residents of major cities of Bangladesh are also exposed to high level of noise pollution.

Environmental pollution especially water, air, and soil pollution are increasingly getting priority in the country's development strategies and plans. Environmental degradation is affecting the country's economic growth. A lack of proper implementation and monitoring of environmental rules, however, hinder the achievement of environmental goals.

The Ministry of Environment and Forests has initiated a project called "Clean Air and Sustainable Environment" with the aim of improving the country's air quality. Under this project, the DoE has established 11 Continuous Air Monitoring Stations (CAMS)

in 8 major cities: Dhaka, Chittagong, Gazipur, Narayanganj, Sylhet, Barisal, Khulna, and Rajshahi. The findings thus far from these monitoring stations is highly alarming, especially during the dry months, with particulate matter and sulfur dioxide concentrations frequently exceeding standard limits.

Bangladesh has also developed an Air Quality Index (AQI), which compares ambient air quality relative to national air quality standards. The AQI is worst in February and March and improves from May to August. The sources of air pollution in Bangladesh can be divided into three major categories: point, non-point, and transboundary sources. Point sources include brick kilns, textile industries, power plants, and fertilizers. Non-point sources of pollution are primarily emissions from vehicles. In addition, transboundary pollution comes from across national borders, and is impacted by wind direction and seasonal variation.

Water pollution, then, comes primarily from industrial discharges, municipal waste, agrochemicals, salinity intrusion, and arsenic contamination. Pollution not only compromises water quality, but also impacts health through the bioaccumulation of toxic substances. In addition to pollution, groundwater is also over-exploited, making it increasingly more difficult to ensure that the population has access to an adequate water supply. This is especially pertinent since approximately 87 percent of Bangladeshis depend on groundwater, and about 79 percent of irrigation for agriculture comes from groundwater (BBS 2010).

Effluents and wastes from different industries accumulate in water sources from both their direct disposal on the surface and from seepage through soil layers into groundwater. Saha and Ali (2001) examined the contamination of groundwater in Dhaka city from tanneries. They found high concentrations of sulfide, lead, manganese, and chromium in ground water samples, which matches the pollutants that are released by the tannery industry. These types of industrial waste disposal threaten both human and environmental health.

Additionally, excess use of fertilizer and pesticides causes runoff, which pollutes water bodies and rivers. Rivers are also polluted from sewage in cities, which often goes untreated. The sewage discharge from cities creates pollution problems in stagnant water bodies in rural areas. Furthermore, ships cause river pollution as sea traffic and accidents increase, damaging ecosystems.

Municipal solid waste also poses a serious environmental challenge for urban areas in Bangladesh Poor solid waste management leads to failures in drainage systems, water clogging, deterioration of soil quality, soil pollution, air pollution, foul odor, surface and groundwater pollution, and the spread of infectious and vector borne diseases in landfill areas (Chowdhury et al. 2013). Only between 44 and 76 percent of the total municipal solid waste is collected, leaving huge amounts uncollected and untreated. This creates a public nuisance as well as a health hazard (Waste Concern 2005). As population and waste generation increase rapidly, the consequences of poor waste management are only likely to grow in the future.

Noise pollution is another, less recognized type of pollution in urban areas that is emerging as a serious environmental challenge in Bangladesh. Lack of enforcement of noise-related

rules and regulations has led to noise levels exceeding the acceptable limit of 50 decibels in major divisional cities. Sources of this pollution include road, rail, and air traffic, as well as industry, construction, and hydraulic horns. GoB has thus far remained apathetic to the noise pollution problem despite the fact that it can lead to several health hazards and mental conditions.

There are enormous health consequences from the pollution sources outlined thus far Bangladesh has ranked fourth among 91 countries with the worst urban air quality, according to the latest air pollution monitoring report of the World Health Organization (WHO). Air pollution is detrimental to public health and can lead to premature death. Air pollution causes respiratory problems, asthma, bronchitis, headaches, dizziness, nasal congestion, and renal damage. Around 7 million people in the country suffer from asthma, about half of which are children. It is estimated that a 20 to 80 percent decrease in air pollution in Bangladesh could save between 1,200 and 3,500 lives annually.

Additionally, water contamination causes major water-borne diseases such as diarrhea, cholera, jaundice, and typhoid. These problems become even more prevalent during floods. Arsenic contamination in drinking water has also been shown to lead to melanosis, leucomelanosis, keratosis, dorsum, and gangrene, have been identified in 37 districts in Bangladesh. Those exposed to arsenic over a long period also have shown increased risk of skin, lung, liver, kidney, bladder, and prostate cancer.

Finally, poor waste management then leads to various communicable diseases. It has been estimated that 20 percent of biomedical waste, for example, is highly infectious and often ends up in sewage systems or drains (Bhuiya, 2007). Reports have suggested that most cases of child mortality can be linked to this poor sanitation problem. Mosquitos and bad odor can also lead to health consequences and are among the negative impacts of poor waste management (Memon 2002).

2.2.2 National Policies on environment

Bangladesh is on track to become a middle-income country by 2021. However, investments in the Environment, Forestry, and Climate Change (EFCC) sectors have suffered from a lack of coherence and have delivered uncertain results.

Table 6: Policy documents in environmental sector

Policy documents	Description
7th Five Pear Plan, 2016	Sets goals for wetland and coastal restoration projects, pollution reduction, and promoting zero discharge effluent practices, but has weak monitoring and evaluation mechanisms and underdeveloped sustainability approaches.
BCCSAP, 2009	In addition to addressing climate change, the BCCSAP promotes energy sector development, expanding the forestry program, coastal program, and clean energy program.
Country Development Analysis Environment; ADB	Reviews the environment sector, focusing on development, pollution, wetlands, forestry, biodiversity loss, and energy.

Policy documents	Description
Perspective plan of Bangladesh (2010-2021)	Envisions Bangladesh's development future while concentrating on forestry and forest coverage as well as energy efficiency and renewable energy.
The Bangladesh Environment Conservation Act, 1995/2010	Discusses Bangladesh's conservation rules and policies through DoE, samples collection, environmental impact assessments, and the declaration of ecologically critical areas.
National Report onSustainable Development, 2012	Describes achievements on various dimensions of sustainable development in Bangladesh since the 1992 Rio Earth Summit and outlines future directions and challenges.
National Environment Management Action Plan (NEMAP), 1995	Aims to provoke the development of policies for the future of environment and forestry development.
National Biodiversity Strategy & Action Plan (NBSAP), 2004	A national framework for conserving biodiversity outlining its benefits. Aims to conserve biodiversity for future generations, maintain environmental stability for ecosystems, ensure the protection of biological heritage, and prevent species invasion.
Coastal Zone Policy 2005/ Integrated Coastal Zone Management Plan, 2005	Focuses on the management of coastal resources to ensure sustainability, defining appropriate policies.
National Land Use Policy, 2001	Reduces illegal land use conversion to ensure that land use activities are in line with environmental conservation.

2.3 State of Water Resources

Bangladesh faces immense challenges related to water. Located in the Ganges-Brahmaputra-Meghna (GBM) river system, the availability of water is mostly seasonal and dependent on upper riparian countries. A burgeoning population, increasingly intensive modern agricultural practices, and industrial activity in the GBM catchment all threaten the country's water resources. Additionally, repetitive flood and water scarcity is the most critical issue for water resources in Bangladesh.

The water resources available to Bangladesh consist of surface water resources (from rainfall and runoff), trans-boundary inflows, and groundwater. The surface water resources include main and regional rivers and a vast network of wetlands. These sources are at serious environmental risk due to pollution, encroachment, and disconnections between wetlands and the river system. Groundwater is critical for agricultural irrigation, but is threatened by pollution and depletion from overuse.

Bangladesh, through a complex system of rivers, drains an area of approximately 1.76 million square kilometers in the GBM catchment, only about 7.5 percent of which lies in Bangladesh (Islam and Albrecht 2011). There are 405 rivers crisscrossing the country, of which 57 are transboundary. Because Bangladesh is located at the downstream part of the basin, the activities upstream also have a large impact on the nation's environment. Due the dam and barrage construction in the upper reaches of the Ganges, sediment-influx into Bangladesh has decreased, resulting in higher coastal erosion, lower sedimentation, intensification of tidal range, and lower land formation (Khalequzzaman, 2013).

2.3.1 Water quality and pollution

Surface water quality issues in Bangladesh can be divided into two broad categories: salinity and pollution. Surface water salinity depends on the volume of freshwater discharges from upstream river systems, the salinity in the Bay of Bengal, and the circulation pattern of coastal waters induced by ocean currents. A reduction in freshwater inflows from the Ganges River, siltation of the tributaries of the Ganges, and siltation of other rivers following the construction of the coastal polder system has resulted in a significant increase in river salinity during the dry season (World Bank, 2014). Pollution of surface water can be broken down into three major categories: domestic/municipal, agricultural, and industrial. Sources of pollution include industrial effluent discharge, thermal pollution from power plants, fecal contamination, residual pesticides, oil products, and hospital waste.

About 11 percent of the rivers in Bangladesh are polluted by industry wastes, and 32 rivers are considered to have severe pollution from industry (BDP baseline study, 2016). Industries are primarily concentrated along the banks of rivers, especially in and around the Dhaka watershed. Agricultural contamination, though relatively less polluting, also affects the water quality of ponds and beels across the country. About 1.6 million tons of chemical fertilizer and 4 to 5 thousand tons of pesticides are used in agriculture annually. Though illegal, 9 out of 12 persistent organic pollutants (POPs) are being used for agricultural and household purposes, which ultimately gets into waterways (BDP baseline study, 2016).

Groundwater availability and contamination also must be taken seriously. Massive groundwater development has taken place since the 1980s, especially in the Barind Tract. Shamsudduha et al. (2011) show that shallow groundwater levels declined rapidly between 1985 and 2005. In addition to declining levels, major groundwater quality problems had been considered coastal salinity and localized highly dissolved iron, until arsenic was detected. About three million tubewells, installed at shallow depths (10 to 50 meters), discharge groundwater with arsenic concentrations above the Bangladesh drinking water standard of 50 µg/l (BGS-DPHE, 2001). About 28 to 35 million Bangladeshis have been exposed to drinking water containing arsenic exceeding the national standard. In addition to arsenic, some deeper aquifer systems are characterized by high manganese concentrations, and increasingly chloride.

Water availability and usage is also of concern in Bangladesh. The per capita water consumption in the country is 7,939 m3 per year, but only 688 m3 per person per year is generated within the country. Water is actually the most abundant resource available in Bangladesh. It is estimated that around 80 percent of the people in Bangladesh have access to an improved water source; an increase from 75 percent from 1990 (BDP baseline study, 2016). Apart from domestic and municipal water supply, industry, fishery, forestry and navigation are the other main water using sectors. It has been estimated that the total annual freshwater withdrawal in Bangladesh was 35.87 billion cubic meters in 2009 of which water withdrawal for the agriculture sectors was 87.82 percent, domestic 10.04 percent, and industry 2.15 percent. A quickly growing economy, and the potential risks associated with climate change and trans-boundary infrastructure development, requires the countries' water planners to undertake precise and comprehensive balancing of water supply and future demand.

There are both natural and man-made challenges to water resource management, including alternating floods and droughts, cyclones, a growing population, large-scale sedimentation and erosion, rapid urbanization and industrialization, deforestation, and climate change. An additional and growing challenge is the deterioration of surface and groundwater quality, the decline of natural wetlands and water bodies, and the maintenance of healthy aquatic ecosystems. Critical challenges include:

- Decline of wetlands and the disconnection of wetlands from the regional and main river system, negatively impacting water quality, the quality of fish habitats and ecology, and pressure on ecologically sensitive areas.
- Unsustainable groundwater use in the north-west and north-central hydrological regions (including Dhaka).
- Decreased dry season and tidal flows in the south-west due to decreases in dry-season flows and an obstruction of drainage paths from flood control dam construction, causing water-logging and increased salinity in the coastal area.
- Deteriorating surface and groundwater quality caused by untreated effluent disposal by industrial and domestic sources.
- Flood risks from extreme rainfall, cyclones, and storms, likely to increase with urbanization and economic growth in the near future.
- Water-logging in urban and rural areas cause by unplanned and ineffective drainage, encroachment on wetlands, and the hampering of tidal flows in the coastal area.
- Gender-focused planning, given the important role of women in providing drinking water and food security for their families, as well as their own vulnerability to water hazards.
- River bank erosion occurs at a rate of approximately 6000 hectares per year, resulting in the undermining of embankments, farmers losing their land, and an estimated annual displacement of around 50,000 people.

2.4.2 National Policies on water resources

The policies and rules-regulations pertaining to water resources management and water pollution control are presented in Table

Table 7: Policy documents in water resources management

Policy documents	Elements/highlights on water resource management
Irrigation water rate ordinance, 1983	Consolidate and amend the law relating to the imposition of a water rate for supply, regulation or storage of water for irrigation or drainage.
Groundwater management ordinance, 1985	An ordinance to manage the groundwater resources for agricultural production.
National Environment Policy, 1992	The policy adheres to environmentally sound development of each sector and sustainable use of natural resources including water resources.
Water resources planning act, 1992	An act made to ensure the development and balance use of water resources.

Policy documents	Elements/highlights on water resource management
Environment conservation act, 1995 and its subsequent amendments	The act has the provisions on conservation of the environment, improvement of environmental standards and control and mitigation of water pollution; the amended act includes stringent measures to the perpetrators.
National Fisheries Policy, 1998	Poverty alleviation through creating self-employment and improvement of socio-economic conditions of the fisheries; achieve economic growth through earning foreign currency by exporting fish and fish products; Maintain ecological balance, conserve biodiversity, ensure public health and provide recreational facilities.
National Policy for Safe Water Supply & Sanitation, 1998	This policy was formulated with the objective of making water and sanitation services accessible to all within the shortest possible time at a price affordable to all.
National water policy, 1999	The main objective of this policy is to guide both public and private sectors to ensure optimal development and management of the water sector that benefits both individuals and the society at large.
National Agricultural Policy (1999)	Emphasis is placed on efficient irrigation and where this is possible from an environmental and social point of view (maintaining safe drinking water supplies), increase the development of groundwater irrigation. Specific attention is paid to promoting socially and environmentally friendly agriculture and maintaining a client-oriented agriculture system.
Natural water body protection and prevention of open space and playground act, 2000	The act has been enacted to preserve the natural water bodies, open place and playground.
National water management plan, 2001	This policy adheres to the environmental impact assessment process and highlights the adequacy of upland flow in water channels, resuscitation of natural water bodies, stopping illegal filling up of water bodies and land encroachment.
National Land use policy 2001	There are mention of various land types and their sustainable management including management of wetlands.
National policy for arsenic mitigation 2004 & Implementation Plan for Arsenic Mitigation in Bangladesh	Access to safe water for drinking and cooking shall be ensured through implementation of alternative water supply options in all arsenic affected areas. All arsenic cases shall be diagnosed and brought under an effective management system. Impact of arsenic on agricultural environment shall be assessed and addressed. Policy includes general guidelines for slow sand filters and protocol for installation of arsenic safe tube wells in arsenic affected delta and floodplain areas of Bangladesh.
Coastal Zone Policy, 2005	The policy has the imperative towards integrated management of coastal resources for ensuring the sustainability.
Pro-poor Strategy for Water Supply and Sanitation in Bangladesh, 2005	Emphasizes that the existing policy of the government is to contribute 10 percent of the capital cost of water supply projects irrespective of the poverty level to the beneficiary household.
Bangladesh Climate Change Strategy and Action Plan 2009	This strategy emphasizes planning, design and implementation of resuscitation of canals and rivers through dredging and de-siltation works.

Policy documents	Elements/highlights on water resource management
Hazardous waste management and ship breaking rules, 2011	The rules enacted under environment conservation act provides a regulatory management system on ship-breaking and hazardous wastes.
National water act, 2013	Water Act 2013 is based on the National Water Policy, and designed for integrated development, management, extraction, distribution, usage, protection and conservation of water resources in Bangladesh.
Haor Master Plan, 2013	This Master Plan is a framework plan for developing the haor areas through optimal utilization of natural and human resources for the next 20 years (up to FY 2031-32).
River Protection Commission Act, 2013	It establishes composition, duties and responsibilities of the above mentioned Commission, entitled to: manage and control water and environmental pollution, caused by industrial pollution of rivers, construction of illegal structures and to prevent irregularities and restore the normal flow of the river, to control flood and drainage; hydrology, the use of surface and ground water; and to examine the equipment.
Participatory Water Management Rules, 2014	The Rules relate to formation and functions of water management organizations (WMOs) in water resources projects. The most important shift which the PWM Rules 2014 suggest is that from now on the WMOs will be registered under Bangladesh Water Development Board (BWDB) rather than the Department of Cooperatives (DoC). The Rules emphasize on larger enrollment of local stakeholders in the water management groups (WMGs) and their participation in operation and maintenance (O&M) of the water management infrastructures.
National Industrial Policy, 2016	It has a section on environment friendly industries (section-14). It says while setting up of an industry, its impacts on local land, water and environment and on human should be properly assessed including setting up of ETP and waste management aspects should be ensured.
The 6th Five-year Plan	The Sixth Five Year Plan (SFYP, 2011 to FY2015) of the Bangladesh Government ascribes significant importance to the water resources sector and the concept of Integrated Water Resource Management (IWRM) in support of economic, social and environmental sustainability.
Perspective Plan of Bangladesh (2010-2021)	Making Vision 2021 a Reality" is a strategic articulation of the development vision, mission, and goals of the Government in achieving a prosperous Bangladesh grounded in political and economic freedoms a reality in 2021. In water sector, it emphasizes the efficient, adaptive management considering the aspects in Integrated Water Resource Management, Water Management for Irrigation, Water scarcity, Climate change and Long-term Water Resource Management Strategies.
The 7th Five-year Plan	The Seventh Five Year Plan (SFYP, 2016 to FY2020) of the Bangladesh Government emphasizes on safe drinking water for all, promote Zero discharge of industrial effluents, urban wetlands restoration and protections etc.
Delta plan 2100	"Ensure long term water and food security, economic growth and environmental sustainability while effectively coping with natural disasters, climate change and other delta issues through robust, adaptive and integrated strategies, and equitable water governance.

3. The Future

3.1 Building Capacity for Climate Change, Environment, and Water Resources

The government of Bangladesh must have a vision for 2041 of combating climate change while also pursuing economic growth. The vision for capacity building must bring all stakeholders together in a participatory policymaking and implementation process. It should aim to build a highly-informed society that offers inclusive access to quality knowledge services and democratic input.

Capacity has become a policy buzzword; its definition is highly dependent on context. The Food and Agriculture Organization (FAO), for example, characterizes capacity as, "the capacity of individuals, associations, and society all in all to deal with their actions effectively." It conveys notions of instruction, preparation, and human resources, emphasizing the space in which people, hierarchies, and social networks connect. Capacity building does not imply a lack of existing capacity. It instead asserts that existing capabilities of individual and organizations should be expanded and strengthened. It also calls for the coming together of various stakeholders to combine their capacities to better tackle issues, define goals, and implement solutions.

The primary avenue for enhancing national capacity is education – for policymakers, practitioners, and local communities. Such education must include knowledge about the ecological, social, and economic ramifications of climate change, and job training for fields that take on these challenges.

Article 11 of the Paris Agreement demands that capacity building be nation-driven and in light of and receptive to national needs. Capacity building must be guided by lessons learned from other countries, participatory processes, cross-cutting collaboration, and gender inclusiveness. This should be true for adaptation and mitigation actions, and should facilitate technology development, access to climate finance, public awareness-raising, and the transparent, timely, and accurate communication of information.

3.1.1 Components of capacity building

Individuals are at the core of any effort to respond to climate change, regardless of whether they are government leaders, businesspeople, NGO workers, or members of civil society. Mitigating and responding to the impacts of climate change requires a cumulative effort from all levels in order for Bangladesh to thrive. Additionally, it is important that those with increased capacity in identifying the impacts of climate change and formulating solution are supported in country to put their expertise to use in initiatives specific to Bangladesh.

Everyone has the capacity to learn, and to achieve a sustainable future, individuals must engage in a transformative learning process to change traditional perspectives and open new doorways (Wals 2007). This can be done collectively through "learning by doing" among community members, helping to improve understanding, the need to take action, and to enhance strategy-building through communal reflection. Mentoring systems can be a beneficial means for improving individuals' understanding of an existing problem. Facilitated discussions area an important tool for encouraging people to think critically

and act promptly. Facilitators can help participants build plans and learn from experience, establishing effective strategies such as platforms for open dialogues, using social media of outreach, and organizing awareness-raising campaigns. This can occur through both formal and non-formal education systems.

Community-based adaptation refers to actions taken at the local level by accumulations of individuals in communities that are vulnerable to the impacts of climate change. It includes the identification, assistance, and implementation of community-driven development projects that strengthen the capacity of the local people to adapt to living in a riskier and more uncertain climate. Moreover, community-based adaptation includes planning and implementation through participatory processes, involving local stakeholders and disaster risk reduction practitioners. It integrates climate adaptation and development by improving livelihoods of poor, vulnerable groups.

Generating adaptive capacity at the community level is critical because it builds social networks and a strong sense of collective community responsibility, mutual aid, all of which facilitate the sharing of food and equipment to ensure rapid response to crisis (Ayers and Forsyth 2009). Adaptation must involve learning through action, engaging with indigenous capacities, and honing experiential knowledge. New activities, technologies, and practices can then be introduced as appropriate (Reid and Huq 2007).

Gender inclusiveness must also become central to capacity building. Social and cultural norms cause women to face greater challenges due to climate change and environmental stressors than men do. The decisions at COP22 (the 22nd Conference of the Parties under the UNFCCC) emphasizes the importance of adopting a gender-responsive climate policy. This involves capacity building for both men and women in areas such as technology development and transfer. Identifying the different roles and responsibilities of men and women will enhance the possibility of an environmentally resilient society in Bangladesh (UNDP 2010).

While gender inclusiveness has been integrated into national policymaking, it also needs to be articulated at the local level (UNDP 2010). Women are often the primary managers of natural resources in poor countries, but in most cases lack the power to make independent decisions. Inability to access formal and non-formal education, as well as limited to no access to information and restricted mobility makes women more susceptible to climate change risks. The BCCSAP, 7th Five Year Plan, and National Plan for Disaster Management all address the issue of women's greater vulnerability to climate change and sensitivity to disaster events. Therefore, women's knowledge in environmental management and conservation should be given priority, and investments should be made in education, capacity building training, technology transfer, and women-focused environmental projects.

To create a holistic approach to climate change, young people must also be thoroughly engaged. Integrating climate education into the formal education system is a great first step in building informal, global citizens, who are ready to build solutions. This relates directly to the UNFCCC's "Climate Change Education" thematic area (UNESCO). Furthermore, knowledge dissemination should occur not only through formal but also non-formal avenues for knowledge sharing, such as media, cross-sector partnerships, and social networks.

The GoB has worked to incorporate climate change into education policy (National Education Policy 2010). NGOs and think tanks are also working with young people to promote climate change awareness, and are making use of media and technology to advance knowledge and a call to action. Capacity building trainings for this group might include alternative sustainable livelihood skills, water monitoring, green entrepreneurship, and early warning identification. The public sector should do this and more to mobilize young people in this field.

The education of girls to fight climate change should be a priority. While women's empowerment in Bangladesh is accelerating, it is critical that the country invests in girls' education so that they can become agents of change in the environmental sector. By educating girls they can become initiators of alternative livelihoods, such as home gardening and livestock raising, and can be made the primary family caregivers during natural disasters. Everyone that is able should contribute to the effort to combat climate change.

The vision for long term national stability and prosperity cannot be achieve without strong institutional capacity to understand and plan for the impacts of climate change. Universities in particular are important institutions as they are centers of knowledge, excellence, and shared thinking, with the potential to sustain the socioeconomic and environmental development of the nation. They are well-positioned to generate solutions for climate change, which requires knowledge and collaboration across disciplines. Thus, they are an ideal context for capacity building. Universities have a mandate to train and educate students, and their students have the potential to advance sustainable initiatives. Efforts should then be made to develop a comprehensive curriculum for tertiary academic research, and training (Okoli 2014; Mangizvo et al. 2010; Waas et al. 2010).

There is an increasing need for knowledge production and sharing on matters related to environmental issues and climate change. Effectively managing knowledge is essential for tackling these issues and serving as a catalyst for action (OHCHR KM 2011). The GoB has already shown interest in this strategy at both the local and the national level (Planning Commission 2015). Digitally managing knowledge related to climate change is crucial in that it allows for easy knowledge sharing. Additionally, knowledge brokers can work to bridge the gap between policymakers and researchers to build comprehensive and effective solutions.

Regarding information access, the GoB has made a progressive move in making reports, news, storm warnings, policies, and public dialogues on ministry websites. Additionally, the ministries circulate information via social media, including on Facebook. These efforts to make information broadly available should be expanded, especially to ensure dissemination and access for those who are illiterate or without internet access.

The private sector is also working to build their knowledge hub. Think tanks, NGOs, and research institutions are creating their own knowledge portals for research journals and other publications. The Intergovernmental Panel on Climate Change (IPCC) also shares their research documents for free, via their official website. In addition, the UNFCCC capacity building portal also shares regional and country-based climate change information free of charge. These resources can help link information between countries for better understanding and action (Williams et al. 2015).

Dialogues on climate resilient development planning present an opportunity to bring policymakers together across sectors, and build consensus about common goals. To ensure that consensus and sharing is possible, policymakers should develop specific infrastructures to nurture these results. Additionally, to move from policies to implementation, there should be a shared understanding of a collective approach that will bridge traditional sectoral divides, such as those between environment, planning, energy, and agriculture. Such learning and exchange should then also include broader stakeholder consultation and dialogue. This sort of multi-stakeholder engagement platform can additionally advise how country systems can absorb climate finance and better construct five year plans.

Short courses of about a week in length should be developed, in which participants from various backgrounds and disciplines can learn from instructors about issues and strategies related to climate change and the environment. Participants will have the opportunity to not only learn from experts, but to network with others and take home new skill and knowledge sets. Courses should target professionals from NGOs, INGOs, and government offices, who can contribute on adaptation and mitigation efforts.

Furthermore, joint knowledge production implies not only the cooperative exchange of knowledge across sectors, but also the application of that knowledge. This should include stakeholder preferences regarding management options, as well as a broad understanding of the values, specific interests, and perspectives that underlie these preferences. When differences are recognized, it becomes easier to ensure success (Hegger et al 2012).

3.1.2 International collaboration

Climate change is a complex problem that requires cross-cutting and multi-scalar global efforts to address it. Though multinational collaboration may not be enough to stop climate change entirely, it can work to ensure sustainable development in countries like Bangladesh, which should continue through 2041.

Bangladesh is well-positioned to lead in knowledge transfer across Global South nations, especially in fostering new ideas in the public sector (Chowdhury 2017). The fields of water management, agriculture, and environmental management can especially benefit from integrated responses from researchers, academics, policymakers, and practitioners between southern countries (UNFCCC Tech Brief #9). Virtual hubs can be useful tools for idea sharing, research exchange, technology transfer, partnership development, and networking connections.

However, there are already countries that have bilateral relationships with Bangladesh on climate-related collaborative projects. China, for example, is providing a soft loan for the "Shahjalal Fertilizer Factory" to improve agricultural activity and socioeconomic development (Planning Commission 2015). Argentina is also a project partner to Bangladesh on technology transfer in agricultural water usage, conservation, and impacts on the natural environment and health. Additionally, the Republic of Korea has plans to work with Bangladesh on environmental protection programs (Planning Commission 2015). There is also a need to focus on improving women's livelihood. For example, the Argentine project mentioned above could improve the livelihood of women to collect water from far away, and engage with technology.

There are also limitations in south-south cooperation. As most global south countries qualify as developing or poor, they have a lack of financial resources, insufficient regulatory frameworks, and inadequate technical capacity (7th Five Year Plan). Knowledge, though, is easily transferable with little cost. Bangladesh is a good example of a country with few economic resources, but one that has much to share in knowledge and practice of climate change adaptation measures. South-South as well triangular cooperation means between developing countries (South-South) and between developing as well as developed countries (Triangular)

In addition, north-south collaboration should complement the south-south collaboration process. As Bangladesh grows in terms of climate adaptation and development, it can benefit from technology transfer for green energy pathways, energy efficient transportation, water security, and knowledge sharing. Thus, north-south collaboration should be encouraged in these areas.

On energy, 105 developing countries pointed out in their Nationally Determined Contributions (NDCs) to take action on energy efficiency and standards for appliances, buildings and industries, and efficiency in power generation. The transportation sector also have room for improvement via technology transfer, as it is still largely dependent on petroleum and natural gas (Huq 2017). Water management can also be improved through new technologies, including water-saving irrigation systems and wastewater treatment.

There are also opportunities for transferring knowledge from southern to northern countries. Thus, a combination of knowledge generation and sharing between all countries will work to build capacity at a larger global scale.

Finally, triangular cooperation is an important avenue for exploration in addressing climate change. The U.N.'s working definition of triangular cooperation is, "Southern-driven partnerships between two or more developing countries, supported by a developed country(ies) or multilateral organization(s), to implement development cooperation programmes and projects." It is strongly believed that south-south and triangular collaboration will be the key modalities for addressing climate change. Through triangular cooperation, Southern development assistance providers can benefit from the financial and technical support, experience and technical know-how of multilateral and developed-country partners. The beneficiaries' country priorities however, should be central to the triangular cooperation process including negotiation, formulation, implementation, and evaluation (Fordelone 2009).

3.2 Green Growth and Renewables

The term "green growth" has expanded in use over the last 30 years, sparking varied and sometimes conflicting definitions. Two prominent examples, from the OECD and the World Bank respectively, are:

"fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies;" and

"making growth processes resource efficient, cleaner and more resilient without necessarily slowing them down." (EDGG 2017)

Further, green growth has been defined from a policy angle as:

"an integrated policy approach balancing low carbon development, macroeconomic growth, social inclusion, environmental sustainability and climate resilience." (Savage and Chiappe 2014).

Two key elements are central to these formulations of green growth: continued economic growth, and sustainable and efficient use of resources. The policy definition also specifies the development of a low carbon and climate resilient policy approach, as well as social sustainability, as two additional aims of green growth. Another definition of green growth emphasizes climate change:

"the optimum tradeoff between 'catching' climate change in time while maintaining a reasonable rate of growth, even in the short term." (Aghion et al. 2009).

(Comment 11: Can you briefly explain about South-South Triangular Cooperation?)

According to Savage and Chiappe (2014), green growth has generally not been well defined in South Asian policy so far, and there is little evidence of policy being formulated around the concept in the region. This presents an opportunity in Bangladesh for formulation of both a forward-looking definition of green growth, and policy that can deliver on this vision.

3.2.1 Climate change and green growth

There are several macroeconomic development policies and plans in Bangladesh that provide for ideas and strategies that pertain to elements of green growth. The Seventh Five Year Plan (2015) and the Perspective Plan of Bangladesh ("Vision 2021") (2010) both address elements of green growth, such as environmental strategy in Vision 2021. The National Adaptation Plan of Action (2005) and the Bangladesh Climate Change Strategy Action Plan (BCCSAP) constitute the core planning framework for climate change (Savage and Chiappe 2014). Finally, the National Sustainable Development Strategy of Bangladesh (2008) aims to:

"ensure sustained economic growth, environmental protection and social justice which implies improvement of livelihood options of the people, reduction of poverty; ensuring wise use of natural resources, good governance and people's participation;"

with four priority areas of sustainable economic development, agriculture and rural development, social security and protection, and environment and natural resource management (McGregor et al. 2016). However, there remains no single, comprehensive definition of green growth or strategy to implement it in Bangladesh. The balance of benefits and trade-off, inclusive policies to address inequality, and barriers to advancing green growth must be considered in creating and implementing a green growth strategy.

The green growth narrative highlights a narrative of positive progress. However, some benefits are more easily quantifiable than others, and those that are less so pose an evidential challenge (Savage and Chiappe 2014). Benefits of green growth include: (i) having sustained natural assets on which green growth and human well-being can be

built, and which can provide inputs for marketable goods and ecosystem services; (ii) new opportunities for economic growth and new job opportunities, especially in ecosystem service provision and technological innovation; and (iii) reduced poverty (Savage and Chiappe 2014). Elaborated further, green growth includes benefits for:

- Climate Change – Political obligations in the Paris Agreement and looming domestic impacts are both policy drivers
- Protection of Natural resources – Protects natural resources from depletion, degradation and the impacts of industrialization and urban growth
- Promotes economic growth – Improves industrial competitiveness, creates green jobs and addresses short term challenges
- Sustainable finance opportunities – Addresses budgetary pressure through the creation of environmental taxes and leveraging finance from international climate funds
- Broad security issues – Has the capacity to improve renewable energy resources, food security, and rural livelihoods

Many countries choose to pursue green growth for these reasons to become more competitive in the global economy. Alternatively, environmental benefits are referred to as co-benefits of green growth rather than the driver for policy action (Savage and Uddin 2016).

Compared to the benefits, less is understood about the potential trade-offs in green growth, likely because this notion challenges the positive progressive narrative of sustainable development (Savage and Chiappe 2014). They include short-term investment injections that are required in specific sectors. For example, the cost of investing in industrial scale solar arrays may have an impact on GDP in the short term. However, it is expected that green growth can enable greater growth over the long term (Savage and Chiappe 2014).

Though there is limited evidence on the potential trade-offs between growth, environmental goals, and social objectives over time, potential trade-offs include the following: the size of the formal economy could reduce the effectiveness of policy instruments that are implemented. Additionally, high levels of inequality, and the dependence of the poor on natural resources, both require a greater focus on managing distributional costs and benefits of green growth. Weak competitiveness could potentially prevent innovation and expansion into new growth sectors (Savage and Uddin 2016).

Ultimately, policies and plans for green growth must be inclusive, providing benefits to all sectors of society, in order to address elements of social sustainability such as poverty and inequality (McGregor et al. 2016). Savage and Chiappe (2014) argue that social sustainability and poverty reduction, as they relate to green growth, share many fundamental synergies with equitable natural resources use and climate change impacts. They suggest that social work programs, oriented towards community development, are a key way of supporting local livelihoods while concurrently promoting ecosystem services.

Though green growth is critical, there are also barriers that must be acknowledged and overcome. A common barrier to green growth is regulatory uncertainty (McGregor et

al. 2016). They propose that governments should articulate clear plans and strategies on bringing private and social returns together, in order to provide confidence to all actors in the green growth narrative. Savage and Chiappe (2014) also identify general barriers to public sector implementation of green growth strategy. This includes lack of commitment, lack of implementing power, weak inter-ministerial capacity, competition for scarce resources, a weak evidence base for green growth, and challenging operating environments.

Bangladesh faces several challenges in mainstreaming green growth as traditional growth models still dominate government thinking, in spite of advances made in climate change mitigation, resilience, and finance. There is a lack of an evidence base for green growth that could inform the costs and benefits of moving to such a strategy. For this reason, policymakers are hesitant to take action. There is also a lack of policy implementation (specifically environmental policies such as environment and climate risk screening and environmental impact assessments) are not conducted for every development project as there should be. Though there are policies for these environmental assessments and fines for not complying with them, they are still not properly implemented.

Furthermore, inter-agency coordination remains one of the biggest challenges for Bangladesh. Sector ministries lack the technical capacity to implement a green growth strategy on their own. Though several policy frameworks contain some elements of green growth, it is yet to be grounded in policy discourse (Savage and Uddin 2016).

In order to remove barriers to green growth, Bangladesh must work to build: (i) new institutions; (ii) coordination across government structures; (iii) environmental risk assessment of policy, plans, and programs; (iv) policy implementation review; (v) demonstration of benefits of green growth in key sectors; (vi) political devolution to the local government level; (vii) collaboration with private sector in development of all policy and investments; (viii) PPP acceleration through working with private sector and financial sector; (ix) green data development to underpin policy development; and (x) financial mechanism liberalization and development (McGregor et al. 2016).

Industry actors' attitudes toward green growth also play a role (McGregor et al. 2016). As highlighted above, cost is a trade-off, with green growth likely causing long-term overall gains, but short-term costs for many sectors. Industry actors generally have a lower level of perception of green growth than policymakers (McGregor et.al. 2016). In addition, Bangladesh has a large informal economy, in which about 75 percent of the working population are engaged (McGregor et.al. 2016). This presents a challenge in developing policy to support the actual sources of income for most of the population, as well as in reporting and measuring impacts of that policy on the macroeconomic status of the country.

Bangladesh has the benefit of learning from many other countries have implemented green growth strategies and provide useful examples for Bangladesh. For example, Rwanda introduced the Green Growth and Climate Resilience National Strategy for Climate Change and Development in 2011, which aims to create a low carbon and climate resilient economy by 2050 through a secure low-carbon energy supply, sustainable water and land use, and social protections (including disaster risk reduction) (McGregor et al. 2016). Chile also launched its National Green Growth Strategy in December 2013, which outlines actions including environmental management instruments, promoting a market for environmental goods and services, and measuring progress over the short, medium and long term (Savage

and Uddin 2016). In Ethiopia, the Climate Resilient Green Economy Vision (2011) and the Green Economy and Climate Resilience Strategy (2011) have been introduced (Savage and Chiappe 2014). These each can serve as a model for the development of a Bangladesh national strategy.

China and India are the two largest sources of imports to Bangladesh, and therefore influence the country's production technology (McGregor et.al. 2016). In India, strong economic growth has come at a heavy environmental cost, so a clean energy fund has been established and novel partnerships are being pursued to increase green investment. China, which in 2012 accounted for 29% of global GHG emissions due to its heavy reliance on coal, has set binding targets for emissions reductions and created innovative financing mechanisms, including a loan loss reserve fund ('LLRF') (McGregor et.al. 2016).

Overall, there is much scope for Bangladesh to create and pursue synergistic policies for green growth, moving beyond the established categories of mitigation and adaptation and into policies that are designed to foster consistent pursuit of green growth from angle and sector. Green growth must be incorporated into the national vision.

3.2.2 Future investment areas in climate change and green growth

Bangladesh has progressed in investment in green growth-related areas that support mitigation to climate change, i.e. a reduction in Greenhouse Gas ('GHG') emissions. For example, Bangladesh Bank has utilized various financial mechanisms, including supporting the development of clean power plants through a BDT 2 billion refinancing scheme at a 5% interest rate (McGregor et al. 2016). Bangladesh Bank has been instrumental in raising awareness of green finance in the banking sector (Dorasil and Gross 2014). In terms of adaptation, climate resilient infrastructure is key, and private sector involvement in this area is strongly encouraged (World Economic Forum 2013). And estimated 7% of public expenditure in Bangladesh should be invested in green growth-related measures (McGregor et.al. 2016). Savage and Chiappe (2014) estimate however that 80% of investment for Green Growth will come from the private sector. This raises the question: what are the key investment areas for the future and how will these be targeted?

Energy is a key sector in which green growth can be used to address climate change mitigation issues. It is particularly significant in Bangladesh because of the huge increase in anticipated power demand and production, with the vision in place to produce 50% of power from coal. However, this 'lock-in' to fossil fuel reliance and subsequent expansion of carbon footprint can be avoided (McGregor et.al. 2016).

The Bangladesh Bank Refinance Scheme for Renewable Energy & Environment Friendly Financeable Sectors focuses on green products such as solar energy, bio-gas plants, and effluent treatment plants (ETP). This refinance scheme was established by Bangladesh Bank with BDT 2 billion of its own fund in 2009. Initially it was launched with only 10 products, which has increased to 50 types under 11 categories: Renewable Energy, Energy Efficiency, Solid Waste Management, Liquid Waste Management, Alternative Energy, Fire Burnt Brick, Non Fire Block Brick, Recycling & Recyclable Product, Green Industry, Ensuring Safety & Work Environment of Factories and Miscellaneous. To date, 39 banks and 19 Financial Institutions have signed a participation agreement with Bangladesh Bank to avail finance from this scheme (Khan et al. 2017)

Solar has huge potential for power generation in Bangladesh, as evidenced by an IDCOL program that has brought solar home systems to millions. This has been supported through a combination of capital subsidies, interest rate subsidies and concessional financing (Dorasil and Gross 2014). However, there is a policy issue that may affect using renewables on a larger scale: base-load options under regulation do not yet recognize renewables (McGregoret.al., 2016). An update to this policy to include renewables could facilitate uptake of solar at a larger scale. Another promising policy direction is the development of feed-in tariffs, which received support from 98% of those surveyed by EDGG, including both policymakers and industry actors (McGregor et al. 2016).

Transport is another key area for climate change-focused green growth, as curbing GHG emissions from fossil fuel vehicles is essential for mitigation. There are also major co-benefits to improving transport systems, particularly in Dhaka, which has been said to suffer chronic traffic congestion, low quality and reliability of public transport, lack of safety for pedestrians, and worsening air pollution (McGregor et al. 2016).

Though the GoB has lead investment in this sector, there are now 13 public-private partnership (PPP) transport projects underway in Bangladesh. The Bangladesh Transport Policy Note (2009) by the World Bank reinforced the need to involve the private sector in transport development, since the cost of transport infrastructure projects often far exceed available public finances (McGregor et.al. 2016). So far, the private sector has not emerged as a 'green champion' in the transport field, but the rapid expansion of the field means it is an optimal time to engrain this vision. As the EDGG summarizes, "a national transportation green growth agency and a national green growth coordination committee would be essential to pursue green growth agenda," (McGregor et.al. 2016).

Next, the garment industry makes up a large part of Bangladesh's economy and has particular potential to make advancements in green investment to address climate change. This isdue to the fact that the majority of textile and garment factories are high emitters of GHGs, and are yet to adopt cleaner technologies (McGregor et.al. 2016). There appear to be multiple barriers to the adoption of green technologies in this sector. In an interview with a knitwear factory owner in Narayangonj conducted by EDGG, they identified the following barriers to adopting new, green technology at the factory: (i) large initial investment; (ii) incentives weighted in favor of larger companies; (iii) inadequate access to finance for green investment; and (iv) limited commercial incentives from the supply chain (McGregor et.al. 2016). One potential example model that could be emulated in Bangladesh to increase availability of lending for green factory upgrades is the LLRF model used in China. This fund uses finance from the IFC and GEF to guarantee commercial loans to energy management companies, and could be used as a model across industries in Bangladesh. Related issues are explored further below.

There is also significant possibility for increasing energy efficiency in industry. According to the surveys conducted by EDGG in its Green Growth Diagnostic (McGregor et.al., 2016), use of efficient motors in industry is below 25 percent and use of biogas is below 6 percent, indicating significant room for improvement. Over half of the respondents cited financial constraints as their rationale for not investing (McGregor et al. 2016). This suggests that incentives such as tax discounts could facilitate greater uptake for investments inefficiency.

Figures 6 and 7 below show the investments made in energy efficient technologies across sector type (Figure 6) and sector size (Figure 7). The consistency of technology investments across both charts indicates that macroeconomic factors have driven investment decisions (McGregor et al. 2016).

Figure 6: Investments in selected energy efficient technology by private sector respondents (EDGG 2016)

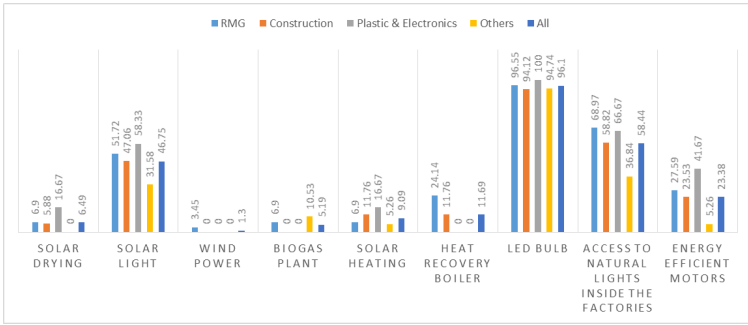
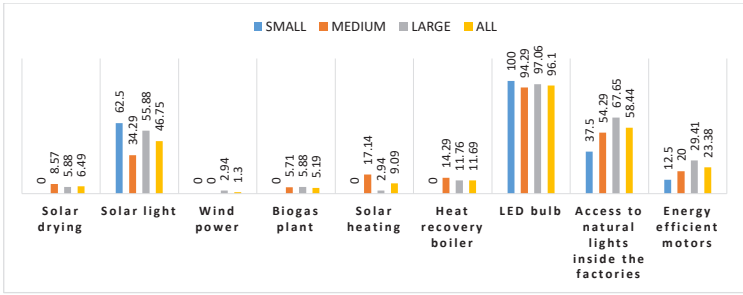


Figure 7: Use of Energy and Energy Saving Technology by Size of Industries



However, given the perceived financial savings that energy efficiency would bring, ranging from 19 to 34 percent of energy bills, it appears that cost is not the sole deterrent for investment (McGregor et al. 2016). Positive impacts on reputation and compliance with ISO standards may also incentivize investment, but more research is required to establish whether these drivers can be adopted for green growth (McGregor et al. 2016). This combination of financial and reputational incentives could encourage private sector industries to invest profits into mitigation technology.

3.2.3 Environment, water resources, and green growth

When Bangladesh gained independence in 1971, it began its development trajectory from the very bottom. In less than 46 years the country has already made remarkable progress in terms of its economic growth and development. In order to continue that progress into the future while also preventing environmental degradation and its significant negative impacts on human wellbeing, the country must shift towards green growth.

Economic growth without considering environmental bottlenecks such as air pollution, water scarcity, and availability of scarce natural resources will have long term impacts

on sustainability, risking overall economic growth and development (OECD 2012). Environmental degradation, depletion of natural resources, and pollution are widely observed in Bangladesh across sectors pursuing growth. In Bangladesh's case, these effects have been exacerbated by over-population, poverty, and lack of awareness amongst the public (McGregor et al. 2016)

At present, global water demand is projected to increase by 55 percent by the year 2050, which will result water stress for at least 40 percent of the world's population. By the same year estimations suggest a further decline in global terrestrial biodiversity by at least 10 percent (OECD 2012). Considering the state of natural resources on a global scale, green growth no longer seems like a choice, but perhaps the only way forward.

The cost of environmental degradation is difficult to quantify monetarily. A large portion of these impacts await us in the future, many of which will be irreversible, or close to it. For example, a destroyed rainforest may take thousands of years to grow back.

New evidence has shown that countries pursuing a green growth strategy exhibit higher economic growth, poverty reduction, increased resilience to climate change and natural disasters, greater energy security, and more secure livelihoods for those directly dependent on the use of natural resources. There are visible impacts to integrating green growth into policy making; the social benefits for poor and vulnerable communities include livelihood improvement, capacity building, gender equity, health benefits and job creation. Economic benefits include output growth, natural resource efficiency, cost effectiveness and improved productive capacity. Finally, environmental benefits include emissions reduction, energy efficiency measures and ecosystem conservation (McGregor et al. 2016).

Bangladesh is in the process of rapid industrialization and urbanization. If not conducted in a responsible manner, these processes could be harmful to the environment as well as to the population. The way development has been undertaken so far has not been particularly green, with the exception of the Solar Home System initiative; most of Bangladesh's development strides have been considerate of economic aspects rather than environmental ones. In fact, the country has been ranked one of the lowest in the global Environmental Performance Index (2016), prepared by Yale Centre for Environmental Law and Policy. In sectors that are pursuing growth at a rapid pace there is a risk of environmental degradation, depletion of natural resources, and pollution, which are worsened by over-population, existing poverty, and lack of awareness among the public (McGregor et al. 2016).

For Bangladesh, green growth is still a new addition to the 7th Five Year Plan (FYP) and it will surely take time before it is mainstreamed within national plans and policies. The country however has excelled in the Millennium Development Goals (MDGs) and is taking preparation for achieving the Sustainable Development Goals (SDGs) or Agenda 2030. The SDGs with 17 goals and 169 targets aim to resolve some of the core social, economic, and environmental issues concerning the world today. Some of the targets under the SDGs are relevant to environmental sustainability. For example, goal 8 aims to:

Promote sustained, inclusive, and sustainable economic growth, full and productive employment and decent work for all.

Target 8.4 under goal 8 contains a more specific mandate to:

Ensure global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation.

The country has already mapped out the different SDGs under the various ministries responsible for addressing specific goals and targets. A special monitoring unit is set under the Prime Minister's Office to keep SDG progress on track. Civil society has also taken initiative through the Citizens Platform for SDGs Bangladesh, to enable a platform for civil society organizations and NGOs working on different issues covered in the SDGs, to come together and take actions ensuring SDG success. Some of the other relevant goals under the SDGs are goal 6 on clean water and sanitation, goal 7 on affordable and clean energy, goal 11 on sustainable cities and infrastructure, goal 13 on climate Action, goal 14 on life underwater and goal 15 on life on land. Each of these have targets that are in line with the principles of green growth. Therefore, for the country to work towards achieving the SDGs, aspects of green growth must be embedded into the country's action plans.

3.2.4 Future investment areas in environment, water resources, and green growth

Bangladesh is largely dependent on the agriculture sector as approximately 87 percent of the rural population of the country relies on agriculture for their income. While agriculture has helped economic growth in Bangladesh, reducing poverty levels from 48.9 percent in 2000 to 31.5 percent by 2010 (Gautam and Faruquee 2016) the way the sector has not been structured in an environmentally conscious manner. As such, to some degree it can be said that the sector has expanded at the expense of the environment. In an attempt to obtain larger outputs excessive chemical fertilizer and insecticides, herbicides and pesticides have been used. Such practices negatively impact crop yield and soil fertility, which can also lead to adverse health impacts on farmers and consumers (World Bank 2012).

Intensifying agriculture at this rate can impact human, fish, and animal health. In fact, over-pumping groundwater affects the water table, causing salinity intrusion and decreasing potable water. These actions can lead to siltation of rivers and water bodies. Eutrophication, resulting from pesticide runoff from agricultural land into bodies of water harms aquatic life and pollutes drinking water sources. Despite its benefits, if farming is conducted on sensitive and protected land it can contribute to deforestation and affect the local ecological conditions of the area (McGregor et.al. 2016).

In order to make sure agriculture continues to boost the country's economy without having adverse and sometimes even irreversible environmental damage, it is essential to focus on green growth. Globally, UNDP has taken measures such as the Green Commodities Program (GCP) with an aim to promote sustainable agriculture. The GCP works to enable 8 million farmers across the world to manage 20 million hectares of land sustainably and improve their agriculture practices. Some of the ways to incorporate green growth practices into the agricultural sector includes improving production techniques to enhance efficiency, higher yields, and better production quality. This is likely to reduce overuse of chemical fertilizers, save money, and decrease environmental impact (Soliman 2015).

So far Bangladesh has taken some steps towards developing sustainable agriculture practices by incorporating some green revolution strategies such as solar irrigation systems and improved seeds suitable for different geographical areas (McGregor et al. 2016). Future areas for investment should include research into salinity-tolerant crops to utilize salinized land in the coastal areas and improve livelihood and farming opportunities for the coastal population (Rabbani et al. 2013). Furthermore, Bangladesh should invest in efforts such as sandbar cropping. For example, in char areas of Rangpur, farmers are planting pumpkins that can grow with in sandy land with little water and moisture (Ali 2014).

Although Bangladesh has made significant progress in terms of energy generation, there are many pockets in the country that are still left without access to energy. However, ensuring universal access to energy in the future should not include exploitation of natural resources and reliance on fossil fuels. Expanding these traditional sources of energy will cease to be cost effective in the long run, as the price for oil will continue to rise and the cost of renewable energy technology will become more affordable. Owen (2006) said that the cost of solar energy is likely to decrease significantly due to technological progression and economies of scale combining to lower unit generating costs.

Therefore, Bangladesh should incorporate green growth within its plan for expanding the energy sector. This includes investing in sustainable and renewable energy sources. The GoB conducted a comprehensive assessment of renewable energy technologies that include utility-scale solar PV, grid-connected solar rooftop arrays, solar home systems, solar irrigation, solar mini-grids, wind, biomass, biogas, waste-to-energy facilities, small hydro, geothermal, hydrokinetic, tidal energy, and improved cook stoves. Bangladesh has already achieved success in this area, but there is ample opportunity to scale up renewable energy programs with the right mix of technology and finance (Khan et al. 2017).

Green growth investment should be made in sustainable waste management in Bangladesh. On a global scale, practices of waste to energy have flourished significantly, but in Bangladesh there is much left to be done and ample opportunity. For example, a Bangladesh-Denmark initiative on sustainable energy development called CCAMP has two engagements that are in line with the green growth agenda. The first is on Waste-to-Energy Engagement, which will be implemented by the International Finance Corporation. This will endorse waste-to-energy in poultry and large dairy farms throughout the country by employing successes from past experience. The engagement will extend to stakeholders such as service providers and the financial sector to explore and develop partnership opportunities. There are also plans to enhance the production of organic fertilizers from biogas slurry, which will be a natural substitute for chemical fertilizers that have negative effects on the environment. The biogas produced from the waste is also a source of energy that can be used for heating and cooking purposes.

Secondly, CCAMP also promotes energy efficiency. The Energy Efficiency Engagement will be implemented by the Nordic Chamber of Commerce and Industries (NCCI) and will encourage more companies to embark on energy efficiency initiatives. These companies will have access to professional guidance and funding to implement energy efficiency investments in Bangladesh. There is another initiative in this package known as the 3e initiative, implemented by NCCI and funded by DANIDA, which will reduce carbon dioxide emissions from selected industries and reduce energy costs. This will happen through exploring energy efficiency strategies within companies and industries.

Rural Bangladesh is already making efforts for clean cooking facilities. In the year 2014 five lakh clean cooking stoves were installed, which was increased to 7 lakh the year after. Bangladesh is in the top five countries to have installed domestic biogas plants. Currently the number of biogas plants stands at 45,610 in Bangladesh.

4. Key Goals for 2041

4.1 Priority goals

1. Investing in girls to make them climate innovators

Justification: Investing money, resources, and education in girls has been proven to have impacts beyond the individual, but also for their families and communities. This approach should not only be gender-sensitive but gender-biased. Though it is also important to invest in boys, the return for investing in girls will be greater. Rather than spending money on immediate need and only on themselves, girls have been seen to think more broadly and longer-term about investing to maximize the impact on the larger group. It will ensure that girls are engaged in advanced technologies and ICT in order to generate cost effective solutions for climate change that will be relevant not only for Bangladesh, but for the world.

Expected results: Girls hold enormous potential in innovation and development that has thus far remained largely untapped due to gender restrictions from religious and social norms. By highly educating girls in all fields, but especially in climate-related natural and social sciences, they can generate solutions that will benefit the whole country. Further, their already existing socialization as caretakers will likely lead them to generate solutions that consider several issues and their consequences for communities and families at once in a way that is more all-encompassing than many other initiatives.

Plan for implementation: Classes must be developed at all levels that specifically encourage girls to get the training required to develop ongoing solutions to climate change and related issues. This includes technological skills trainings as well as concerted efforts to bring girls into science and IT fields. This might include scholarships as well as female-only funding opportunities to pursue advanced degrees that focus specifically on climate change.

Outside of formal education, courses must be arranged at the community level that allows girls in climate-vulnerable areas to develop and manage local solutions to climate-related issues. Girls and young women can be trained in farming techniques, for example, that are more climate-resilient, can be trained to receive and interpret storm warnings, and can be taught to recognize early warning signs for weather and seasonal changes that may impact local livelihoods.

Timeline:

2026 Scholarship programs and local training programs developed to encourage girls to focus their work on climate solutions.

2031 All girls knowledgeable about climate change issues and solutions.

2036 Girls' contributions on climate change solutions continuously formally acknowledged and rewarded publically.

2041 Women in at least half of government research, and academic positions, especially top positions, in environment- and climate-related fields.

2. Climate change mainstreamed

Justification: The approach of "grow first and clean later" that has so far guided development in Bangladesh must be discarded in favor of one that takes climate and environment issues into account from the start. Climate change is an issue that impacts all sectors at once. It cannot be taken as an isolated issue that should only be considered in contexts that are more obviously related to climate change, such as coastal erosion prevention and infrastructure development. Instead, all work and planning done in Bangladesh must incorporate climate change and fully consider the long-term environmental impacts. Furthermore, the implementation of plans and projects must follow through on the necessary steps and assessments that will ensure that it will not increase climate vulnerability and will not negatively impact the environment. This will ensure the long-term sustainability of projects and will prevent economic costs that will result from initiatives that are not resilient to climate change and that damage the environment and human health, disrupting national production and well-being.

Expected results: All climate will be climate finance and all development will be sustainable development. This means that all investments, business models (including business profit reporting and accounting), public policies, real estate plans, and technologies account for and positively address climate change, by being climate resilient and minimizing emissions, as well as funding positive transformational adaptation. Financial planning will automatically account for environmental inputs and losses in accounting.

Additionally, even after Bangladesh has achieved developed country status it will need to implement continuing development projects. Any development project must have zero or negligible environmental impact and must be sustainable into the foreseeable future without limitations. Economic growth must be foregone in favor of sustainability.

Plan for implementation: The country must develop and follow a green growth policy that is integrated in all ministries and sectors, and at all scales. Policymakers and project implementers must be trained in the specifics of green accounting and sustainable development with particular training on anticipating and minimizing impacts that would increase climate vulnerability and environmental harm. Conversely finance and development projects and should be acknowledged and rewarded for their work in mainstreaming climate change and prioritizing sustainability.

Timeline:

2026 Development of comprehensive national green growth policy

2031

2036

2041 All finance climate finance; all growth green growth

3.Migrant-friendly cities

Justification: Bangladesh is already experiencing strain due to an influx of migrants from coastal areas to cities, leading to extreme congestion and growing informal settlements. These migrants are overwhelming settling in Dhaka, as the urban center with the greatest economic opportunities and places where they have the strongest social ties. However, Dhaka cannot continue to handle the growing number of migrants flocking in each year, especially if planners want to improve city planning and enhance environmental conditions. Climate change will only increase the number of people moving to cities from vulnerable coastal regions, and thus all cities in Bangladesh must be made ready to accept them and to have ample opportunities that facilitate their transition to urban life both economically and socially.

Expected results: Cities will be restructured to be ready to receive migrant populations, as the uncertainties of climate change mean that flows of people could be entering a city without warning. All of the nations' cities will be made migrant-friendly, with strong and efficient systems for facilitating migrant integration into the city, adequate housing for new populations, and job opportunities for those who are looking to work. All cities should have a network of social workers focused specifically on migrants, who keep track of their needs and work to enhance their well-being. Urban planners and city governments will continuously work with the migrant populations to ensure that the community's needs are being met and that all who seek to migrate from climate-vulnerable regions are able to do so.

Plan for implementation: As urban development plans are implemented, special efforts should be made to develop systems for accepting and managing climate migrants. Migrants should be fully integrated into urban life and should become integral components to the functioning of the city. The planning for migration should begin at the level of community of origin, with a focus on climate-vulnerable areas that educates potential migrants about the services available once they arrive in urban areas and encourages them to move to various cities around the country. A new national service sector should be developed that deals with migrant issues and planning exclusively.

Timeline:

2026 Urban areas outside Dhaka develop city plans to facilitate the welcoming of migrants; Dhaka creates a city plan to better manage and support its migrant population; and a national plan on encouraging migration to all urban centers will be developed.

2031 All cities have infrastructure and social services to manage and support migrants; programs have been planned and implemented that educate potential migrants about the available services in urban centers.

2036 Plans have been created and implemented that actively integrate migrants into urban life and communities of migrants are developed that are mutually supportive and contributing to the development of further planning to better manage and support migrants.

2041 All cities have thriving migrant populations that are fully supported through national and city-specific services and planning.

4.National mitigation plan

Justification: Though Bangladesh is not currently one of the world's top emitters of greenhouse gas emissions, as it develops the country will need to ensure that it is doing so in a way that does not further contribute to climate change. Thus, a national mitigation plan is essential for ensuring a sustainable future. Development will likely include an increase in emissions, and so the national mitigation plan should aim for zero emissions long-term.

Expected results: Besides the development of a national mitigation plan, renewable energy sources that meet 80 percent of the country's energy needs should be implemented to contribute to mitigation action on the way to achieving the 100% renewable energy goal that is currently set for 2050. This will additionally contribute to the broader goals of making the country more climate resilient and environmentally sustainable.

Timeline:

2026 20% renewable energy

2031 40% renewable energy

2036 60% renewable energy

2041 80% renewable energy; National Mitigation Plan

4.2 Other goals

1. 100% food security through sustainable farming

Bangladesh should be able to completely support its population through sustainable agricultural practices. Malnutrition should be eliminated and food distribution and access should be prioritized in the country's plans. Most importantly, the practices used to produce this food should be sustainable in the long-term and without environmental impact. Environmentally contaminating fertilizers and pesticides cannot be used, water must be conserved and utilized responsibly, and exploitation of the soil through over-farming and high-yield methods should be eliminated. Furthermore, changes in agricultural practice must accord with the impacts of climate change, such as storm damage and salt water intrusion. GoB must be active in supporting farmers through crop damage and encouraging technological innovation to manage changes.

2. 100% safe water and sanitation

It is imperative that the national population has access to drinking water, and that this drinking water is free of contaminants that are harmful to human health, such as arsenic. This will include an elimination of harmful chemicals from agriculture, and the distribution of proper filtration and cleaning systems, either on a large scale or household-based, where water is already contaminated. Furthermore, this entails an end to litter and unsanitary sewage disposal, especially in cities. An effective sewage system must be implemented in all cities and large villages. Waterways must be dredged and cleaned wherever possible, and new pollutants must be avoided at all costs.

3. Pollution/carbon tax

Pollution is currently a major problem in Bangladesh and must be eliminated by 2041. A pollution tax should be implemented to deter industries and development projects from contaminating the environment and harming human health. Alongside a pollution tax, a carbon tax should be implemented, in accordance with the national mitigation plan described above. This will discourage the development of climate-damaging industries such as coal in the country's pursuit of economic growth.

4. National resilience to disasters

Despite efforts to mitigate and adapt to climate change, Bangladesh will continue to face natural disasters such as cyclones and landslides. First, all individuals in the country should be taught to understand early warning signals and what to do in case of an emergency. Next, strong health services must be developed so that disaster victims have access to care, not only in the immediate aftermath but over the long-term. Following a disaster, a first aid team should include emergency support for infections, pregnancy and lactation support, snake bite assistance, water purification, mold prevention, food supplies, and mental health services. This last component – mental health services – is particularly important and thus far has been entirely neglected from post-disaster care. Individuals need support in dealing with the stress and loss after a traumatic event. The development of these services around disaster is in addition to greater emphasis on mental health services nationally, and a de-stigmatization of mental illness.

5. Sustainable production and consumption

Production and consumption in Bangladesh must be reimagined so that it does not have environmental consequence. This includes the entire lifecycle of products that are produced and the manner in which they are consumed. The current state of production and consumption is extremely harmful to the environment and human health in that it involves enormous amounts of waste that is poorly disposed of, creating further environmental consequences. The country must make a concerted effort to completely revamp production and consumption.

6. Promoting and implementing research and innovation

There is currently a disconnection between researchers, innovators, and policymakers. GoB must work to build a strong connection with research institutions, scientists, and technological innovators to ensure that the latest knowledge and technology are integrated into national planning and that innovation is directed at country priorities. This is crucial for there to be continuous climate adaptations as the challenges faced by the country continue to evolve.

7. Mobilize the private sector for green investments in mitigation and adaptation

All resources and contributors are needed in order to continue tackling climate change. The private sector has some of the greatest potential to develop projects that will be effective in mitigating emissions as the country develops, as well as adapting to changes that will inevitably occur. GoB must begin working closely with the private sector and

implementing incentives that will encourage private investment in sustainable projects. These projects should especially include ones that address the impacts of climate change, through adaptation and mitigation. Public-private partnerships should also be pursued to maximize the possibilities for green growth and sustainable development in Bangladesh.

8. Green transportation system

Justification: Green transportation system includes ensuring the banning of the vehicles that are old and causes excess smoke emission. The transport system can be converted to pollution free by using biofuel instead of fossil fuel, electric vehicles, imposing penalties to the pollution maker in transportation system, giving incentives to the owners (transportation organizations) of the green vehicles and so on.

Expected Result: This will obviously reduce the carbon emission. Though Bangladesh is not one of the most carbon emitter but with the time rising, the industrialization and urbanization would led to an increase in carbon emission. It is better to take measures early so that the emission rate would get slow with the time.

Plan for implementation: The law implementation authority and officials related to green energy supply should work together. The perfect collaboration of administration, fuel supply and distribution authority and law imposer could turn this system a greener one.

9. Green and environment-friendly industries

Justification: Every industries in Bangladesh should follow the ISO 14001 Environmental management system for less pollution and low emission of CO2 with sustainable production capabilities. The industries should use environment friendly technologies for their production and operation. As much as solar power and renewable energysources should be used. The whole walls and the building can be covered by useful and non-damaging plants for mitigation of carbon emission. Trees should be planted in and around the industrial areas. The industries should ensure the occupational health and safety for the workers and ensure better pollution free working environment.

Expected Result: It would reduce the environmental pollution and carbon emission. It will help Bangladesh to decrease environmental pollution and other associated problems. Moreover it will reduce the fossil fuel burning and demand of fossil fuel which would reduce the pressure on non-renewable resources. The people working in those industries would also grow themselves as environment conscious for working in such industries.

Plan for implementation: This type of plans should consider at the ministry which deal with the industrial issue and also the DoE. In this case the implementation of the rules or environmental consciousness should be broaden by DoE and the enforcing of the industries to turn them to green industries should be led by the ministry of commerce and industry under the sub-secretariats related to this issue. And last, but not the least, Bangladesh need investors for this.

10. Ecological security and eco-tourism

Justification: Ecological security view the nature as an individual entity. That means, harm of any single part of that individual can cause disturbance or illness to the whole system of ecology. The systems and paradigms of the cycle are all interrelated. So, ecological security to different aspects of the ecology should be ensured. It can be done by imposing law and prevention of different illegal and curse full attempts to various parts of the ecology.

Eco tourism is on other hand, a growing economical investment for Bangladesh. It has enough tourist attraction places, but without maintaining the conventional state, the attraction and the beauty won't be ensured for long. Both, the marketing plan and the conserving regulation should be followed unitedly.

Expected Result: The ecology and biodiversity would be saved by this type of steps. The richness and balance would increase. On the other hand, this will attract the environment conscious tourists from all over the world which would be a source of foreign currency. It would be better for different researcher around the world for coming to Bangladesh and do their research on different issues. As Bangladesh has enough endemic organisms as well as unique natural indicators like mangrove forest and world's longest seas beach.

Plan for Implementation: This type of projects should be run by the board of tourism with the help of DoE. And the administrative bodies should be involved too, for ensuring security and enforcement of law.

11. Including courses about environment and climate change in the education system

Environmental and climate change related courses should be included in the primary, secondary and tertiary level of education. These will help every citizen to have the basic knowledge about environmental and climate change. It will make the future generation more concern about saving the environment and become climate resilient.

12. Zero poverty and 100% employment with green job facilities

Justification: In poverty mitigation, Bangladesh is uprising its situation. The inclination should be maintained as before with green job facilities. To get rid of poverty fully, the people should be ensured of jobs or inspired to be entrepreneur. The social environment also has a great effect on poverty termination. The whole process or system should work together for mitigating this problem as this is one of the driving force of all other problems.

According to UNEP, "Work in agricultural, manufacturing, research and development (R&D), administration and service activities that contributes substantially to preserving or restoring environmental quality"

So Bangladesh should create different job opportunities for the youth who are eager to work for the country's welfare. As a country BD has not so much fossil fuel sources. She might face a great problem in energy generation if the situation of present energy source is not examined and replaced with other renewable sources. In that case, green job opportunity is a must.

Expected results: Of the poverty goes to 0%, then anything can be possible for Bangladesh. The driven force of people is ensuring their daily meal. So, the working capacity would increase and all will be changed for marinating the increasing standard of living.

The new job holders may examine the quality, ensure the green activities, and implement different eco-friendly systems or imposing laws related to environmental management. As Bangladesh has limited resource physically but with her population, she can do better. In future they would lead the youths with their experiences.

Plan for Implementation: To convert to this statement need all department's collaboration as well as the related ministry. The ministry of education is needed, the ministry of commerce is needed and so on. And also Bangladesh need investors for starting different green agencies.

13. Green technology based modern agricultural operation and market system

Justification: Different green technology can be imposed to agricultural system. They should use more bio-composting materials and non-chemical sources, different gene technology can help in this context. The small home farming in urban areas can be a great source of different food items in small scale. It can also lessen the pressure of the farmers. Hydroponic farming can be a great measure in Bangladesh as many of the lands of her lies under water for a certain time. Upgrading of composting, implementation of drought and saline tolerant variant would be great for random use.

The market system should be friendly for agro-products. More preserving cells should be built for ensuring preservation of agro-products.

Expected Result: Without using the chemical fertilizers or less insecticides, the soil fertility would increase. Using different non-land harvesting would lessen the pressure to the soil. With the modern market system, with the use of e-commerce, the farmers would get their valid money for any good. As they can meet the buyer directly through e-commerce system. And modernization would lessen the rotting of food materials.

Plan for implementation: Department of agriculture and associated offices should work accordingly. To implement these processes or modernization, they have to work from the root level. This type of implementation need more baseline data, surveying and remote examination than office works or documents.

14. Online environmental database and forecasting with predictions for all hazards and disasters

Justification: There should be web portal which will provide necessary information on environment and climate change to the grassroots people. All the baseline data on environmental survey should be available online to the citizen of Bangladesh. The climatic data and the predicted models should be shared with public so that they have the idea of present situation and future environmental hazards. It will help the vulnerable groups to be prepared for any hazardous events. The online database should be maintained properly as, the present age is the era of modernization. Simulation through software about different hazards and disaster predictions are common in present butsome strong methodology should be developed of for predicting hazardous events.

Expected Result: People all over the world might get the news about Bangladesh climate and environment with one click. Before any disaster and hazards, it would be easier to take preventive and mitigating steps than the past.

Plan for implementation: ICT department and the administration would implement this system with the help of weather department, SPARSO, relief and disaster management ministry and other experts of remote sensing, GIS, meteorology and other sub-division of prediction and mitigation of disaster and hazard.

15. Bangladesh as a Climate change adaptation knowledge powerhouse

It is known that Bangladesh is one of the most adaptive countries in the world in the context of climate change. Bangladesh is practicing various adaptive measures to combat with the adverse impact of climate change from decades. The adaptation knowledge of Bangladesh can be exported to the other vulnerable countries. The exchange of this adaptive local measures with the other disaster prone countries would be better for them for adapting the calamities. The process and techniques of Bangladesh for adaptation is easy and cost effective, so other countries will be benefited if the experts from Bangladesh train them to adapt in disaster in best possible way. Bangladesh will become the global leader of climate change adaptation.

16. Healthy Bangladesh with no environmental diseases

Justification: In this context, the most important thing is to manage the pollutant in the environment, as most of the environmental diseases which are making people vulnerable are rises from air, water, soil and noise pollution and damage human health. Pollution reduction in different sources and eco-friendly technologies can help to develop healthy Bangladesh.

Expected Result: Less death from diseases from environmental pollution.

Plan for implementation: The health department can work for the survey and judgement of environmental diseases patients, also the minimum rate of exposures to different pollutant can be imposed by them but they can't ensure the maintenance without the law enforcing department. Good law enforcement with other preventing measures in environmental pollution and implementing those could be a solution.

17. Sustainable River management with resolved trans-boundary issues

Sustainable river management, including dredging and illegal infrastructure removal should be done by eco-friendly way. The internal issues can be solved by law enforcement and awareness, but the most important issue about this subject is solving the trans-boundary issues. The trans-boundary meeting and settlement should also consider the issues related to environmental and ecological disturbance.

18. Comprehensive environmental and climate change governance

The experts on relevant field having strong background on the current global and regional environmental negotiations should be placed in different sectors for environment and

climate change governance for the best result. It is another important thing to develop strong and relevant policies for marinating the environment properly. Global negotiations and establishment of environmental laws, protocols and ethics can be done by comprehensive environmental and climate change governance.

19. Decentralization of the capital

Dhaka city suffers from pervading water pollution, air pollution, accommodation crisis, electricity crisis and so on. Every year almost half a million people move to Dhaka and the city has not the infrastructure to accommodate its current residents. Considering the present situation, immediate decentralization and proper adaptation are essential for the development of the country. It includes the decentralization of administration, education, health facilities etc. High manpower dependent industries should be moved to district towns with proper effluent treatment facilities. To ensure this, private and public investors will have to be encouraged to invest in other districts to create employment opportunities. A modern and effective policy, short and long term, should be prepared for this. Without the development of our districts we cannot think for our total development. So, we have to increase the consciousness about decentralization of assets and thus ensuring proper utilization of resources.

20. Ensuring that everyone works together on implementation

This is the most important issues among the issues that are discussed above. As the above systems and measures can't not be implemented without the help of mass people. So the people should make aware of the issue environment and ecology and their usefulness to our lives.

Timeline

Investing in girls							
Climate change mainstreamed		Development of comprehensive national green growth policy			All finance climate finance; all growth green growth		
Climate friendly cities	Elimination of poverty				Infrastructure and support for migrants in all cities		
National mitigation plan			40% Renewable Energy	60% Renewable Energy	80% Renewable Energy	100% Renewable Energy	
Policies	8th FYP; Vision 2021	9th FYP	SDGs; Paris Agreement; 10th FYP	11th FYP	Vision 2041; 12th FYP		Delta Plan
Years	**2021**	**2025-26**	**2030-31**	**2035-36**	**2041**	**2050**	**2100**

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Part-2

Strategies for a paradigm shift in agriculture, aquaculture, animal husbandry and forestry for food security and nutrition in Bangladesh

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Executive Summary

The overall objectives of the study is to focus on emerging issues and challenges in Bangladesh agriculture in the context of the national objective of ensuring food security and adequate nutrition standards over the next decades.

Contribution of Agriculture to GDP Growth and Poverty Reduction

The agricultural GDP grew with an average growth rate of about 3.7% p.a., during 1997 to 2013. Agriculture being an important engine of growth of the economy, government has invested in this sector to develop it for the alleviation of poverty and achievement of food security and the generation of employment opportunities for the huge population of the country are both directly linked to the development of agriculture. The relative shares of crops, livestock and fisheries changed little over the years. The agriculture of Bangladesh is dominated by crops which now account for 68% of total agricultural GDP. We have decomposed changes in aggregate GDP into main components and found that contribution of agriculture in overall GDP growth was 2% during the period 1999-2014 while the leading role in overall growth was played by industry (2.6%). The contribution of the service sector to overall growth was at a smaller rate.

Bangladesh experienced substantial poverty reduction during the last 15 years. During this period, the average annual rate of poverty reduction was 1.4%. It was found that GDP growth had a higher impact on poverty in Bangladesh than other south Asian counties. Regression analysis showed that there is negative relationship between poverty rates and GDP per worker from agriculture and non-agriculture. As GDP per worker increased poverty rate reduced. The estimated coefficient for agricultural GDP per worker is significantly higher than that for non-agriculture GDP. The coefficient of agriculture GDP per worker is -0.39 and is highly significant at the 1% level. It implies that, other things remaining the same, for 1 percent increase of income of agriculture GDP per worker would reduce poverty by 0.39 percent.

Analysis of the shifting paradigm in agriculture and food security: *Productivity status of sector:* Over the last 30 years, rice production tripled from approximately 10 million metric tons in the mid-1970s to almost 34 million tons in 2014/15. Such productivity improvement came through the cultivation of high-yielding varieties under irrigation with use of chemical fertilizers. It enabled Bangladesh to increase food availability to meet the demands of a rapidly growing population.

Total factor productivity (TFP) of rice was analyzed for the period 2004 and 2014 using a panel data from large sample of rice farmers from 64 districts of Bangladesh. It was found that the TFP of modern Aus and Aman rice increased by 2.3% and 19.6%, respectively while the TFP modern boro declined by 16.8% but remained positive and the TFP of total rice increased by 1.9% during 2004-2014. During 2004-2014, rice output produced per man-day labour use increased while it declined for fertilizer.

We have estimated farm specific mean technical efficiency of the sample boro rice farmers of 64 districts in 2004 and 2014 . The mean efficiency of the boro rice growers was 68% in 2004 and it increased to 80% in 2014. It implies that 12% more rice output could be produced in 2014 compared to using same level of inputs used in 2004. It shows that there

is a considerable improvement of the mean technical efficiency of the sample farmers over the last decade. The main driver of reducing inefficiency in rice production was the human capital of the farmer, i.e, education, training and experience of the farmers.

The non-crop agricultural sectors performed better than the crop sector during the SFYP period. In 2013-14, the growth rate for fisheries, forestry, livestock and crop subsectors were 6.19%, 5.05%, 2.83% and 1.91% respectively. Within the agriculture sector, the share of the livestock sub-sector has increased relative to crop, fisheries and forestry. The livestock share of agricultural income increased from 7.6% in 1973–74 to 12.9% in 1998–99 and is projected to increase to 19.9% in 2020.

During 2001/02–2011/12, livestock output grew at 4.0% against the crop output growth of 4.1% (at 1995-96 constant prices). Milk production in the country increased from 1.29 million tones in 1987–88 to 3.5 million tonnes in 2011-12. During the same period production of meat and eggs also sharply increased. It was found that that there is an increasing trend in TFP of milk production for Cross Breed Cows and Local Cows over the past two decades.

During the period 2003-4 to 2013-14 total fisheries production in Bangladesh sharply increased from about 20 lakh MT to 35 lakh MT. The major contribution to such a large increase came from changes in three sources – inland fisheries (capture), inland fisheries (culture) and marine fisheries. In 2003-04, shares of inland capture, culture and marine fisheries were 38%, 39% and 24%, respectively. During 2003-14, the share of inland culture fisheries to the country's total fish production sharply increased to 56%, while the share of inland capture fisheries declined to 22% and marines fisheries also declined to 12%. Also, flood plain fisheries production and case and pen culture also had an increasing trend and contributed positively towards increasing the country's total fisheries production. The trend of pond production over the last two decades has been increasing. There is increasing trend in brackish water shrimp and golda production which could further enhanced through use intensive improved technology. Around 70 to 80% of shrimp produced are exported each year. Marine fisheries provide a livelihood to about 0.51 million fisher folk. Improvement in landing and industrialization of the sub-sector will improve the livelihood of this population. Bangladesh has a coast line of about 714 km and an Exclusive Economic Zone (EEZ) of 164,000 Km2, of which 44% is continental shelf. It offers great potential for marine fisheries production. Ban on hilsha catch during breeding period increased its production considerably over the years. The fishing ban should be continued in the next decades for sustainable reproduction of hilsa and increase of jatka as well as hilsa production.

The drivers of paradigm shift in agriculture for the next decades: ***Driver 1: Soil fertility and fertilizer use:*** Increase in food production and attaining self-sufficiency in Bangladesh requires sustainable growth of the agricultural sector in order to supply adequate food for its increasing population. Bangladesh has a wide variety and complexity of soils. Balanced fertilization is the key to enhancing crop productivity and maintenance of good soil health. It evident from different studies that severe leaching of N and K are going on in the country's soil system causing low productivity of soils and decline in crop yields. Apart from the natural factors, a major reason is unbalanced use of fertilizer. Awareness-raising for balanced fertilizer application and popularization of more efficient fertilizer application

techniques, can help preserve soil quality, raise output, lower costs of production. food production of this country can be increased through expansion of HYVs and balanced use of fertilizer. Timely supply and availability of fertilizer should receive top priority to increase crop production in Bangladesh over next decades.

As part of government policy to promote balanced use of different fertilizers by reducing use of urea and increasing use of non-urea fertilizers, the Government in the past drastically reduced prices of non-urea fertilizers (TSP, MP and DAP) while the price of urea was raised. In line with the Government policy, urea use decreased while TSP and MoP use increased since 2012-13. Although government is trying to promote balanced use of fertilizers for crop production through implementation of fertilizer policy and New Agricultural Extension Policy still there exists high extent of imbalance fertilizer use at the farmers level. There is knowledge gap of the farmers on the recommended fertilizer dose. Promoting balanced fertilizer use could be an important tool for improving agricultural productivity in the next decades.

Driver 2: Irrigation: 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. Agricultural growth in the country has been largely due to the expansion of minor irrigation with private sector investment. There was increasing trend of irrigation growth in Bangladesh from 1982 to 2014. A regression analysis showed that the degree of acceleration in irrigation was stimulated by the market privatization of minor irrigation equipment.

Rice production accounts for 93% of the total Consumptive Water Use (CWU) and 90% of the total irrigation CWU in Bangladesh. Boro rice accounts for almost all the irrigation CWU of rice. The total irrigation water demand (CWU) for Boro rice production in Bangladesh was 11.8 Billion m3 in 2000 with 265 mm per ha CWU. Water demand has increased by 40% to 16.5 Billion m3in 2010 (Amarsinghe. et al, 2014).We have estimated irrigation CWU demand in 2030 and 2050 by using the irrigation CWU per hectare of 2010 level. We have projected that water demand for Boro rice in 2030 will be 17.23 Billion M3 after this period it will stabilize and would remain at 17.23 Billion M3 in 2041 of which 13 Billion M3 would come from ground water.

Groundwater is the source for more than 75% of the irrigated area in Bangladesh (BBS, 2011). It contributed to about 13 Billion m3 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. Already we have caused much stress on ground water level. In order to reduce ground water use we need to increase water use efficiency in crop production and enhance utilization of surface water irrigation. Given the falling groundwater tables and water quality issues in Bangladesh, it will be extremely difficult to exploit groundwater resources. Without an increase in water productivity (WP), it will be difficult to meet future water demand in 2030 and 2041.

Driver 3: HYV Seeds, fingerlings, chicks, breeds and feeds: During the 1990s to 2000s the seed market has been liberalized with the New Seed Policy 1993, Seed Amendment Acts 1997 and 2005, and the Seed Rules 1998 and opened market for participation and rise of private enterprises in seed production, import, and distribution. In Bangladesh the

national requirement for quality seeds of all crops is estimated to be 9,32,250 metric tons. The performance of the seed supply system through quality seed replacement rate (SRR) against national requirement up to 2013-14 was 25% of which about 80 percent seed is being fulfilled through the informal seed system of farmers' own saved seeds. Agricultural growth is dependent on a very wide-scale switch to HYV seed, but seed quality in general remains a major problem. Various related investments are needed to enhance provision of quality seeds in adequate quantities. Some of the non-government organizations and the private sector have started to enter the seed sector with positive impacts on availability, although quality still remains a vexing issue in some cases.

Agricultural growth is dependent on a very wide-scale switch to HYV seed, but seed quality in general remains a major problem. Various related investments are needed to enhance provision of quality seeds in adequate quantities. Some of the non-government organizations and the private sector have started to enter the seed sector with positive impacts on availability, although quality still remains a vexing issue in some cases. Further private-public partnerships for seed, marketing, and extension need to be promoted in the next decades of perspective planning period (2030-41).

Bangladesh has a total of 882 fish hatcheries of which 92 are government and 790 are private across the country. A total of 489,331 kg spawn has been produced from private and Government hatcheries in the year 2014, There is gap in the supply of quality fingerling against requirement. Paradigm shift in aquaculture in the next decades would require a boost in production and supply of quality fish seeds and fingerlings.

Livestock production of Bangladesh could have a paradigm shift in the next decades through enhancing sustainable supply of quality chicks, breeds, feeds, vaccines and veterinary medicines. The production of day-old-chicks (DOCs) is currently lower than the total demand and therefore the chicks are priced higher. Out of 4.9 million milking cows, 4.2 million are local breed and 0.7 million are crossed breed. There is tremendous scope of improving dairy productivity in the next decades through enhancing supply HYV cross breed cows. The acute shortage of feeds and fodder is one of the single most important obstacles to livestock development in Bangladesh. Recently, there are 74 feed manufacturing and marketing company in the country, whereas 35-40 feed industries are in large size and producing poultry and fish feeds but the amount cannot satisfy the needs of the growing poultry farms. Bangladesh produces only 2.73 million tons of commercial animal feeds most of which is used for commercial poultry production against a total poultry feed requirement of 5.94 million tons meeting only 46% of the need. As a result there is enough scope for increasing growth of livestock feed industry.

Driver 4: Agricultural credit: Agricultural credit, as an input, plays an important role in driving the agriculture of Bangladesh towards a sustainable level. Food security, employment generation and poverty alleviation are closely linked with the development of the agriculture sector. There was an increasing trend in disbursement of agricultural credit during 2005-2016. While demand for credit is increasing with the advent of new technologies and high value crops, the supply side has remained less vibrant. According to data of the 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 (MFIs). The demand for credit is much more than that met by non-institutional sources.

Driver 5: Technology generation and adoption: The options for improving agricultural productivity in the next decades are promoting balanced use of land and water resource, improving soil fertility, varietal development, improved technology and mechanization. Technological breakthrough is needed for development improved varieties of rice, wheat, maize, vegetables, spices and fruits. The new HYV varieties should be resilient of diseases and climate change. Supports are needed for development of agricultural research and extension for appropriate technology generation and dissemination for the next decades. The Sixth and Seventh FYP prioritized the importance of research and extension for agricultural intensification, diversification and resilience to climate change.

There could be paradigm shift in production of livestock and fisheries in the country through generation of appropriate technology and technological breakthrough in the context of climate change. Emphasis should be given on improving genetic resources of livestock and fisheries, improved livestock rearing and aquaculture practices and disease control. Research on conservation of native genetic resources should be emphasized.

Driver 6: Agro-processing, value chains and exports: The size of food processing sector is worth US $2.2 billion and grew on an average at 7.7 percent per annum between FY2004/05 and FY2014/15. The food processing sector is thus growing rapidly with prospects for continued growth as Bangladesh's GDP continues to grow. Bangladesh exports over $700 million worth of processed food and beverages, of which over 60 percent are shrimp and fish products. Export of fresh fruits and vegetables from Bangladesh significantly increased in the past decade. Frozen foods are the second largest export sector of the economy. It is estimated that Bangladesh could earn more than $1,800 million per year in 2034 from the export of fresh and processed foods. The export potential of fruit and vegetables is about 160 thousand metric tons and potatoes would be around 200 thousand metric tons.

Projections of food demand and supply in 2030 and 2041

With growing population, planning for future food production to meet food security challenges would require projections of future supply and demand for foods. Using ARIMA models we have projected demand and supply of major food items for the periods 2030 and 2041. Food consumption in Bangladesh has diversified over time. Cereals still provide a major part of the calorie intake, but their share in total calorie consumption has decreased from 92% in 1990 to 89%by 2010. Projections show that it will further decrease to 87% by 2030 and 86% by 2050. The contribution to calorie intake from potato, vegetables, animal and fish products gradually increased during 1990 to 2010 and will continue to increase up to 2030 and 2041.

It was projected that Bangladesh's total demand for rice will be 37.5 million metric tons in 2030 and 39.4 million metric ton (MMT) in 2041. The total demand of potato, pulses, vegetable and fruits in 2030 will be 12.3, 1.2, 7.0 and 3.2 MMT, respectively. The projected demand for these food items in 2041 will be 12.8, 1.2, and 7.3 MMT, respectively. The total demand for meat, egg, milk and fish in 2030 will be 3.2, 2.0, 0.4, 4.9 and 4.2 MMT, respectively. The total demand for these animal products in 2041 will further rise to 2.1, 1.1, 6.0 and 4.8 MMT, respectively.

Total cereal supply (including rice, wheat and maize) will be 43.2 MMT by 2030 and 45.3 MMT by 2041. Total cereal production will be enhanced by 14% by 2030 than the 2013 level and it will be further enhanced by 15% compared to 2013 level by 2041.

Projections show that areas of non-cereal crops, specifically, potato, pulses, vegetables and fruits will expand gradually from 2013 level and will continue up to 2041 as a result of partly substituting land for more remunerative crops. Supply of total animal products will also be enhanced from domestic production to 8.8 MMT by 2030 from 2013 level of 7.00 MMT and further rise to 9.83 MMT by 2041. The individual animal product items like meat, egg, milk and fish will also increase.

Projection of surplus and deficit of food supply

The projections show that Bangladesh will have a surplus rice production of 1.2 MMT and surplus maize production of 1.8 MMT by 2030. On the other hand, the country will have deficits of productions of wheat, potato, pulses, vegetables, meat, egg and fresh water fish amounting 2.6, 0.5, 0.8, 0.7, 1.0, 0.1 and 0.7 MMT. Bangladesh will have a surplus production of rice, maize, potato, vegetable and fruit by 2041 and have deficit production of wheat, pulses, meat, egg, milk and fresh water fish.

Analysis of food security status and safety nets

Availability of food: Per capita rice production has increased substantially over the level at the time of independence. Wheat production is showing a declining trend in recent years. Production of vegetables and fruits also increased, but at a slow rate. 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 2013-14. Per capita availability of cereals (rice and wheat) has been found to increase from 374 gm/day in 1994-95 to 647 gm/day in 2010-11. 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

Access to food: Since 2005 nine million people have been lifted out of extreme poverty. This development helped to achieve the poverty reduction target of MDG1 by 2015. The decline in poverty has been accompanied by an overall improvement of people's purchasing power, which strengthened their ability to access basic foods. The drop in poverty rates has arguably been the most powerful driver as it allows more people to access and afford better diets. The decline in poverty has been accompanied by an overall improvement of people's purchasing power, which strengthened their ability to access basic foods.

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. A large proportion of marginal farmers go to market to access food as their own production is inadequate to meet the household needs. The income growth per year has accelerated since 1990, reaching 7.0 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.

The periodic floods, cyclones and disasters that have affected the country in 2004, 2007, 2010 and 2017 have impacted progress on the food and nutrition situation. The hike in food prices after the food crisis in 2007 and 2017 had a negative impact on the real wages and access to food.

Utilization 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 dominant diet. Over the period, the per capita consumption of rice and wheat has been declining, while the consumption of vegetables, fruits and fish and meat has been growing.

Approximately 9 million Bangladeshi children between six months and five years of age suffer from under-nutrition, with 41 percent of children stunted, 36 percent of children underweight, and 16 percent wasted. Bangladesh has made significant progress in reducing under-nutrition for the children. The nutritional status of women shows a better trend. Malnutrition is also severe in the country. More than 90 percent of rural Bangladeshis are not getting enough vitamins A and have iron deficiency.

Safety net programmes

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 natural shocks. A number of food safety net programmes are in operation in Bangladesh. 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.

Identification of challenges of shifting paradigm in agriculture

The major challenges identified were (i) degradation of natural recourses, Scarcity of surface water for irrigation, Groundwater level decline, Arsenic pollution Drainage congestion, water logging, Low water-use efficiency and productivity and Degradation of forest resources in protected areas, (ii) Climate change, (iii) Constraints of supply of inputs: Inadequate availability of quality seeds to the farmers, (iv) Constraints of agricultural extension and veterinary services, (vi) High post harvest losses. (vii) Constraints of market access and value chains: These include - inadequate market infrastructure and poor transpiration facility, inadequate agro-processing and value addition, inadequate capacity of the stakeholders in the supply chain on safe food issue, (viii) Lack of easy credit to smallholders and market intermediaries (ix) Constraints of availability of agriculture labour, (x) Constraints of farm mechanization, (xi) Degradation of forest resources and low productivity of forestry, (xii) malnutrition and food insecurity related vulnerabilities

Synthesis of recent development strategies:

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.

The new National Agriculture Policy (NAP) 2013 focused on development of sustainable commercial agriculture and adaptation to climate change. 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 perspective plan (2010-21) considered "Achieving food security" and "pursuing environmental friendly development" as broad goals. The *Sixth Five Year Plan* 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 *Seventh Five Year Plan* (SFYP) focused on the need of enhancement of sustainable agricultural production, commercialization, livelihood improvement.

Strategy of recent food production and food security

The Ministry of Agriculture has prepared a comprehensive agricultural policy 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.

The Ministry of Fisheries and Livestock also prepared fisheries and livestock policy. The major policies included in the National Livestock Policy are: (1) promotion of smallholder dairy and poultry development; (2) development of goat, buffalo and duck in high potential areas through special projects; (3) institutional reform of DLS and enactment of laws and regulations for quality control of drugs, vaccines, feeds, chicks and breeding materials; (4) privatization of veterinary services of private good nature; and (5) explore all alternatives for producing fodder.

Fisheries Department has developed a strategy and action plan to implement the fisheries policy. The main objectives are: (1) enhancing fisheries resources and production; (2) generating self employment for poverty alleviation of fishers; (3) meeting the demand of animal protein; (4) increase foreign exchange earnings through export of fish and fisheries products; and (5) maintain ecological balance, conserve biodiversity and improve public health.

Development Strategies for the Perspective Plan (2021-2041)

1. Agriculture, rural development and food security

1.1 Technology generation and dissemination: These include –(i) *Enhance research and technology generation:* (1) For crops, varietals development (short maturing Aus and Aman rice, new HYVs, biotechnology), (2) Promote frontier technology development through enhanced investment in R&D for increasing productivity. This will include activities: (a) Develop new varieties, crops, improving food quality, bio-fortification, nutrition, etc. (b) Enhance agricultural productivity through diversification, sustainable management of natural resources (in flood plain and Chittagong Hill Tract) and inputs. (c) Promote "agro-ecologically suitable" and "climate-smart" agriculture that are effective to feed the population sustainably in the long term. (d) Supporting transformation of agriculture

by building innovative, action-oriented partnerships with different countries. (ii) *Improve research-extension-farmer linkages and extension services.*

1.2 Irrigation and water resource development: These include –(i) Surface water augmentation for irrigation development: Develop water reservoirs, recharge of ground water, reduced use of ground water to avoid hazard of arsenic contamination. (ii) Promote water saving technology for improving water use efficiency: It is necessary to promote installation of facilities to reduce distribution losses. (iii) Reduce impact of saline water intrusion in the South and enhance river water flow: The focused priorities for the coastal region

1.3 Sustainable supply of quality inputs: These include –(i) *Enhance availability of quality agricultural inputs:* There is strong demand to improve sustainable supply of improved quality seed, feed, breed, brood and finger ling to enhance agricultural productivity of the country in the next decades. (ii) *Improve and increase sustainability of soil fertility management:* The proposed interventions are to promote fertilizer use efficiency and balanced use of fertilizer to strengthen environmentally sound fertility management practices.

1.4 Commercialization, agro-processing and value addition: These include –(i) Improvement of road, market infrastructure and storage facilities, (ii) Capacity building of value chain actors and market promotion (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 laboratories at the central and regional level need to be established to facilitate support to food manufacturers, individuals and the enforcement of laws.

1.5 Climate resilient sustainable agriculture: An integrated approach which combines traditional knowledge with innovative strategies needs to be adopted to address current vulnerability while building adaptive capacity to face emerging challenges. Interventions should include: (i) Program to promote adaptive knowledge and technologies among communities/farmers. (ii) Enabling local communities to improve preparedness and participate in effective operation and maintenance of flood protection works, and modeling and or researching the effectiveness of adaptations under extreme climatic events. (iii) Development of salt, drought and flood resistant and heat tolerant crop varieties.

1.6 Interventions for development of fisheries: These include –(i) Development of riverine fisheries. Priorities are Community based fisheries management, Establishment of community managed sanctuary, Expansion of cage and pan culture farming, Ensure quality seed and feed, (ii) Development of Beel and floodplain fisheries. Priorities include: Restoration of habitats and establishment of beel nurseries, Expansion of small-scale aquaculture technologies and establishment of co-management approaches. (iii) Development of pond aquaculture. The priority is expansion of aquaculture technologies,

1.7 Interventions for development of livestock: These include –(i) Improving diagnostic capacity and veterinary clinical services, (ii) Promoting smallholder poultry and dairy development: The priorities are (i) Promoting artificial insemination services (ii) quality feeds and chicks at affordable price, (iii) promoting HYV fodder production, (iv) supply chain development through group marketing, (v) processing and value addition and

(vi) community based vaccination program. (vii) dissemination of livestock and poultry technologies and (viii) strengthening training, demonstration and publicity.

1.8 Agricultural development of thrust areas: This includes investment for agricultural development of the coastal areas, Haor areas and Hill Tract. Agriculture of these areas are less developed with low productivity.

1.9 Enhance productivity of forest: It is necessary to improve productivity of forest and agro-forest. Sustainable afforestation and reforestation of degraded land will contribute to food security by providing fruits and other edible products; energy security by providing fuel wood; livelihood security by employing people in forest plantations; harvesting and trade in forest products; and can protect land from soil erosion and landsides.

1.10 Improved land management: It is necessary to prevent encroachment of agricultural and forest lands from expanding urbanization and non-agricultural uses. The priorities include: (i) *Promote Compact Township to reduce substitution of agricultural land for non-agricultural purposes and (ii) Improvement of land information, land administration and management:* 1.11 Infrastructure development: This includes development rural roads, connectivity, market infrastructure, electricity, communication and transportation system. Construction of flood control and drainage system and polders in the coastal areas.

7.1.11 Farm mechanization: Priorities include- (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.

1.12 Infrastructure development: This includes development rural roads, connectivity, market infrastructure, electricity, communication and transportation system. Construction of flood control and drainage system and polders in the coastal areas

2. Safety nets for food and nutrition security

2.1 Livelihood improvement and food security: The priorities are: (i) Development of programs of alternative income generation and food security to reduce malnutrition of women, children and distressed population. (ii) Development of community based nutrition activities through livelihood approaches (iii) Livelihoods improvement of population of vulnerable and disadvantageous areas of char land, haor, coastal region and Chittagong Hill Tract, (iv) Expand and strengthen programs for supporting women, children, elderly and disable persons, (v) Enhance Investment in Employment and Income Generation Programs with focus on Productive Safety Net program, (vi) Interventions for improvement of public food management: The priorities are: Increase and modernize food storage and handling facilities, especially in disaster prone areas, Strengthen institutional capacities for implementation of safety net program

Introduction

1.1 Background and importance of the sector

Total land area of Bangladesh is about 14.8 million hectares, of which net cropped land is 7.8 million ha. (59%).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 force is still employed in Agriculture.

During the recent decade, the overall Gross Domestic Product (GDP) of Bangladesh has shown a considerably increasing trend. But the growth in agricultural GDP slightly declined, with an average growth of about 3.4% during 1997 to 2014. Agriculture being an important engine of growth of the economy, there is no other alternative but to develop the agriculture sector for the 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.

Bangladesh will graduate out of LDC status by 2021, aspires to reach upper middle income country status by 2030, and expects to become a developed economy in the 2040s decade, through a process of rapid inclusive growth leading to elimination of poverty. The cornerstone of an inclusive development strategy is a robust strategy of job creation through raising agricultural productivity and employment-intensive export-oriented manufacturing growth. The agriculture sector is dynamic, changing with demand of the 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 to climate change. For planning and sustainable development purposes, a diagnostic study of Bangladesh Agriculture is required in order to foster growth of this important sector harmonizing with the management of natural resources and addressing the challenges.

1.2 Objectives of the study

In light of past progress and long-term future outlook for the agriculture sector, globally and in the domestic economy, the overall objectives of the study is to focus on emerging issues and challenges in Bangladesh agriculture in the context of the national objective of ensuring food security and adequate nutrition standards over the next decades.

The following specific issues were covered under the study:

- Analyze the shifting paradigm in agriculture and rural development, noting the growing importance of sub-sectors such as agriculture, aquaculture, animal husbandry and forestry;
- Analyze the leading issues likely to impact agricultural development over the next two decades;
- Examine the potential for sustainable growth in agriculture as an important source for nation's exports.
- How to transform to high-tech modernized commercial agriculture
- Explore Safety-net approaches to handle hunger and vulnerability towards human resource development.
- Evolving approaches to food security and nutrition in the coming decades
- Discussion of effective and inclusive strategies for sustainable agriculture and rural development while ensuring food security and nutrition;
- Suggest strategies and policies for food and nutrition security and safety nets for addressing food insecurity and vulnerability from price and production instability ensuring food security to remove hunger and malnutrition.
- Adaptation and mitigation measures in agriculture under climate change impacts;
- Setting benchmarks, strategies and goals with production targets with a discussion of implementation issues;
- Examine any other issues relevant for sustainable and commercial agricultural sector

2. Methodology

The methodology used includes:

- Collection of primary data: We have used BRAC Survey database of randomly selected households in 62 villages of 62 districts, which have so far been surveyed in four rounds (1988, 2000, 2008 and 2014). This helped the generation of longitudinal panel data at household level to serve as the most credible and confident source of statistics. The 2014 data base - generated by BRAC funding - could be construed as the most recent representation of the national situation on any rural indicator.
- Review of relevant policy and planning documents – Seventh Five Year Plan, Sixth Five Year Plan, Agriculture Policy, Livestock and Fisheries Policy, Food Policy, Input Policy, Irrigation and Land Use Policy, etc.
- Collection of secondary information from BBS, DAE, MOA, MOF, etc. and various on-line resources, etc.
- Analysis and synthesis: different econometric models have been used for estimation and a description of underlying models and estimation techniques have been stated in the Annex.
- Report preparation.

3. Contribution of Agriculture to GDP Growth and Poverty Reduction

3.1 Overview of sectoral growth and contribution of different subsectors

Bangladesh Agriculture plays a dominant role in the growth and stability of the economy. More than three quarters of the total population in rural areas derive their livelihood from this sector. About 48 percent of the labour force is still employed in agriculture.

During the recent decade, overall gross domestic product (GDP) of Bangladesh has shown a considerable upward trend. The agricultural GDP grew with an average growth rate of about 3.4% p.a., during 1997 to 2013. Agriculture being an important engine of growth of the economy, government has invested in this sector to develop it for the alleviation of poverty and achievement of food security, by attaining accelerated economic growth. Since the achievement of food security, and the generation of employment opportunities for the huge population of the country are both directly linked to the development of agriculture, there have been continued efforts by the Government for the overall development of this sector.

Table 3.1 presents the contribution of Bangladesh agriculture to GDP during 1980-2014. There is continuous transformation of Bangladesh's economy as indicated by changes in the sectoral shares of 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 16.3 percent in 2016. Notably, the industry and service sectors have expanded at a good pace at this stage of economic transformation. During 1971 to 2014, value addition of the service sector to GDP increased considerably from 34.2% to 56.1% and value addition of the industrial sector to GDP almost doubled from 13.2% to 27.2% (Table 3.2). Much of the growth in the service sector is related to the marketing and processing of agricultural products resulting from rapid commercialization and diversification in agriculture. Although the relative share of agriculture's GDP to total GDP declined much with the expansion of industry and the service sector, but the size of total contribution of this sector to GDP is increasing at the rate of around 3.4% per annum.. However, 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. The relative shares of crops, livestock and fisheries changed little over the years. The agriculture of Bangladesh is dominated by crops which now account for 68% of total agricultural GDP.

Table 3.1. Trend of structural transformation of sectoral shares in GDP and growth rate at constant prices.

Share (in percent)										
Sector	**1980-81**	**1985-86**	**1990-91**	**1995-96**	**2000-01**	**2005-06**	**2010-11**	**2011-12**	**2012-13**	**2013-14**
Agriculture	33.07	31.15	29.23	25.68	25.03	19.01	18.01	17.38	16.78	16.33
Industry	17.31	19.13	21.04	24.87	26.20	25.40	27.38	28.08	29.00	29.61
Service	49.62	49.73	49.73	49.45	48.77	55.59	54.61	54.54	54.22	54.05
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Average growth rate (in percent)										
Agriculture	3.31	3.31	2.23	3.10	3.14	5.50	4.46	3.01	2.46	3.35
Industry	5.13	6.72	4.57	6.98	7.45	9.80	9.02	9.44	9.64	8.39
Service	3.55	4.10	3.28	3.96	5.53	6.60	6.22	6.58	5.51	5.83

Source: Bangladesh Economic Review 2014.

Bangladesh agriculture is considered central to growth for two reasons. It has a big share of GDP and it stimulates "structural transformation" - the process whereby resources move from low productivity sectors to higher productivity sectors. There are two possibilities for structural transformation. It can be driven by productivity improvements within the agricultural sector and it can be driven by productivity improvement outside the agriculture sector.

Table 3.2. Value addition from agriculture, industry and service sectors during 1971-2014.

Year	Value added (% of GDP)				Industry	Service
	Agriculture					
	Crops	Livestock	Fisheries	Total		
1971-80	38.3	4.2	10.0	52.4	13.3	34.2
1981-90	26.0	4.2	3.6	33.8	20.7	45.5
1991-00	18.6	2.3	4.9	25.8	23.3	50.8
2001-10	13.4	2.2	4.1	19.7	25	55.3
2011-14	11.4	1.8	3.5	16.7	27.2	56.1

3.2 Decomposition of the growth process

We have decomposed changes in aggregate GDP into main components: contribution form the sectors, i.e., changes in growth within sectors and intra-sectoral resource shifts or reallocation effect ("structural transformation") associated with the movement of workers between sectors. The result of decomposition is presented in Table 3.4 and compared with India and China.

The decomposition result showed that agriculture played an important positive role in driving the overall GDP growth of Bangladesh. The contribution of agriculture in overall GDP growth was 2% during the period 1999-2014 while the leading role in overall growth was played by industry (2.6%) (Table 3.3). Bangladesh agriculture grew at a good pace of 3.7% per year from 1999 to 2014, but industry contributed the most to growth, expanding at a spectacular rate of 9% per year. The contribution of the service sector to overall growth was at a smaller rate. The reallocation effect was also at a smaller rate.

Table 3.3 Decomposition of overall growth in output per worker in Bangladesh, India and China

Country, period		Percentage contribution to growth, Decomposition of within sector effect			Decomposition of intra-sector effect
	Total	Agriculture	Industry	Service	Reallocation
Bangladesh 1999–2014	6.4 (100)	2.0 (31.7%)	2.6 (41.3)	0.95 (15.1)	0.80 (11.9%)
India 1993-2004	4.6 (100)	0.5 (10.9%)	0.9 (19.6%)	2.0 (43.5%)	1.2 (26.1%)
China 1978-93	6.4 (100)	1.2 (18.8%)	2.4 (37.5%)	1.1 (17.2%)	1.7 (26.6%)

Source: Author' estimation, for India and China: Bosworth and Collins (2008)

Both in China and India, agriculture played a positive role but not a leading role in driving overall growth. China's agricultural sector grew at a very rapid pace, 4.6 percent per year from 1978 to 2004. But it was industry that contributed most to growth, expanding at a spectacular rate of 10 percent per year. Its service sector also grew as rapidly as industry - even slightly faster on average - but because of its smaller share in output, contributed less to aggregate growth. India's agricultural sector also had a strong but less spectacular 2.5 percent growth rate over the same period.

3.3 Contribution of agriculture to poverty reduction

The emerging pattern of growth in poverty reduction in Bangladesh is encouraging. Bangladesh experienced substantial poverty reduction during the last 15 years (Figure 3.1). During this period, the average annual rate of poverty reduction was 1.4%. It was found that GDP growth had a higher impact on poverty in Bangladesh than that of all South Asian countries in the region, although Vietnam, China, and Thailand had a higher GDP growth rates than Bangladesh and had even further reductions in poverty (World Bank, 2008)

Figure 3.1 Trend in poverty reduction rate of Bangladesh(1999-2014)

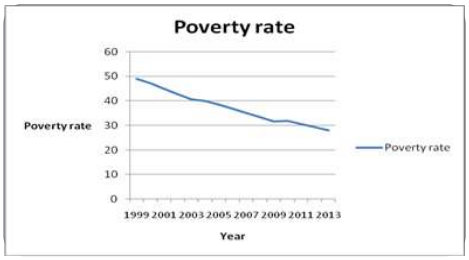
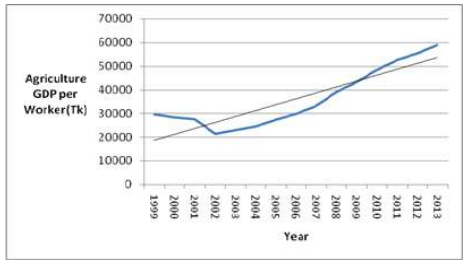
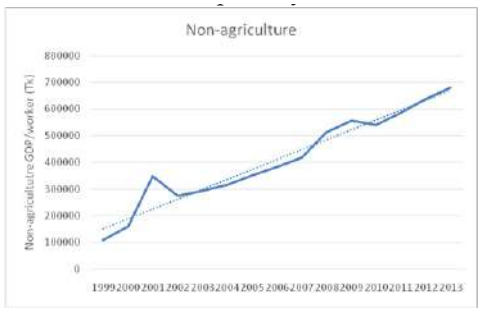


Figure 3.2 Trend in agriculture GDP per worker



During 1999-2014, GDP per worker both in agriculture and non-agriculture increased substantially and contributed to poverty reduction in Bangladesh (Fig 3.2-3.3).

Figure 3.3 Trend in non-agriculture GDP per worker during 1999-2014



It revealed that the there is negative relationships between poverty rates and GDP per worker from agriculture and non-agriculture (Fig 3.4-3.5). This result found was consistent and confirms the findings of a study of Cervantes-Godoy and Dewbre (2010) conducted in 25 countries of Asia and Africa. But, among the two sectors, which has been the most important source of reduction in observed poverty rates? Answering such a question requires, first, quantitative estimates of the statistical relationship between each of the two variables and the poverty rate. We estimated the relationships using a multiple regression analysis to quantify the contribution of growth of GDP per worker from agriculture and non-agriculture to poverty reduction. The estimated coefficients and related statistics are presented Table 3.7.

Figure 3.4 Relationship of agriculture GDP and poverty rate

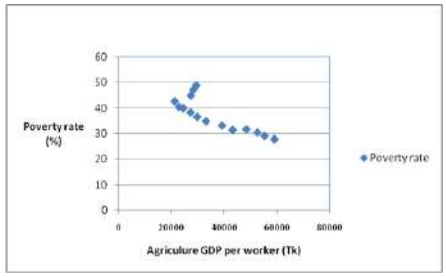
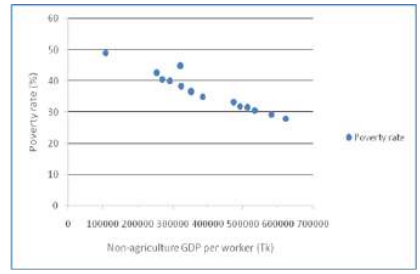


Figure 3.5 Relationship of non-agriculture GDP and poverty rate



The regression model explains a high percentage of variation in the dependent variable of poverty rate of Bangladesh as evidenced by high value of R2 (Table 3.4). The regression coefficients for agricultural GDP per worker and non-agricultural GDP per worker are statistically significantly negative as supported by theory and also confirmed by the data plotted in Figures 3.4 and 35. There is an inverse relationship between the poverty rate and productivity growth of GDP per worker from agriculture and non-agriculture. The estimated coefficient for agricultural GDP per worker is significantly higher than that for non-agriculture GDP. The coefficient of agriculture GDP per worker is -0.39 and is highly significant at the 1% level. It implies that, other things remaining the same, for 1 percent increase of income of agriculture GDP per worker would reduce poverty by 0.39 percent. Similar result that that agricultural development is correlated with reductions in poverty is also confirmed by Ligon and Sadoulet (2007), Irz et al (2001), Diao et al (2008).

Table 3.4 Estimated coefficients of regression analysis of poverty rate and GDP per worker form agriculture and non-agriculture

Variables	Coefficients	t-value	R2	F-value
Constant	2.62	2.90**	0.78	19.79*
Agriculture GDP per worker	-0.39	-4.92**		
Non-agriculture GDP per worker	-0.11	-2.26*		

** Significant at 1% level and * significant at 5% level

4. Analysis of the shifting paradigm in agriculture and food security

4.1. Productivity status of sector

4.1.1 Productivity status of crops

Productivity of rice

The production of main staple rice has shown a long term growth trend of 2.8 percent per annum over the period from 1981/82 to 2014/15. 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.

Figure 4.1 illustrates the trends of rice production over the past 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 2014/15. 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 4.2 presents trends in rice production in Bangladesh by season. It was found that during 1970-2010 growth in Aus rice production was almost stagnant while both Boro and Aman Rice production had increasing trends.

Figure 4.1: Trends of rice production during 1995-2011 period, source: Islam, 2013

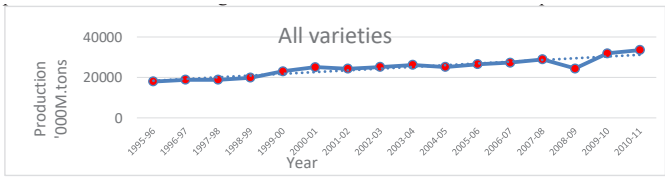
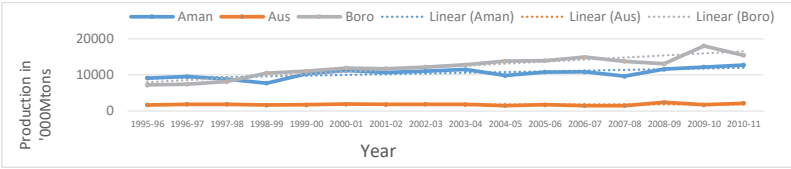


Figure 4.2 Trends of rice production by season during 1995-2011 period, source: Islam, 2013



We have analyzed total factor productivity (TFP) of rice for the period 2004 and 2014 using a panel data from large sample of rice farmers from 64 districts of Bangladesh. It was found that the TFP of modern Aus and Aman rice increased by 2.3% and 19.6%, respectively while the TFP modern boro declined by 16.8% but remained positive and the TFP of total rice increased by 1.9% during 2004-2014 (Table 4.1). The result is found to be consistent with the findings of Alam et al (2011) that during the post-policy reform period the TFP of modern rice declined but was positive. Alam et al (2011) used a panel data set of BIDS, IRRI and IFPRI of the period 1987, 2000 and 2004 from 64 districts of Bangladesh and estimated TFP of modern rice from farm specific information. It was found from our analysis of input-output information from a the sample farmers that during 2004-2014, rice output produced per man-day labour use increased while it declined for fertilizer (Table 4.2). During this period per ha labour use declined (Fig 4.3) while the fertilizer cost increased considerably (Fig. 4.4).

Table 4.1 Changes in TFP of modern rice production of sample farmers of 64 Districts of Bangladesh by season (2004-14)

Year	Mean TFP			
	Aus	Aman	Boro	All rice
2014	113	119	90	108
2004	111	100	108	106
Change (%)	2.3	19.6	-16.8	1.9

Table 4.2 Productivity of labour and fertilizer for modern rice production (2004-2008)

Input used	Rice Output produced (in Kg)					
	MV Aus		MVAman		MV Boro	
	2014	2004	2014	2004	2014	2004
Per man-day labour use	130.22	23.45	128.89	36.06	169.55	45.33
Per Tk invested in fertilizer	0.74	2.09	0.95	2.98	0.89	1.82

Fig. 4.3 Labour use in MV rice (2004-2014)

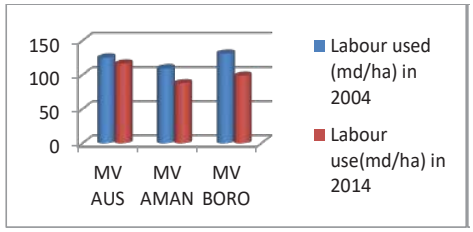
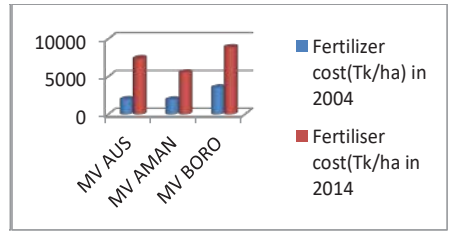
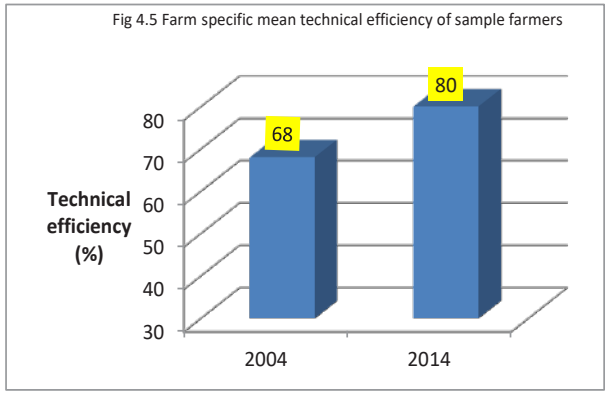


Fig 4.4 Fertilizer cost of MV rice cultivation (2004-14)



We have estimated farm specific mean technical efficiency of the sample boro rice farmers of 64 districts in 2004 and 2014 are illustrated in Figure 4.5. The mean efficiency of the boro rice growers was 68% in 2004 and it increased to 80% in 2014. It implies that 12% more rice output could be produced in 2014 compared to using same level of inputs used in 2004. It shows that there is a considerable improvement of the mean technical efficiency of the sample farmers over the last decade. The main driver of reducing inefficiency in rice production was the human capital of the farmer, i.e, education, training and experience of the farmers.

Fig 4.5 Farm specific mean technical efficiency of sample farmers



Productivity of non-rice crops

The non-crop agricultural sectors performed better than the crop sector during the SFYP period. In 2013-14, the growth rate for fisheries, forestry, livestock and crop subsectors were 6.19%, 5.05%, 2.83% and 1.91% respectively. Between 2007-08 and 2012-13 period, the area under wheat, maize, oilseeds, spices, potato and vegetables increased, though the area under sugarcane and fruits decreased. It was found that production of all the crops

except pulses and banana increased during the SFYP period (Table 4.3). A sharp increasing trend in production was observed for brinjal and edible oilseeds. With the exception of bananas and jackfruit, all the crops maintained an almost steady increasing trend in production since 2009-10.

Table 4.3: Annual change in major non-rice crop production and change in yields (3 year moving average)

Crops	2009-10		2010-11		2011-12		2012-13		2013-14	
	Change(%)		Change(%)		Change(%)		Change(%)		Change(%)	
	Production	Yield	Production	Yield	Production	Yield	Production	Yield	Production	Yield
Wheat	6.1	9.6	7.9	6.3	2.4	5.1	26.1	7.7	3.8	6.3
Maize	21.6	-0.7	14.8	0.9	27.5	5.0	14.4	4.3	4.1	4.4
Potato	50.5	9.3	5.0	5.5	-1.5	1.8	4.8	2.0	4.0	3.3
Pulses	12.5	3.7	3.9	0.5	4.7	3.6	10.7	0.6	-40.7	9.8
Brinjal	1.1	0.8	-0.4	1.0	3.9	2.2	4.8	3.7	20.7	10.4
Oilseeds*	11.9	2.3	5.2	1.4	2.7	4.0	5.4	0.7	16.1	3.5
Mango	1.7	0.0	5.5	8.9	6.3	4.5	1.3	6.3	3.7	-2.9
Banana	-2.1	-3.9	-2.1	-2.7	-6.8	-3.7	3.8	1.9	-0.5	4.2
Jackfruit	3.1	2.3	-4.4	-2.1	-3.6	-1.6	3.0	1.1	5.0	7.9

Note: * Includes sesame, rape & mustard, groundnut and soya bean, Source: FPMU 2013, 2014 and 2015

4.1.2 Productivity of livestock

During the last three decades a structural transformation has taken place in Bangladesh agriculture. The country has achieved self-sufficiency in food grain production due to an appreciable growth rate in the sector but the share of agriculture in GDP has declined relative to other sectors. Within the agriculture sector, the share of the livestock sub-sector has increased relative to crop, fisheries and forestry. The livestock share of agricultural income increased from 7.6% in 1973–74 to 12.9% in 1998–99 and is projected to increase to 19.9% in 2020. During 1973/74–1989/90, livestock output grew at 5.2% per annum compared to 1.7% for crop output and 2.6% for agricultural output in general (Hossain and Bose 2000, Jabbar, et al, 2005). During 2001/02–2011/12, agricultural output grew at 4.2% while livestock output grew at 4.0% against the crop output growth of 4.1% (at 1995-96 constant prices). Milk production in the country increased from 1.29 million tones in 1987–88 to 3.5 million tonnes in 2011-12. However, current national production is inadequate to meet demand. During the same period production of meat and eggs also sharply increased (Fig. 4.6 and 4.7).

During last two decades there was a rapid growth in demand for livestock products due to income and population growth and urbanization. The demand growth for livestock products Bangladesh is expected to continue well into the nest two decades, creating the opportunity for a veritable Livestock Revolution if the increased demand can be met from increased domestic production. Producers may gain through increased income and employment and consumers through access to cheaper livestock products. Evidence from field studies in Bangladesh show that rural poor and landless households typically derive a larger share of their cash income from livestock than do well-off farmers (Jabbar and Islam. 2004).

Figure 4.6 Trend in production of milk and meat

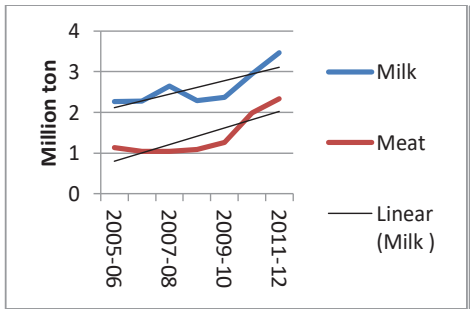
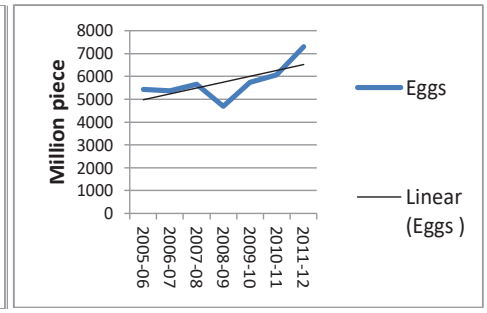


Figure 4.7 Trend in production of egg



Dairy and poultry are the most important livestock enterprises produced by smallholder crop–livestock farmers in Bangladesh. Milk production still remains predominantly in the hands of small-scale mixed farms and landless households with 1–2 local cows, who produce70–80%of the milk in the country. Dairy development efforts through cross-breeding, milk collection and processing for urban markets are limited to a number of milk sheds. Beef fattening are getting popularity with rapid spread of such farms across the country. On the other hand, poultry is the most widely-held livestock species among smallholder farmers, especially poor and landless households and can be considered as a tool for poverty reduction. In response to rapidly rising urban demand for poultry meat and eggs, beginning from the early 1990s, a commercial poultry (broiler and layer) sector has emerged using intensive production techniques(exotic and crossbred birds, concentrate feeds and drugs) and with technical and policy support (subsidized credit, local production and import of DOCs, drugs etc). Demand for livestock product will further increase in the coming decades. Achievement of a high growth rate in the livestock sector has the potential to create employment and income generation for a large number of smallholder producers and others involved in dairy and poultry production, processing and marketing, and get them out of poverty. Dairy and poultry generate more regular cash income and their production, processing and marketing generate more employment/unit value added compared to crops (Asaduzzaman 2000; Omore et al. 2002).

Table 4.4 presents productivity of the livestock sub sector during the sixth Five Year Plan. The contribution of the livestock sub-sector to GDP at constant prices was 2.58 percent in FY 2010-11.The estimated contribution to GDP during FY 2011-12 from this sub-sector was 2.50 percent. Though the share of the livestock sub- sector in GDP is small, it makes an immense contribution towards meeting the daily animal protein requirements. A number of initiatives have been taken for livestock development. The most important ones include: production and distribution of vaccine for poultry and livestock, supply of ducklings and chicks at a cheaper price, artificial insemination extension programme for improved breeds, transfer of improved farming technology, prevention and control of anthrax, foot and mouth diseases and avian influenza.

According to the estimate of the Department of Livestock Services, the population of livestock and poultry rose to 52,836,000 thousand and 288,566,000 respectively in 2011-12. Table 4.5 shows the growth of the livestock and poultry population of the country during 2005-12. Table 4.6 shows increasing trends in production of milk, meat and eggs.

Table 4.4 Productivity of livestock subsector during Sixth Five Year Plan, 2009-14

SFYP output proxy indicators	2009-10	2010-11	2011-12	2012-13	2013-14
GDP from livestock sector as % of agricultural GDP (excluding forest, at constant price 2005-06)	12.4%	14.1%	12.2%	12.3%	14.08%
Total production of Egg (millions)	5,742.4	6078.5	7,304	7,617	10168
Milk (millions MT)	2.37	2.97	3.47	5.07	6.9
Meat (million MT)	1.26	1.99	2.33	3.62	4.52
Annual change in artificial insemination	15.25%	7.67%	10.11%	7.40%	na
Annual change in number of poultry deaths due to avian flu	274%	231%	-75.4%	-95.1%	na

Source: FPMU 2013, 2014 and 2015 & BER (2014)

Table 4.5 Growth of Livestock and Poultry in Bangladesh. (Number in lakh)

Livestock/ Poultry	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2014-15
Cattle	228.0	228.7	229.0	229.76	230.51	231.21	231.95	
Growth Rate (%)	-	0.31	0.13	0.33	0.33	0.30	0.32	
Buffalo	11.6	12.1	12.6	13.04	13.49	13.94	14.43	
Growth Rate (%)	-	4.13	3.97	3.37	3.34	3.23	3.40	
Goat	199.4	207.5	215.6	224.01	232.75	241.49	251.16	
Growth Rate (%)	-	3.90	3.76	3.75	3.76	3.62	3.85	
Sheep	25.7	26.8	27.8	28.77	29.77	30.02	30.82	
Growth Rate (%)	-	4.10	3.60	3.37	3.36	0.83	2.60	
Total livestock	**464.7**	**475.1**	**485.0**	**495.58**	**506.52**	**516.66**	**528.36**	
Growth Rate (%)	**-**	**2.19**	**2.04**	**2.13**	**2.16**	**1.96**	**2.21**	
Chicken	1948.2	2068.9	2124.7	2213.94	2280.35	2346.86	2428.66	
Growth Rate (%)	-	5.83	2.63	4.03	2.91	2.83	3.37	
Duck	381.7	390.8	398.4	412.34	426.77	441.20	457.00	
Growth Rate (%)	-	2.33	1.91	3.38	3.38	3.27	3.46	
Total Poultry	**2329.9**	**2459.7**	**2523.1**	**2626.28**	**2707.12**	**2788.06**	**2885.66**	
Growth Rate (%)	**-**	**5.28**	**2.51**	**3.93**	**2.99**	**2.90**	**3.38**	

Table 4.6 Trend in production of milk, meat and eggs

Product	**Unit**	**Production**						
		2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Milk	Lakh tonnes	22.7	22.8	26.50	22.86	23.65	29.47	34.63
Meat	Lakh tonnes	11.3	10.4	10.40	10.84	12.64	19.86	23.32
Eggs	Lakh piece	54220	53690	56532	46920	57424	60785	73038.9

Total factor productivity (TFP) of milk production of both Cross Breed Cow (CBC) and Local Cow (LC) has been estimated and presented in Table 4.7. It was observed that there is an increasing trend in TFP of milk production for CBC and LC.

Table 4.7 Total factor productivity (TFP) of milk production (per cow/day)

	Local cow			Cross breed Cow		
	1991	2002	2008	1991	2002	2008
Total output (Tk/cow)	14.64	16.11	52.27	13.81	16.24	224.76
Total inputs(Tk/cow)	14.12	13.61	32.85	10.41	10.47	71.23
TFP	1.04	1.18	1.59	1.33	1.55	3.16

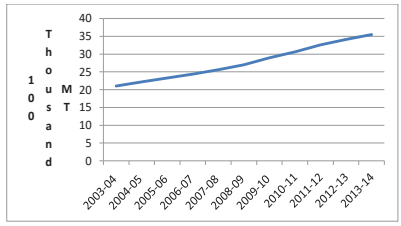
Source: author's estimation

4.1.3 Productivity of Fisheries

The country's fisheries resources can be divided into two major categories such as inland fisheries and marine fisheries. Inland fisheries are further classified into two groups, i.e. inland culture and inland capture. Inland fisheries occupy an area of 47.04 lakh ha with an area of 1,18,813 sq.km along with 200 nautical miles. The culture fisheries include ponds, ox-bow lakes and coastal shrimp farms. The flood-plains and the beels, which cover an area of 29.25 lakh ha, offer tremendous scope and potential for augmenting fish production by adopting appropriate aquaculture enhancement techniques.

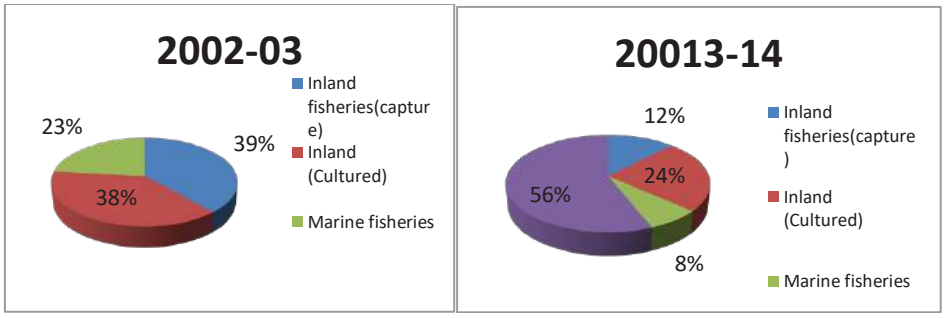
During the period 2003-4 to 2013-14 total fisheries production in Bangladesh sharply increased from about 20 lakh MT to 35 lakh MT (Fig. 4.9). The major contribution to such a large increase came from changes in three sources – inland fisheries (capture), inland fisheries (culture) and marine fisheries. In 2003-04, shares of inland capture, culture and marine fisheries were 38%, 39% and 24%, respectively. During 2003-14, the share of inland culture fisheries to the country's total fish production sharply increased to 56%, while the share of inland capture fisheries declined to 22% and marines fisheries also declined to 12%. Also, flood plain fisheries production and case and pen culture also had an increasing trend and contributed positively towards increasing the country's total fisheries production.

Fig. 4.8 Increasing trend in fisheries production of Bangladesh



Source: Bangladesh Economic Review, 2015, 2010

Fig. 4.9. Share of different sources of fish production to country's total production (2002-14)



Productivity of inland open water fisheries: Bangladesh is rich in terms of inland water resources, including 24,000 km of rivers, streams and canals with an estimated area of 480,000 ha, some 114,161 ha of natural depressions or beels, 68,800 ha of reservoir and some 5.5 million ha of floodplains. Rivers and canals roughly cover 5.8% of the total area

of the country. Annual flooding during the rainy season inundates up to 60% of the total land surface. Permanent flooded areas represent 6.75% of Bangladesh's landmass. After China and India, Bangladesh is the third largest country in the world in inland fisheries. But at present the average yield for inland fishery is low and declining by about 2.7 per cent a year. Inland waters comprise numerous rivers, canals, haors, beels, lakes and a vast area of flood plains amounting to about 4.4 million ha (88.45% of total) and produce about 1.6 million MT which was about 41.36% of total fish production.

Beel fishery has taken a new dimension in certain areas, particularly in the greater Mymensingh region, wherein about 45-50% beels have been brought under intensive pangas cultivation giving a production from 10 MT/ha/year to 40MT/ha/year. Similarly, floodplain fisheries have also become a profitable business following the Daudkandi model of community based aquaculture in the floodplain area. However, some initiatives such as community based management of resources, fingerling stocking in open waters, expansion of cage and pen culture in the open water, Jatka- the juveniles of hilsa - protection and sanctuary development in the open water areas have been taken up, although these are not sufficient. One of the major problems faced by the open water fisheries is the leasing system of the Jalmohal which is based on revenue collection only but the production enhancement and biological management has not been considered. As a result, the poor fisherman's livelihood will not be sustained. Another problem is the open access to the flowing water has restricted the access of the poor fishermen and encouraged the richer. To support the poor fisherman's livelihood from such water bodies, a licensing system should be introduced for the genuine fishermen. Other problems confronting the development of open water fishery are overfishing, lack of proper implementation of fisheries regulations, lack of awareness development and non participation of the community, conflict of water uses, environmental pollution and habitat degradation.

Productivity of Hilsa fishery: Hilsa is our national fish and has the highest contribution to the country's fish production as a single fish species. During the year 1989-90, hilsa contributed 34.14% of the total capture fisheries whereas during 2015, it contributed around 27.35%. Hilsha productivity in Bangladesh is declining over time. The main causes of declining hilsha productivity are destruction of spawning grounds, higher salinity in the spawning grounds and Jatka (young hilsha) killing in the coastal districts. To ensure its steady growth in production, the Ministry of Fisheries and Livestock adopted several management measures since 2008. These include conservation of jatka through declaring five fish sanctuaries in the major nursery and spawning grounds of river system and protection of berried hilsa catches for 15 days during the peak breeding season are the most important initiatives. The fishing ban was found effective for successful breeding of hilsa. The study of Rahman et al (2015) showed that fishing ban during spawning seasons have significant role in the successful reproduction of hilsa. The fishing ban should be continued in the next decades for sustainable reproduction of hilsa and increase of jatka as well as hilsa production.

Productivity of marine fisheries: Bangladesh has a coast line of about 714 km and an Exclusive Economic Zone (EEZ) of 164,000 Km2, of which 44% is continental shelf. It offers great potential for marine fisheries production. In spite of this high potential, this sub sector contributes only about 21% of the total fish production among which

artisanal fisheries contributes 93% and industrial fisheries only 6% of the total marine fish production. Though the Bay of Bengal has about 442 species, only about 20 species are harvested commercially. The trend of marine fishing over the last 15-16 years has been declining.

Data indicated that, as inland sources were being gradually depleted, pressure has been mounting on the remaining marine and estuarine sources. Therefore, marine and estuarine sources are being over exploited, which might lead to diminishing fish resources in these regions in the near future. Indiscriminate and over fishing have already been reported to leading fish resources in the coastal seas to near-exhaustion. Illegal fishing by other countries is also depleting the country's valuable deep sea resources affecting the fishermen as well. Marine fisheries provide a livelihood to about 0.51 million fisher folk. Improvement in landing and industrialization of the sub-sector will improve the livelihood of this population.

Productivity of cultured fishery

Pond culture: Fish culture in ponds has been practiced in a total area of about 3.7 lakh ha which is 7.9 % of total inland water. Pond aquaculture is producing about 19.6 lakh MT fish contributing 56% of total inland production in 2013-14. The average productivity of pond fish is 3,430 kg/ha (DOF, 2013). Pond aquaculture is contributing about 866,049 MT representing 41.92% of total inland production (2839 Kg/ha), which is far lower compared with other neighbouring countries.

The trend of pond production over the last two decades has been increasing. Most of the pond production involves poly-culture. Under monoculture of certain species (catfish, tilapia, perch), average production reached up to 3,500-4,000 kg/ha/year. Under the improved poly-culture system, production was found to be doubled. Intensively managed ponds, using improved fingerling, commercial feed and good pond management practices produced up to 10,000 kg/ha/year (NMTPF 2010).There are instances that private farmers in Narshingdi, Trishal and Mymensingh areas have improved poly-culture systems of carp, pangas and tilapia etc. There are records of producing over 40 tons per hectare of pangas under intensive farming with improved supplemental feeds in the Trishal area. In the greater Mymensingh region, most of the aman and boro lands are being converted into ponds for pangas culture. As a result, the total pond area has been increasing. This trend of fish cultivation has already been expanded throughout several districts in the country. The future development of aquaculture depends on the status of existing resources and the potential for bringing more resources under management using aquaculture principles.

Fish culture in the floodplain and paddy field: An opportunity for increased production in the flood-prone ecosystem is the integration of fish culture with rice farming. The flood-prone areas are seasonally flooded during the monsoon and remain submerged for 4 to 6 months. Community-based management approaches have been successfully used to culture fish in the floodplain. It has been estimated that paddy fields cover an area of about 80 lakh ha of which 28.34 lakh ha are floodplains which remain under water for 4-5 months. Government has taken the initiative to increase fish production from these flood plains through stocking fish fingerlings.

The Department of Fisheries (DoF) along with partner NGOs has taken initiatives to maximize fish production from rice fields and to extend the coverage area. The fish production obtained from the floodplain aquaculture projects in and around the Daudkandi area ranges from 2.5 to 3.0 ton/ha. It is very encouraging for the landowners and farmers to have the additional income from their land within a 4-6 months period, when land is usually left fallow. The farmers on average get a gross return of Tk. 176,385/ha and a net return of Tk 61,077 /ha. Flood plain fish culture is now intensively practiced in the Teesta Basin regions of Rangpur, Kurigram, and Nilphamari districts. If 10% of paddy fields come into this culture system where paddy fields go under water, then about 85 lakh MT more fish will grow annually producing 300 kg fish per ha (DOF 2013).

Cage and pen culture: The production achieved through cage culture was encouraging and satisfactory. Cage culture of mono sex tilapia is being practised in Chandpur, Laxmipur Faridpur, Barishal, Mymensingh, Dhaka, Munsigonj, Gopalganj, Narshindi, Chapainawabgonj and other regions of Bangladesh. In 2013 about 6750 MT fish was produced from 6000 cages. Pen culture is also one of the potential means of producing fish from vast water bodies or water channels (DOF 2013). The fish species reared in the pen are carp, tilapia, pangas etc. Pen culture is also becoming popular in and around Dhaka and Narayanganj and expanding every year.

Productivity of Shrimp culture in the coastal region: Among shrimp producing countries, Bangladesh ranks fourth with respect to area under shrimp farming and sixth in volume of production. Among the coastal districts, the highest concentration in shrimp farming occurred in Bagerhat, Khulna, Satkhira and Cox's Bazar. Again, within these districts the highest numbers of shrimp farms were raised in Shyamnagar, Paikgacha, Rampal and Chakaria Upazilas. By 2012 over 209,456 ha of land were brought under bagda culture. The culture system of bagda varies from traditional extensive to improved extensive. In 2012-13 bagda production in Bangladesh was 57,785 MT. There is increasing trend in brackish water shrimp and golda production which could further enhanced through use intensive improved technology (Fig 4.10-4.11).

Fig 4.10 Trend in brackish water shrimp area and production

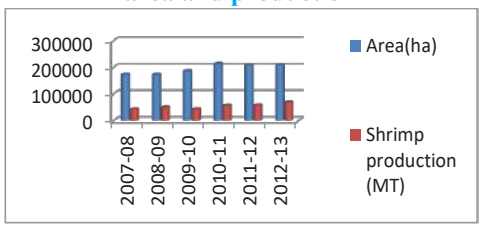
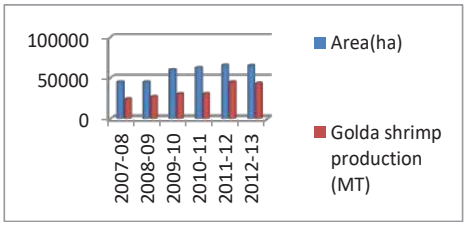


Fig 4.11 Trend in Golda shrimp area and production



Source: Fisheries Statistical Year Book of Bangladesh, 2013,2014

The shrimp farming system in Bangladesh is mostly traditional extensive type with a low level of productivity per hectare. Overall shrimp production has increased steadily over the last 20 years, but is still much lower than that of the neighbouring countries such as Thailand with 800 kg/ha (Samsak et al. 2006) and India with 600 kg/ha (Vasu, 2006). Golda are cultured in gher, pond and paddy fields covering an area of about 0.63 lakh

ha. About additional 0.60 lakh MT fish are produced along with the golda. There is an increasing trend in golda production during 2007-08 to 2012-13. Around 70 to 80% of shrimp produced are exported each year.

Currently the shrimp sector is facing a number of problems. These are: land use conflicts among the various user groups and agencies; social opposition to the environmental effects of large scale bagda monoculture; lack of proper pond engineering design and management; diseases; quality control and post harvest technology; inadequate infrastructure and financial facilities; lack of technical knowledge and skill; lack of resources information and non compliance.

4.2 The drivers of paradigm shift in agriculture for the next decades

4.2.1. Driver 1: Soil fertility and fertilizer use

Bangladesh has a wide variety and complexity of soils at short distances due to the diverse nature of physiographic conditions, parent materials, land, 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. Most of the soils of the country are depleted and are in urgent need of replenishment with organic matter and fertilizers in order to enhance crop productivity.

Balanced fertilization is the key to enhancing crop productivity and maintenance of good soil health. It evident from different studies that severe leaching of N and K are going on in the country's soil system causing low productivity of soils and decline in crop yields. Apart from the natural factors, a major reason is unbalanced use of fertilizer. Awareness-raising for balanced fertilizer application and popularization of more efficient fertilizer application techniques, can help preserve soil quality, raise output, lower costs of production.

Increase in food production and attaining self-sufficiency in Bangladesh requires sustainable growth of the agricultural sector in order to supply adequate food for its 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 expansion of HYVs and balanced use of fertilizer. Timely supply and availability of fertilizer should receive top priority to increase crop production in Bangladesh over next decades.

There has been a progressive shift in fertilizer policies in Bangladesh. In 1970s fertilizer was popularized with introduction of heavy subsidy. Later Bangladesh gradually moved towards privatization, deregulation, and a reduction of subsidies, which began in the mid-1980s and continued until the mid 1990s. This was partially reversed following the severe fertilizer crisis in 1995. During the global food price crisis in 2007-08 public sector roles were further strengthened towards market intervention and providing subsidy of fertilizers for achieving self-sufficiency and food security.

Growth in urea fertilizer use was 4.24 during 1984-85 to 2011-12 (Table #). Fig # shows that annual consumption of urea fertilizer had increasing trend during 1981-82 to 2007-08. Thereafter, the growth rate of urea declined. But the growth rate of TSP and MP sharply increased during 2004-12 due to government subsidy on these fertilizers. It promoted towards use of balanced fertilizer (Table 4.8).

As part of government policy to promote balanced use of different fertilizers by reducing use of urea and increasing use of non-urea fertilizers, the Government drastically reduced prices of non-urea fertilizers (TSP, MP and DAP) while the price of urea was raised from 2008-09. The price of urea reached Tk 16/kg in 2013-14, from Tk 6/kg in 2008-09. For non-urea fertilizers prices in 2013-14 were at least one-fifth of the price in 2009-10. Compared to 2009-10, subsidy on urea and non-urea in 2012-13 was raised by nearly 2.44 and 3.38 times respectively. The process of rebalancing subsidy among different fertilizers started from 2007-08. The share of the subsidy to urea was reduced from 89% in 2007-08 to 40% in 2012-13 (FPMU 2014). In line with the Government policy, urea use decreased while TSP and MoP use increased, though use in 2012-13 was marginally lower than that in 2011-12 (Fig 4.12).

Figure 4.12. Fertilizer use by different types in Bangladesh: 1981-82 to 2011-12

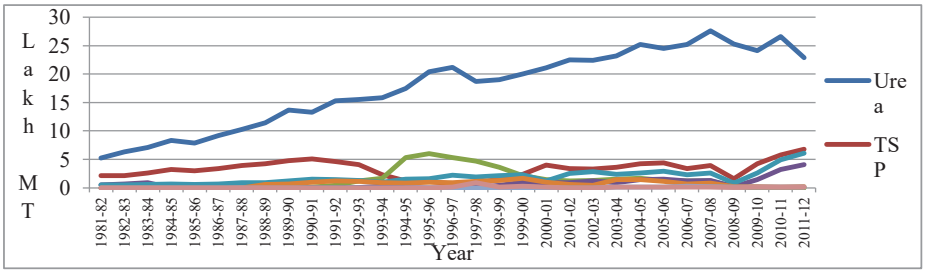


Table 4.8 Growth rates (Percentage) of fertilizer consumption over time (1984-85 to 2011-12)

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

Although government is trying to promote balanced use of fertilizers for crop production through implementation of fertilizer policy and New Agricultural Extension Policy still there exists high extent of imbalance fertilizer use at the farmers level (Table 4.9). There is knowledge gap of the farmers on the recommended fertilizer dose as well as risk on the increased investment of fertilizer, lack of money to purchase high priced non-urea fertilizers are the some of the reason for not using balanced fertilizers or recommended dose. Promoting balanced fertilizer use could be an important tool for improving agricultural productivity in the next decades.

Table 4.9 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	4.26	72.28	75.36
T. Aman	166	101	69	135	30	24	18.67	70.30	65.22
Boro	269	131	121	192	47	37	28.62	64.12	69.42

4.2.2 Driver 2: Irrigation

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 from 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 a necessary precondition to enhancing agricultural production in Bangladesh in the next decades.

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. Irrigation policy in Bangladesh has been evolved in 2-3 stages. The irrigation policy of Bangladesh evolved from operating state owned nationalized irrigation system towards privatization. As a result of a policy shift towards privatization of irrigation equipment, STWs under private ownership played a significant role for irrigation development during the 1980s with a sharp increase in use of STWs. During the 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.

Agricultural growth in the country has been largely due to the expansion of minor irrigation with private sector investment. There was increasing trend of irrigation growth in Bangladesh from 1982 to 2014. In 2014, the national irrigation coverage was 6.5 million hectares which is 77.6% of the total cultivable land, where groundwater covered 65.4% and surface water covered 34.6% of the total irrigated area (MoF, 2014).

The following linear trend lines were fitted on the time series data on irrigated areas from 1976 to 2008 to assess the degree of acceleration in irrigation that was stimulated by the market privatization of minor irrigation equipment.

Total irrigated area (000 ha) = 540 + 108 Time variable– 830 Dummy variable + 59 Time*Dummy, the standard errors of the estimates are: (4.18), (6.68), (3.55) and (3.40) respectively, R2= 0.98

Shallow Tubewell irrigated area (000 ha) = -154 + 87 Time – 612 Dummy + 66 Time* Dummy, the standard errors of the estimates are: : (-1.52), (5.89), (-3.73) and (4.16) R2=0.99. Where Dummy is a dummy variable to represent the period of privatization that takes a value of 1 for the period 1988 to 2008 when the irrigation market remained fully privatized and a value of 0 for the earlier period when irrigation development was under the control of BADC. The positive and the statistically significant coefficient of the interaction term, Time*Dummy indicates that there has been significant acceleration in the diffusion of modern irrigation since the change in policy in favor of privatization. The

value of the coefficients indicates that the irrigated area accelerated from 108,000 ha per year during the pre-liberalization period to 167,000 ha since liberalization in 1988. In the post-liberalization period, the expansion was entirely due to the use of shallow tube wells. The area irrigated by tube wells increased at a rate of 153,000 ha/year since 1988, which represents a 92 percent expansion of the total irrigated area.

The information obtained from the survey on the ownership of STWs by different groups of farmers is reported in Table 4.10. As noted, only 4.6 percent of the farms owned STWs in 1988, but this grew to 16 percent in 2000, and 22 percent in 2007. Thus, one out of five farmers now own STWs. The data from the survey confirms that the cost of the tube wells has also declined from USD 670 to USD 220 within the last two decades. This decrease is due to the availability of relatively low-cost machines imported from China and the increasing use of second-hand machines. In 2007, almost 90 percent of farmers operating over 2.0 ha owned STWs, compared to only six percent for marginal farms operating up to 0.4 ha. The latter group constitutes 52 percent of farm households in Bangladesh.

Table 4.10. Distribution of ownership of STWs in the landownership scale, 1988, 2000, and 2007

Farm size (ha)	Percent of households with own STWs			Average replacement cost of STWs		
(USD per unit)	1988 (n=818)	2000 (n=1,083)	2007 (n=1,131)	1988	2000	2007
Up to 0.4	2.4	2.8	6.8	598	278	194
0.4 to 1.00	2.1	15.6	22.7	692	263	191
1.00 to 2.0	3.9	36.5	60.9	560	280	218
Over 2.0	17.2	81.4	89.7	770	343	273
All farms	4.6	16.1	22.1	671	302	223

Source: Hossain (2009)

Demand for irrigation water

Rice production accounts for 93% of the total Consumptive Water Use (CWU) and 90% of the total irrigation CWU in Bangladesh. Boro rice accounts for almost all the irrigation CWU of rice. Aus and Aman rice have some irrigated area. However, climatic data show that these seasons require hardly any irrigation.

CWU of Boro (598 mm) is 31% and 10% more than the CWU of Aus and Aman rice. Effective rainfall contributes to only 38% of the total CWU of Boro rice. The balance is from irrigation. Boro rice has the highest physical water productivity (WP) (0.56 kg/m3), which is 52% and 84% more than Aman and Aus rice, respectively. The study by Alauddin and Sharma (2013) showed that a large potential still exists for improving rice water productivity in several districts of Bangladesh

The total irrigation water demand (CWU) for Boro rice production in Bangladesh was 11.8 Billion m3 in 2000 with 265 mm per ha CWU. Water demand has increased by 40% to 16.5 Billion m3in 2010 (Amarsinghe. et al, 2014).We have estimated irrigation CWU demand in 2030 and 2050 by using the irrigation CWU per hectare of 2010 level. We have projected that water demand for Boro rice in 2030 will be 17.23 Billion M3 after this period it will stabilize and would remain at 17.23 Billion M3 in 2041 of which 13 Billion M3 would come from ground water.

Groundwater is the source for more than 75% of the irrigated area in Bangladesh (BBS, 2011). It contributed to about 13 Billion m3 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. Already we have caused much stress on ground water level. In order to reduce ground water use we need to increase water use efficiency in crop production and enhance utilization of surface water irrigation. 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 falling groundwater tables and water quality issues in Bangladesh, it will be extremely difficult to exploit groundwater resources. Without an increase in water productivity (WP), it will be difficult to meet future water demand in 2030 and 2041. Alauddin and Sharma(2013) also raised similar concerns about the unsustainable use of groundwater for increasing Boro rice production without sufficiently improving water productivity. Comparison of irrigation CWU and usable groundwater recharge show that a few districts have already passed the sustainable thresholds of groundwater use. These districts include Khulna in the Khulna region, and Bogra and Pabna in the Rajshahi region, where irrigation CWU exceeds the usable ground water recharge. In a few other districts, such as Barisal, Chittagong, Kishoreganj, Kushtia and Rajshahi, groundwater withdrawals for irrigation may exceed the usable recharge (Amarsingheet al 2014).

Two important issues arise from scarcity of availability of irrigation water and rising costs. First, how can water-use efficiency increased to reduce the cost of production of crops, particularly boro rice? Higher water-use efficiency would also reduce energy consumption and lower greenhouse gas emissions, for example, through the adoption of the alternative wetting and drying method. Development of new crop varieties that consume less water can also help reduce boro water needs. Second, how far can surface water be substituted for groundwater, particularly in areas where surface water is more abundant, for example, in the Southwest?

4.2.3 Driver 3: HYV Seeds, fingerlings, chicks, breeds and feeds

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 organization providing agricultural input supply and service-named as the Bangladesh Agricultural Development Corporation (BADC) in 1971. The BADC started its journey with the production of a small quantity of 13.8 tons of quality seeds in 1972. During 2014-15 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 the post green revolution period (1960-80s) there was heavy subsidization of seed and the public sector role played in the seed market through BADC. During the 1990s to 2000s the seed

market has been liberalized with the New Seed Policy 1993, Seed Amendment Acts 1997 and 2005, and the Seed Rules 1998 and opened market for participation and rise of private enterprises in seed production, import, and distribution.

In Bangladesh the national requirement for quality seeds of all crops is estimated to be 9,32,250 metric tons. The performance of the seed supply system through quality seed replacement rate (SRR) against national requirement up to 2013-14 was 25% of which about 80 percent seed is being fulfilled through the informal seed system of farmers' own saved seeds.

During 2013-2014, the SRR of the quality rice seed of HYVs/MVs/Hybrids has increased to about 43 percent from 25% in 2005-2006 of which a major proportion of seed is being fulfilled through the informal seed system of farmers' own saved seeds, The contribution of BADC alone is significant i.e. 39% against 10% in 2005-2006. This has made a significant contribution to the increase in the country's rice production to over 33.9 million tons in 2013-14.

The supply of improved seeds from the BADC, DAE and private companies continued decreasing for the consecutive two fiscal years for all the crops except vegetables (Table 4.11).

Ensuring supply of quality seeds and controlling marketing of adulterated seeds was emphasized in the Sixth and Seventh Five Year Plan. Agricultural growth is dependent on a very wide-scale switch to HYV seed, but seed quality in general remains a major problem. Various related investments are needed to enhance provision of quality seeds in adequate quantities. Some of the non-government organizations and the private sector have started to enter the seed sector with positive impacts on availability, although quality still remains a vexing issue in some cases. Further private-public partnerships for seed, marketing, and extension need to be promoted in the next decades of perspective planning period (2030-41).

Table 4.11: Improved seed supply of BADC, DAE and private companies as a percentage of total agricultural requirements of Bangladesh

Crop	Improved seed supply of as a percentage of total agricultural requirements of Bangladesh				
	2009-10	**2010-11**	**2011-12**	**2012-13**	**2013-14**
Rice	44.5%	57.9%	58.8%	52.4%	33%
Wheat	67.0%	55.1%	71.5%	56.5%	55%
Maize	84.2%	100.0%	95.9%	74.4%	28%
Potato	3.3%	4.2%	11.8%	9.5%	6%
Pulses	2.8%	4.7%	11.8%	14.8%	8%
Vegetables	32.1%	32.7%	19.8%	20.3%	76%
Edible oilseeds*	4.4%	8.1%	11.5%	13.6%	5%

Note: * Includes sesame, rape & mustard, groundnut and soya bean, Source: FPMU 2013, 2014 and 2015

Bangladesh has a total of 882 fish hatcheries of which 92 are government and 790 are private across the country. 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. There is gap in the supply of quality fingerling against requirement.

Paradigm shift in aquaculture in the next decades would require a boost in production and supply of quality fish seeds and fingerlings. The DoF is restoring the natural Breeding habitats of the Halda River to protect natural breeding ground of Indian Major Carps.

The commercial aquaculture and commercial fish feed production in Bangladesh have been increasing rapidly at the same pace in the past 10 years. Sustainable supply of quality fish feed could be a tool for enhancing fish productivity during the perspective plan period 2030-2041.

Livestock production of Bangladesh could have a paradigm shift in the next decades through enhancing sustainable supply of quality chicks, breeds, feeds, vaccines and veterinary medicines. There are 8 grand parent stock farms are in Bangladesh and supplies about 80% of the total demand of parent stock; the rest 20% is imported. There are 82 parent stock farms and hatcheries are in operation in Bangladesh and producing 55-60 lac day old broiler and 5 lac day old layer chicks per week. The production of day-old-chicks (DOCs) is currently lower than the total demand and therefore the chicks are priced higher. Crisis of DOCs and quality feed and instability in poultry sector are the obstacles for the expected growth of the industry. 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. There is tremendous scope of improving dairy productivity in the next decades through enhancing supply HYV cross breed cows.

The acute shortage of feeds and fodder is one of the single most important obstacles to livestock development in Bangladesh. Feed resources for livestock are primarily derived from crop residues and by-products such as straw, grass and tree leaves. Supplementary and concentrate feed are provided rarely and inadequately. This has resulted in stunted growth, reproduction and reduced productivity. One of the major problems in the development of the poultry subsector in Bangladesh is the lack of sufficient and appropriate feed. Recently, there are 74 feed manufacturing and marketing company in the country, where as 35-40 feed industries are in large size and producing poultry and fish feeds but the amount cannot satisfy the needs of the growing poultry farms. Bangladesh produces only 2.73 million tons of commercial animal feeds most of which is used for commercial poultry production against a total poultry feed requirement of 5.94 million tons meeting only 46% of the need. As a result there is enough scope for increasing growth of livestock feed industry.

The manufactured feeds of different feed mills available are not homogeneous in nature and differ in quality. Most of the dairy, poultry and fish farmers are facing the problem of adulterated and inferior quality of commercial feeds. Government intervention is needed for boosting sustainable supply of quality livestock feed in the next decades. 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.

4.2.4 Driver 4: Agricultural credit

Agricultural credit, as an input, plays an important role in driving the agriculture of Bangladesh towards a sustainable level. Food security, employment generation and poverty alleviation are closely linked with the development of the agriculture sector. To strengthen the agricultural and rural credit programme, Bangladesh Bank formulated its Agricultural and Rural Credit Policy and Programme. The objective of this policy is to ensure easy access to the agricultural and rural credit facilities by the farmers from the scheduled banks of the country. There was an increasing trend in disbursement of agricultural credit during 2005-2016 (Table 4.12). During the Sixth Five Year plan period, agricultural credit disbursement steadily increased. During the last two fiscal years, disbursement was more than target whereas in other years it was almost close to the targets (Table 2.11). Recovery of agricultural credit increased by 16% to 143.62 billion taka in 2012/13 from 123.6 billion taka in 2011/12 (Bangladesh Bank 2013).

Table 4.12 Year-wise disbursement and recovery of agricultural credit (In crore Taka)

Fiscal year	Target	Disbursement	Recovery	Balance
2005-06	5982.21	5496.21	4164.35	15376.79
2006-07	6351.30	5292.51	4676.00	14582.56
2007-08	8308.55	8580.66	6003.70	17822.50
2008-09	9379.23	9284.46	8377.62	19598.15
2009-10	11512.30	11116.88	10112.75	22588
2010-11	12617.40	12184.32	112148.61	25492.13
2011-12	13800.00	13132..15	12359.00	25974.97
2012-13	14130.00	14667.49	14362.29	31057.69
2013-14	14595.00	16036.81	17046.02	34632,82
2014-15	15550.00	15978.46	15406.96	32936.80
2015-16	16400.00	17646.39	17056.43	34477.37

Source: Bangladesh Bank

While demand for credit is increasing with the advent of new technologies and high value crops, the supply side has remained less vibrant. The volume of institutional credit is low and the proportion of the public sector in the total volume of institutional credit is even smaller. According to data of the 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 (MFIs) including NGOs and the Grameen Bank. However, the demand for credit is much more than that met by non-institutional sources.

Table 4.13 Agricultural credit disbursement during 2009-14

	2009-10	2010-11	2011-12	2012-13	2013-14
Credit disbursed (billion taka)	111.17	212.84	131.32	146.67	160.37
% of target	97%	97%	95%	104%	110%

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. As of July 2015, there were 527 NGOs registered by the Microfinance Regulatory Authority (MRA). The

average amount of microcredit received per person from MFI sources has been Tk 7,144 (Planning Commission, 2011). The total amount of credit received per person would be higher as people borrow from multiple sources.

As total demand for credit far outweighs its supply, private moneylenders dominate the credit market. Poor farmers have little choice. In order to increase access to credit of the marginal and small farmers it is necessary to promote more flexible credit products with easy interest rate. Also, besides reducing cost of agricultural credit it is necessary reduce risk of investment in agricultural production through introducing different type of insurance.

4.2.4 Driver 5: Technology generation and adoption

Availability of cultivable land will shrink next two decades. So, it will not be possible to increase agricultural production through expansion of cultivable land. The remaining options are promoting balanced use of land and water resource, soil fertility, varietal development, improved technology and mechanization. Technological breakthrough is needed for development improved varieties of rice, wheat, maize, vegetables, spices and fruits. The new HYV varieties should be resilient of diseases and climate change. Supports are needed for development of agricultural research and extension for appropriate technology generation and dissemination for the next two decades.

The government of Bangladesh has given priority to the agricultural sector to boost agricultural production. Increasing the speed 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 4.14 presents information on technology generation and innovations in Bangladesh agriculture during 2004-14.

Table 4.14 Technology generation and innovations in Bangladesh agriculture during 2004-14

Product type	Examples of innovations
Inputs	
Seed	Rice, hybrid rice and maize, Cultivars for potatoes, vegetables, spices 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, color sorters, and graders for rice processing; and solvent extraction for oil seeds and rice bran

The Sixth and Seventh FYP prioritized the importance of research and extension for agricultural intensification, diversification and resilience to climate change. Since 2009-10, the Government of Bangladesh (GoB) agencies developed 23 new rice varieties (Table 2.10). Of these, some important ones are: saline tolerant rice variety BRRI Dhan 61, the world's first zinc-enriched rice variety BRRI Dhan 62, submergence tolerant BINA

Dhan-11 and 12, water logging resistant BINA Dhan-14, BINA Dhan-13, three new stress tolerant rice varieties (BRRI Dhan 55, 56 and 57) and one short duration (BRRI Dhan 58) rice variety. The released varieties are expected to address adverse climatic conditions, particularly in the south and northern regions of the country. For non-rice crops, five new varieties were developed for vegetables, while no new varieties were released for maize and potato in 2013-14 (Table 4.15).

Table 4.15: Technological innovations in varietal development and irrigation coverage

SFYP output proxy indicators	2009-10	2010-11	2011-12	2012-13	2013-14
No. of improved new rice varieties developed by GoB agencies	5	2	5	3	8
No. of new non-rice varieties developed					
Wheat	2	0	2	1	2
Maize	0	0	0	1	0
Potato	2	2	11	13	Na
Pulses	1	5	0	4	2
Vegetables	3	11	7	5	5
Edible oilseeds*	1	7	0	4	4
Fruits	10	4	3	4	2
% of cropped area under irrigation	45.3%	45.8%	46.8%	47.4%	Na
Surface water irrigation area as % of total irrigation area	22.0%	21.3%	21.3%	20.9%	21%
No. of farmers trained on sustainable agriculture practices by DAE (lakh)	13.34	12.78	12.77	12.83	Na

Source: FPMU 2013, 2014 and 2015

There could be paradigm shift in production of livestock and fisheries in the country through technological breakthrough and automation in the context of climate change. Emphasis should be given on improving genetic resources of livestock and fisheries, improved livestock rearing and aquaculture technology, disease control and automation. Research on conservation of native genetic resources should be emphasized.

It is important to mention that a paradigm shift in productivity of Bangladesh agriculture during next two decades would require a technological transformation in agriculture – production, marketing and institutions. Application of technology and automation are going to be key drivers of agricultural productivity as Bangladesh moves into high gear towards becoming a developed country. South Korea is an excellent example of an economy that went through a process of transformation from developing to developed economy, with transforming agriculture in the process. In this regard emphasis should be given on technological back through as well as capacity development of farmers, market actors and concerned institutions.

4.2.4 Driver 6: Agro-processing, value chains and exports

The size of food processing sector is worth US $2.2 billion and grew on an average at 7.7 percent per annum between FY2004/05 and FY2011/12 (USDA, 2012).The beverage industry more than doubled during the same period to US dollar 29 million, with an average growth rate exceeding 8%. The food processing sector is thus growing rapidly with prospects for continued growth as Bangladesh's GDP continues to grow. Bangladesh exports over $700 million worth of processed food and beverages, of which over 60 percent are shrimp and fish products.

About 100 types of fruits and vegetables are exported from Bangladesh to more than 40 countries in the world. Export of fresh fruits and vegetables from Bangladesh significantly increased in the past decade. Table 4.16 presents export growth of fresh fruits and vegetables.

Table 4.16: Export growth of fresh fruits and vegetables

Fiscal Year	Quantity Exported (MT)	Export Value (in Million US$)	Export Growth (%)
2008-09	24670	50.71	-
2009-10	29370	64.21	(+) 26.62
2010-11	48428	109.41	(+) 70.39
2011-12	59573	134.59	(+) 23.01
2012-13	80660	182.23	(+) 35.39

Source: Export Promotion Bureau (EPB) and Hortex Foundation 2013

Table 4.17: Export growth of potato in Bangladesh

Fiscal Year	*Quantity exported (MT)*	*Export value (million US$)*
2011-12	34232	8.50
2012-13	41830	10.93

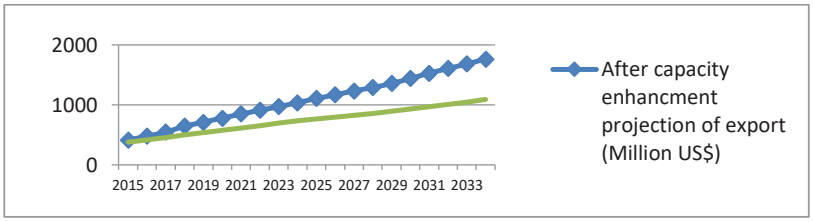
Source: EPB 2014

Frozen foods is the second largest export sector of the economy. The massive natural resources available in Bangladesh make this sector particularly promising for investors looking to supply in international as well as in domestic markets. Export earning from shrimp and fish export in 2016 was around 348.28 million US$ and 348.28 million US$ in 2015.

There is potentials to transform Bangladesh's export markets of fresh, frozen horticultural crops and processed food. It is projected that Bangladesh's export earnings could be around $1,765 million per year from the export of fresh and processed foods in 2034 from base year level export value of 380 million USD (Fig 4.13 and Table 4.18). This would require capacity development of value chain actors, compliance of certification of food quality and safety and improvement of storage and transportation facilities. The export potential of fruit and vegetables is about 160 thousand metric tons and potatoes would be around 200 thousand metric tons. During 2015-2034 total export under business as usual scenario is US $ 14,773 million and under improved scenario is US $21,556 million and additional benefit due to improvement is US $ 6,803 million. Table 4.19 presents top ten vegetables exporters globally. It revealed that similar to Bangladesh's export value of horticultural crops in 2015 the export value of vegetables of Thailand was 562 million USD in 2004 and within a 10 year period it rose to 1797 million USD in 2014.

Though agriculture is the least automated or digitized there is vast scope for automation (not necessarily in farming) in agricultural processing and value chain integration, according to recent research. A paradigm shift in agro-processing in the next decades could be achieved through automation in agro-processing and value chain integration. As South Korea did in the past.

Figure 4.13: Projection of export of fresh, frozen horticultural crops and processed food (Million US$) under business as usual and enhanced capacity



Source: Karim and Islam (2014)

Table 4.18 Projection of export of fresh, frozen horticultural crops and processed food (in Million US$) under business as usual and enhanced capacity scenarios

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

Source: Karim and Islam (2014)

Table 4.19 Top ten vegetables exporters globally (Value in million USD)

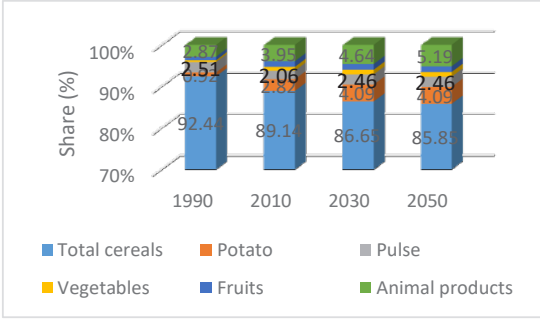
Year	China	Netherlands	Spain	Mexico	USA	Canada	Belgium	France	Thailandd	Italy
2004	2,537	4,336	4,172	2,997	2,151	1,471	1,730	1,733	562	1,003
2005	3,052	4,258	4,308	3,122	2,421	1,714	1,829	1,812	518	1,084
2006	3,715	5,076	4,410	3,479	2,681	1,910	1,967	1,991	673	1,211
2007	4,043	6,122	5,037	3,558	3,010	2,379	2,315	2,431	789	1,416
2008	4,222	6,630	5,528	3,869	3,468	3,039	2,508	2,452	730	1,564
2009	4,853	5,939	5,539	3,694	3,401	3,023	2,295	2,174	858	1,438
2010	7,477	6,779	5,297	4,324	3,785	3,365	2,319	2,385	1,071	1,756
2011	8,723	7,462	5,474	4,992	3,939	3,667	2,312	2,599	1,278	1,696
2012	6,906	6,981	5,591	4,969	4,045	3,169	2,335	2,381	1,371	1,583
2013	7,871	7,906	6,367	5,398	4,405	4,275	2,812	2,773	1,590	1,793
2014	8,226	7,620	6,330	5,420	4,512	4,448	2,579	2,350	1,797	1719

4.3 Projections of food demand and supply in 2030 and 2041

While the on-going efforts of the Government of Bangladesh are contributing towards enhancing agricultural productivity growth and attaining the food security, a quantitative analysis of demand and supply for food is a worthwhile consideration for the perspective plan (2030-2041).With growing population, planning for future food production to meet food security challenges would require projections of future supply and demand for foods. Using ARIMA models we have projected demand and supply of major food items for the periods 2030, 2041 and 2050. In the ARIMA model we have used projected population growth and income growth of Bangladesh for estimation demand for food. The results are discussed below:

Food consumption in Bangladesh has diversified over time. Cereals still provide a major part of the calorie intake, but their share in total calorie consumption has decreased from 92% in 1990 to 89%by 2010. Projections show that it will further decrease to 87% by 2030 and 86% by 2050 (Fig. 4.14). The contribution to calorie intake from potato, vegetables, animal and fish products gradually increased between 1990 to 2010 and will continue to increase up to 2030 and 2050 (Islam 2016).The consumption of animal products (meat, milk, egg and fish) and non-cereals (potato, vegetables and fruits) followed similar increasing trend during 1990 to 2030.Absolute demand for animal products increased from 52.5 kcal/person/day in 1990 to 83.5 kcal/person/day in 2010 and will further increase to 92.8 kcal/person/day in 2030 and to 112.7 kcal/person/day in 2050 (Fig 4.15).

Figure. 4.14. Share of major food items in total calorie intake

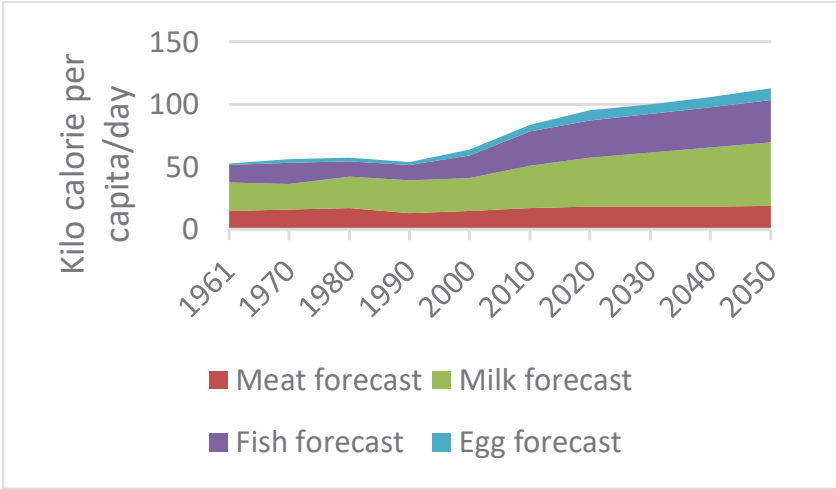


Food demand

Using ARIMA model, we have projected that Bangladesh's total demand for rice will be 37.5 million metric tons in 2030 and 39.4 million metric ton (MMT) in 2041 (Table 2.35).. The total demand of potato, pulses, vegetable and fruits in 2030 will be 12.3, 1.2, 7.0 and 3.2 MMT, respectively. The projected demand for these food items in 2041 will be 12.8, 1.2, and 7.3 MMT, respectively.

The total demand for meat, egg, milk and fish in 2030 will be 3.2, 2.0, 0.4, 4.9 and 4.2 MMT, respectively. The total demand for these animal products in 2041 will further rise to 2.1, 1.1, 6.0 and 4.8 MMT, respectively.

Figure. 4.15. Projection of per capita calorie intake from animal products.



Food supply

Projections of food supply were estimated considering structural changes in the production characteristics/technology of agriculture over the periods 2030 and 2041. Forecasts of ARIMA models, using Business as usual (BAU) scenery, show that supply of rice will be 38.7 MMT in 2030 and 43.2 MMT in 2041. This projection of rice production in 2030 is closely similar to the projection of Ganesh et al, (2013) under BAU scenario. Ganesh et al projected that rice production in 2030 will be 38.8 MMT under BAU scenery. The projection of Amarasinghe et al (2014) shows that production of rice in 2030 will be 49 MMT under BAU scenery. However, a contentious point in the projection of Amarasinghe is the area expansion, mainly for Boro rice, Boro rice area will expand from 4.10 million ha in 2010 to 5.7 million ha by 2030. With increasing pressure on land due to urbanization and development and decreasing availability, it is not plausible whether such a horizontal expansion of area is possible.

Amarasinghe's projection also shows that with the forecasts of yield growth, self-sufficiency of rice is possible even without this area expansion. His estimation shows that even under the pessimistic scenario of lower growth in yield, i.e. along the 75% Lower Limit of Confidence interval (PS scenario), the total rice production of 39 MMT would be more than sufficient to meet the total demand by 2030. But our projections show that expansion of rice area would not be feasible in the long run, beyond 2020 rice area will stabilize (at Aus 1.0 million ha, Aman 5.6 million ha and Boro 4.7 million ha) and remain so up to 2041. This seems more plausible result under the context of increasing population pressure and urbanization on land resources and gradual decline of cultivable land over time in Bangladesh. Moreover, land will shift from rice to high value non-rice crops as a result area of non-rice crop will expand.

Compared to 2013 level, wheat production will increase by 0.6 million ton by 2030 from 2013 level and 0.3 million ton by 2041 from 2030 level as result of slight expansion of

area and yield. Similarly, compared to 2013 level, maize production will increase by 0.7 million by 2030 and will further increase by 0.3 million ton in 2041. Beyond 2041 maize area and yield will stabilize at 0.4 million ha and 7.5 ton/ha. Total cereal supply (including rice, wheat and maize) will be 43.2 MMT by 2030 and 45.3 MMT by 2041. Total cereal production will be enhanced by 14% by 2030 than the 2013 level and it will be further enhanced by 15% compared to 2013 level by 2041.

Projections show that areas of non-cereal crops, specifically, potato, pulses, vegetables and fruits will expand gradually from 2013 level and will continue up to 2041 as a result of partly substituting land for more remunerative crops and partly due to increasing cropping intensity. Per ha yield of potato, pulses and vegetable will increase to 20.5 ton, 1.3 ton and 8.5 ton by 2030 from 18.1 ton, 1.2 ton and 8.0 ton of 2013 level, respectively. As a result, production of potato, pulses, vegetables and fruits will also be enhanced and reach to 11.8, 0.4, 6.4 and 3.6, respectively, by 2030. Fruits production will increase by 2030 because of area expansion. Production of potato and vegetables will further rise to 12.8 MMT, and 7.3 MMT respectively by 2041. Beyond 2030 pulses area will stabilize and its production also does so at 0.4 million tons. But fruits production will slightly increase to 3.3 MMT by 2041 as a result of increasing yield of this perennial crop.

Supply of total animal products will also be enhanced from domestic production to 8.8 MMT by 2030 from 2013 level of 7.00 MMT and further rise to 9.83 MMT by 2041. The individual animal product items like meat, egg, milk and fish will also increase to 0.9, 0.4, 4.3, and 3.2 MMT by 2030, respectively. The supply of these products will rise to 1.1, 0.43, 4.8 and 3.5 MMT in 2041, respectively.

Projection of surplus and deficit of food supply

Bangladesh is self-sufficient in rice now. Rice production was 5% less than the demand in 2005 and in 2000, but there was a surplus of 5% in 2010. The projections show that Bangladesh will have a surplus rice production of 1.2 MMT and surplus maize production of 1.8 MMT by 2030. On the other hand, the country will have deficits of productions of wheat, potato, pulses, vegetables, meat, egg and fresh water fish amounting 2.6, 0.5, 0.8, 0.7, 1.0, 0.1 and 0.7 MMT. Bangladesh will have a surplus production of rice, maize, potato, vegetable and fruit by 2041 amounting 3.8, 1.5, 2.4, 0.1 and 0.2 MMT, respectively. It will have deficit production of wheat, pulses, meat, egg, milk and fresh water fish (Table 4.20).

The policy implication of the above projections is that Bangladesh could export some amount of rice and import wheat and some other non-cereal food. Alternatively, it could reduce rice production and enhance diversified productions of non-cereal food items to reduce deficit by 2030 and 2050.

4.4 Analysis of food security status and safety nets

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). 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.

Table 4.20. Projections of demand and supply of food by 2030 and 2041 (Based on estimates of ARIMA model (Quantity in million ton)

Year	Rice	Wheat	Maize	Potato	Pulses	Vegetable	Fruits	Meat	Egg	Milk	Fresh water fish
Food Demand											
2030	37.5	4.2	1.1	12.3	1.2	7.0	3.2	1.9	0.5	4.2	3.9
2041	39.4	4.5	1.4	12.8	1.2	7.3	3.3	2.1	1.1	6.0	4.8
Food Supply											
2030	38.7	1.6	2.9	11.8	0.37	6.4	3.6	0.9	0.4	4.3	3.2
2041	43.2	1.9	2.9	15.2	0.39	7.4	3.5	1.1	0.43	4.8	3.5
Surplus(+)/deficit(-)											
2030	1.2	-2.6	1.8	-0.5	-0.8	-0.7	0.4	-1.0	-0.1	0.1	-0.7
2041	3.8	-2.6	1.5	2.4	-0.81	0.1	0.2	-1	-.67	-1.2	-1.3

Source: Author's estimation

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.

4.4.1 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 the staple food rice. The Bangladesh economy has made remarkable progress in tripling rice production from 11 million tonnes in 1971 to 34 million tonnes in 2015 for its 160 million people. Per capita rice production has increased substantially over the level at the time of independence.

Wheat production is showing a declining trend in recent years. Its production decreased from 1.6 million tons in 2001-02 to 1.20 million tons in 2013-14. 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 4.1 million tons and 3.7 million tons in 2013-14 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 2013-14 (Table 4.21). 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 4.21: 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
2013-14	33.4	1.20	8.30	0.30	0.84	4.1	3.7

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.

Fresh water fish production in the country increased from 1.89 million tons in 2001-02 to 2.6 million tons in 2013-14. Meat, milk and egg production has also increased significantly over the last ten years and reduced the deficit of demand and supply. But there is still shortage of meat.

Per capita availability

Per capita availability of cereals (rice and wheat) has been found to increase from 374 gm/day in 1994-95 to 647 gm/day in 2010-11. 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. 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.

4.4.2 Access to food

Poverty of Bangladesh has decreased significantly since 1992. Bangladesh's commitment to social protection and safety-net programs has led to a sustained decline in poverty. Since 2005 alone, nine million people have been lifted out of extreme poverty. This development helped to achieve the poverty reduction target of MDG1 by 2015.

The decline in poverty has been accompanied by an overall improvement of people's purchasing power, which strengthened their ability to access basic foods. The drop in poverty rates has arguably been the most powerful driver as it allows more people to access and afford better diets. The major achievements in term of food access are: i) Per capita income has been increased more than two folds in the last 10 years; ii) Employment generation has increased through public and private sector programmes; iii) Number of extreme poor reduced from 44 million in 2000 to 26 million in 2010.

The share of households that do not spend enough to meet their basic needs almost halved over the past two decades, from 56.6 percent in 1990 to 31.5 percent today. Improvements are even more pronounced when applying a lower expenditure threshold. In addition, targeted interventions such as homestead gardening, social protection schemes and nutrition education programmes have facilitated or directly promoted access to a larger variety of foods, and strengthened awareness of the importance of dietary diversity. Regardless of wealth quintiles in the society, malnutrition is pervasive and is present in all sections of the society.

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. 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 to market to access food as their own production is inadequate to meet the household needs.

The results of BIHS data (2011-12) indicated that in 2011–12, 36.8% households in the Government's Feed the Future (FTF) zone and 35.3 percent of households in the rural national sample were food energy-deficient (below 2,122 kcal/person/day) 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 income growth per year has accelerated since 1990, reaching 7.0 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 2015. 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.

One-third of households in the country are affected by food insecurity with significant inequalities in access to food due to gender and age-related issues and great regional disparities. Food insecurity and under-nutrition are generally worse in rural areas and urban slums. The most food-insecure regions are in river flood plains in north-east part, cyclone-prone areas in the southern coastal belt and the southeastern part of Bangladesh.

The periodic floods, cyclones and disasters that have affected the country in 2004, 2007, 2010 and 2017 have impacted progress on the food and nutrition situation. The hike in food prices after the food crisis in 2007 and 2017 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.

4.4.3 Utilization 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 dominant diet. Over the period, the per capita consumption of rice and wheat has been declining, while the consumption of vegetables, fruits and fish and meat has been growing (Table 5.4). 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. 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. Table 4.22 shows that 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.

Table 4.22 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, BBS, various years and Bangladesh National Nutrition Council

The average numbers also mark 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. 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. 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.

Approximately 9 million Bangladeshi children between six months and five years of age suffer from under-nutrition, with 41 percent of children stunted, 36 percent of children underweight, and 16 percent wasted. Bangladesh has made significant progress in reducing under-nutrition for the children (Figure 4.16). There was good decline in the prevalence of underweight children 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) this decline is likely to be related to the reductions in poverty and fertility and improving health services and enrolment in education over the same time frame.. 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 (Fig 4.17).

Fig. 4.16 Trends in Children Nutritional Status

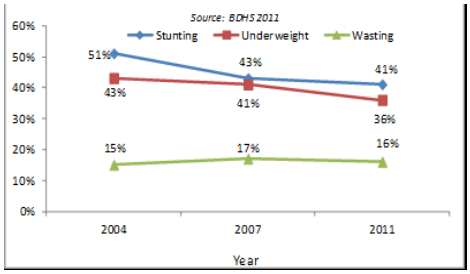
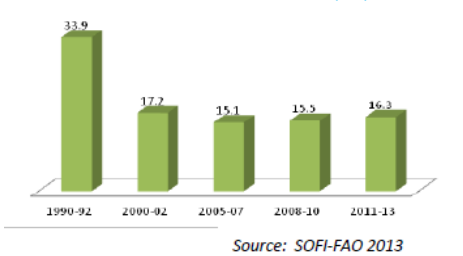


Fig. 4.17 Prevalence of Undernourishment (%)



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 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).

4.4.4 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.

4.5 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 in the coming decades.

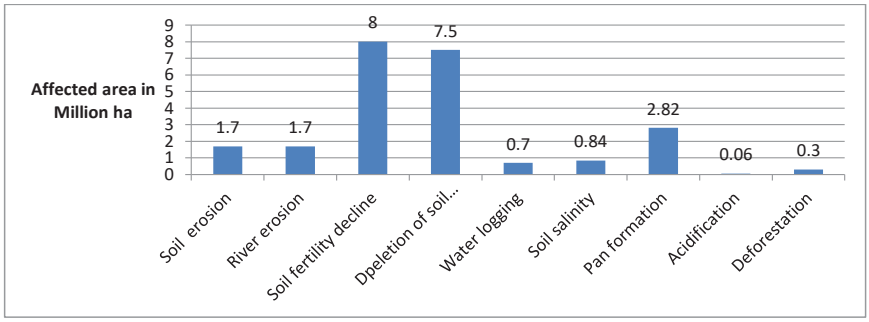
The recent global food price inflation illustrates the critical importance of ensuring food security for a large number of poor people of the country. Past progress in rice production suggests that Bangladesh has the capacity to achieve food security through domestic production. The emphasis on productivity 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 prioritized to address the global food insecurity susceptibility due to climate change.

5.0 Identification of challenges of shifting paradigm in agriculture

5.1 Degradation of natural recourses

One important obstacle that Bangladesh agriculture will face in the next two decades is degradation of its natural resources. The growing population of Bangladesh places stress on decreasing agricultural lands and a waning supply of 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 and building of new infrastructure. In addition, regular degradation is occurring due to soil erosion, river erosion, soil fertility decline, depletion of soil organic matter, water logging, soil salinity, pan formation, acidification and deforestation (Fig 5.1). In the last three decades,170,000 ha area of agriculture land has been affected by increased salinity. Soil fertility is declining in Bangladesh due to imbalanced use of fertilizer, intensification of crop cultivation without appropriate techniques for sustainable natural resources management.

Fig 5.1. Degradation of Agricultural Land in Bangladesh, Source:. Karim, et al, 2001 and Karim 2009



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 kilometres of riverbank are eroding and more than 5,000 kilometres river banks face erosion-related problems in the country. 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 kilometres of riverbank are eroding and more than 5,000 kilometres river banks face erosion-related problems in the country. 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. The charlands are frequently subject to erosion. Active floodplains, i.e. charlands and adjoining bank lines, account for about six percent of total land area of the country and support four percent of the total population.

Scarcity of surface water for irrigation: Expansion of surface water irrigation by LLP has stagnated in recent years, largely due to reduction of trans-boundary stream flows, shrinkage of wetlands and siltation of river resulting reduction of base flow to the river and increased salinity. As the lowest riparian of all the 57 trans boundary rivers, Bangladesh carries huge sediment load through its river system. According BWDB it is ranging to the tune of 1.0 to 1.4 billion ton per year. This resulted in a serious deadlock in the available flow during the dry season. Capital dredging in water resource management is vital in the context of revitalization of the river systems and ecological balance.

Groundwater level decline: Over the last decade irrigated area has significantly increased owing to the rapid expansion of Shallow Tube Wells (STWs). It has already resulted in a continued decline of water tables during the peak dry months and in the .north-west region of the country the situation became already alarming.

Arsenic pollution: It has been reported that arsenic contamination of the tubewells, especially STWs and Hand Tubewells (HTWs), have occurred due to over exploitation of groundwater. Within 59 districts of the country where about 1.44 million tubewells have been affected and people are exposed to arsenic toxicity.[1]

1 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.

Drainage congestion and water logging: Because of low-lying topography the country is inundated during monsoon season each year and vast area remains under water logging condition even after recession of flood. So, drainage is equally important like irrigation; because the benefits out of drainage are: (i) potential increase in cropped area, (ii) higher yield from transplanted Aman rice through early planting, (iii) more control over crop calendars and patterns through control of water regime. But, little attention has so far been paid to the importance of field drainage to intensify crop production and increase yields.

Low water-use efficiency and productivity: Irrigated agriculture of the country is impeded by low water use efficiency and low water productivity i.e. production of crop in kg per cubic meter of applied water. The irrigation water efficiency in STW command areas is below 60% and the water productivity is equally low at about 0.3 kg/cubic meter of water (NMTPF, 2010). This situation has been created by faulty design of equipment, improper matching of pump and prime mover, improper operation and maintenance (O&M) of pump sets, water losses in conveyance and distribution at field level, etc.

Cost of irrigation is one of the vital factors considered for profitable agriculture. Around 90% of the minor irrigation equipments are operated by diesel fuel and the rest are electrically driven prime movers. Cost of irrigation using electrically operated pumping sets are 30 – 35% lower than those using diesel engines. But, major disadvantage is the load shedding, especially during the dry season when demand for irrigation is in the peak.

Degradation of forest resources in protected areas: 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, jhum 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, top soil loss, etc. FAO reported in 1988 that Bangladesh accounted annual losses of about 38,000 hectares of forest between 1980 and 1988. A large tract of forest land is denuded in the north-east and Chittagong hill tract regions..

5.2 Climate change

Bangladesh is currently ranked as the most climate-vulnerable country in the world. Some of the adverse impact of climate change that the Bangladesh agriculture likely to face in the next decades are increasing trend in flood, drought, intrusion of saline water, drying up of wetlands due to decrease of up stream flow and intensification of irrigation, resulting in severe degradation of ecosystems during the dry season. Extreme flood frequency has increased in recent years. The locations most threatened by climate change and natural disasters are charlands, coastal areas, haor areas, flood plain and drought zones of Bangladesh.

According to SRDI produced soil salinity data shows that a large area has become salt affected over 27 years and more than 170,000 ha has been affected in the 11 coastal districts (Table 9.8). The situation has been further aggravated since 2000. This is a very severe threat which affects productivity and livelihoods in the area. Finally, high salinity in groundwater is known to threaten drinking water wells in the coastal zone, particularly at shallow depths, and limit the possibility for groundwater irrigation for crop production.

Climate change will diminish rainfall in the dry season and will increase winter and pre-monsoon temperatures significantly, causing more frequent and more severe droughts in Bangladesh. Some part of the Northern region and some part of the hill region will experience moderate drought during the Rabi and Pre-Kharif season (November to February) by 2030.

The agriculture sector of Bangladesh is very vulnerable to climate change. According to NAPA, temperature rise and drought will affect crops, livestock and fishery of North West region, Sea level rise and salinity intrusion will affect agriculture of coastal areas, flood will affect agriculture of the North East and Central regions and charlands, drainage congestion will affect agriculture of the coastal region, storm surge will affect marine fishing.

Climate change has several after effects on water resources which are: water scarcity, reduction in fisheries production, poverty, lack of potable water, sanitation and hygiene problems, conflict among users and environmental hazards etc. The most important challenge for agriculture in the country is to develop technologies e.g. crop varieties, production packages etc. to escape from the on-set of natural hazards like cyclones, tidal surges, water and soil salinity, floods and climatic changes risks.

Due to its position in the delta, the Southern region is the most affected by environmental risks, including climate change, and has the lowest records of agricultural development. The current agricultural land use in the South consists of transplanted Aman rice, irrigated Boro rice, agroforestry, livestock and fisheries (eg: shrimps), but their productivity constrained by the predominance of traditional technologies. Nevertheless, the region has very good bio-physical resource base and diversified opportunities for integrated crop, fish and livestock farming. Greater R & D thrust wouldbe required for this unfavourable eco-system with a view to boost up agricultural and rural development and food security.

5.3 Supply of inputs

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 seed replacement rate of quality seed against national requirement was 12.61% in 2005-2006 which has increased to 25% in 2014-2015. For improving total crop production, seed replacement rate must be enhanced in the next two decades and the private sector has to be encouraged to play a major role in this endeavour.

5.4 Agricultural extension and veterinary services

The National Mainstream Extension Approach of DAE, DLS and DOF does not have adequate capacity to cope with the emerging challenges in each sector. Equally, research scientists are only slowly adjusting the research agenda to meet the needs of farmers and producers. A technological break through will be needed to coop with the challenges of climate change and boost agricultural productivity in the next two decades (2021 – 2041). This would require strengthening NARS and extension organizations for generation of climate smart technology and dissemination.

Bangladesh is highly vulnerable to infectious animal diseases, with a shortage of quality community based animal health care services, diagnostic facilities and veterinary surgeons, causing serious impediment to livestock production. The quality and quantity of vaccine, medicine and veterinary service delivered by the DLS are inadequate, and the private sector is also not stepping in to fill the void.

Recently there are many emerging diseases for fisheries and shrimp. The current capacity of DOF to address this problem is inadequate due to shortage of skill manpower and diagnostic facilities. Addressing this problem would not only benefit livelihoods of fisher folk, but would increase the exportability of Bangladeshi fishery products.

5.5 Post harvest losses

There is huge post harvest loss of around 20% in rice and 30% in vegetables and fruits. There is 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 estimated total fish production of the country is around 35.5 lakh MT of which 0.89 lakh MT go to waste 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. Recently a number of challenges have been identified by some studies for fish marketing and these are lack of modern infrastructure at lending site and markets, lack of cold storage facilities, lack of refrigerated transportation facilities, unhygienic post harvest handling and exploitation of middle men (Rahman et al., 2013, Ali et al., 2014, Alam et al., 2012, Rahman et al.,2009, Al-Hasan et al., 2014).

5.6 Market access and value chains

Inadequate market infrastructure and poor transpiration facility: Rising income, urbanization, liberalized trade, advancing technology-all are driving the demand for high value fresh and processed agricultural products. This development demand quality and timely delivery of products to the consumers, posing special challenge to the smallholders. The performance of marketing is often hampered by poor transports and inadequate market infrastructure, pushing up transaction cost and price volatility. Improved market infrastructure can reduce the cost of food and uncertainty of supply and improving the food security of poor and nonpoor households (World Bank, 2008), Although there has been substantial expansion of road communication over the past years, existing roads, railways and waterways, particularly in rural areas, are insufficient which pose negative impact on the growth of perishable high value products. Besides road network, attention should be given to improve waterways by re-excavation of rivers and canals. The rail transport facilities fall far short of requirement and need to be expanded and improved for transporting agricultural products at a cheaper rate.

The farmers of char lands and remote areas are suffering with inadequate transports with small number of petty traders. 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. Government initiatives and supports will be required to develop service for enhancing market access for small producers and farmers' groups. Besides, sustainable development is needed for growth centres, rural markets, women market centres and UP complex.

Inadequate agro-processing and value addition: The possibility of processing agricultural products to value added items signifies sizeable potential for the development of the agricultural sector in Bangladesh. Processing of perishable products can also play an important role in reducing wastage of food. Adequate focus on the agro-processing sector to strengthen the links between agriculture and industry will be of critical importance in coming decades. (Gosh, 2014). Although there has been a significant expansion of agro-processing industries, but still there is gap between requirement and supply, more support is needed for further expansion. More agro-processing zones may be developed in different regions with government initiative.

There are also traditional food processing activities at household level where participation of women is high. Such traditional fruits and vegetable processing are suffering from inadequate capital and food quality problem. From a strategic point of view, where possible, policies should be directed at increasing the capacity of traditional actors.

Agri-business and agro-processing activities are extremely limited, 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. The 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.

Inadequate capacity of the stakeholders in the supply chain on safe food issue: 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). The findings of National Food Safety Laboratory revealed the presence of high residues of banned pesticides and chemical preservatives in fresh produce in Dhaka markets (Robson, 2014). 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. As food products move through every stage of the supply chain, it is crucial to extend training to all stakeholders in the supply chain in order to ensure quality and safety of food along the way "from the field to the table".

Lack of easy credit to smallholders and market intermediaries: Credit play an important role in agricultural development and it is believed that expansion of credit programs will have beneficial effect on agricultural production and income of small farmers and traders. It is also key to poverty alleviation, livelihood diversification and increasing the business skill of small farmers and traders. A study showed positive relationship between institutional credit and agricultural production and therefore suggested expansion of agricultural credit disbursement particularly to small farmers (Khondker, 2013). It is also found that timely sanction and hassle free advance is more preferred by the farmers than the lower interest rate. Although in FY2014/15 about Tk.160 billion credit was disbursed to the farmers through different banks, no credit reportedly disbursed to the poor traders in the supply chain of agricultural products (Bangladesh Bank, 2016). Therefore, it is the challenge of government to extend more timely and hassle free credit to the poor farmers as well as poor traders in the supply chain.

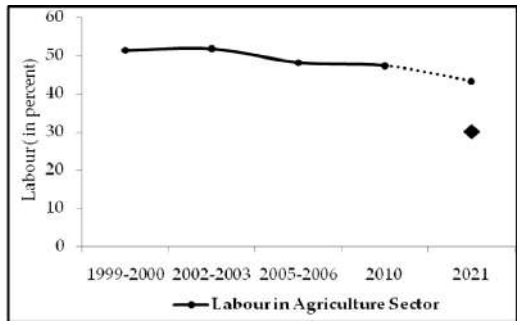
5.7 Availability of agriculture labour

The share of the agricultural sector in informal economic activity in Bangladesh is very high (Sixth Five Year Plan, 2011). The contribution of labour in the agricultural sector is decreasing over the years (Figure 5.2). The participation rate of the labour force in the agricultural sector changed over the decades. Household panel data of BRAC collected from 62 villages of Bangladesh showed that adult male participation in agriculture has sharply declined from 83% in 1988 to 56% in 2000, a decrease of 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's participation has increased by about 8%. Findings indicated that decrease in agricultural activities by adult males was due to less involvement in crop cultivation in recent years. About 79% of 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 to be due to productive and well paid jobs available 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 the labour force engaged in the agricultural sector to 30 percent by 2021. Based upon historical trends, 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 about 10 percent than 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 family members from agriculture to non-farm occupations. With the absence of males, women's role is changing from unpaid family workers to farm managers.

Figure 5.2: Labour employed in agriculture sector



Source: Various Issues of Labour Force Survey, Bangladesh Bureau of Statistics

5.8 Farm mechanization

Modernization in the Bangladesh agricultural sector is going on with the increased use of machineries like power tillers, irrigation equipment, threshers, drum seeders, maize shellers, rice milling machines, 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$ 4,000 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 land, poor buying capacity of farmers, lack of quality machines for farm operation, inadequate knowledge of the users about machines and insufficient awareness of building activities. For the modernization of the agricultural sector, support is needed in 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 expansion of credit facilities for farm mechanization.

5.10 Degradation of forest resources and low productivity of forestry

Deforestation is a cause of land degradation when the steeply and sloping land is cleared or has shallow or easily erodible soils such as in Chittagong hill districts and when clearance is followed by shifting cultivation “Jhum” in the hill districts. Encroachment of forest land due to population 20 pressure and crop/horticultural farming is also regarded as a major cause for deforestation. FAO reported in 1988 that Bangladesh accounted annual losses of about 38,000 hectares of forest between 1980 and 1988. A large tract of forest land is denuded in the north-east and Chittagong hill tract regions. Absence of participatory co-management practices has been identified as the principal cause of degradation.

The output of forests in Bangladesh is one of the lowest in the world. Even within the country the yield of forests managed by Forest Department is less than village forests. Apart from

illicit felling, the productivity is low due poor management practices, low initial survival, incompatible species composition, low soil efficiency, etc. The other problems in low productivity call for immediate addressing appropriate management practices including improving the nursery techniques, selection of site specific species, using quality planting materials, controlling pests and diseases, applying appropriate silviculture practices, etc.

5.11 Malnutrition, stunted growth and food insecurity vulnerabilities

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 labor 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.

6. Synthesis of recent development strategies

6.1 Review of 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.

The new National Agriculture Policy (NAP) 2013, focuses on development of sustainable and profitable agricultural production; development and dissemination of new technologies; crop diversification, commercialization; adaptation to climate change.

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 revised 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 much subsidy on TSP and MP fertilizers for promoting balanced use of fertilizers and enhancing productivity and food security.

The national seed policy aims at balanced growth of both public and private sector seed production and distribution system. Bangladesh has been successful in switching over to high-yielding varieties (HYV) for rice production, the source of its impressive agricultural growth.

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 provided 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) translated 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.

The perspective plan (2010-21) considered "Achieving food security" and "pursuing environmental friendly development" as broad goals. This would be achieved through successive five year plans- *The Sixth Five Year Plan and Seventh Five Year Plan.* Priority was given for crop intensification in the coastal zone. The plan identified interventions for improvement of local and export markets, packaging materials, cool chains, storage facilities at rural level, modern testing facilities and capacity development for SPS compliance and competitiveness.

The *Sixth Five Year Plan* 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 plan provided 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 and adaptation to climate change. It considered "Ensuring food security" as a key strategy emphasizing agro-processing and non-farm economic activities in the backward regions. Some important strategies adopted in Sixth Five Year Plan crop sector:

- Sustainable achievement of self-sufficiency in the production of rice.
- Diversification of agricultural crops.
- Crop intensification in the coastal zone, Sylhet region and the char areas in the northern poverty stricken region.
- Growing high profit non-rice crops in Rabi season
- Motivate farmers to use balanced fertilizers and organic fertilizer to enhance soil fertility.
- R&D for technology development for stress tolerant varieties (salt, submergence and drought tolerance for rice as well as heat tolerance for wheat).

The *Seventh Five Year Plan* (SFYP) focused on the need of enhancement of sustainable agricultural production, commercialization, livelihood improvement. It emphasized post harvest transformation, value chain development and improvement of marketing of agricultural products in Bangladesh through:

- Encouraging wider women participation in homestead based agricultural production, post

- harvest management, agro-food processing, and marketing.
- Creating opportunity for agricultural product processing and establishing agro-based
- industry
- Strengthening agricultural market management system and improving transport,storage and processing facilities; and
- Promoting the effective use of ICT in agriculture.

The development strategies included in the plan were:(i) creating opportunities for Sustainable Agriculture and Green Growth through capacity building of farmers, extension providers, dealers, distributors, entrepreneurs, agribusiness people, trainers and researchers, (ii) introduction and popularization of Good Agricultural Practices (GAP) for safety, quality and creating market opportunities (iii) post harvest management, (iv) value chain development, (v) promotion of easy agricultural credit.

The Country Investment Plan (CIP 2011)- A road map towards investment in agriculture food security and nutrition provided a coherent set of 12 strategic priority investment programmes under three components of food security: access, availability and utilization.

The Master Plan for agricultural Development of the Southern Region of Bangladesh provided a road map for the integrated development of Bangladesh's coastal region focusing on increasing agricultural productivity and sustainable food security. It also designed investment plan for development of market linkage of the small farmers and value chain improvement of high value crops.

The Bangladesh Delta Plan considered intervention for development of market infrastructure, agro-processing, storage facilities development and value chain development of high value crops.

The Sustainable Agricultural Development Strategies for the Chittagong Hill Tracts were developed considering some concerns over environmental degradation and food insecurity in the region and identified priorities: i) enhancing productivity, conservation and diversification, ii) more sustainable Jum, iii) upscaling technology and sustainable input supply, iv) market/value chain development, v) food security and nutrition.

6.2 Strategy of recent food production and food security

Ensuring food security for the poor is a fundamental strategic goal of the Government. 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.

Policy developments and programmes of the Ministry of Agriculture (MoA) is underway and needs for further action. Under subprogramme 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.

The Government budget for the research institutes under NARS 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 focused on farming system research in different agro-ecological zones; and building linkage between research and extension.

The National Agriculture Policy 2013 identified different strategies for research and development in the areas of planning and financing of research, technology transfer, ICT in agriculture, improve agriculture extension services and public private partnership.

Livestock and fisheries development

The Ministry of Fisheries and Livestock also prepared fisheries and livestock policy. The major policies included in the National Livestock Policy are: (1) promotion of smallholder dairy and poultry development; (2) development of goat, buffalo and duck in high potential areas through special projects; (3) institutional reform of DLS and enactment of laws and regulations for quality control of drugs, vaccines, feeds, chicks and breeding materials; (4) privatization of veterinary services of private good nature; and (5) 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 implemented 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 objectives: (1) enhancing fisheries resources and production; (2) generating self employment for poverty alleviation of fishers; (3) meeting the demand of animal protein; (4) increase foreign exchange earnings through export of fish and fisheries products; and (5) maintain ecological balance, conserve biodiversity and improve public health. 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 services to farmers, Fish Act implementation and Jatka protection. As many as 12 development projects supported by different donors were implemented, 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

- Closed water fisheries production.
- Increasing fresh water golda shrimp production in coastal areas.
- Cage culture in flood plains
- Supply of inputs and promotion of technical knowledge among the educated youth for culture of pond and other closed water bodies.
- Adoption and implementation of the concept of fishermen cooperatives in government-owned water bodies.

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 it implemented "National Food Policy Capacity Strengthening Program". 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:

- Promoting food security by sustaining 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 partnership among the Government, private sector and NGOs

7. Development Strategies for the Perspective Plan (2021-2041)

Bangladesh economy is transforming towards a middle income country (MIC) and would further transform to high income country (HIC) in the next 25 years. Agriculture should be linked with the process to play a greater role towards poverty reduction and food security for advanced society. Still majority of the population of Bangladesh depends on agriculture for their livelihoods. It revealed from our analysis that growth in agriculture played greater role for poverty reduction than the non-agriculture sector. Like South Korea we need to design strategies for expected positive transformation in agriculture through technological breakthrough, mechanization as well as institutional capacity development for farm production, marketing, agro-processing and value addition. The economy would demand more high value nutritious food and less cereals and it is expected that the agriculture will be transformed towards sustainable high value commercial agriculture with conservation of natural resources and would accelerate towards agro-processing, value chain development and industrialization. The goal is to transform agriculture with enhanced productivity to meet need of the society as MIC and HIC for food and nutrition security. Considering these, we have designed following development strategies for the Perspective Plan (2021-2041):

7.1 Agriculture, rural development and food security

7.1.1 Irrigation and water resource development

7.1.1.1 Surface water augmentation for irrigation developmen: Develop water reservoirs, recharge of ground water, reduced use of ground water to avoid hazard of arsenic contamination. Key priority investment includes: (1) the development of small scale surface irrigation in the southern part of the country. Thus require new infrastructure and capacity building; (2) partially reduce reliance on deep tube well irrigation in the northern part of the country, reduce costs and mitigate the risk of arsenic contamination; (3) rehabilitate dikes and embankments particularly affected by previous cyclones to protect vulnerable households and production base against sea intrusion in the extreme south, with effective community-based operation and maintenance of infrastructure (4) improved drainage and saline intrusion control in the coastal region and (5) Flood control and management in the Haor area.

7.1.1.2 Promote water saving technology for improving water use efficiency: It is necessary to promote installation of facilities to reduce distribution losses. Priorities include: (i) reduce water losses in existing schemes through improved water management through capacity building of water management organizations, development of water saving crop production technology. Improvement of distribution system is very important to ensure efficient use of irrigation water in light texture soil situation like Teesta Basine Region, where water use efficiency is 28% - 30%. In this context programs should be taken up for construction of buried pipe distribution system with all DTWs and LLPs above 1.00 cusec discharge capacity. And for STWs and LLPs below 1.00 cusec capacity hosepipe should be used to minimize water losses and increase water use efficiency.

7.1.1.3 Reduce impact of saline water intrusion in the South and enhance river water flow: The focused priorities for the coastal region include: rehabilitation of polders and their management; tidal river management; enhanced surface water irrigation; and improved brackish water resource management practices.

7.1.2 Commercialization, agro-processing and value addition

Though agriculture is the least automated or digitized there is vast scope for automation (not necessarily in farming) in agricultural processing and value chain integration, according to recent research. Following interventions are needed:

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.

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.

Establishment of agrot processing zones: Harness opportunities to expand market linkages and agribusiness with establishment of agro processing zones. This will create a big transformation in agriculture and enhance value addition, reduce post harvest loss and accelerate GDP growth

Improving Food Safety and Quality for Consumer Health and Nutrition: Food analytical laboratories 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 of food borne illnesses would therefore be necessary. These would include among others, strengthening capacity of the existing institutions, strengthening consumer protection and improving insufficient food safety activities.

7.1.2 Climate resilient sustainable agriculture

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 needs 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 livelihood 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 communities to improve preparedness and participate in effective operation and maintenance of flood protection works, and modelling/researching the effectiveness of adaptations under extreme climatic events. (iii) Development of salt, drought and flood resistant and heat tolerant crop varieties.

7.1.4 Interventions for development of fisheries

Fisheries and aquaculture is important livelihood for the people of different regions of Bangladesh. The opportunity of development fisheries productions are discussed by habitats as follows:

Development of riverine fisheries

Community based fisheries management: Large area of public water bodies exist in the country with low productivity. The community based fisheries management by involving Community Based Organizations (CBOs) and NGOs is a good option for efficient management of public water bodies. The local administration should arrange for distribution of public water bodies among the real fishers and their capacity to improved productivity need to be enhanced by training.

Establishment of community managed sanctuary: Establishment and maintenance of fish sanctuaries is one of the key instruments to maintain the sources of fish fingerlings and to conserve aquatic diversity. To enhance productivity of riverine ecosystem as well as to conserve biodiversity, wetland sanctuary may be actively considered in feasible locations of Bangladesh. The river, canals and khals in Teesta region are almost silted-up. Government should take up re-excavation program of all the water bodies and in all main courses of rivers and canals delineating potential locations of sanctuaries.

Expansion of cage and pan culture farming: In riverine eco-system cage and pan farming may be introduced by involving local beneficiaries. Teesta barrage water distribution canals, coastal regions and haor regions, Kaptai lake may be considered for cage farming, whereas secondary and tertiary canals could be used for pan farming. To reduce the poverty level of the poor fish farmers/fishers of different regions through creating employment opportunities, expansion of area-specific cage and pan farming in feasible water areas is to be prioritized.

Ensure quality seed and feed: For sustainable aquaculture expansion in the country, seed (spawn/ fry/fingerling) and feeds are the most important production inputs. But now-a-days quality seed and feeds become more crucial for sustaining the aquaculture production. Government interventions are needed to address this issue.

Development of Beel and floodplain fisheries

Restoration of habitats and establishment of beel nurseries: Due to expansion of cropped area fish habitat has severely been destroyed. During lean period the Teesta river bad displayed lot of sand and silt with a narrow water cannel. Until the water flow in Teesta is increased through mutual inter-governmental agreement and dredging of it is done in the downstream, it would not be possible to sustain any fish habitat. Therefore, the priority need is to obtain more water from upper riparian countries by water diplomacy.

Expansion of small-scale aquaculture technologies: In the recent past years small-scale floodplain aquaculture is popularizing at community level. Small-scale aquaculture in potential areas may be actively considered as one of the important adaptation measures of climate change impacts. It could be an alternative option of increasing open-water productivity.

Establishment of co-management approaches: The Government of Bangladesh is accentuating to ensure co-management approaches of the potential beel and floodplain fisheries to explore its due potentials. Through strengthening CBOs, co-management approaches may be established for ensuring biological production system in beel and floodplain fisheries.

Development of pond aquaculture

Expansion of aquaculture technologies: Considering the agro-ecological context, government in collaboration with development agencies and partners is emphasizing for the expansion of drought resistant and short-cycle species in ponds and seasonal water-bodies. To ensure food security in the poverty-prone Teesta Basin area, coastal region and Haor regions, expansion of pond aquaculture could be one of the important alternatives.

7.1.5 Interventions for development of livestock

Increased livestock production will depend ultimately on the adoption of appropriate technologies, improved support services, market access and infrastructural development. Following interventions are needed to explore the potentials of the region for developing the livestock sub-sector.

Improving diagnostic capacity and veterinary clinical service

At present disease diagnostic of capabilities of Department of Livestock services (DLS) is limited and are constrained by lack of skilled manpower and modern analytical facilities. Therefore, support would be required to improve diagnostic capacity and veterinary clinical services of DLS. Promotion of Community Health Worker approaches is required to address the lack of professionals.

Promoting smallholder poultry and dairy development:

Promoting small holder poultry and dairy development is important for agricultural diversification, poverty reduction food security and employment generation. It needs supports for (i) quality feeds and chicks at affordable price, (ii) promoting HYV fodder production, (iii) supply chain development through group marketing, (iv) processing and value addition and (v) community based vaccination program. (vi) dissemination of livestock and poultry technologies and (vii) strengthening training, demonstration and publicity.

7.1.6 Agricultural development of thrust areas

This includes investment for agricultural development of the coastal areas, Haor areas and Hill Tract. Agriculture of these areas are less developed with low productivity due to slow dissemination of improved technology, poor market infrastructure and value chains, high population density and incidence of high poverty.

7.1.7 Infrastructure development

This includes development rural roads, connectivity, market infrastructure, electricity, communication and transportation system. Construction of flood control and drainage system and polders in the coastal areas.

7.2 Safety nets for food and nutrition security

7.2.1 Livelihood improvement and food security

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

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 a food based nutrition approach and also complemented by integrated horticultural development, fish ponds, behaviour change communication and other activities. This strategy will include linking agriculture and food based nutrition to

other nutrition efforts, including health. The proposed programme 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.

Livelihoods improvement of population of vulnerable and disadvantageous areas of char land, haor, coastal region and CHT: All of the chars regions are not easily accessible and people are beset with many problems and suffering. 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. People living in Char lands particularly struggle with floods and river erosion. 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, achievement of the millennium development goals (MDGs), accelerated economic growth and nationwide poverty reduction policies of the Government are hindered. Pioneering work by the government Char Livelihood Project and Char Development and Settlement Project may be mainstreamed and up scaled by covering more geographical areas and increasing the number of beneficiaries. Special extension program need to be promoted to harness the potentials of charlands without depleting soil fertility and process of land formation. Keeping these objectives in mind a coordinated extension program with national and regional NGOs and Public extension service is required with increasing availability of seeds of newly released modern varieties along with skill development of the farming community through training. There are also a few programmes targeted towards the ethnic communities of the Chittagong Hill Tract region which also need to be scaled up in terms of reaching the relatively inaccessible areas.

Expand and strengthen programs for supporting women, children, elderly and disable persons: The NSSS would require to strengthen the transformation towards a life cycle system by consolidation of programmes into a smaller number of priority schemes. The five core life cycle programmes suggested by NSSS are (i) Programme for Children: child grant, school stipend, school meals, immunization, (ii) Programmes for the Working Age: education and training, workfare for the unemployed poor, sickness, maternity and accidental insurance/ allowance, (iii) Comprehensive Pension Scheme for Elderly: old age allowance, universal pension scheme to be funded through employer and employee contribution of both public and private sectors, (iv) Programmes for People with Disabilities: disability benefit for working age population including women, (v) Special Programmes for the Freedom Fighters: to support the freedom fighters and their families under the consolidated freedom fighter benefit programmes..The food based programmes can be made nutrition-sensitive through distribution of micronutrient-fortified rice and wheat. For improving child nutrition and school attendance of children, school feeding has proved to be an effective programme which can be scaled up to a significant extent.

Enhance Investment in Employment and Income Generation Programs with focus on Productive Safety Net programs: There are as many as 8 workfare schemes of which the two largest programmes are Employment Generation Programme for Poorest (EGPP) and Food for Work Programme (FWP). The two missing areas of social security for working

age group are the unemployment insurance promramme and the injured workers' insurance scheme. The lack of any social insurance is more pronounced in the informal sector which accounts for 87.5 percent of all employment (NSSS 2015). These aspects need to be paid due attention in reforming the present social security system.

Interventions for improvement of public food management

This includes investment on development of public food storage and safety net programs for the vulnerable population of the country:

Increase and modernize food storage and handling facilities, especially in disaster prone areas: The frequency of occurrence of environmental shocks likely to increase during the Second Perspective Plan period. One priority intervention is to build modern storage facilities that are better equipped to adapt to the climate change impacts and resist disaster shocks, repair and rehabilitation of existing warehouses and improving ambient environment of stocks to maintain quality and increase shelf life in the coastal region and Haor areas. Some progress has been made with respect to building of public storage facility development. Efforts are under way to develop household level storage facilities through use of mini silos on which some piloting has been done. Scaling up of such facilities is a priority area of intervention.

Strengthen institutional capacities for implementation of safety net program: Capacities should be strengthened to develop a multi-year strategy to improve the targeting performance of SSNs, streamline and coordinate these safety net programmes. Attempts should also be made to improve synergies between safety net programmes (food or cash for work) with productive infrastructure such as irrigation, rural transport and markets. Targeting effectiveness needs to be improved to ensure that the benefits of the programmes reach the poorest and the food insecure groups of people. These efforts need to be strengthened with particular focus on agriculture-related risks and disasters. Making food available to the disaster-affected people is contingent upon two factors: availability of requisite food stocks in the local supply depots and adequate transport infrastructure through which food can be channelled to the intended beneficiaries. A successful implementation of emergency distribution programmes calls for effective interagency/inter-ministerial cooperation and coordination.

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