



BANGLADESH: AGRICULTURE SECTOR

Assessing the Investment & Financial Flows
Required to Address Climate Change



UNDP ENVIRONMENT & ENERGY GROUP | AUGUST 2011



Capacity development for policy makers: addressing climate change in key sectors

In May 2008, the United Nations Development Program (UNDP) launched the global project, “Capacity Development for Policy Makers to Address Climate Change”. The overall goals of the project are twofold:

- Increased national capacity to raise awareness and co-ordinate Ministerial and stakeholder views on climate change, leading to enhanced participation in the UNFCCC process;
- Support for long-term climate change planning and priority setting, using assessments of investment and financial flows to address climate change in key sectors, which can provide a better understanding of the magnitude and intensity of national efforts needed to tackle climate change, as well as provide more accurate estimates of the funds needed to implement mitigation and adaptation actions.

Bangladesh is one of the 15 countries participating in the project that undertook the assessment of investment and financial flows, using a UNDP methodology. National experts in Bangladesh identified three key sectors for the assessment: energy (for mitigation actions), and agriculture and water (for adaptation options).

This project was made possible with funding from the governments of Norway, Switzerland, and Finland, as well as UNDP and the United Nations Foundation.

Disclaimer

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Acknowledgements

The author(s) gratefully acknowledge the technical comments received from Susanne Olbrisch, UNDP, and The Energy and Resources Institute (TERI), based in India, which operated as a regional centre of excellence under this project.

UNDP GLOBAL PROJECT: CAPACITY DEVELOPMENT FOR POLICY MAKERS TO ADDRESS CLIMATE CHANGE

Assessment of Investment and Financial Flows to Adapt to the Climate Change Effects in the Agriculture Sector

Z KARIM

AUGUST 2011

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Acronyms and Abbreviations

ADP	Annual development programme
ADB	Asian Development Bank
GOB	Government of Bangladesh
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BCCRF	Bangladesh climate change resilient fund
BDT	Bangladesh Taka (currency)
CIDA-	Canadian International development
DP	Development partner
DFID	Department of International Development
ERD	External Resource Department
EU	European Union
FAO	Food and Agriculture Organization
JICA	Japan International Cooperation Agency
IFC	International Finance Corporation
PD	Paris Declaration
LGED	Local Government and Engineering Department
MORF	Ministry of Environment and Forest
NGOs	Non- Governmental Organization
NAPA	National Adaptation Programme of Action
MOFDM	Ministry of Food and Disaster Management
IPCC	Intergovernmental Panel on Climate Change
PPCR	Pilot programme for climate resilience
PRSP-1	Poverty reduction strategy paper 1
SPCR	Strategic Program for Climate Resilience
UNDP	United Nations Development Programme
WB	World Bank

1. INTRODUCTION

The geographic location and geomorphologic condition of Bangladesh have made the country one of the most vulnerable ones to climate change. Climate change vulnerabilities affect all aspects of livelihood including food security, crops, livestock, fish, bio-diversity, environment, water resources & ground water dependent irrigated agriculture, industry, infrastructure, transport, navigation and public health. Floods, tropical cyclones, storm surges and droughts are common threats to Bangladesh. Extreme flood frequency has increased in the recent years. In the last twenty five years, Bangladesh has experienced six severe floods. These happen in the months just before and after the monsoon. During recent years cyclone Sidr (2007) and Aila (2009) hit the southern region of Bangladesh. Devastating Sidr affected 33 districts and Aila affected 26 districts damaging around 9 million households with huge loss of crops, livestock and fishery. They also made considerable damage to infrastructures and coastal embankments. Bangladesh experienced moderate to severe droughts in 1973, 1978, 1979, 1981, 1982, 1989, 1994, and 1995. The Fourth Assessment of Intergovernmental Panel on Climate Change (IPCC) has also observed increased climate variability and extreme events in Bangladesh. Rising global temperature are likely to increase the frequency and intensity of cyclones in the Bay of Bengal as well as monsoon rainfall, resulting in catastrophic floods in the Ganges–Brahmaputra–Meghna Basin. Sea level rise and the consequent coastal flooding and saline intrusion into aquifers constitute serious threats. The challenge of climate change will exacerbate by the fast growth rate and high density of population. This will have large negative impact on people's livelihood and her prospect to improve growth performance and reducing poverty.

1.1 Objectives

The objective of this report is therefore two fold. On the one hand, it develops technical knowledge and methodologies to assist developing countries cost, prioritize and sequence robust adaptation strategies of water sector into the development plans and budgets of Bangladesh.

On the other hand, it intends to estimate the cost of adaptation for water sector in order to inform the international community's efforts on the additional resources needed to allow developing countries adapt to climate change.

1.2 Background

1.2.1 Previous Analyses Utilized

A number of studies/analyses were utilized for the sectoral assessment. These are briefly described below:

(i) Pilot Programme for Climate Resilience (PPCR)

During the first PPCR Joint MDB Mission held in February 2010, it was agreed with the government of Bangladesh (GOB) that, the ADB and WB will support the MOEF in preparing the draft Strategic Program for Climate Resilience (SPCR).

Preparation has involved desk study of existing development policies and strategies including the Bangladesh Climate Change Strategy and Action Plan (BCCSAP), the revised National Adaptation Program of Action (NAPA), the draft Strategy to ensure the Private Sector in Climate Change Adaptation in Bangladesh, other relevant report, studies and policies on climate change particularly for the coastal zone, and a stocking of planned and ongoing climate change projects by GOB, MDBS, development partners, the private sector and NGOs.

During the MDB's held various consultations and meetings with BWDB, DMB, BMD, MOFDM, MOEF, LGED, FD, ERD, all government agencies associated with the PPCR process and development partners. The output of those consultations is SPCR which presents a comprehensive package of plans, programs and actions for climate resilience what can be financed through PPCR, the government confirmed that priority interventions will be channelled through MDBs (ADB, IFC and WB) in line with the program design.

(ii) Evaluation of the Implementation of the Paris Declaration (PD) and effectiveness of aid utilization, Phase – II, Country Evaluation Bangladesh, 2010

The assessment reports on the relevance of the PD in Bangladesh, progress of the PD implementation towards attaining the expected intermediate outcomes since signing of the Declaration in 2005 and PD's influence on strengthening contribution of aid to sustainable development results. The evaluation also includes studies on the imple-

mentation of the PD in three selected sectors namely, Health, Transport, and Power and Energy and a cross cutting issue- Climate Change.

(iv) Worked in synergy and complementary with the GOB planning process which includes review and determining intervention areas from PRSP-I, NSAPR-II, Medium Term Budget Framework (MTBF), GOB Perspective Plan 2010-2021 (draft), concept note of GOB Sixth Five-Year Plan 2011-2015 (through consultation with Planning Commission), Agricultural Sector Review 2006 (GoB/FAO, 2006), National Food Policy Plan of Action (2008-2015), Utilized Annual Development Programme (ADP) of GOB for cost analysis.

1.2.2 Institutional Arrangements and Collaborations

Data gathered from Ministry of Planning, Ministry of agriculture, Ministry of Fisheries and Livestock, Ministry of Environment and Ministry of Water. These ministries have programmes and information on investments in agricultural development and adaptation.

1.2.3 Basic Methodology and Key Terminology

The methodology and reporting guidance provided in the UNDP User Guide on I&FF Assessments has been used for this study. The methodology for I&FF assessments consists of eight steps to be undertaken in agriculture sector assessment:

i. Establish key parameters of the assessment

- Define detailed scope of the sector
The agriculture sector can be broadly divided into different sub-sectors: crops, livestock, and fishery. The base line scenarios of the sub-sectors were examined as: a) Current status of crop productions; b) Current status of livestock productions and c) Current status of fishery productions.
- Specify the assessment period and the reference year
The base line year is considered to be 2011. The assessment period is 2011- 2030. The adaptation and incremental I&FF have been estimated for this period.
- Identify preliminary adaptation measures
- Select analytical approach.

ii. Compile historical Investment Flows (IF), Financial Flows (FF) and operation and maintenance costs (O&M) data, subsidies and other input data for scenarios

iii. Defining baseline scenario

Describe the socio-economic and technological change, national and sectoral plans, and expected investments, given the current national and sectoral plans.

iv. Derive I&FF for baseline scenario

The base line scenario has been estimated excluding all adaptation investments due to climate change considering ADP 2011-12. Annual investment requirement is estimated considering base line investment and assuming a growth rate of 8% which is similar to GDP growth rate.

v. Define the adaptation scenario

Described the socio-economic and technological change, adaptation measures and investments, given the implementation of adaptation measures and estimated annual investment for the adaptation scenario considering ADP 2011-12.

vi. Derive I&FF for adaptation scenario

Annual investment requirement is estimated considering base line investment and assuming a growth rate of 8%.

vii. Calculate incremental I&FF needed for adaptation by subtracting I&FF values of baseline scenario from values of adaptation scenario

viii. Assess policy implications

Different GOB policies affecting investments in the agriculture sector (crops, livestock, fisheries, forestry) were examined to review implications. The chapter on policy implications would mainly focus on policies that are useful to implement the results of the I&FF assessment.

Key Terminology

The cost accounting parameters were distinguished between two distinct types of investments: investment flows and financial flows:

An “Investment Flow” (IF) is the capital cost of a new physical asset with a life of more than one year, such as the capital cost of a new agricultural irrigation system or flood control embankments. Investment flows are limited to new physical assets because such investments have climate

change implications for the duration of the operating lives of the facilities and equipment purchased.

A “**Financial Flow**” (FF) is an ongoing expenditure on programmatic measures; financial flows encompass expenditures other than those for expansion or installation of new physical assets. Examples of financial flows include expenditures for an agricultural extension program for farmers, a malaria prevention program to distribute mosquito nets, or the implementation of improved forest management techniques.

Other than this, “**Operation and Maintenance Costs**” are also separated from the IF and FF flow enumeration. The O&M cost is the expenditure associated with the operation and maintenance of the asset acquired. Examples include ongoing fixed and variable costs such as salaries and raw materials.

Investment entity: An “investment entity” is the body or thing making the investment in the asset. This study defines three types of investment entities: families, companies and government.

Government: Governments are the national, provincial, county and local governments of a country. Financial and non-financial corporations owned wholly or in part by governments, such as public universities, research institutions and publicly held oil companies, utilities and management of waters and forestry authorities belong to this category. Government entities invest in physical assets and long-term programs and services that provide public benefits.

Corporations: The companies include both financial firms as non-financial businesses, and organizations may be profit or non-profit. Financial firms are entities such as banks, credit unions and insurance companies that provide financial services to non-financial business, households and governments. The non-financial firms produce goods (such as fossil fuels, electricity, food or wood). The non-governmental organizations are a kind of company of non-profit. Firms invest in physical assets and programs. Their sources of investment funds are from domestic sources and external sources and can be in the form of shares (shares in domestic capital markets and FDI), debt (loans from commercial banks and bonds sold in capital market), national government support (subsidies) or public foreign aid (in the form of grants and loans conditional preference, known as ODA

or ODA).

Households: Households are individuals or groups of people (e.g. families) acting as one unit financially. Households invest in assets such as houses, farms, crop fields. It is assumed that all their investment funds, including capital (savings), debt (borrowing from friends, family, financial institutions) and government support in form of grants (that is to say-refundable deductions tax, tax credits on purchases) are national funds, to simplify the estimation of I&FF.

Scenario: A scenario is an internally consistent and plausible characterization of future conditions over a specified period. For each sectoral assessment of I&FF for adaptation, it must include a baseline scenario and an adaptation scenario for that sector.

Baseline Scenario: The baseline scenario describes the conditions of the status quo, that is to say, this is a description of what will probably happen if no new policy measure to address climate change is put in place.

Adaptation Scenario: The adaptation scenario includes measures to adapt to climate change, that is to say, the adaptation scenario should describe the expected socio-economic developments, technological change (if appropriate), new measures to adapt to climate change and the expected investment in the sector given the implementation of adaptation measures.

Assessment period: The evaluation period is the time horizon for assessment i.e. the number of years.

Base year: The base year is the first year of the assessment period, that is to say the first year of baseline, mitigation and adaptation. The base year should be a recent year for which information on the I&FF and O&M is available so that the IF, FF and O&M costs for the first year of these scenarios are all historical data. In fact, the reference year as the starting waves of cost data for each scenario is based.

Discounting of future costs: We enumerated all costs valued in constant 2010 prices and future costs were discounted at a rate of 5% for computation of present value.

2. SCOPE, DATA INPUTS, AND SCENARIOS

2.1 Sectoral Scope

According to the Bangladesh Bureau of Statistics (2007) about one-fifth of populations are hard core poor who consume less than 1805 kcal per capita per day (BBS, 2007). Bangladesh had an estimated 40.2 million undernourished people in 2004-06. Food security worsens with inter-year shortfall in food grain production caused by climatic variations and natural disaster such as floods, tidal surge, drought, insects and pests attacks.

Bangladesh grows 46 economic crops of which rice are the dominant, producing more than 33 million metric tons annually. Besides, about 8.0 million metric tons of potato, 0.79 million metric tons of oilseed and 0.66 million metric tons of pulses are produced. All these crops require temperature between 18-25°C and are highly sensitive to fog, cloud and change in humidity. Results from crop simulation studies examining climate change impacts on agriculture showed a negative impact on crop productivity in Bangladesh.

Fisheries, livestock and forestry sectors are also largely affected by climate change variability. The impact is aggravated by disaster, flood, rising salinity, changing course of the rivers etc. It affects habitat's alteration, fish reproduction, fish migration, natural fish breeding and fish biology. Livestock production is also affected by the climate changes due to reduction in the quality and availability of feed, water, increased diseases and other environmental stresses.

As the country is located between the Himalayas and the Bay of Bengal and with three major rivers converging on its territory, Bangladesh will remain prone to floods, torrential rains, erosion, and severe cyclonic storms and tidal surge. The climate change induced devastating events will worsen livelihood of people with increased poverty.

2.2 Data Inputs and Scenarios

2.2.1 Assessment Period and Cost Accounting Parameters

In this assessment, the year 2010 is considered as the base year. For future IF and FF calculation, the next 20 years (up to year 2030) have been considered as the assessment period. In order to address inflation and

fluctuation in values of Bangladesh currency (BDT), the accounting units are U.S. dollars in 2005 constant values and a conversion rate of 1 USD=BDT 70 has been used. All costs were enumerated in constant 2005 US dollars discounted at a rate of 5% for computation of present value at 2005 constant price, the formula used was $P_n = P_t / (1 + r)^t$, where P_n is present value of investment, P_t is investment cost in year t , and r is the interest rate of 5%.

2.2.2 Analytical Approach

The approach for calculating the additional investment needed is the approximation of additional investment needed to equal marginal cost of adaptation to marginal avoided damages. For estimating FF, IF and O&M costs for the base line and adaptations we followed basic methodology described earlier in section 1.2.2. The base line scenario of investment in agriculture sector was assessed considering investment data base of ministry of finance and planning commission available in Annual development Programme (ADP) of Government of Bangladesh (GoB) for the years 2006- 2010 without any climate change adaptation costs. Annual investment requirement in agriculture sector of Bangladesh is estimated considering base line investment and assuming an annual growth rate of 8% (over the year 2011-2030) which is similar to GDP growth rate. The baseline scenario reflects a continuation of current policies and plans, i.e., a future till year 2030 when no new measures are taken to address climate change (otherwise referred to as a “business as usual” scenario).

The adaptation scenario of investment in agriculture sector was assessed considering ADP in 2010 with inclusion of costs of all adaptations to climate change. Considering this as adaptation costs projections has been made for the period 2011-30 with an annual growth rate of 8% which is similar to GDP growth rate. The adaptation scenario till year 2030 reflects new adaptation measures taken in agriculture sector (an “adaptation scenario”)

The investment costs of the baseline and adaptation scenarios are then compared to determine the changes in investments needed to mitigate or to adapt to the impacts to the agriculture sector in Bangladesh.

2.2.3 Historical IF, FF, and O&M Data, and Subsidies

The historical data on investment allocations of Bangladesh government in the agriculture sector was gathered from the Ministry of Finance (MoF) and the Ministry of Planning (MoP) for the period 2005-2011. Table 1 presents information on GoB's investment allocation in the annual development programme for the agriculture sector during 2005 to 2011. In a 7 year period average annual investment of GoB in the agriculture sector was 9.37 billion BDT, which was 3% of the total national budget. Year to year fluctuation was observed in investments.

Table 1. Historical data on investment allocation of GoB in ADP in the agriculture sector of Bangladesh

YEAR	ALLOCATION (BILLION BDT)	% OF GOB TOTAL ANNUAL DEVELOPMENT BUDGET
2005	12.20	4.70
2006	10.41	3.90
2007	7.75	3.37
2008	8.95	3.00
2009	5.36	2.00
2010	10.54	3.00
2011	10.37	1.00
Average of 7 years	9.37	3.00

Source: Ministry of Finance, GoB and Planning Commission

2.2.4 The baseline scenario

2.2.4.1 Demographic information

The baseline scenario describes the conditions of the status quo. In this respect, it reflects the continuation of the historical trend of achieving the investment and financial flows throughout the period used for the assessment (2005-2030).

Table 6.1 presents information on urban and rural population in Bangladesh. For national aggregation purpose, to collect the following information: In 2000 total urban population of Bangladesh was 29.60 million and rural population was 99.70. and 20% live in urban areas and 80% in rural areas. In 2010 total urban population increased to 33.9 million and rural population to 109.1 million with a total population of 143 million. The sex ratio of male and female was almost stable (around 105) in the last decade with a population growth rate of around 1.42 (Table 6.2). A large proportion of population belongs to teen age group (39.4%) or dependent group, the proportion of active population is around 56%. District wise land area and demographic information is presented in Table 6.4.

Table 2 Total urban and rural population of Bangladesh (in million)

YEAR	BOTH SEX	MALE	Female	Growth Rate (Annual)	Urban Population	Rural Population
2000	129.3	66.3	63.0	1.41	29.60	99.70
2001	131.1	67.1	62.9	1.54	30.00	101.10
2002	132.9	68.2	64.7	1.40	30.60	102.30
2003	134.8	69.1	65.7	1.43	31.30	103.50
2004	136.7	70.1	66.6	1.42	32.40	104.30
2010	143.0	73.4	69.6	1.4	33.9	109.1

Source: UNFPA 2008

Table 3 Urban population as a percent of total population

YEAR	1950	1960	1970	1980	1990	2000	2009	2015	2030
Urban population (%)	4.20	5.10	7.60	14.9	19.9	23.2	25.0	29.6	39.3

Source: UNFPA 2008

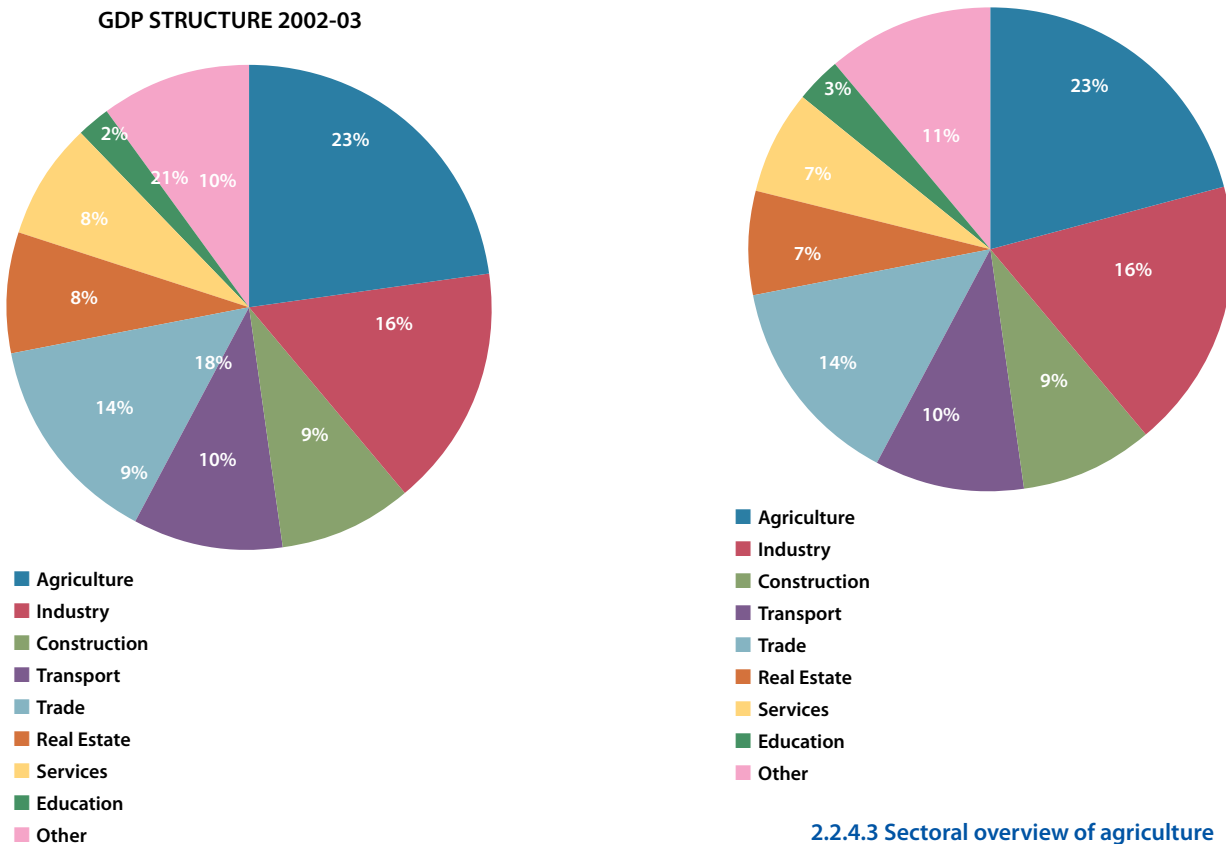
One of the important challenges facing Bangladesh is its continuous increase of population. In 2015 the total population of Bangladesh would be around 157.64 million and it would further rise to 168.99 million in 2020 which would aggravate food insecurity problem of Bangladesh. Bangladesh would face enormous challenges of increasing food production with shrinking of crop lands and increased negative shocks of climate change.

In 2005, one quarter of the population resided in urban areas. By 2030, it is expected that 40 percent of the population will reside in cities and urban centers (UNFPA). One influencing factor is the increase in population, which is projected to increase by approximately 40 million by 2030 (Table 2).

2.2.4.2 Macroeconomic perspective

Despite the losses caused by the two consecutive floods and the cyclone 'Sidr' in 2007 and also the adverse effects arising from unprecedented price hike of crude oil in international market and agricultural inputs, the GDP growth over the last five years grew consistently at an average rate above 6 percent. The growth of import-export trade, secular increasing trend in the flow of remittance and the favourable balance of the current account kept the external sector to some extent stable.

Fig. 2 Recent changes in structure of GDP



During the recent decade overall GDP of Bangladesh has been considerably shown upward trend. But the growth in agriculture GDP slightly declined with an average of 3.4% during 1997 to 2008. Agriculture being the supportive of growth of the economy, there is no other alternative but to develop agriculture sector for alleviation of poverty by attaining accelerated economic growth. Since provision of food security, improvement of the living standard 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.

2.2.4.3 Sectoral overview of agriculture

Agriculture is the most important sector of Bangladesh economy due to its role in food security, employment and livelihood. The current share of agriculture to GDP is around 21%, although this share has been declining in the last ten years along with the one of the agricultural sub sectors' (Table 1). Still more than 70% of the people in Bangladesh are directly or indirectly employed in this sector.

The agriculture of Bangladesh is dominated by crops which accounts about half of total agricultural GDP. Fisheries & livestock are also important sub-sector contributing to agricultural GDP (Table 3). It is important to note that in the recent decade the subsector of livestock, forestry and fisheries had faster growth rate (Table 4). There are, however, substantial year to year fluctuations in these rates and it is most pronounced in case of crops.

Table 3. Contribution of agriculture to GDP (%) at constant prices (Base: 1995-96=100)

SECTOR/ SUB-SECTOR	YEAR								
	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
Agriculture	25.58	25.03	23.99	23.47	23.08	22.28	21.85	21.37	20.88
A. Crops	14.59	14.7	13.75	13.43	13.23	12.51	12.28	12	11.7
B. Livestock	3.02	2.95	2.96	2.93	2.91	2.95	2.92	2.88	2.79
C. Forestry	1.88	1.87	1.88	1.86	1.83	1.82	1.79	1.76	1.75
D. Fishing	6.09	5.51	5.4	5.25	5.11	5	4.86	4.73	4.64

Source: Statistical Yearbook of Bangladesh 2007

Table 4. Growth rate of agriculture and its sub-sectors at constant price (Base: 1995-96=100)

SECTOR/ SUB-SECTOR	YEAR								
	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
GDP growth rate	5.94	5.27	4.42	5.26	6.27	5.96	6.63	6.43	6.21
Agriculture	6.16	4.59	2.36	3.54	4.13	4.03	5.07	4.81	3.85
A. Crops	8.10	6.18	-2.39	2.88	4.27	0.15	5.03	4.43	3.44
B. Livestock	2.74	2.81	4.70	4.51	4.98	7.23	6.15	5.49	2.41
C. Forestry	4.94	4.85	4.91	4.43	4.18	5.09	5.18	5.24	5.42
D. Fishing	8.87	4.53	2.22	2.33	3.09	3.65	3.91	4.07	4.11

Source: Statistical Yearbook of Bangladesh 2007 & Statistical Pocket Book 2008

Rice dominates Bangladesh agriculture covering more than 80% of the land area. 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 2006/07. During 1997 to 2005, Boro acreage substantially increased with the reduction of rain-fed Aus which showed about 6.3 percent annual growth during the same period. Boro rice accounts for about 60 percent of total food grain production (Figure 1 and 2).

Figure 1. Rice acreage by season

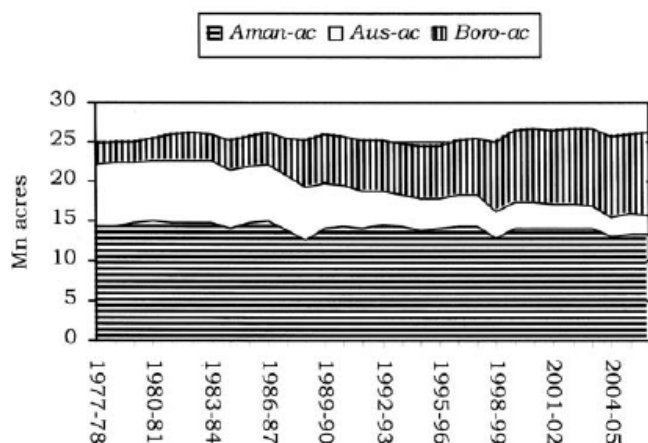


Figure 2. Rice output by season

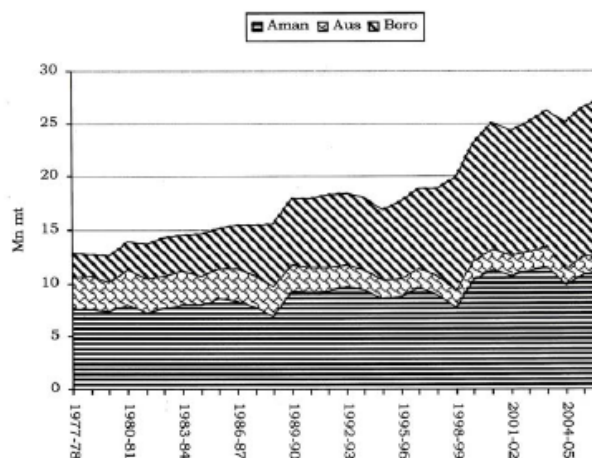
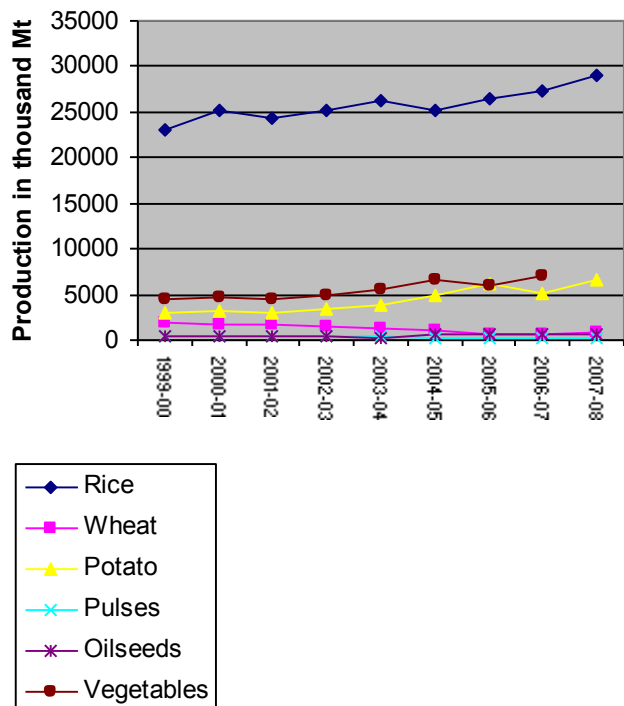


Fig. 3 Trend in production of rice and non-rice crops



During the same period production of potato and vegetables also increased considerably (Fig 3). For other crops long term growth remains unsatisfactory. Usually little land is used to grow nutritionally important food crops such as vegetables, fruits, pulses and oilseeds (Table 5). During recent years both production and area of wheat, pulses and oilseeds have been greatly reduced.

Table 5 Percentage of land area planted to different crops in 2004-05

FOOD ITEMS	LAND AREA PERCENTAGE
Rice	79.4
Wheat	4.09
Pulses	>2.80
Oilseeds	>2.37
Potato	>2.39
Jute	>2.86
Fruits	>1.36
Sugar cane	>1.15
Tea	>0.39
Spices and condiments	>2.21
Vegetable	>2.14

During recent years both production and area of wheat, oilseed and pulses have greatly reduced. The growth of pulses was only 0.3% while sugar was negative 1.2% other than rice and potatoes all other crops showed the decline in growth rate (Table 6).

Table 6 Growth of non rice crops in Bangladesh during 1971 to 2007

FOOD ITEMS	PERCENT/YEAR (1971-2007)
Wheat	-2.9
Pulses	0.3
Oil crops	2.3
Potatoes	3.0
Vegetables	1.5
Sugar	-1.2
Fish	2.5
Meat	2.3
Milk	2.3
Egg	4.0
Vegetable	>2.14

Livestock: In 2006-07, total cattle population of the country was about 23 million, buffaloes 1.21 million, goat and sheep 23 million and poultry and duck 246 million. The production of milk, meat (beef, mutton and chicken) and eggs had an increasing trend over the past several years (Fig 4 and 5). However, its total production is still far below the national requirements. The milk production showed slow growth but sustained growth while recently meat production is slightly decreasing. On the other hand, the egg production largely fluctuates due to avian influenza.

Fig. 4 Trend in production of milk and meat in Bangladesh

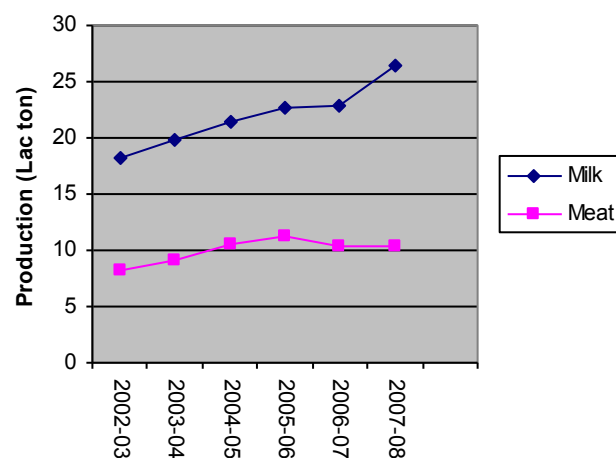
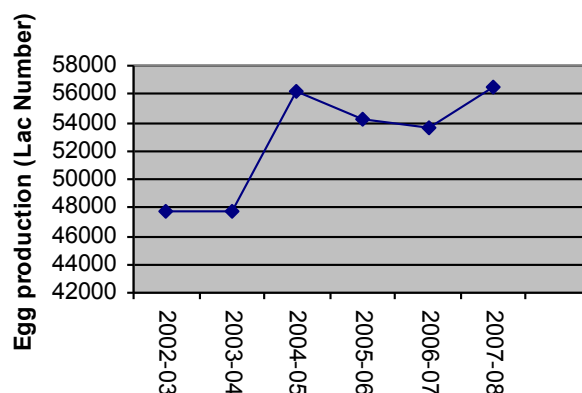


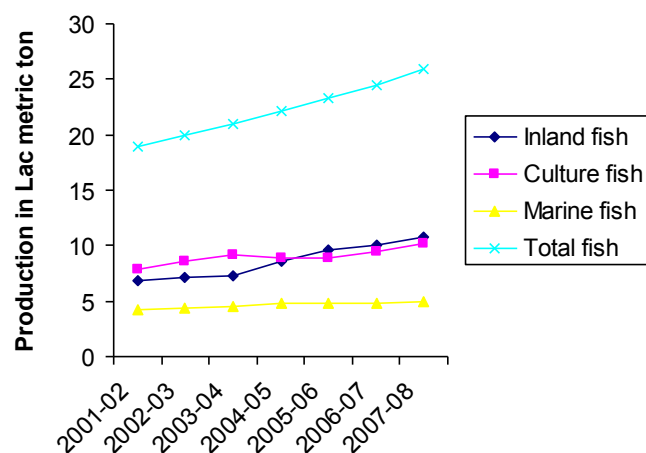
Fig. 5 Trend in egg production in Bangladesh
Data from Bangladesh Economic Review, 2009



Data from Bangladesh Economic Review, 2009.

Fisheries: Long term growth rate in production of fish during 1971 to 2007 was 2.5%. During 2001-02 to 2007-08 total fish production increased from 1.89 million MT to 2.59 million MT with an average annual growth rate of 5.3%, while inland fish and cultured fish production had growth rates of 8.2% and 4.2%, respectively (Table 7). Overall shrimp production has increased steadily over the last 20 years (Figure 6 and 7), but still much lower than that of the neighbouring countries such as Thailand with 800 kg/ha (Samsak et al. 2005) and India with 600 kg/ha (Vasudevappa, 2005). Among shrimp producing countries, Bangladesh ranks fourth with respect to area under shrimp farming and sixth in volume of production.

Fig. 6 Trend in production of milk and meat in Banglaesh



Source: Data from Bangladesh Economic Review, 2009.

Table 7 Recent trend in fish production in Bangladesh during 2001-08

COMMODITY	GROWTH (DURING 2001-2008)
Inland fish	8.2
Culture fish	4.2
Marine fish	2.4
Total fish	5.3

Source: Bangladesh Economic Review, 2009 and authors calculation.

Agro-Forestry: The production of wood in Bangladesh since 1970 is increasing. This increase depends largely on the expansion of new social forestry plantations involving private participants. Beside these, over 10 million homesteads in about 88 thousand villages across the country possess a large quantity of trees. These homesteads are the major suppliers of wood for the nation. The role of the homesteads in growing stock is presented in Table 8. The total forest area in Bangladesh is 2.53 million hectare in 2007; but all do not necessarily carry tree cover. The tree covers 48.8% of the forest land.

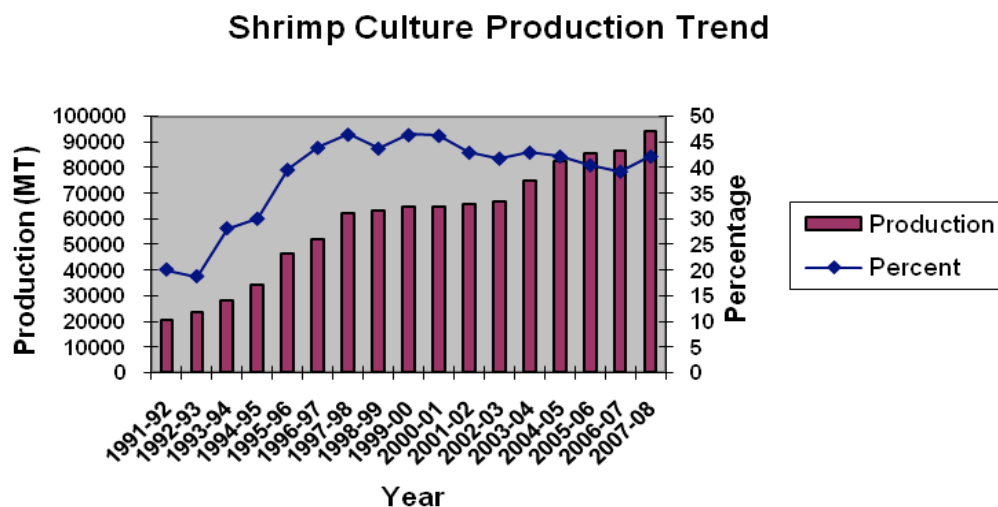
Table 8. Estimated growing stock of wood in Bangladesh

FOREST TYPE	GROSS VOLUME OF GROWING STOCK OF WOOD, MILLION M3		
	1990	2000	2005
Hill forest*	19.34	17.26	16.03
Plain land forest*	2.07	1.98	1.97
Littoral forest* (Mangroves)	13.14	11.97	12.00
Village/homestead forest**	69.16	89.58	101.94

* Data from FAO, 2005.

**Hammermaster data of 54.8 million m3 in 1981 with growth rate of 2.62 (Choudhury and Hossain 2009 used to derive the estimated data).

Fig. 5 Trend in egg production in Bangladesh
Data from Bangladesh Economic Review, 2009



2.2.4.4 Current Food security situation

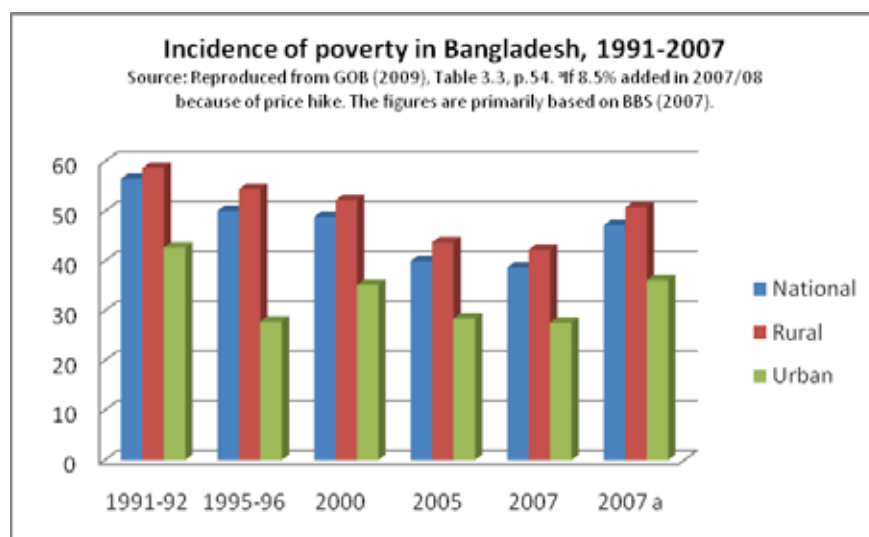
About 40% of Bangladesh’s total population are calorie poor, consuming less than 2122 kcal per capita per day, while one-fifth of population are hard core poor who consume less than 1805 kcal per capita per day (BBS, 2007). According to SOFI 2009, Bangladesh has an estimated 40.2 million undernourished people in 2004-06¹. One positive aspect is that the proportion of undernourished in total population has declined from 36% in 1990-92 to 26% in 2004-06. Out of a total of 336.6 people who are estimated to be undernourished in South Asia, 12% comes from Bangladesh (India’s share is 75%). The most recent estimates (Household Income Expenditure Survey – HIES, 2005) revised to up to 56 million (still 40% of the population) the absolute number of undernourished people, those who fail to meet minimum level of caloric consumption needs of 2122 Kcal/person/day. Within this population 27 million are unable to consume 1805 Kcal/person/day and 11 million are below the consumption level of 1600 Kcal/person/day.

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

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% per year. It further declined to 40% in 2005 with a decreasing rate of 3.9% per annum (Fig. 8). In spite of the advancement, about 57.7 million people are poor with one-third caught in hard-core or extreme poverty.

¹ Undernourishment exists when caloric intake is below the minimum dietary energy requirement (MDER). The MDER is the amount of energy needed for light activity and a minimum acceptable weight for attained height, and it varies by country and from year to year depending on the gender and age structure of the population.

Fig 8. Proportion of population below national poverty line during 1991 to 2005 (estimates for 2007)



2.2.4.5 Some historical programmes for climate change adaptations in Bangladesh by GOB

1. Flood management schemes to raise the agricultural productivity of many thousands of km of low-lying rural areas and to protect them from extremely damaging severe floods;
2. Flood protection and drainage schemes to protect urban areas from rainwater and river flooding during the monsoon season;
3. Coastal embankment projects, involving over 6,000 km of embankments and polder schemes, designed to raise agricultural productivity in coastal areas by preventing tidal flooding and incursion of saline water;
4. Over 2,000 cyclone shelters to provide refuges for communities from storm surges caused by tropical cyclones and 200 shelters from river floods;
5. Comprehensive disaster management projects, involving community-based programmes and early warning systems for floods and cyclones;
6. Irrigation schemes to enable farmers to grow a dry season rice crop in areas subject to heavy monsoon flooding and in other parts of the country, including drought-prone areas;
7. Agricultural research programmes to develop saline, drought and flood-adapted high yielding varieties of

rice and other crops, based on the traditional varieties evolved over centuries by Bangladeshi farmers;

8. Coastal 'greenbelt' projects, involving mangrove planting along nearly 9,000 km of the shoreline.

2.2.4.6 Financial need assessment in National Adaptation Programme of Action (NAPA)

- Developed under the Least-Developed Country Fund (LDCF)/Global Environment Facility (GEF) initiative with the participation of civil society organisations (CSOs) as well as UN institutions.
- Focused on three particular effects of climate change: increasing sea level rise, changing rainfall patterns; and increases in the frequency and intensity of extreme events.
- Identified 15 immediate and urgent projects that will address the country's vulnerability to climate change in the original plan and 18 specific projects in the revised plan. So far, only one of the 15 projects has been supported by LDCF/GEF (Table 9).

Table 9. Allocations for climate change adaptations in NAPA

NO.	PROJECT TITLE	TYPE OF PROJECT	PRIMARY IMPLEMENTING AGENCY	TOTAL COST
1	Reduction of climate change hazards through Coastal afforestation with community participation	Intervention	Forest Department (FD)	Full project: USD 23 million Project design: USD 100,000
2	Providing drinking water to coastal communities to combat enhanced salinity due to sea level rise	Intervention	Department of Public Health Engineering (DPHE)	Full project: USD 1.5 million Project design: USD 25,000
3	Capacity building for integrating climate change in planning, designing of infrastructure, conflict management and land-water zoning for water management institutions.	Capacity building	Water Resource Planning Organization (WARPO)	USD 2.0 million Project design: USD 25,000
4	Climate change and adaptation information dissemination to vulnerable community for emergency preparedness measures and awareness raising on enhanced climatic disasters.	Awareness and Capacity Building	Ministry of Environment and Forest (MoEF)	Full project: USD 7 million Project design: USD 50,000
5	Construction of flood shelter, and information and assistance centre to cope with enhanced recurrent floods in major floodplains.	Intervention	Disaster Management Bureau (DMB) and Local Government Engineering Department (LGED)	Full project: USD 5 million Project design: USD: 50,000
6	Mainstreaming adaptation to climate change into policies and programmes in different sectors (focusing on disaster management, water, agriculture, health and industry).	Capacity building	Department of Environment (DoE)	Full project: USD 1 million Design phase: USD 25,000
7	Inclusion of climate change issues in curriculum at secondary and tertiary educational institution.	Awareness raising	Board of Education	Full Project: USD 0.5 million Project design: USD 25,000
8	Enhancing resilience of urban infrastructure and industries to impacts of climate change	Capacity building	Department of Environment (DoE)	Full project: USD 2 million Design phase: USD 25,000
9	Development of eco-specific adaptive knowledge (including indigenous knowledge) on adaptation to climate variability to enhance adaptive capacity for future climate change.	Intervention	NGO consortium	Full project: USD 5 million Design phase: USD 50,000
10	Promotion of research on drought, flood and saline tolerant varieties of crops to facilitate adaptation in future.	Research	Bangladesh Agricultural Research Council (BARC)	Full project: USD 5 million Design phase: USD 50,000
11	Promoting adaptation to coastal crop agriculture to combat increased salinity.	Intervention	Bangladesh Agricultural Research Institute (BARI)	Full Project: USD: 6.5 million Project design: USD 50,000
12	Adaptation to agriculture systems in areas prone to enhanced flash flooding – North East and Central Region	Intervention	Department of Fisheries (DoF)	Full project: USD 4.5 million Project design: USD 50,000
13	Adaptation to fisheries in areas prone to enhanced flooding in North East and Central Region through adaptive and diversified fish culture practices.	Intervention	Department of Fisheries (DoF)	Full project: USD 4.5 million Project design: USD 50,000
14	Promoting adaptation to coastal fisheries through culture of salt tolerant fish special in coastal areas of Bangladesh	Intervention	Department of Fisheries (DoF)	Full project: USD 4 million Project design: USD 50,000
15	Exploring options for insurance to cope with enhanced climatic disasters.	Research	Department of Environment (DoE)	Full project: USD 0.2 million Project design: USD 25,000

Bangladesh is one of the few countries that have successfully developed participatory disaster management. Since 2003, the Comprehensive Disaster Management Programme (CDMP) of the Ministry of Food and Disaster Management (MoFDM) has advanced government-wide and agency risk reduction efforts. The Ministry of Environment and Forests (MoEF), guided by the National Environment Council, which is chaired by the Prime Minister, tackles climate and environmental issues. Following recent structural changes, the MoEF's Climate Change Unit (CCU) now coordinates other ministries to implement climate change-related projects and programmes.

The draft version of the sixth five-year development plan (2011–15) set 16 core targets – for economic growth, employment, poverty reduction, human resources development, gender balance and environmental protection. Along with higher per capita income, the government's Vision 2021 manifesto projects a development scenario where citizens will have higher living standards, better education and social justice. It aims to ensure a more equitable socio-economic environment and sustainable development through better protection from climate change and natural disasters.

The government has earmarked more than \$10 billion in investments for the period 2007 to 2015 to make Bangladesh less vulnerable to natural disasters. Despite this effort, the direct annual cost of natural disasters over the last 10 years is estimated to be between 0.5 and 1 per cent of GDP.² (The social safety net budget is 2.1 to 2.8 per cent of GDP.) The first phase of the Comprehensive Disaster Management Programme (CDMP), successfully implemented by the MoFDM, cost about \$26 million.

There are several funds in Bangladesh for climate change adaptation. The subsequent section below describes about these funds.

2.2.4.7 Current availability of financial resources by DPs: Pilot Programme for Climate Resilience (PPCR)

During the first PPCR Joint MDB Mission held in February 2010, it was agreed with the government of Bangladesh (GOB) that, the ADB and WB will support the MOEF in preparing the draft Strategic Program for Climate Resilience (SPCR). It was agreed that the preparatory process would be carried out in close consultation with other development partners and concerned ministries/agencies of the GOB and interventions will focus in the coastal zone.

Preparation has involved desk study of existing development policies and strategies including the Bangladesh Climate Change Strategy and Action Plan (BCCSAP), the revised National Adaptation Program of Action (NAPA), the draft Strategy to ensure the Private Sector in Climate Change Adaptation in Bangladesh, other relevant report, studies and policies on climate change particularly for the coastal zone, and a stocking of planned and ongoing climate change projects by GOB, MDDBS, development partners, the private sector and NGOs.

During the MDB's held various consultations and meetings with BWDB, DMB, BMD, MOFDM, MOEF, LGED, FD, ERD, all government agencies associated with the PPCR process and development partners. The out put of that consultations is SPCR which presents a comprehensive package of plans, programs and actions for climate resilience what can be financed through PPCR, the government confirmed that priority interventions will be channelled through MDDBs (ADB, IFC and WB) in line with the program design presented in the Table 10.

Table 10 Assessment in PPCR for climate change adaptations in 2010

PROGRAM	OBJECTIVES	IMPLEMENTING AGENCY	DPS	AMOUNT MILLION US\$
Promoting climate resilient agriculture and food security	1. Livelihood diversification through adaptive agriculture 2. Scaling up of climate resilient varieties including efficient irrigation system 3. Early warning system for farming communities	DAE, MOA and BMD	ADB, IFC and World Bank	13
Coastal embankment improvement and afforestation	1. Embankment stabilization 2. Internal polder management	BWDB, FD, BFRI	World Bank	130
Coastal climate resilient water supply and infrastructure improvement	1. Improve safe drinking water supply and sanitation 2. Improve connectivity (small roads, bridges, culverts, etc.) within the coastal districts	LGED, Water Supply and Sewerage Authority, DPHE	ADB	250
Preparatory studies and technical assistance	1. Feasibility studies on individual climate resilient family housing in the coastal zone 2. Capacity building for mainstreaming resilience to climate change and knowledge management, strengthening capacity of climate change department of MOEF	MOFDM	IFC	0.7
TOTAL				393.7

2.2.4.8 GOB initiatives for climate change adaptations

The government has taken several positive actions to implement BCCSAP-2009. GoB set up a 'Climate Change Trust Fund (CCTF) and allocated about US\$ 100 million in its budget for tackling climate change. A similar amount has been budgeted for 2010-11 as well. Early this year government has instituted a Board for managing CCTF. The government has also established a Climate Change Unit under the MoEF to deal with all matters related to climate change and implementation of BCCSAP -2009. So far the CCTF has approved a total of 66 projects (38 from GoB and 28 from NGOs). Thirty four GoB projects are under implementation of which 4 are on food security, social protection and health, 3 for comprehensive disaster management, 7 for infrastructure, 6 for research and knowledge development and 6 for mitigation and low carbon development. The country has invested heavily in adaptation measures such as flood management schemes, coastal embankments, cyclone and flood shelters, as well as raising roads and highways and research and development towards climate resilient farming. Over the last three decades Bangladesh has developed some ability to manage disasters, in particular, floods and cyclones.

The governments of Bangladesh and the United Kingdom jointly organized a conference in London in September

2008 to highlight the climate change vulnerability of Bangladesh and need for international cooperation. In the London conference, a multi-donor trust fund for climate change was proposed as a modality for the Development Partners (DPs) to support Bangladesh in implementing the BCCSAP.

Following this, the Bangladesh Climate Change Resilience Fund with an amount of US\$ 110 million with contribution from number of donors was set up in May 2010. The DFID has committed US\$86.7 million, Sweden US\$11.5 million, Denmark US\$1.6 million (DKK 10 million) and the EU US\$10.4 million to BCCRF. No other DPs so far made any commitment to the BCCRF. The World Bank Group and Asian Development Bank are processing a project entitled the Pilot Programme for Climate Resilience (PPCR) for US\$110 million from global fund as part of the Climate Change Investment Fund. During recent years several DPs are active and only now committing some resources, but mostly with Technical Assistance (TA) to climate change programs of BCCSAP. It is difficult to compile an exhaustive list as the process of commitment by DPs is in transition, however, a list so far obtained is provided in the Table 11.

Table 11: Some Commitment/ ongoing DP's supported projects on climate change

NAME OF DONORS	TITLE OF THE PROJECT	AMOUNT
ADB	Supporting Implementation of Bangladesh Climate Change Strategy and Action Plan	\$2.0 million
	Strengthening the Resilience of the Water Sector in Khulna to Climate Change	\$ 600 thousand
	Emergency Disaster Damage Rehabilitation	\$ 120 million
	Adaptation and Impact Assessment	\$ 1.2 million
CIDA	Bangladesh Environmental Institutional Strengthening Project (BEISP)	\$ 5.0 million
	Emergency Disaster Damage Rehabilitation Project of ADB	\$10.2 million
DFID	CDMP by supporting Climate Change Cell of MoEF	£ 12.0 million
	'Climate Change Program – Climate and Life' (2009-2014)	£ 30.0 million
Denmark	Support to some Climate Change Projects	DKK 25 million
German Technical Cooperation (GTZ) & European Commission	Complementary project of 'Integrated Protected Area Co-management Project	\$ 7.0 million
EU	Action plan on Climate Change in Development	€ 23.3 million
EU/FAO	Support to Assist Landless and Small Farmers in Impoverished Areas	\$ 10 million
JICA	Emergency Disaster Damage Rehabilitation Project	JPY 6.9 billion
	Grant for Disaster Prevention and Construction of Multipurpose Cyclone Shelters in the cyclone Sidr affected areas	JPY 960.0 million
	Grant for Flood Forecast/Warning System	JPY 260.0 million
	Small Scale Water Resource Development Project	JPY 7.5 billion
USAID	Integrated protected area co-management	\$ 15 million
	Construction of 75-100 Multi-purpose cyclone shelters in cyclone Sidr affected areas of Khulna and Barisal	\$38.4 million
Sweden International Development Agency (SIDA)	UNICEF Post Cyclone Project	SEK 24.3 million
Swiss Agency for Development and Cooperation (SDC)	Emergency Assistance for cyclone Sidr and for post flood rehabilitation	\$ 5.5 million
United Nations Development Programme (UNDP)	Community Based adaptation to climate change through coastal afforestation	\$ 5.6 million
	Second National Communication to the UNFCCC	\$ 0.5 million
	Comprehensive Disaster Management Program (CDMP-II)	\$ 50 million
	Poverty-Environment-Climate Mainstreaming	\$ 3.0 million
	Coastal and Wetland Biodiversity Management at Cox's Bazar and Hakaluki Haor	\$ 5.0 million
	Sustainable environmental Management Program (SEMP)	\$ 26.4 million
	Empowerment of Coastal Fishing Communities (FCFC)	\$ 6.0 million
World Bank	Clean Air and Sustainable Environment	\$ 62.2 million
	Water Management Improvement Project (WMI)	\$ 102.26 million
	Rural Electrification and Renewable Energy Development (RER Project)	\$ 130 million
	Emergency Cyclone Recovery and Restoration Project	\$ 109 million

It is estimated that a \$500 million programme will need to be initiated in Years 1 and 2 (e.g., for immediate actions such as strengthening disaster management, research and knowledge management, capacity building and public awareness programmes, and urgent investments such as cyclone shelters and selected drainage programmes) and that the total cost of programmes commencing in the first 5 years could be of the order of \$5 billion. Between 2007 and 2010, the government invested significantly to build more than 1,000 new shelters to save lives during cyclonic storm surges.

2.2.4..9 Comprehensive Disaster Management Programme phase 2 (CMDP2)

The Swedish Government decided on a Climate Change Initiative for the years 2009-2012, with new and additional funding amounting to 4 000 MSEK, to tackle climate change in developing countries. For Bangladesh, a total of 180 MSEK has been allocated above already committed bilateral support. Sweden currently supports the CDMP2 within the scope of the Climate Change Initiative: CDMP2 aims at reducing Bangladesh's vulnerability to adverse natural and anthropogenic hazards and extreme events, including the devastating potential impacts of climate change. The implementation period is January 2010 to December 2014. Apart from Sweden and UNDP, the programme is supported by Norway, UK, Australia, and the European Union. Total project budget amounts to 70 MUSD, out of which the Swedish contribution is 7 MUSD. CDMP2 is managed by UNDP and implemented by the GoB.

2.2.4.10 Baseline IF, FF and O&M expenditures

Table 12 presents baseline scenario IF, FF and O&M estimates by investment type in Bangladesh agriculture without any climate change adaptations costs. They were classified into 17 programme areas:

1. Awareness building.
2. Infrastructure development,
3. Disaster preparedness,
4. Disaster rehabilitation,
5. Research, Technology generation and knowledge management,
6. Agricultural extensions,
7. Livestock development,
8. Fisheries development,
9. Food and nutrition security,
10. Wet land conservation,
11. Biodiversity management,
12. Improved agricultural production and adaptation prac-

tices to reduce emissions of green house gases from agricultural land,¹³. Agro-processing & agri-business development,¹⁴. Market infrastructure development,¹⁵. Irrigation and water management, Irrigation and water management adaptations includes channel digging, capital dredging, development of irrigation structure, improving water distribution system, increasing on-farm irrigation efficiency, training of water users association/groups, etc. Some of these programmes of Ministry of agriculture (MOA) may overlap with water sector programmes in Bangladesh under Ministry of water resources.¹⁶. Agro-forestry,¹⁷. Coastal zone management.

Table 12. Baseline scenario of IF, FF and O&M Estimates by Investment Type in agriculture (2005 million USD)

YEAR	1. AWARENESS BUILDING				2. INFRASTRUCTURE DEVELOPMENT				3. DISASTER PREPAREDNESS				4. DISASTER REHABILITATION			
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total
2012	0.1	0.5	0.4	1.1	40.9	306.6	61.3	408.8	3.1	12.5	5.2	20.8	20.9	83.4	34.8	139.0
2013	0.1	0.6	0.5	1.2	44.1	331.1	66.2	441.5	3.4	13.5	5.6	22.4	22.5	90.1	37.5	150.1
2014	0.1	0.6	0.5	1.2	47.7	357.6	71.5	476.8	3.6	14.5	6.1	24.2	24.3	97.3	40.5	162.1
2015	0.1	0.7	0.5	1.3	51.5	386.2	77.2	514.9	3.9	15.7	6.5	26.2	26.3	105.1	43.8	175.1
2016	0.1	0.7	0.6	1.5	55.6	417.1	83.4	556.1	4.2	16.9	7.1	28.2	28.4	113.5	47.3	189.1
2017	0.2	0.8	0.6	1.6	60.1	450.5	90.1	600.6	4.6	18.3	7.6	30.5	30.6	122.6	51.1	204.3
2018	0.2	0.8	0.7	1.7	64.9	486.5	97.3	648.7	4.9	19.8	8.2	33.0	33.1	132.4	55.2	220.6
2019	0.2	0.9	0.7	1.8	70.1	525.4	105.1	700.5	5.3	21.4	8.9	35.6	35.7	143.0	59.6	238.3
2020	0.2	1.0	0.8	2.0	75.7	567.4	113.5	756.6	5.8	23.1	9.6	38.4	38.6	154.4	64.3	257.3
2021	0.2	1.1	0.9	2.1	81.7	612.8	122.6	817.1	6.2	24.9	10.4	41.5	41.7	166.7	69.5	277.9
2022	0.2	1.2	0.9	2.3	88.2	661.9	132.4	882.5	6.7	26.9	11.2	44.8	45.0	180.1	75.0	300.1
2023	0.2	1.2	1.0	2.5	95.3	714.8	143.0	953.1	7.3	29.0	12.1	48.4	48.6	194.5	81.0	324.1
2024	0.3	1.3	1.1	2.7	102.9	772.0	154.4	1029.3	7.8	31.4	13.1	52.3	52.5	210.0	87.5	350.1
2025	0.3	1.5	1.2	2.9	111.2	833.8	166.8	1111.7	8.5	33.9	14.1	56.5	56.7	226.8	94.5	378.1
2026	0.3	1.6	1.3	3.1	120.1	900.5	180.1	1200.6	9.1	36.6	15.2	61.0	61.2	245.0	102.1	408.3
2027	0.3	1.7	1.4	3.4	129.7	972.5	194.5	1296.7	9.9	39.5	16.5	65.9	66.1	264.6	110.2	441.0
2028	0.4	1.8	1.5	3.7	140.0	1050.3	210.1	1400.4	10.7	42.7	17.8	71.1	71.4	285.8	119.1	476.3
2029	0.4	2.0	1.6	4.0	151.2	1134.3	226.9	1512.4	11.5	46.1	19.2	76.8	77.2	308.6	128.6	514.4
2030	0.4	2.1	1.7	4.3	163.3	1225.1	245.0	1633.4	12.4	49.8	20.7	83.0	83.3	333.3	138.9	555.5

Table 12a. Baseline scenario of cumulative IF, FF and O&M Estimates by Investment Type in agriculture (2005 million USD)

SOURCE	1. AWARENESS BUILDING				2. INFRASTRUCTURE DEVELOPMENT				3. DISASTER PREPAREDNESS				4. DISASTER REHABILITATION			
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total
Government	3	13	10	25	965	7235	1447	9647	74	294	123	490	492	1969	820	3281

Note: Private investment assessment is not possible because of lack of base line data

Table 12. Base line scenario of IF, FF and O&M Estimates by Investment Type in agriculture (2005 million USD) (continued)

YEAR	5. RESEARCH, AND KNOWLEDGE MANAGEMENT				6. AGRICULTURAL EXTENSIONS				7. LIVESTOCK DEVELOPMENT				8. FISHERIES DEVELOPMENT			
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total
2012	0.9	4.2	0.9	6.0	7.7	36.1	7.7	51.6	3.5	16.1	3.5	23.0	4.3	20.0	4.3	28.5
2013	1.0	4.5	1.0	6.5	8.4	39.0	8.4	55.7	3.7	17.4	3.7	24.9	4.6	21.6	4.6	30.8
2014	1.1	4.9	1.1	7.0	9.0	42.1	9.0	60.2	4.0	18.8	4.0	26.9	5.0	23.3	5.0	33.3
2015	1.1	5.3	1.1	7.6	9.8	45.5	9.8	65.0	4.4	20.3	4.4	29.0	5.4	25.2	5.4	36.0
2016	1.2	5.7	1.2	8.2	10.5	49.2	10.5	70.2	4.7	21.9	4.7	31.3	5.8	27.2	5.8	38.8
2017	1.3	6.2	1.3	8.8	11.4	53.1	11.4	75.8	5.1	23.7	5.1	33.8	6.3	29.4	6.3	41.9
2018	1.4	6.7	1.4	9.5	12.3	57.3	12.3	81.9	5.5	25.6	5.5	36.5	6.8	31.7	6.8	45.3
2019	1.5	7.2	1.5	10.3	13.3	61.9	13.3	88.5	5.9	27.6	5.9	39.5	7.3	34.2	7.3	48.9
2020	1.7	7.8	1.7	11.1	14.3	66.9	14.3	95.5	6.4	29.8	6.4	42.6	7.9	37.0	7.9	52.8
2021	1.8	8.4	1.8	12.0	15.5	72.2	15.5	103.2	6.9	32.2	6.9	46.0	8.6	39.9	8.6	57.1
2022	1.9	9.1	1.9	13.0	16.7	78.0	16.7	111.4	7.5	34.8	7.5	49.7	9.2	43.1	9.2	61.6
2023	2.1	9.8	2.1	14.0	18.1	84.2	18.1	120.3	8.1	37.6	8.1	53.7	10.0	46.6	10.0	66.6
2024	2.3	10.6	2.3	15.1	19.5	91.0	19.5	130.0	8.7	40.6	8.7	58.0	10.8	50.3	10.8	71.9
2025	2.5	11.5	2.5	16.4	21.1	98.3	21.1	140.4	9.4	43.8	9.4	62.6	11.6	54.3	11.6	77.6
2026	2.7	12.4	2.7	17.7	22.7	106.1	22.7	151.6	10.1	47.4	10.1	67.6	12.6	58.7	12.6	83.8
2027	2.9	13.4	2.9	19.1	24.6	114.6	24.6	163.7	11.0	51.1	11.0	73.1	13.6	63.4	13.6	90.6
2028	3.1	14.4	3.1	20.6	26.5	123.8	26.5	176.8	11.8	55.2	11.8	78.9	14.7	68.5	14.7	97.8
2029	3.3	15.6	3.3	22.3	28.6	133.7	28.6	191.0	12.8	59.7	12.8	85.2	15.8	73.9	15.8	105.6
2030	3.6	16.8	3.6	24.0	30.9	144.4	30.9	206.2	13.8	64.4	13.8	92.0	17.1	79.9	17.1	114.1

Table 12a. Base line scenario of cumulative discounted IF, FF and O&M Estimates by Investment Type in agriculture (2005 million USD) (continued)

SOURCE	5. RESEARCH, KNOWLEDGE MANAGEMENT				6. AGRICULTURAL EXTENSIONS				7. LIVESTOCK DEVELOPMENT				8. FISHERIES DEVELOPMENT			
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total
Government	21.3	99.4	21.3	142.0	182.7	852.6	182.7	1218.1	81.5	380.5	81.5	543.6	101.1	471.6	101.1	673.7

Table 12. Base line scenario of IF, FF and O&M Estimates by Investment Type in agriculture (2005 million USD) (continued)

YEAR	14. MARKET INFRASTRUCTURE DEVELOPMENT				15. IRRIGATION AND WATER MANAGEMENT				16. AGRO-FORESTRY				17. COASTAL ZONE MANAGEMENT				ALL
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	
2012	34.5	160.9	34.5	229.8	30.0	140.2	30.0	200.2	1.5	6.9	1.5	9.8	13.4	62.5	13.4	89.3	1375.3
2013	37.2	173.8	37.2	248.2	32.4	151.4	32.4	216.2	1.6	7.4	1.6	10.6	14.5	67.5	14.5	96.5	1485.3
2014	40.2	187.7	40.2	268.1	35.0	163.5	35.0	233.5	1.7	8.0	1.7	11.5	15.6	72.9	15.6	104.2	1604.2
2015	43.4	202.7	43.4	289.5	37.8	176.6	37.8	252.2	1.9	8.7	1.9	12.4	16.9	78.8	16.9	112.5	1732.5
2016	46.9	218.9	46.9	312.7	40.9	190.7	40.9	272.4	2.0	9.4	2.0	13.4	18.2	85.1	18.2	121.6	1871.1
2017	50.7	236.4	50.7	337.7	44.1	205.9	44.1	294.2	2.2	10.1	2.2	14.5	19.7	91.9	19.7	131.3	2020.8
2018	54.7	255.3	54.7	364.7	47.7	222.4	47.7	317.7	2.3	10.9	2.3	15.6	21.3	99.2	21.3	141.8	2182.5
2019	59.1	275.7	59.1	393.9	51.5	240.2	51.5	343.1	2.5	11.8	2.5	16.9	23.0	107.2	23.0	153.1	2357.0
2020	63.8	297.8	63.8	425.4	55.6	259.4	55.6	370.6	2.7	12.8	2.7	18.2	24.8	115.8	24.8	165.4	2545.6
2021	68.9	321.6	68.9	459.5	60.0	280.2	60.0	400.2	3.0	13.8	3.0	19.7	26.8	125.0	26.8	178.6	2749.3
2022	74.4	347.4	74.4	496.2	64.8	302.6	64.8	432.3	3.2	14.9	3.2	21.3	28.9	135.0	28.9	192.9	2969.2
2023	80.4	375.1	80.4	535.9	70.0	326.8	70.0	466.8	3.4	16.1	3.4	23.0	31.2	145.8	31.2	208.3	3206.7
2024	86.8	405.2	86.8	578.8	75.6	352.9	75.6	504.2	3.7	17.4	3.7	24.8	33.7	157.5	33.7	225.0	3463.3
2025	93.8	437.6	93.8	625.1	81.7	381.2	81.7	544.5	4.0	18.7	4.0	26.8	36.4	170.1	36.4	243.0	3740.3
2026	101.3	472.6	101.3	675.1	88.2	411.7	88.2	588.1	4.3	20.2	4.3	28.9	39.4	183.7	39.4	262.4	4039.6
2027	109.4	510.4	109.4	729.1	95.3	444.6	95.3	635.1	4.7	21.9	4.7	31.2	42.5	198.4	42.5	283.4	4362.7
2028	118.1	551.2	118.1	787.4	102.9	480.2	102.9	685.9	5.1	23.6	5.1	33.7	45.9	214.3	45.9	306.1	4711.7
2029	127.6	595.3	127.6	850.4	111.1	518.6	111.1	740.8	5.5	25.5	5.5	36.4	49.6	231.4	49.6	330.6	5088.7
2030	137.8	642.9	137.8	918.5	120.0	560.0	120.0	800.1	5.9	27.5	5.9	39.4	53.6	249.9	53.6	357.0	5495.8

Table 12a. Base line scenario of cumulative discounted IF, FF and O&M Estimates by Investment Type in agriculture (2005 million USD) (continued)

SOURCE	14. MARKET INFRASTRUCTURE DEVELOPMENT				15. IRRIGATION AND WATER MANAGEMENT				16. AGRO-FORESTRY				17. COASTAL ZONE MANAGEMENT				ALL
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	
Government	814	3797	814	5425	709	3308	709	4725	35	163	35	232	316	1476	316	2109	32459

2.2.5 Adaptation Scenario

2.2.5.1 Scenario description

Bangladesh is already feeling the impact of climate change. Frequency of disasters like cyclone, flood and drought has already risen above the normal level. IPCC 4th assessment report (IPCC, 2007) has already listed Bangladesh as one of the most vulnerable countries of the world. It has mentioned that climate impacts will effect Bangladesh in several ways: a) sea level rise will permanently inundate roughly 1/3rd of the country if it is not properly protected with embankments and polders; b)

frequent floods will force millions to become climate refugees; c) deteriorate the poverty, health and nutrition scenario; and d) increase salinity in coastal areas (Haque, 2008). The report further went in to suggest possible adaptation options for the developed nations in energy, transportation, construction, industry, agriculture, forestry, and waste disposal mechanism to reduce or arrest the growth of carbon emission into the atmosphere. The agriculture sector of Bangladesh is much vulnerable to climate change. The climate related elements, critical vulnerable areas, most impacted sectors and intensity of impacts are presented in Table 13 and 14.

Table 13. Causes of impacts, vulnerable area and impacted sectors

CLIMATE AND RELATED ELEMENTS	CRITICAL VULNERABLE AREAS	MOST IMPACTED SECTORS
Temperature rise and drought	• North-west	• Agriculture (crop, livestock, fisheries) • Water • Energy • Health
Sea Level Rise and Salinity Intrusion	• Coastal Area • Island	• Agriculture (crop, livestock, fisheries) • Water • Energy • Health
Floods	• Central Region • North East Region • Char land	• Agriculture (crop, fisheries, livestock) • Water (urban, industry) • Infrastructure • Human settlement • Health • Disaster • Energy
Cyclone and Storm Surge	• Coastal and Marine Zone	• Marine Fishing • Infrastructure • Human settlement • Life and property
Drainage congestion	• Coastal Area • Urban • South West	• Water (Navigation) • Agriculture (crop)

Source: NAPA team

Table 14. Intensity of impacts on different sectors due to climate change

PHYSICAL VULNERABILITY CONTEXT								
Extreme Temperature	Sea Level Rise		Drought	Flood		Cyclone and Storm Surges	Erosion and Accretion	Sectoral Vulnerability Context
	Coastal Inundation	Salinity Intrusion		River Flood	Flash Flood			
+++	++	+++	+++	+	++	+++	-	Crop Agriculture
++	+	+	++	++	+	+	-	Fisheries
++	++	+++	-	-	+	+++	-	Livestock
+	++	-	-	++	+	+	+++	Infrastructure
++	+++	++	-	++	+	+	-	Industries
++	+++	+++	-	++	-	+	-	Biodiversity
+++	+	+++	-	++	-	++	-	Health
-	-	-	-	-	-	+++	+++	Human Settlement
++	+	-	-	+	-	+	-	Energy

2.2.5.2 Adaptations to climate change in agriculture of Bangladesh

Bangladesh has to adapt to the changing circumstances. The people of Bangladesh have become adapted over generations to the risk of floods, droughts and cyclones. In areas where inundation is at risk, they raise their houses on mounds, above the normal flood level, and adjust their cropping patterns to take advantage of the flood water. Farmers across the country are adapted to local flooding and rainfall patterns by growing a wide range of indigenous and high-yielding varieties of rice and other crops. Rural roads, paths, tracks and other infrastructure, such as schools, are also raised above flood level, where possible. Potential adaptation measures those pertinent for the water sector are described below:

In order to enable the agriculture sector to adapt to the adverse effects of climate change, a number of measures should be promoted to enable it play its role in a context of food security and general economic crisis. Various adaptation to climate change for agriculture sector of Bangladesh is identified through review of various documents and consultations which are presented in Table 15 (Karim 2009, Karim and Iqbal 2001, MoA 1996/1997/1999/2008, MoEF 1994/2009, MoF 2005, MoFL 1998/2007, Karim and Islam 2010, Planning Commission 2010/2011).

The Bangladesh Climate Change Strategy and Action Plan (BCCSAP) in 2009, provided a set of programmes under six priority action pillar (see figure 8). It is a 10-year programme (2009-2018) for capacity building and country resilience to climate change challenges. First five-year part based on six themes encompasses 44 programmes related to adaptation and mitigation.

For adaptation investment planning, the same investment heads as of the baseline investment have been considered. A total of 17 investment programme areas have been planned to be implemented over a period of the next 20 years until 2030. Table 15 identifies the programmes that are selected or detailed I&FF calculation in the agriculture sector. Appendix 1 presents details of each broad programme area.

Table 15 Various adaptation to climate change in agriculture of Bangladesh

BROAD PROGRAMME AREAS	SPECIFIC ADAPTATION
1. Awareness building	Specific extension and mass media programmes
2. Infrastructure development	Construction and repairing of roads and embankments
3. Disaster preparedness	Climate services, cyclone shelters, training and awareness
4. Disaster rehabilitation	Construction and management of food storage, silos, etc; distribution of inputs (seeds, fertilizers, saplings).
5. Research, Technology generation and knowledge management:	Development of climate resilient cultivars, species and management practices and the specific on-farm adaptation measures.
Crops:	Varietal development: salt and draught tolerant varieties, management practices: short maturing varieties, fertilizer and soil management trials
Livestock:	Development of livestock species tolerant to climatic conditions, Animal health and diseases, Feeds and fodder production, Animal insurance, special breeding and
Fisheries:	Technology generation for increasing shrimp and fishery productivity, dredging of rivers, channels, community based management of water bodies and rehabilitation of fishers
6. Agricultural extensions services development	Technology disseminations: salt and draught tolerant varieties, improved farming practices for crops, livestock and fisheries, sustainable supply of inputs (seeds, fertilizers, breed, feed, fingerling, vaccines, etc.), irrigation and water management, soil fertility management (conservation and restoration of soil quality), plant protection and epidemiological surveillance.
Livestock development	Expanding veterinary health services, disease control, feeds and fodder production, special breeding and biogas production.
Fisheries development	Management of water reservoir, improved sanctuaries, disease control, improvement of fish landing sites and market infrastructure development, enhanced R & D and for climate resilient species development and management practices, protection of fish habitat from intrusion of salt water and establishment of improved hatchery
7. Food and nutrition security	Ensuring food availability, access, and utilization
8. Wet land conservation	Dredging, development of mangroves, sanctuary management and alternative income generation activities
9. Biodiversity management	Regeneration and protection of biodiversity in varied ecosystems and promotion of improved management practices.
10. Reducing emission of green house gases from agriculture land	Adaptation measures on land management practices including different form of tillage and conservation agriculture towards ensuring ecology and reduction of emissions from agricultural land in the diversified agricultural system(crop, fisheries, livestock and agro-forestry).
11. Agro-processing	Promoting climate resilient agro-processing technique, value chain management specifically HRD and post harvest loss minimization
12. Market infrastructure development	Creation of facilities at all stages from farm to fork, development of long term storage facilities and quality control
13. Irrigation and water management	Improved water reservoir, channels, rivers and improved distribution system and on-farm water management technology, restructuring of land use based on availability and productivity. Interventions in this programme area is focused to increase water productivity and solely on the agriculture system.
14. Agro-forestry	Improved nursery plantation and management practices, development of climate resilient species, training on nursery and plantation
15. Coastal zone management	Polder management towards enhanced agricultural productivity, development of improved drainage, land suitability zoning, and agricultural intensification, , climate resilient technology and improved management practices, establishment of special agricultural R & D centres, market development, promotion of off-farm activities, agro-tourism and human resettlement

In Bangladesh most of the adaptation measures are taken by public sector department/institutions. There are some NGOs carrying out awareness building programmes and developing local level community groups. Research and extensions would be the major functions of public sector agencies. The role of private sector would be in the area of agro-processing and market infrastructure development. Construction of polders, dredging of rivers are the responsibility of three ministries including water resources, local government and agriculture. Whereas the role of NGOs, community organizations and private sectors is the operation and maintenance of infrastructure.

We have briefly presented below discounted cumulative IF FF and O&M of each of the adaptation considered under the broad investment heads (Table 15 and 16):

1. **Awareness building:** The total discounted adaptation investment is US \$ 56.1 million of which FF, IF and O&M costs are 5.6, 28.0 and 22.4, respectively. One important project undertaken under this programme is Intensification of agricultural information services of AIS at 10 agricultural regions (Annex 1)
2. **Infrastructure development:** The total discounted adaptation investment is US \$ 21438.2 million of which FF, IF and O&M costs are 2143.8, 160.78 and 3215.7 million dollar respectively. Six projects under taken in 2010-11 (annex 1).
3. **Disaster preparedness:** These include only for agriculture sector. The total discounted adaptation investment is US \$ 1089 million of which FF, IF and O&M costs are 163.4, 653.4 and 272.3 million US dollar respectively. Three projects under taken in 2010-11 (annex 1).
4. **Disaster rehabilitation:** These include only for agriculture sector. The total discounted adaptation investment is US \$ 7291 million of which FF, IF and O&M costs are 1093.7, 4374.6 and 1822.8 million US dollar respectively. Six projects under taken in 2010-11 (annex 1).
5. **Research, technology generation and knowledge management:** The total discounted adaptation investment is US \$ 315.5 million of which FF, IF and O&M costs are 47.3, 220.8 and 47.3 million US dollar respectively.
6. **Agricultural extensions services development:** The total discounted adaptation investment is US \$ 2706.8 million of which FF, IF and O&M costs are 406, 1894.8 and 406 million US dollar respectively. Seven projects under taken in 2010-11 (annex 1).
7. **Livestock development:** The total discounted adaptation investment is US \$ 1207.9 million of which FF, IF and O&M costs are 181.2, 845.6 and 181.2 million US dollar respectively. Eight projects under taken in 2010-11 (annex 1).
8. **Fisheries development:** The total discounted adaptation investment is US \$ 2706.8 million of which FF, IF and O&M costs are 406, 1894.8 and 406 million US dollar respectively. Elevenx projects under taken in 2010-11 (annex 1).
9. **Food and nutrition security:** The total discounted adaptation investment is US \$ 3490.2 million of which FF, IF and O&M costs are 523.5, 2094.1 and 872.6 million US dollar respectively. Six projects under taken in 2010-11 (annex 1). Six projects under taken in 2010-11 (annex 1). Four projects under taken in 2010-11 (annex 1).
10. **Wet land conservation:** The total discounted adaptation investment is US \$ 1490.8 million of which FF, IF and O&M costs are 223.6, 1043. and 223.6 million US dollar respectively.
11. **Biodiversity management:** The total discounted adaptation investment is US \$ 786.3 million of which FF, IF and O&M costs are 117.9, 550.4 and 117.9 million US dollar respectively. Seven projects under taken in 2010-11 (annex 1).
12. **Reducing emission of green house gases from agriculture:** The total discounted adaptation investment is US \$ 1815.8 million of which FF, IF and O&M costs are 242.4, 1131.1 and 242.4 million US dollar respectively. One projects under taken in 2010-11 (annex 1).
13. **Agro-processing & agribusiness development:** The total discounted adaptation investment is US \$ 1388.2 million of which FF, IF and O&M costs are 208.2, 971.7 and 208.2 million US dollar respectively. One projects under taken in 2010-11 (annex 1).
14. **Market development:** The total discounted adaptation investment is US \$ 1203 million of which FF, IF and O&M costs are 180, 843 and 180 million US dollar respectively. Three projects under taken in 2010-11 (annex 1).

15. Irrigation and water management: The total discounted adaptation investment is US \$ 1049.5 million of which FF, IF and O&M costs are 157, 735 and 157.5 million US dollar respectively.

Fifteen projects under taken in 2010-11 (annex 1).

16. Agro-forestry: The total discounted adaptation investment is US \$ 516.5 million of which FF, IF and O&M costs are 77, 361.5 and 77.5 million US

dollar respectively. Three projects under taken in 2010-11 (annex 1).

17. Coastal zone management: The total discounted adaptation investment is US \$ 8685 million of which FF, IF and O&M costs are 702, 328 and 702.9 million US dollar respectively. Three projects under taken in 2010-11 (annex 1).

Table 16. Adaptation Scenario: Annual IF, FF, and O&M Estimates by Investment Type
Table Adaptation in Bangladesh agriculture due to CC (2005 million USD)

YEAR	1. AWARENESS BUILDING				2. INFRASTRUCTURE DEVELOPMENT				3. DISASTER PREPAREDNESS				4. DISASTER REHABILITATION			
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total
2012	0.2	1.2	1.0	2.4	90.8	681.3	136.3	908.4	6.9	27.7	11.5	46.1	46.3	185.4	77.2	308.9
2013	0.3	1.3	1.0	2.6	98.1	735.8	147.2	981.0	7.5	29.9	12.5	49.8	50.0	200.2	83.4	333.6
2014	0.3	1.4	1.1	2.8	106.0	794.6	158.9	1059.5	8.1	32.3	13.5	53.8	54.0	216.2	90.1	360.3
2015	0.3	1.5	1.2	3.0	114.4	858.2	171.6	1144.3	8.7	34.9	14.5	58.1	58.4	233.5	97.3	389.2
2016	0.3	1.6	1.3	3.2	123.6	926.9	185.4	1235.8	9.4	37.7	15.7	62.8	63.0	252.2	105.1	420.3
2017	0.3	1.7	1.4	3.5	133.5	1001.0	200.2	1334.7	10.2	40.7	16.9	67.8	68.1	272.3	113.5	453.9
2018	0.4	1.9	1.5	3.8	144.1	1081.1	216.2	1441.4	11.0	43.9	18.3	73.2	73.5	294.1	122.6	490.2
2019	0.4	2.0	1.6	4.1	155.7	1167.6	233.5	1556.8	11.9	47.4	19.8	79.1	79.4	317.7	132.4	529.4
2020	0.4	2.2	1.8	4.4	168.1	1261.0	252.2	1681.3	12.8	51.2	21.4	85.4	85.8	343.1	143.0	571.8
2021	0.5	2.4	1.9	4.7	181.6	1361.9	272.4	1815.8	13.8	55.3	23.1	92.2	92.6	370.5	154.4	617.5
2022	0.5	2.6	2.1	5.1	196.1	1470.8	294.2	1961.1	14.9	59.8	24.9	99.6	100.0	400.2	166.7	667.0
2023	0.6	2.8	2.2	5.5	211.8	1588.5	317.7	2118.0	16.1	64.6	26.9	107.6	108.0	432.2	180.1	720.3
2024	0.6	3.0	2.4	6.0	228.7	1715.5	343.1	2287.4	17.4	69.7	29.0	116.2	116.7	466.8	194.5	777.9
2025	0.6	3.2	2.6	6.5	247.0	1852.8	370.6	2470.4	18.8	75.3	31.4	125.5	126.0	504.1	210.0	840.2
2026	0.7	3.5	2.8	7.0	266.8	2001.0	400.2	2668.0	20.3	81.3	33.9	135.5	136.1	544.4	226.8	907.4
2027	0.8	3.8	3.0	7.5	288.1	2161.1	432.2	2881.5	22.0	87.8	36.6	146.4	147.0	588.0	245.0	980.0
2028	0.8	4.1	3.3	8.1	311.2	2334.0	466.8	3112.0	23.7	94.9	39.5	158.1	158.8	635.0	264.6	1058.4
2029	0.9	4.4	3.5	8.8	336.1	2520.7	504.1	3360.9	25.6	102.4	42.7	170.7	171.5	685.8	285.8	1143.0
2030	0.9	4.7	3.8	9.5	363.0	2722.4	544.5	3629.8	27.7	110.6	46.1	184.4	185.2	740.7	308.6	1234.5

Table 16a. Adaptation scenario of cumulative discounted IF, FF and O&M Estimates by Investment Type in agriculture
(2005 million USD)

SOURCE	1. AWARENESS BUILDING				2. INFRASTRUCTURE DEVELOPMENT				3. DISASTER PREPAREDNESS				4. DISASTER REHABILITATION			
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total
Government	5.6	28.0	22.4	56.1	2143.8	16078.7	3215.7	21438.2	163.4	653.4	272.3	1089.0	1093.7	4374.6	1822.8	7291.0

Note: Private investment assessment is not possible because of lack of base line data

Table 16. Adaptation in Bangladesh agriculture due to climate change (2005 million USD) (Continued)

YEAR	5. RESEARCH, AND KNOWLEDGE MANAGEMENT				6. AGRICULTURAL EXTENSIONS				7. LIVESTOCK DEVELOPMENT				8. FISHERIES DEVELOPMENT			
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total
2012	2.0	9.4	2.0	13.4	17.2	80.3	17.2	114.7	7.7	35.8	7.7	51.2	9.5	44.4	9.5	63.4
2013	2.2	10.1	2.2	14.4	18.6	86.7	18.6	123.9	8.3	38.7	8.3	55.3	10.3	48.0	10.3	68.5
2014	2.3	10.9	2.3	15.6	20.1	93.6	20.1	133.8	9.0	41.8	9.0	59.7	11.1	51.8	11.1	74.0
2015	2.5	11.8	2.5	16.8	21.7	101.1	21.7	144.5	9.7	45.1	9.7	64.5	12.0	55.9	12.0	79.9
2016	2.7	12.7	2.7	18.2	23.4	109.2	23.4	156.0	10.4	48.7	10.4	69.6	12.9	60.4	12.9	86.3
2017	2.9	13.7	2.9	19.6	25.3	118.0	25.3	168.5	11.3	52.6	11.3	75.2	14.0	65.2	14.0	93.2
2018	3.2	14.8	3.2	21.2	27.3	127.4	27.3	182.0	12.2	56.9	12.2	81.2	15.1	70.5	15.1	100.7
2019	3.4	16.0	3.4	22.9	29.5	137.6	29.5	196.6	13.2	61.4	13.2	87.7	16.3	76.1	16.3	108.7
2020	3.7	17.3	3.7	24.7	31.8	148.6	31.8	212.3	14.2	66.3	14.2	94.7	17.6	82.2	17.6	117.4
2021	4.0	18.7	4.0	26.7	34.4	160.5	34.4	229.3	15.3	71.6	15.3	102.3	19.0	88.8	19.0	126.8
2022	4.3	20.2	4.3	28.9	37.1	173.3	37.1	247.6	16.6	77.3	16.6	110.5	20.5	95.9	20.5	137.0
2023	4.7	21.8	4.7	31.2	40.1	187.2	40.1	267.4	17.9	83.5	17.9	119.3	22.2	103.5	22.2	147.9
2024	5.0	23.6	5.0	33.7	43.3	202.2	43.3	288.8	19.3	90.2	19.3	128.9	24.0	111.8	24.0	159.7
2025	5.5	25.4	5.5	36.4	46.8	218.3	46.8	311.9	20.9	97.4	20.9	139.2	25.9	120.8	25.9	172.5
2026	5.9	27.5	5.9	39.3	50.5	235.8	50.5	336.9	22.5	105.2	22.5	150.3	27.9	130.4	27.9	186.3
2027	6.4	29.7	6.4	42.4	54.6	254.7	54.6	363.8	24.4	113.6	24.4	162.4	30.2	140.9	30.2	201.2
2028	6.9	32.1	6.9	45.8	58.9	275.0	58.9	392.9	26.3	122.7	26.3	175.3	32.6	152.1	32.6	217.3
2029	7.4	34.6	7.4	49.5	63.7	297.0	63.7	424.4	28.4	132.6	28.4	189.4	35.2	164.3	35.2	234.7
2030	8.0	37.4	8.0	53.4	68.7	320.8	68.7	458.3	30.7	143.2	30.7	204.5	38.0	177.4	38.0	253.5

Table 16a. adaptation scenario of cumulative discounted IF, FF and O&M Estimates by Investment Type in agriculture (2005 million USD)

SOURCE	5. RESEARCH, KNOWLEDGE MANAGEMENT				6. AGRICULTURAL EXTENSIONS				7. LIVESTOCK DEVELOPMENT				8. FISHERIES DEVELOPMENT			
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total
Government	47.3	220.8	47.3	315.5	406.0	1894.8	406.0	2706.8	181.2	845.6	181.2	1207.9	224.6	1048.0	224.6	1497.2

Table 16. Base line scenario of IF, FF and O&M Estimates by Investment Type in agriculture (2005 million USD) (continued)

YEAR	9. FOOD AND NUTRITION SECURITY				10. WET LAND CONSERVATION				11. BIODIVERSITY MANAGEMENT				12. AGRO-PROCESSING & AGRIBUSINESS DEVELOPMENT				
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	Total	FF	IF	O&M	Total
2012	22.2	88.7	37.0	147.9	9.5	44.2	9.5	63.2	5.0	23.3	5.0	33.3	68.5	8.8	41.2	8.8	58.8
2013	24.0	95.8	39.9	159.7	10.2	47.8	10.2	68.2	5.4	25.2	5.4	36.0	73.9	9.5	44.5	9.5	63.5
2014	25.9	103.5	43.1	172.5	11.1	51.6	11.1	73.7	5.8	27.2	5.8	38.9	79.9	10.3	48.0	10.3	68.6
2015	27.9	111.8	46.6	186.3	11.9	55.7	11.9	79.6	6.3	29.4	6.3	42.0	86.2	11.1	51.9	11.1	74.1
2016	30.2	120.7	50.3	201.2	12.9	60.2	12.9	85.9	6.8	31.7	6.8	45.3	93.1	12.0	56.0	12.0	80.0
2017	32.6	130.4	54.3	217.3	13.9	65.0	13.9	92.8	7.3	34.3	7.3	49.0	100.6	13.0	60.5	13.0	86.4
2018	35.2	140.8	58.7	234.7	15.0	70.2	15.0	100.2	7.9	37.0	7.9	52.9	108.6	14.0	65.3	14.0	93.3
2019	38.0	152.1	63.4	253.4	16.2	75.8	16.2	108.3	8.6	40.0	8.6	57.1	117.3	15.1	70.6	15.1	100.8
2020	41.1	164.2	68.4	273.7	17.5	81.8	17.5	116.9	9.2	43.2	9.2	61.7	126.7	16.3	76.2	16.3	108.9
2021	44.3	177.4	73.9	295.6	18.9	88.4	18.9	126.3	10.0	46.6	10.0	66.6	136.9	17.6	82.3	17.6	117.6
2022	47.9	191.6	79.8	319.3	20.5	95.5	20.5	136.4	10.8	50.3	10.8	71.9	147.8	19.0	88.9	19.0	127.0
2023	51.7	206.9	86.2	344.8	22.1	103.1	22.1	147.3	11.7	54.4	11.7	77.7	159.6	20.6	96.0	20.6	137.1
2024	55.9	223.4	93.1	372.4	23.9	111.3	23.9	159.1	12.6	58.7	12.6	83.9	172.4	22.2	103.7	22.2	148.1
2025	60.3	241.3	100.5	402.2	25.8	120.3	25.8	171.8	13.6	63.4	13.6	90.6	186.2	24.0	112.0	24.0	160.0
2026	65.2	260.6	108.6	434.4	27.8	129.9	27.8	185.5	14.7	68.5	14.7	97.9	201.1	25.9	120.9	25.9	172.8
2027	70.4	281.5	117.3	469.1	30.1	140.3	30.1	200.4	15.9	74.0	15.9	105.7	217.2	28.0	130.6	28.0	186.6
2028	76.0	304.0	126.7	506.6	32.5	151.5	32.5	216.4	17.1	79.9	17.1	114.1	234.6	30.2	141.1	30.2	201.5
2029	82.1	328.3	136.8	547.2	35.1	163.6	35.1	233.7	18.5	86.3	18.5	123.3	253.3	32.6	152.3	32.6	217.6
2030	88.6	354.6	147.7	590.9	37.9	176.7	37.9	252.4	20.0	93.2	20.0	133.1	273.6	35.3	164.5	35.3	235.0

Table 16a. Adaptation scenario of cumulative discounted IF, FF and O&M Estimates by Investment Type in agriculture (2005 million USD) (continued)

SOURCE	9. FOOD AND NUTRITION SECURITY				10. WET LAND CONSERVATION				11. BIODIVERSITY MANAGEMENT				12. AGRO-PROCESSING & AGRIBUSINESS DEVELOPMENT			
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total
Government	523.5	2094.1	872.6	3490.2	223.6	1043.6	223.6	1490.8	117.9	550.4	117.9	786.3	208.2	971.7	208.2	1388.2

Table 16. Adaptation in Bangladesh agriculture due to climate change(Continued)

YEAR	13. MARKET INFRASTRUCTURE DEVELOPMENT				14. IRRIGATION AND WATER MANAGEMENT				15. AGRO-FORESTRY				16. COASTAL ZONE MANAGEMENT				ALL
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	
2012	76.6	357.5	76.6	510.8	66.7	311.4	66.7	444.9	3.3	15.3	3.3	21.9	29.8	139.0	29.8	198.5	3056.3
2013	82.7	386.1	82.7	551.6	72.1	336.4	72.1	480.5	3.5	16.5	3.5	23.6	32.2	150.1	32.2	214.4	3300.8
2014	89.4	417.0	89.4	595.8	77.8	363.3	77.8	519.0	3.8	17.9	3.8	25.5	34.7	162.1	34.7	231.6	3564.8
2015	96.5	450.4	96.5	643.4	84.1	392.3	84.1	560.5	4.1	19.3	4.1	27.6	37.5	175.1	37.5	250.1	3850.0
2016	104.2	486.4	104.2	694.9	90.8	423.7	90.8	605.3	4.5	20.8	4.5	29.8	40.5	189.1	40.5	270.1	4158.0
2017	112.6	525.3	112.6	750.5	98.1	457.6	98.1	653.7	4.8	22.5	4.8	32.2	43.8	204.2	43.8	291.7	4490.6
2018	121.6	567.4	121.6	810.5	105.9	494.2	105.9	706.0	5.2	24.3	5.2	34.7	47.3	220.5	47.3	315.1	4849.9
2019	131.3	612.8	131.3	875.4	114.4	533.8	114.4	762.5	5.6	26.3	5.6	37.5	51.0	238.2	51.0	340.3	5237.9
2020	141.8	661.8	141.8	945.4	123.5	576.5	123.5	823.5	6.1	28.4	6.1	40.5	55.1	257.2	55.1	367.5	5656.9
2021	153.2	714.7	153.2	1021.0	133.4	622.6	133.4	889.4	6.6	30.6	6.6	43.7	59.5	277.8	59.5	396.9	6109.5
2022	165.4	771.9	165.4	1102.7	144.1	672.4	144.1	960.6	7.1	33.1	7.1	47.2	64.3	300.1	64.3	428.6	6598.2
2023	178.6	833.7	178.6	1190.9	155.6	726.2	155.6	1037.4	7.7	35.7	7.7	51.0	69.4	324.1	69.4	462.9	7126.1
2024	192.9	900.4	192.9	1286.2	168.1	784.3	168.1	1120.4	8.3	38.6	8.3	55.1	75.0	350.0	75.0	500.0	7696.2
2025	208.4	972.4	208.4	1389.1	181.5	847.0	181.5	1210.0	8.9	41.7	8.9	59.5	81.0	378.0	81.0	540.0	8311.9
2026	225.0	1050.2	225.0	1500.2	196.0	914.8	196.0	1306.8	9.6	45.0	9.6	64.3	87.5	408.2	87.5	583.2	8976.8
2027	243.0	1134.2	243.0	1620.3	211.7	988.0	211.7	1411.4	10.4	48.6	10.4	69.4	94.5	440.9	94.5	629.8	9695.0
2028	262.5	1224.9	262.5	1749.9	228.6	1067.0	228.6	1524.3	11.2	52.5	11.2	75.0	102.0	476.1	102.0	680.2	10470.6
2029	283.5	1322.9	283.5	1889.9	246.9	1152.4	246.9	1646.2	12.1	56.7	12.1	81.0	110.2	514.2	110.2	734.6	11308.2
2030	306.2	1428.7	306.2	2041.1	266.7	1244.5	266.7	1777.9	13.1	61.2	13.1	87.4	119.0	555.4	119.0	793.4	12212.8

Table 16a. Adaptation scenario of cumulative discounted IF, FF and O&M Estimates by Investment Type in agriculture (2005 million USD) (continued)

SOURCE	13. MARKET INFRASTRUCTURE DEVELOPMENT				14. IRRIGATION AND WATER MANAGEMENT				15. AGRO-FORESTRY				16. COASTAL ZONE MANAGEMENT				ALL
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	
Government	1808.2	8438.4	1808.2	12054.8	1575.1	7350.5	1575.1	10500.7	77.5	361.5	77.5	516.5	702.9	3280.1	702.9	4685.9	72130.9

3. RESULTS

A total of USD 69.67 billion is estimated as incremental adaptation costing for major investment components in the agriculture sector. Majority of the investment proportion is planned to be invested for the infrastructure development (30%) followed by market development (17%), irrigation and water management (15%), and others (14) (Fig. 8).

Table 16b presents cumulative discounted IF, FF and O&M for individual all investment types and Table 17 & 18 presents incremental increases of annual IF, FF and O&M for individual all investment types. The results showed that among the 16 investments significant highest

increase in cumulative FF, IF and O&M were found for infrastructure development which were 1179.1, 8843.3 and 1766.7 million US \$ respectively. Also significant shifts in investments is found for most of the investment type indicating that government would face a main challenge of fund raising from development partners for climate change adaptation. At present there is lack of information on investment by private parties, although potential exists for future public private partnership. Investment on capacity building includes awareness building and disaster preparedness. There is need for coordinated effort on capacity building programmes.

Table 16b Cumulative discounted incremental FF, IF and O&M in Bangladesh agriculture due to climate change adaptation. (2005 million USD)

AREAS OF INVESTMENT	FF	IF	O&M	TOTAL
1. Awareness building	3.1	15.4	12.3	30.8 ***
2. Infrastructure development	1179.1	8843.3	1768.7	11791.0
3. Disaster preparedness	89.8	359.4	149.7	599.0
4. Disaster rehabilitation	601.5	2406.0	1002.5	4010.1
5. Research, technology generation and knowledge management	26.0	121.5	26.0	173.5
6. Agricultural extensions	223.3	1042.1	223.3	1488.7
7. Livestock development	99.7	465.1	99.7	664.4
8. Fisheries development	123.5	576.4	123.5	823.4
9. Food and nutrition security	287.9	1151.8	479.9	1919.6
10. Wet land conservation	123.0	574.0	123.0	819.9
11. Biodiversity management,	64.9	302.7	64.9	432.5
12. Reducing emission of green house gases from agriculture land	133.3	622.1	133.3	888.7
13. Agro-processing & agri-business development	114.5	534.4	114.5	763.5
14. Market infrastructure development	994.5	4641.1	994.5	6630.2
15. Irrigation and water management	866.3	4042.8	866.3	5775.4
16. Agro-forestry	42.6	198.8	42.6	284.1
17. Coastal zone management	386.6	1804.1	386.6	2577.2
All	5359.7	27700.9	6611.4	39672.0

Table 17. Incremental Annual IF & FF Estimates by Investment Type in Bangladesh agriculture due to climate change adaptation (2005 million USD)

YEAR	1. AWARENESS BUILDING				2. INFRASTRUCTURE DEVELOPMENT				3. DISASTER PREPAREDNESS				4. DISASTER REHABILITATION			
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total
2012	0.1	0.7	0.5	1.3	50.0	374.7	74.9	499.6	3.8	15.2	6.3	25.4	25.5	101.9	42.5	169.9
2013	0.1	0.7	0.6	1.4	54.0	404.7	80.9	539.6	4.1	16.4	6.9	27.4	27.5	110.1	45.9	183.5
2014	0.2	0.8	0.6	1.5	58.3	437.0	87.4	582.7	4.4	17.8	7.4	29.6	29.7	118.9	49.5	198.2
2015	0.2	0.8	0.7	1.6	62.9	472.0	94.4	629.3	4.8	19.2	8.0	32.0	32.1	128.4	53.5	214.0
2016	0.2	0.9	0.7	1.8	68.0	509.8	102.0	679.7	5.2	20.7	8.6	34.5	34.7	138.7	57.8	231.2
2017	0.2	1.0	0.8	1.9	73.4	550.6	110.1	734.1	5.6	22.4	9.3	37.3	37.4	149.8	62.4	249.7
2018	0.2	1.0	0.8	2.1	79.3	594.6	118.9	792.8	6.0	24.2	10.1	40.3	40.4	161.8	67.4	269.6
2019	0.2	1.1	0.9	2.2	85.6	642.2	128.4	856.2	6.5	26.1	10.9	43.5	43.7	174.7	72.8	291.2
2020	0.2	1.2	1.0	2.4	92.5	693.5	138.7	924.7	7.0	28.2	11.7	47.0	47.2	188.7	78.6	314.5
2021	0.3	1.3	1.0	2.6	99.9	749.0	149.8	998.7	7.6	30.4	12.7	50.7	50.9	203.8	84.9	339.7
2022	0.3	1.4	1.1	2.8	107.9	808.9	161.8	1078.6	8.2	32.9	13.7	54.8	55.0	220.1	91.7	366.8
2023	0.3	1.5	1.2	3.0	116.5	873.7	174.7	1164.9	8.9	35.5	14.8	59.2	59.4	237.7	99.0	396.2
2024	0.3	1.6	1.3	3.3	125.8	943.6	188.7	1258.1	9.6	38.3	16.0	63.9	64.2	256.7	107.0	427.9
2025	0.4	1.8	1.4	3.6	135.9	1019.0	203.8	1358.7	10.4	41.4	17.3	69.0	69.3	277.3	115.5	462.1
2026	0.4	1.9	1.5	3.8	146.7	1100.6	220.1	1467.4	11.2	44.7	18.6	74.5	74.9	299.4	124.8	499.1
2027	0.4	2.1	1.7	4.1	158.5	1188.6	237.7	1584.8	12.1	48.3	20.1	80.5	80.8	323.4	134.7	539.0
2028	0.4	2.2	1.8	4.5	171.2	1283.7	256.7	1711.6	13.0	52.2	21.7	86.9	87.3	349.3	145.5	582.1
2029	0.5	2.4	1.9	4.8	184.9	1386.4	277.3	1848.5	14.1	56.3	23.5	93.9	94.3	377.2	157.2	628.7
2030	0.5	2.6	2.1	5.2	199.6	1497.3	299.5	1996.4	15.2	60.8	25.4	101.4	101.8	407.4	169.7	679.0

Table 17. Incremental Annual IF & FF Estimates by Investment Type in Bangladesh agriculture due to climate change adaptation (2005 million USD) (continued)

YEAR	5. RESEARCH, AND KNOWLEDGE MANAGEMENT				6. AGRICULTURAL EXTENSIONS				7. LIVESTOCK DEVELOPMENT				8. FISHERIES DEVELOPMENT			
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total
2012	1.1	5.1	1.1	7.4	9.5	44.2	9.5	63.1	4.2	19.7	4.2	28.1	5.2	24.4	5.2	34.9
2013	1.2	5.6	1.2	7.9	10.2	47.7	10.2	68.1	4.6	21.3	4.6	30.4	5.7	26.4	5.7	37.7
2014	1.3	6.0	1.3	8.6	11.0	51.5	11.0	73.6	4.9	23.0	4.9	32.8	6.1	28.5	6.1	40.7
2015	1.4	6.5	1.4	9.3	11.9	55.6	11.9	79.5	5.3	24.8	5.3	35.5	6.6	30.8	6.6	44.0
2016	1.5	7.0	1.5	10.0	12.9	60.1	12.9	85.8	5.7	26.8	5.7	38.3	7.1	33.2	7.1	47.5
2017	1.6	7.6	1.6	10.8	13.9	64.9	13.9	92.7	6.2	29.0	6.2	41.4	7.7	35.9	7.7	51.3
2018	1.8	8.2	1.8	11.7	15.0	70.1	15.0	100.1	6.7	31.3	6.7	44.7	8.3	38.8	8.3	55.4
2019	1.9	8.8	1.9	12.6	16.2	75.7	16.2	108.1	7.2	33.8	7.2	48.2	9.0	41.9	9.0	59.8
2020	2.0	9.5	2.0	13.6	17.5	81.7	17.5	116.8	7.8	36.5	7.8	52.1	9.7	45.2	9.7	64.6
2021	2.2	10.3	2.2	14.7	18.9	88.3	18.9	126.1	8.4	39.4	8.4	56.3	10.5	48.8	10.5	69.7
2022	2.4	11.1	2.4	15.9	20.4	95.3	20.4	136.2	9.1	42.5	9.1	60.8	11.3	52.7	11.3	75.3
2023	2.6	12.0	2.6	17.1	22.1	103.0	22.1	147.1	9.8	45.9	9.8	65.6	12.2	56.9	12.2	81.4
2024	2.8	13.0	2.8	18.5	23.8	111.2	23.8	158.8	10.6	49.6	10.6	70.9	13.2	61.5	13.2	87.9
2025	3.0	14.0	3.0	20.0	25.7	120.1	25.7	171.6	11.5	53.6	11.5	76.6	14.2	66.4	14.2	94.9
2026	3.2	15.1	3.2	21.6	27.8	129.7	27.8	185.3	12.4	57.9	12.4	82.7	15.4	71.7	15.4	102.5
2027	3.5	16.3	3.5	23.3	30.0	140.1	30.0	200.1	13.4	62.5	13.4	89.3	16.6	77.5	16.6	110.7
2028	3.8	17.6	3.8	25.2	32.4	151.3	32.4	216.1	14.5	67.5	14.5	96.4	17.9	83.7	17.9	119.5
2029	4.1	19.0	4.1	27.2	35.0	163.4	35.0	233.4	15.6	72.9	15.6	104.2	19.4	90.4	19.4	129.1
2030	4.4	20.6	4.4	29.4	37.8	176.4	37.8	252.1	16.9	78.7	16.9	112.5	20.9	97.6	20.9	139.4

Table 17. Incremental Annual IF & FF Estimates by Investment Type in Bangladesh agriculture due to climate change adaptation (2005 million USD) (continued)

YEAR	9. FOOD AND NUTRITION SECURITY				10. WET LAND CONSERVATION				11. BIODIVERSITY MANAGEMENT				12. REDUCING EMISSION OF GREEN HOUSE GASES FROM AGRICULTURE LAND				13. AGRO-PROCESSING & AGRI-BUSINESS DEVELOPMENT			
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total
2012	12.2	48.8	20.3	81.3	5.2	24.3	5.2	34.7	2.7	12.8	2.7	18.3	5.6	26.4	5.6	37.7	4.9	22.6	4.9	32.4
2013	13.2	52.7	22.0	87.8	5.6	26.3	5.6	37.5	3.0	13.9	3.0	19.8	6.1	28.5	6.1	40.7	5.2	24.5	5.2	34.9
2014	14.2	56.9	23.7	94.9	6.1	28.4	6.1	40.5	3.2	15.0	3.2	21.4	6.6	30.7	6.6	43.9	5.7	26.4	5.7	37.7
2015	15.4	61.5	25.6	102.5	6.6	30.6	6.6	43.8	3.5	16.2	3.5	23.1	7.1	33.2	7.1	47.4	6.1	28.5	6.1	40.8
2016	16.6	66.4	27.7	110.7	7.1	33.1	7.1	47.3	3.7	17.5	3.7	24.9	7.7	35.9	7.7	51.2	6.6	30.8	6.6	44.0
2017	17.9	71.7	29.9	119.5	7.7	35.7	7.7	51.0	4.0	18.8	4.0	26.9	8.3	38.7	8.3	55.3	7.1	33.3	7.1	47.5
2018	19.4	77.4	32.3	129.1	8.3	38.6	8.3	55.1	4.4	20.4	4.4	29.1	9.0	41.8	9.0	59.8	7.7	35.9	7.7	51.3
2019	20.9	83.6	34.8	139.4	8.9	41.7	8.9	59.5	4.7	22.0	4.7	31.4	9.7	45.2	9.7	64.5	8.3	38.8	8.3	55.4
2020	22.6	90.3	37.6	150.5	9.6	45.0	9.6	64.3	5.1	23.7	5.1	33.9	10.5	48.8	10.5	69.7	9.0	41.9	9.0	59.9
2021	24.4	97.6	40.6	162.6	10.4	48.6	10.4	69.4	5.5	25.6	5.5	36.6	11.3	52.7	11.3	75.3	9.7	45.3	9.7	64.7
2022	26.3	105.4	43.9	175.6	11.3	52.5	11.3	75.0	5.9	27.7	5.9	39.6	12.2	56.9	12.2	81.3	10.5	48.9	10.5	69.8
2023	28.4	113.8	47.4	189.6	12.2	56.7	12.2	81.0	6.4	29.9	6.4	42.7	13.2	61.5	13.2	87.8	11.3	52.8	11.3	75.4
2024	30.7	122.9	51.2	204.8	13.1	61.2	13.1	87.5	6.9	32.3	6.9	46.1	14.2	66.4	14.2	94.8	12.2	57.0	12.2	81.5
2025	33.2	132.7	55.3	221.2	14.2	66.1	14.2	94.5	7.5	34.9	7.5	49.8	15.4	71.7	15.4	102.4	13.2	61.6	13.2	88.0
2026	35.8	143.3	59.7	238.9	15.3	71.4	15.3	102.0	8.1	37.7	8.1	53.8	16.6	77.4	16.6	110.6	14.3	66.5	14.3	95.0
2027	38.7	154.8	64.5	258.0	16.5	77.1	16.5	110.2	8.7	40.7	8.7	58.1	17.9	83.6	17.9	119.4	15.4	71.8	15.4	102.6
2028	41.8	167.2	69.7	278.7	17.9	83.3	17.9	119.0	9.4	43.9	9.4	62.8	19.4	90.3	19.4	129.0	16.6	77.6	16.6	110.8
2029	45.1	180.6	75.2	300.9	19.3	90.0	19.3	128.5	10.2	47.5	10.2	67.8	20.9	97.5	20.9	139.3	18.0	83.8	18.0	119.7
2030	48.8	195.0	81.3	325.0	20.8	97.2	20.8	138.8	11.0	51.3	11.0	73.2	22.6	105.3	22.6	150.5	19.4	90.5	19.4	129.3

Table 17. Incremental Annual IF & FF Estimates by Investment Type in Bangladesh agriculture due to climate change adaptation (2005 million USD) (continued)

YEAR	14. MARKET INFRASTRUCTURE DEVELOPMENT				15. IRRIGATION AND WATER MANAGEMENT				16. AGRO-FORESTRY				17. COASTAL ZONE MANAGEMENT				ALL
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	
2012	42.1	196.6	42.1	280.9	36.7	171.3	36.7	244.7	1.8	8.4	1.8	12.0	16.4	76.4	16.4	109.2	1680.9
2013	45.5	212.4	45.5	303.4	39.6	185.0	39.6	264.3	1.9	9.1	1.9	13.0	17.7	82.6	17.7	117.9	1815.4
2014	49.2	229.4	49.2	327.7	42.8	199.8	42.8	285.4	2.1	9.8	2.1	14.0	19.1	89.2	19.1	127.4	1960.6
2015	53.1	247.7	53.1	353.9	46.2	215.8	46.2	308.3	2.3	10.6	2.3	15.2	20.6	96.3	20.6	137.6	2117.5
2016	57.3	267.5	57.3	382.2	49.9	233.0	49.9	332.9	2.5	11.5	2.5	16.4	22.3	104.0	22.3	148.6	2286.9
2017	61.9	288.9	61.9	412.8	53.9	251.7	53.9	359.6	2.7	12.4	2.7	17.7	24.1	112.3	24.1	160.5	2469.9
2018	66.9	312.1	66.9	445.8	58.2	271.8	58.2	388.3	2.9	13.4	2.9	19.1	26.0	121.3	26.0	173.3	2667.4
2019	72.2	337.0	72.2	481.5	62.9	293.6	62.9	419.4	3.1	14.4	3.1	20.6	28.1	131.0	28.1	187.2	2880.8
2020	78.0	364.0	78.0	520.0	67.9	317.1	67.9	452.9	3.3	15.6	3.3	22.3	30.3	141.5	30.3	202.1	3111.3
2021	84.2	393.1	84.2	561.6	73.4	342.4	73.4	489.2	3.6	16.8	3.6	24.1	32.7	152.8	32.7	218.3	3360.2
2022	91.0	424.5	91.0	606.5	79.2	369.8	79.2	528.3	3.9	18.2	3.9	26.0	35.4	165.0	35.4	235.8	3629.0
2023	98.3	458.5	98.3	655.0	85.6	399.4	85.6	570.6	4.2	19.6	4.2	28.1	38.2	178.2	38.2	254.6	3919.3
2024	106.1	495.2	106.1	707.4	92.4	431.4	92.4	616.2	4.5	21.2	4.5	30.3	41.2	192.5	41.2	275.0	4232.9
2025	114.6	534.8	114.6	764.0	99.8	465.9	99.8	665.5	4.9	22.9	4.9	32.7	44.5	207.9	44.5	297.0	4571.5
2026	123.8	577.6	123.8	825.1	107.8	503.1	107.8	718.8	5.3	24.7	5.3	35.4	48.1	224.5	48.1	320.7	4937.2
2027	133.7	623.8	133.7	891.1	116.4	543.4	116.4	776.3	5.7	26.7	5.7	38.2	52.0	242.5	52.0	346.4	5332.2
2028	144.4	673.7	144.4	962.4	125.8	586.9	125.8	838.4	6.2	28.9	6.2	41.2	56.1	261.9	56.1	374.1	5758.8
2029	155.9	727.6	155.9	1039.4	135.8	633.8	135.8	905.4	6.7	31.2	6.7	44.5	60.6	282.8	60.6	404.0	6219.5
2030	168.4	785.8	168.4	1122.6	146.7	684.5	146.7	977.9	7.2	33.7	7.2	48.1	65.5	305.5	65.5	436.4	6717.1

Figure 8. Incremental Annual IF & FF Estimates by Investment Type in Bangladesh agriculture due to climate change adaptation.

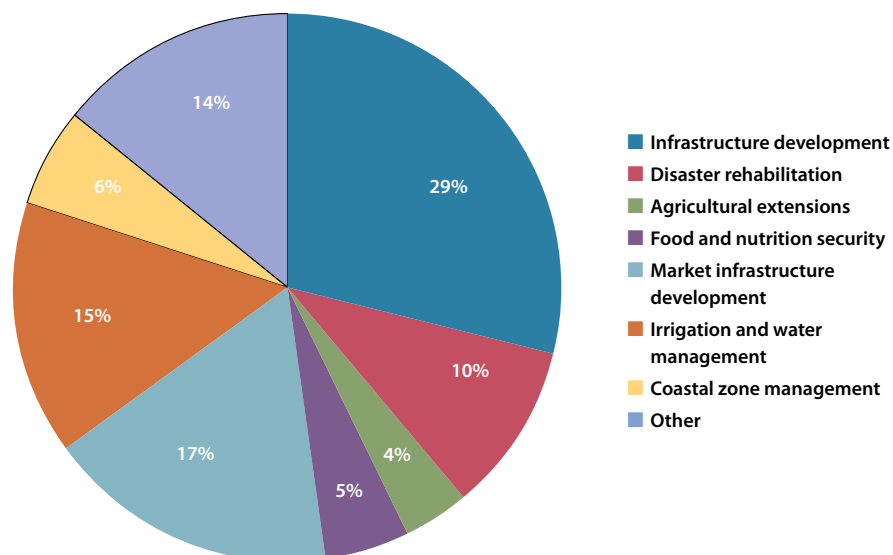


Table 18. Incremental scenario of cumulative discounted IF, FF and O&M Estimates by Investment Type in agriculture (2005 million USD)

SOURCE	1. AWARENESS BUILDING				2. INFRASTRUCTURE DEVELOPMENT				3. DISASTER PREPAREDNESS				4. DISASTER REHABILITATION			
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total
Government	5.6	28.0	22.4	56.1	2143.8	16078.7	3215.7	21438.2	163.4	653.4	272.3	1089.0	1093.7	4374.6	1822.8	7291.0

Table 18. Incremental scenario of cumulative discounted IF, FF and O&M Estimates by Investment Type in agriculture (2005 million USD) (continued)

SOURCE	5. RESEARCH, KNOWLEDGE MANAGEMENT				6. AGRICULTURAL EXTENSIONS				7. LIVESTOCK DEVELOPMENT				8. FISHERIES DEVELOPMENT			
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total
Government	26	121	26	174	223	1042	223	1489	100	465	100	664	124	576	124	823

Table 18. Incremental Annual IF & FF Estimates by Investment Type in Bangladesh agriculture due to climate change adaptation (2005 million USD) (continued)

SOURCE	9. FOOD AND NUTRI-TION SECURITY				10. WET LAND CON-SERVATION				11. BIODIVERSITY MANAGEMENT				12. REDUCING EMISSION OF GREEN HOUSE GASES FROM AGRICULTURE LAND				13. AGRO-PROCESSING & AGRI-BUSINESS DEVELOPMENT			
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total
Government	288	1152	480	1920	123	574	123	820	65	303	65	432	133	622	133	889	115	534	115	763

Table 18. Incremental Annual IF & FF Estimates by Investment Type in Bangladesh agriculture due to climate change adaptation (2005 million USD) (continued)

SOURCE	14. MARKET INFRASTRUCTURE DEVELOPMENT				15. IRRIGATION AND WATER MANAGEMENT				16. AGRO-FORESTRY				17. COASTAL ZONE MANAGEMENT				ALL
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	
Government	995	4641	995	6630	866	4043	866	5775	43	199	43	284	387	1804	387	2577	39672

3.2 Policy implications

Different National Policies directly address the agriculture sector and the inherent risk of climate change. However, the GoB is aware of the importance of climate change and the country's historical sensitivity to climate variability in general as well as its vulnerability. But certain policies exist that are concerned with adaptation and changes in I&FF in the agriculture sector. The lists of the policies reviewed are:

- National agricultural policy, Ministry of Agriculture (MoA), 1999
- National water policy, Ministry of Water Resources (MoWR), 1999
- Environment policy, Ministry of Environment and Forest (MoEF), 1992
- Land use policy, Ministry of Land (MoL), 2001,
- Coastal zone policy, Ministry of Water Resources (MoWR), 2005
- National fisheries policy, (Ministry of Fisheries and Livestock (MoFL), 1998).

National Agriculture Policy (Ministry of Agriculture (MoA), 1999)

National Agriculture Policy (NAP) was developed by the Ministry of Agriculture with a view to develop and sustain agricultural growth in such a way that it ensures the nation with a self-sufficient reliable food security system. NAP 1999 or the New Agricultural Extension Policy (NAEP) 1996 has no specific statement made on the issue of climate change and its impact on agriculture. The National Agricultural Policy Draft 2009 specifically mentions the word climate change as an environmental vulnerability.

Policy issues that indirectly correlate with climate change adaptation procedures:

- i. The policy, under section 3.5, ensures supplementary irrigation in severe and extremely severe drought affected areas, which is an adaptive measure against climate induced variable rainfall and low surface flow. Also section 9.1 states target oriented research and extension programmes will be conducted for region-wise research on irrigate and rain-fed adaptation in Bangladesh agriculture.

National Water Policy (Ministry of Water Resources (MoWR), 1999)

The National Water Policy (NWP) is the first ever water policy document on water resources management for the country pronounced in January 1999. The policy does not make any specific statement on the issue of climate change and its impact on water resources.

Policy issues that indirectly consider the adverse effect of climate change on water resources:

- i. The Policy considers in the introduction common hydro-meteorological phenomena like alternating flood and water scarcity during the wet and dry season, river sedimentation and bank erosion as the most crucial challenges. Although not mentioned, it is implicit that these events are anticipated to be aggravated by climate change.
- ii. The policy under section 4.6 concentrates on the issue of inland salinity intrusion from sea in the southwest and considers that this intrusion is causing groundwater to be unfit for consumption. Although the statement does not suggest any adaptation policy, it indirectly infers the need for alternative sources of water supply for the community. If proper adaptation and mitigation can be done in this respect it will facilitate the task of reducing water related vulnerability due to climate change.

Policy issues that indirectly correlate with climate change adaptation and mitigation procedures:

- i. The section on River Basin Management (section 4.1) emphasizes on cooperation with co-riparian countries. The policy renders importance in exchange of data of the rivers between the sharing countries which might even help in flood forecasting in the lower riparian regions. This is a positive approach in climate change adaptation and mitigation system, as flood is one of the extremities or water related disaster that might exaggerate due to climate change.
- ii. The policy, under section 4.2, considers framing rules, procedures and guidelines for combining water-use and land-use planning for agricultural purposes. Successful implementation of this policy will help adaptation and mitigation in regards of climate change if some additional concern for climate change induced extremes are included and acted on.

- iii. The policy, under section 4.2, highlights the importance of preparing and implementing sub regional and local water-management plans in conformity with NWMP. This increases the potential to work on climate related issues locally by both NGOs and private sectors.
- iv. The NWP highlights the necessity of undertaking comprehensive development and management of the main rivers through a system of barrages and other structural and non-structural measures under section 4.2.j. The policy also calls for developing early warning and flood-proofing systems to manage flood and drought. The statements facilitate further adaptation towards climate change as it safeguards the people from the effect of the extremes like flood and drought which are bound to increase in extent and frequency due to the climate variability and changes.
- v. Section 4.3 of the policy states that the Government can redirect use (of water) during periods of droughts, floods, cyclones, and other natural disasters. The statement clearly creates the scope of emergency adaptation to climate change related water shortage and climate extremity issues in the near future.
- vi. The NWP calls for improvement of resource utilization through conjunctive use of all forms of surface water and groundwater for irrigation and urban water supply under section 4.7. It also promotes strengthening of crop diversification programmes for efficient water utilization. This statement is a planned adaptation to safeguard crop agriculture against the possible impacts of climate change.
- vii. The policy under section 4.7 addresses the need for strengthening appropriate monitoring organizations for tracking groundwater recharge, regulating surface and groundwater use, and monitoring changes in surface and groundwater quality. Under climate change induced low flow regime, there would be increased dependency on groundwater and both irrigation and water supply in that case depends on groundwater. Hence the statement prioritizes the need to manage groundwater along with surface water which will help in tackling climate change.
- viii. The policy states under section 4.9 that fisheries and wildlife are to receive due emphasis in water

resources planning in areas where their social impact is high. As the Sundarbans is a hotspot for flora and fauna and a home to 7-8 million people, not to mention its importance as a UNESCO world heritage site, its river system if gets sufficient acknowledgement from the government according to the policy, it may save the river system from the anticipated salinity intrusion that is occurring from sea level rise and reduced dry season flow, all significant impacts of climate change.

- ix. One of the most significant statements of the policy is under section 4.13 on the preservation of haors, baors and beels and biodiversity. Natural water bodies such as beels, haors, and baors will be preserved under this statement for maintaining the aquatic environment, and developing dry season agriculture and wet season fish habitat in them. Such a step is certainly advancement in preserving surface water as streams and river flow which are assumed to decline during dry season due to climate extremities and variability.
- x. Section 4.15 considers development of a central database and management information system (MIS) consolidating information from various data collection and research agencies on the existing hydrological systems, supply and use of national water resources, water quality, and the eco-system. This is a major step towards advanced research that can incorporate climate related studies and technology transfer.

Environment Policy, (Ministry of Environment and Forest (MoEF), 1992)

The Environmental Policy and Implementation Programme (EPIP) for Bangladesh were pronounced by the Ministry of Environment and Forest in 1992 (MoEF, 1992). The policy does not directly use the term climate change nor is any direct statement made on the effect and consequences or adaptation procedures related to climate change in the context of agriculture, water and environment.

Policy issues that indirectly consider the adverse effect of climate change on coastal areas:

Though climate change is not directly stated in the policy, consideration has been given in the introductory

section that frequent flooding, drought, cyclone, water surge etc. natural calamity; preliminary symptoms of desertification in the northern zone of the country; salinity intrusion in rivers; land erosion; rapid reduction of forest area; variable climatic and weather condition and other environmental problems are observed throughout the country.

Policy issues that indirectly correlate with climate change adaptation procedures:

- i. Section 3.5.3 states that flood controlling structures, embankment, channelization and other local, regional and national level arrangements made for flood protection should be environmentally sound. The policy also states that such flood mitigation measures or interventions will be removed which have adverse environmental effect.
- ii. Section 3.10 concentrates on coastal and marine ecosystem and the conservation and development of its natural resources and biodiversity. This is an adaptive measure to climate change related impacts on the coastal belt and marine biodiversity.

Policy issues that indirectly correlate with climate change mitigation procedures:

- i. An important mitigation step towards climate change is stated in section 3.2 which is to ban those industries which produce pollutant products or have such production procedure that is polluting the nature.

Land Use Policy (Ministry of Land (MoL), 2001)

Bangladesh Land Use Policy 2001 is approved by the Ministry of Land of the GoB. The main objectives of the land use policy are prevention of excessive land use due to the ever increasing demand for crop production, maximum utilization of inlands and wetlands, preservation of 'Khas Lands' and helping in reducing the number of landless people in Bangladesh.

Policy issues that states the adverse effects of climate change

No specific statement considering the impact of climate change on the country or its resources is made in the policy. But the importance of afforestation, environment and mutual sustainability of land use and forest are focused upon in the policy.

Policy Issues that Indirectly Correlate with Climate Change Adaptation and Mitigation Procedures:

- i. Water bodies shall not be used in such way that it contradicts the fisheries policy and still contribute in agricultural irrigation.
- ii. Existing water bodies shall not be encroached for any other land use.
- iii. Regular maintenance of the existing water bodies shall be confirmed.
- iv. Embankments shall be made in a way that provides drainage facility and water-logging does not occur within the enclosed area.

Policy Implications: Mainstreaming Climate Change in Agricultural Sector Development

From the above analysis, significant knowledge has been gathered as well as a number of gaps have been identified which are listed below:

- i. Bangladesh has already enacted its climate change strategy and action plan which provides the principle guideline for adaptation and mitigation planning for agriculture.
- ii. Sectors in which mitigation and /or adaptation is required has already been identified in NAPA and BCCSAP.
- iii. Linkage of adaptation and mitigation activities with the national agricultural development programmes and projects has started to be established. But for better linkage, a road map for Bangladesh is required for mainstreaming climate change considerations across all sectors and at all levels.
- iv. National priority issues have been identified in the long-term, medium term and short-term planning documents and to some extent climate change has been linked with some issues. But efforts targeting toward adapt or to mitigate climate change with overall objective of achieving the national priorities are yet to be achieved.
- v. Some of the national policies have addressed climate change directly, but most of them do not.
- vi. The following gaps are identified in terms of mainstreaming climate change considerations in the national development planning:
 - a) Currently, most policy responses continue to address climate change, development, and disaster management independently;
 - b) There certainly remains a lack of interaction and

institutional overlap among policy makers; in other words, there is a need for more coordination across different ministries;

- c) There is a lack of comparison between the implications of different policy interventions to adapt to climate change;
- d) While many of the Climate Change adaptation policies are consistent with traditional developmental policies (especially in areas of disaster reduction), some Climate Change implications will require changes in policies and new policy instruments, for which there is a considerable knowledge gap;
- e) There is a lack in understanding synergies in and/or obstacles to simultaneous progress in promoting enhanced adaptive capacity and sustainable development;
- f) There are gaps between spatially explicit analyses of vulnerability and aggregate integrated assessment models; and
- g) There are gaps in developing new decision support mechanisms that can identify robust coping strategies in the face of the many critical climate change uncertainties.

Coastal Zone Policy (Ministry of Water Resources (MoWR), 2005)

The Ministry of Water Resources developed the Coastal Zone Policy in 2005 which is of immense importance as the agriculture and livelihoods of coastal zones greatly related to climate change issues. Cyclones, storm surges, floods, drought, earthquakes, erosion, salinity intrusion and arsenic contamination are some of the natural hazards that are frequent in coastal zones. Lack of safe drinking water, overexploitation of natural resources, water logging, river siltation and hill cutting also add to the vulnerabilities in agriculture. The coastal zone of Bangladesh has diverse eco-systems: mangrove, marine, estuary, islands, coral, sandy beaches and sand dunes. This part of the country has both a 'world heritage site' and 'ecologically critical areas'. The Coastal Zone policy and CDS (Coastal Development Strategy) focus on these issues concentrating exclusively on climate change.

In section 1.1 of the policy, it is directly mentioned that the coastal area is vulnerable to risks from climate change. In section 4.3 it is mentioned that the majority of

households in this area are vulnerable to climate change.

- i. Continuing existing institutional arrangements to monitor climate change
- ii. Supporting the upgrading of technology and institutional strengthening for enhancing the capacity to generate better data and more accurate long-term prediction and risk related to climate change
- iii. Implementing adaptive measures that are identified in relation to climate change and coastal zone
- iv. Maintaining sea-dykes along the coastline as first line of defense against predicted sea-level rise
- v. Making an institutional framework to monitor/detect sea level rise and planning to cope with its impact.

Policy issues that indirectly correlate with climate change adaptation and mitigation procedures:

- i. Special measures will be taken to conserve and develop the natural environment of the Sundarbans. This is a required step for safeguarding the Sundarbans against possible climate change impacts.
- ii. Measures will be taken for afforestation in the coastal areas including newly accreted chars. This is a safeguard against water surge and other hazards that are common in the coastal belt of Bangladesh and are extreme events that are likely to increase in extent and frequency due to climate change.
- iii. Salt-tolerant crop varieties will be developed and extended in the coastal belt which is more of a direct approach against salinity intrusion due to reduced upstream flow and sea level rise. Section 4.4.2 also suggests that adequate upland flow shall be ensured in water channels to preserve the coastal estuary ecosystem threatened by the intrusion of soil salinity from the sea. These are very positive measures against salinity intrusion induced by climate change.
- iv. The scope of irrigation facilities will be explored and extended in this area and comprehensive water management for agriculture will be implemented which is a must in the variable climatic conditions during climate change. It is also stated in the policy that small water reservoirs shall be built to capture tidal water in order to enhance minor irrigation in coastal areas.
- v. As water scarcity is going to be a major problem in the overall variable rainfall, salinity intrusion and sea level rise condition in the coastal area, appropriate

water management system stated in section 4.4.2 is of utmost importance. Polders utilizing existing infrastructures will be established for freshwater storage and other water utilization. Rainwater harvesting and conservation shall be promoted. Ponds and tanks will be excavated for conservation of water. Step will be taken to ensure sustainable use and management of ground water.

- vi. Through its responsible agencies, the Government will properly plan and implement schemes for reclamation of balanced land from the sea and rivers. This is a major step towards the sea level rise issue as much of the land is supposed to go under water due to the rise.
- vii. Effective measures will be taken for protection against erosion and for rehabilitation of the victims of erosion. Safety measures will be enhanced by combining cyclone shelters, multi-purpose embankments, killas, road system and disaster warning system. These are all protective measures even if indirectly, against climate change

National Fisheries Policy (Ministry of Fisheries and Livestock (MoFL, 1998)

The National Fisheries Policy was developed by the Ministry of Fisheries and Livestock in 1998. The goal of the policy is to enhance the fisheries production along with poverty alleviation through creating self-employment and improvement of socio-economic conditions of the fishers. It also concentrates on the fulfillment of the demand for animal protein and achievement of economic growth through earning foreign currency by exporting fish and fisheries products.

Though the policy in its objectives pronounces 'maintenance of ecological balance' and 'conservation of biodiversity', it does not directly count 'climate change' as a threat to fish resources. But the policy states that flood control, water drainage and construction of dam and barrage in the irrigation projects without any proper EIA and installment of fish pass, release of hazardous chemicals and poisonous substances from the slum area and different industrial plants into the river and other water bodies, pollution of water using chemical insecticides and fertilizers in the agricultural fields, reduction of water holding capacity of rivers, beels and haors due to siltation, and harvesting of excessive amounts of fish to meet the demand of growing

populations are considered as the main reasons that might hamper fish production in the country.

Policy issues that correlate with climate change adaptation and mitigation procedures

Climate change combat has various aspects, one is to reduce emission of GHG or mitigation and another is to adapt with the changing climate. Securing our food sector is a challenging but most crucial adaptation step towards climate change. Preservation and proper use of fish resources is not only helpful for national development or environmental sustainability, but also required to combat food crisis that may occur in near future due to the varying climatic condition. Some points that would help the fish resources and water resources to attain its ultimate sustainability are enlisted below:

- i. The policy concentrates on conserving fish habitats from damage and taking appropriate care during the implementation of all developmental activities such as flood control, irrigation and drainage projects, agriculture, industries, road and urban development projects.
- ii. Jalmohals designated as fish sanctuaries will be transferred to the Directorate of Fisheries according to the policy. For increased production and to conserve biodiversity, some areas or the whole jalmohal will need to be converted into fish sanctuaries.
- iii. Fish culture will be initiated on a priority basis in lands where 50 cm of inundation is available for a period of more than 3 months to increase fish industry.
- iv. Surveys will be conducted of the water bodies, which become water-logged or closed water bodies due to the flood control and irrigation projects to fulfill the possibility of those water bodies for use in fish culture.
- v. Lakes, beels, ditches-canal and other open water bodies should not be completely dewatered. Instead, water bodies like haors, baors and beels would be renovated for fish culture and these water bodies would not be reduced in size.
- vi. Integrated prawn and fish culture along with rice will be encouraged in brackish water bodies. Measures will be taken to conserve biodiversity in the coastal region and necessary steps will be taken to culture fish/shrimp along with rice crop. Arrange-

- ments will be established within the polders (embankment) and flood control projects to conserve wild life. Each polder will be coupled with arrangements for fish/shrimp culture with rice either in concurrent or in rotational system.
- vii. Expansion of shrimp culture in mangrove forest or destruction of mangrove forest will be completely banned. In order to ensure ecological balance, tree plantation will be encouraged in shrimp culture area.
 - viii. Harvest of fish and shrimp by the trawlers in the shallow coastal areas (within 40- meter depth) will be banned.
 - ix. Appropriate preventive measures will be taken against dumping of hazardous chemicals and atomic wastes into the sea. Discharge of harmful municipal and industrial wastes directly into the water bodies will be considered a punishable crime and measures will be taken to ban the use of harmful chemical substances and insecticides in the agricultural fields.
 - x. Laws will be formulated to ban the disposal of any untreated industrial effluents into the water bodies.

However, in order to implement the results of this analysis; the National Adaptation Programme of Action (NAPA) and Bangladesh Climate Change Strategy and Action Plan (BCCSAP) should be considered as base documents. According to BCCSAP; the prioritized investment options which will supplement the implementation of results of this study are:

1. Improved crops and cropping systems
2. Improved irrigation and water management
3. Flood proofing
4. Early warning system
5. Improved O&M and upgrading of coastal embankments and polders.

The BCCSAP is an integral part of national development policies, plans and programmes including the upcoming Sixth Five Year Plan. BCCSAP has highly encouraged further investments in research on developing new varieties, construction of climate proof infrastructures and capacity building of government, non-government and business actors.

NAPA document has encouraged investments in better access to agricultural services, social protection measures,

i.e. safety-nets, insurance and enhancing awareness, behavioral changes and communication for climate related risks.

The Poverty Reduction Strategy Paper and The Perspective Plan (Vision 2021) are the other two policy documents which may prove to be very effective for implementing the results of this study since these two documents have made climate change as an integral part of policy direction.

There are also some emerging needs of promotion of Public-Private Partnership (PPP), subsidies in agricultural inputs and resources and need for a comprehensive database on agriculture sector.

Besides the abovementioned areas; there are some other critical areas of climate friendly investment options within the agricultural sector:

Key Finding 1: Need for mainstreaming of Climate Change into new Project Documents and Policies, including institutional development and capacity building.

At present there is no TPP/DPP appraisal guideline. The responsible officers evaluate the TPP/DPP with their own wisdom, knowledge and experiences. In general the evaluation is not very intensive due to lack of appropriate guidelines and the evaluators need capacity to do this. The evaluators assess/appraise the projects based on the TPP/DPP completion/formulation “structure”. If the structure is followed well when completing the TPP/DPP, the environmental risks are covered. But Climate Change risks and mitigation issues are not reflected in the TPP/DPP.

Moreover, the mapping and review of policy documents revealed that, with the exception of the National Agricultural Policy (2008, Draft Version), the policies in general do not pay sufficient attention to potential impact from climate change hazards. Most of the existing policies are including environmental concerns in relation to agricultural, fish or livestock production. This is positive of course. But climate change hazards are strongly linked to changes in the environment.

It is clear that many of the policy documents have been developed during a period where environmental degrada-

tion from agricultural and fisheries production has been a main concern. It is clearly a positive finding that environment aspects are being considered to such large extent in existing policy documents and there seem to be a scope for using a similar approach for projection of climate change risks into these policies.

Guidance for institutional development and capacity building are included in the policy documents. Mainstreaming of climate change into institutions covered by the respective policies should therefore be considered an integrated part of the policy development process.

Key finding 2: Need for revision of existing policies and guidelines in order to include climate change risks.

Climatic hazards such as water logging/inundation and flooding are affecting crop agriculture, fisheries and livestock. These risks also cause damage to rural infrastructure in terms of failure of structures, erosion in embankment and roads and damage to road pavement. Although environmental concerns and mitigation for roads construction are to some extent included, existing policy and design criteria does not take into consideration the climate change risks.

Key finding 3: Need for strengthening of linkages between research institutions and farming associations.

A large number of research projects and demonstrations are taking place all over Bangladesh. A review of current procedures together with workshops and meetings with key stakeholders from research and farming has revealed that there is limited coordination and knowledge sharing taking place within and across researchers and farmer groups. Moreover, the yield increases reported from the research stations are far from those registered at the farming level.

Key finding 4: Need for more context specific approaches to climate change adaptation.

To date the analyzing of possible impacts of climate change in Bangladesh has been mainly conceived at the macro level, partly due to data limitations and lack of systematic knowledge of micro level conditions. Such a basis for adaptation work has its limitations, since each of

the agro ecosystems hides considerable local variation in the resource, which makes generalization on technologies and management approaches hazardous.

As per today, there is therefore limited knowledge of which adaptation options that work best under which conditions. Moreover, many ongoing community based adaptation projects have a rather narrow and short term focus, which may not reflect the medium to longer term perspectives on the impacts from climate change hazards.

Key finding 5: Need for more integration of Adaptation with Mitigation.

While most discussions of response to climate change in Bangladesh, focuses on adaptation measures, little attempt is done to investigate how local mitigation measures could help to offset negative impacts from, for instance, sea level rise. Likewise, existing policy documents (including the National Agricultural Policy, 2008) and guidelines are not paying attention to the potential benefit from a more strategic integration of mitigation with adaptation activities.

Key finding 6: Need for an integrated and strategic approach to livelihood development at community level, considering the gradual changes in the environment caused by climate factors. The impacts from climate change hazards are gradually changing the livelihood conditions within many communities, including for crop and fish cultivation and livestock. For instance, it is forecasted that as much as 30% of the current land area of Bangladesh may be inundated as a result of sea level rise and impeded drainage, notably along the coast lines.

These changes may lead to need for new innovative and integrated approaches of how to optimize utilization of land and water resources in the future. Such approach is currently not integrated into the sector policy planning.

Key finding 7: Need for more widespread awareness raising on climate change at the farming level. Although a number of community based adaptation projects spread all over the country are including awareness raising and capacity building of farmers as part of their projects, there seem to be a need for more widespread awareness raising initiatives across the farmers in the country.

Within the AEC, training is being provided both to farmers and mass media on agricultural issues, but not particular including climate change. It is reported that the TV media often lack required professional skills to produce and present well-documented and informative television programmes on climate change risks.

Key finding 8: Need for more and better knowledge sharing on climate change issues

A large number of community based adaptation projects are currently being implemented all over Bangladesh. There is however no systematic overview of who is doing what - and what is being done where. Likewise, knowledge sharing is fragmented and sporadic. Although, those communities that are directly involved in the adaptation projects assumable are benefitting from the interventions, the lack of any systematic knowledge sharing is increasing the possibility for overlapping of activities and reducing the potentials for dissemination and replication.

Implications

There are large number of policies and programmes relating to different sectors but none of them are directly addressing the issues on climate change. In the underlying sections it has been described.

Climate change is an emerging cross cutting issue in Bangladesh. It affects food security, livelihood and many other important sectors limiting economic development of the country. Bangladesh signed the United Nations Framework Convention on Climate Change (UNFCCC) in June 1992 and ratified it in April 1994. The country also ratified the Kyoto Protocol in October 2001. GoB has submitted the Initial National Communication to UNFCCC in October 2002. Later on Bangladesh launched the NAPA in 2005 and it was updated in 2009. It identified 45 adaptation measures with 18 immediate and medium term interventions. GoB also prepared the BCCSAP in 2008 and revised in 2009.

The Government has created a donor funded BCCRF with US \$ 110 million. The DFID has provided major support of US \$ 86.7 million. Sweden, Denmark and the EU have provided some supports to BCCRF. No other DPs so far made any commitments to the BCCRF. The creation of BCCRF is a positive step towards building

ownership. Detailed operational plan yet need to be validated. Some policy decisions are needed on the effective management of multi-donor fund in climate change.

The World Bank Group and Asian Development Bank are supporting the pilot program for climate resilience (PPCR) with an amount of US \$ 110 from Global Fund independent of BCCRF. The management system of BCCRF and PPCR is different, creating complexity of management and operation for the GoB. In order to improve management, it would be worthwhile to reconsider a unified management system of both the funds.

It is important to develop policy and plan on the capacity, coordination and prioritization of programme activities by the government in order to enhance effectiveness of climate change funds from different sources including GoB and DPs. The Ministry of Environment and Forest (MoEF) do not have adequate capacity to effectively manage a large number of stakeholders and different sources of funds. The MoEF do not have any visionary Capacity Building Plan to address emerging climate change threats in Bangladesh.

GoB capacities: The MoEF is a relatively small ministry and does not have adequate capacity to work with the emerging challenges on climate change with different stakeholders, DPs and international negotiations. The climate change unit created under a project yet need to be fully staffed by professionals and qualified technicians in order to enhance their capacity to identify the magnitude of the problem. The unit should not work as like as departments or directorate rather it should be an integral wing of the ministry. The climate change unit should have well developed capacity to do planning, programming, monitoring, evaluation and coordination of all climate change activities across different departments and ministries. The skill of the professional staff working in different Ministries including Planning Commission need to be enhanced to deal with emerging climate change issues.

Coordination: Multiple players are active in the climate change with overlapping mandates and some of them are patchy. There is need of strong stewardship for effective coordination. The capacity of the nodal ministry is relatively weak not only for coordination of DPs program

but also for helping developing programs from different participating ministries and agencies. The Ministry of Agriculture, Ministry of Fisheries and Livestock, Ministry of Health and Local Government Engineering Department have role and responsibility both for adaptations and mitigations. The important organizations are the NARS and national agriculture technology transfer systems along with some NGOs working in climate change. All these need to be coordinated at different steps for program building, its implementation, monitoring and evaluation. The National Technical Coordination Committee (NTCC) operating for technology generation and transfer at BARC need to be integrated into the coordination process.

Prioritization of program of activities: The prioritization of programs in the BCCSAP has not yet been done. As a result some DPs are reluctant to support it and commit fund to BCCRF. This is also true for different ministries and departments carrying out climate change programs which are not yet oriented in line with the program of BCCSAP. Series of stakeholder consultation on priority fixing should regularly be organized.

Mainstreaming: Different ministries and DPs have their own strategies and road maps. Sometimes parallel strategies exist complicating the processes of harmonization and alignment. The MoEF need to systematically assess those. There is also need for determining the path of integration of climate change programs in the mainstreaming planning process of the Planning Commission.

3.3 Key Uncertainties and Methodological Limitations

Global climate risks have now started to take concrete shapes and it is widely predicted that Bangladesh is one of the country's most vulnerable to climate change. Adaptation to climate change risk will put additional strain on agricultural development efforts of Bangladesh. Only the economic cost is expected to be much higher, even excluding the social and environmental costs.

The assessment has opened a window to dive deeper into the issues of climate change with respect to agriculture and environment. More integrated approach towards assessing impacts of climate change may be a welcome

attempt for the government as the challenge has marked strokes on the economy through erratic extremes of hydro-meteorological disasters in Bangladesh.

Major uncertainties of this assessment are:

- Cost calculations are more normative or judgmental rather than focusing on the specificity. Thus the cost figures are subject to vary and need detail study for each of the individual investment programmes prior to final implementation.
- Policy formulation phase will require further research on (i) change in climate change adaptation needs, (ii) reforms in land and water use profiles, (iii) reconstitution of terms of international trade with respect to abatement and adaptation costs and benefits.
- A wider forum for brainstorming on these issues is urgent because the climate change factors are incipient and impacts are undercutting our economic strength in terms of drawing more and more resources to repair the severe dents.

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Annex 1

Table Climate change investment in annual development programme (ADP) of GOB, 2011-12

BROAD AREAS	LAC TK
1. Awareness building	1544
Intensification of agricultural information services of AIS at 10 agricultural regions	1544
2. Infrastructure development	590432
Construction of rural roads and small culverts	90570
Char development and settlement project	15481
Rural infrastructure development project of BRDB	238591
Union link road and infrastructure development	70068
Rural infrastructure development in South-west	148072
Union infrastructure development in Khulna, Sathkhira and Bagerhat district	27650
3. Disaster preparedness	29993
Construction of flood shelter in the flood prone and river erosion areas	3405
Enhancing resilience under Bangladesh country programme	19885
Construction of multipurpose cyclone shelter at Sidor affected areas	6703
4. Disaster rehabilitation	200803
Emergency 2007 cyclone recovery and restoration project (ECRRP)	48222
Rehabilitation of cyclone Sidor of 2007, BWDB	18065
Asrayan (providing home) project phase 2	60856
Reconstruction of upazilla complex damaged through river bank erosion	13856
Emergency disaster damage rehabilitation (rural infrastructure)	30845
Emergency 2007 recovery and rehabilitation	28959
5. Research, Technology generation and knowledge management	8689
Strengthening conservation of rice varieties and production of breeder seeds	1415
Strengthening and capacity building of biotechnology lab of BRRl	1004
Research on agricultural insurance, BARD	110
Forest research	603
Establishment of Shrimp research center in Bagerhat	2268
Research on impact of using drugs and chemical on water environment and productivity	1798
Irrigation development using RDA technology of surface water	1491
6. Agricultural extensions	74548
Production, preservation and distribution of seeds of rice, wheat and jute	8497
Production, of seeds of pulse, oil and onion at farmer's level	2842
Farm mechanization	6929
Integrated farming in Pabna, Sirajgonj, Nator, Bogura and Manikgonj	1867
ASPS phase 2	365
Modernization of quality seed production capacity of BADC	30613
Production of HYV seeds of rice, wheat and maize of BADC	22403
Production of HYV seeds at farm level, Brandra Multi Purpose Authority	1032
7. Livestock development	33268
Strengthening DLS	1025

Avian influenza prevention	10703
Regional fisheries & livestock development (Noakhali component)	9672
Breed up gradation	1158
Vaccine production and lab development	5687
Development of local sheep	842
Poultry development	3351
Development of Red Chittagong breed and preservation	830
8. Fisheries development	41234
Construction of infrastructure for fish culture in the flood area of Daudkandi	1976
Reviving natural breeding ground of Halda river	1369
Regional fisheries development (Barishal component)	6471
Bangladesh marine fisheries capacity development	11947
Expansion of Bagada shrimp culture technology	1931
Establishment of brood bank	1250
Greater Pabna Fisheries development	1112
Conservation of Jatka and alternative employment of fisheries	2289
Fish culture and man agent at Bhabadah of Jessore	986
Reduce poverty and ensure employment in the economically depressed area	8319
Development and management of degraded water bodies and culture of local fish	3584
9. Food and nutrition security	96125
Repairing of damaged food storage and warehouses of directorate of food	2244
Construction of new food storage in the north	24100
Expansion, restructuring and modernization of poverty reduction training center at Kotalipara	3031
Char livelihood project of BRDB	66750
10. Wet land conservation	
11. Biodiversity management	21655
Construction of biodiversity and development of environment in the greater Jessore district	71
Establishment of eco-park	1672
Integrated social afforestation	14097
Development of safari park at Cox Bazar	1314
Construction of biodiversity and development of environment in the Chittagong	929
Construction of biodiversity and development of environment in the greater Rajshahi and Kustia	1320
Afforestation for maintaining natural balance in the Barind tract	2252
12. Reducing emission of green house gases from agriculture land	44501
Fresh air and sustainable environment	44501
13. Agro-processing & agri-business development	38232
Bangladesh agribusiness development project	38232
14. Market infrastructure development	332003
Development & rehabilitation of rural roads, market	262816
Market infrastructure development in Charland	29437
Rural road and market infrastructure development in greater Barishal	39750

15. Irrigation and water management	289201
Construction of raver dam in small and medium rivers	16758
Mahury flood control, drainage and irrigation project	13929
Matomahuri irrigation project	6220
South west integrated water resource planning and management	28331
Tisp barrage project	24862
Depa-Purnabhaba Water development	24862
Channel digging, irrigation and fish culture project	41330
Brandra integrated area development project	28428
Irrigation area development project	16154
Repairing deep tube-wells	19800
Ashugonj-Polas agro-irrigation project of BADC	2450
Greater Khulna-Jessore-Kushtia Integrated agricultural development	2405
Expansion of surface water irrigation by double lifting	9699
Greater Mymensingh, Sylhet and Faridpur small water resource development	47015
Removal of water logging at Bhabahdah bill & surrounding, Jessore	6958
16. Agro-forestry	14224
Integrated social forest	1390
Poverty reduction through social forest	10968
Bamboo, bath, etc	1866
17. Coastal zone management	129055
Rehabilitation of polders in the coastel areas	7127
Construction of embankment from Zianagar to Fullarhat, Pirojpur	3284
Protection of Charfasion and Manpur of Bhola	9768
Drainage of old and new Dakatia river of Noakhali	11525
Agriculture support programme- rural road and link road to rural market at Patuakhali, Borguna, Noakhali and Lakhipur	42552
Rural infrastructure development (Khulna, Bagerhat and Sathkhira	14988
Union link road & infrastructure development(Patuakhali and Borguna)	14490
Greater Noakhali rural infrastructure development	25321
TOTAL	1945507
MILLION USD	2665.078



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