



Final Report of Bangladesh Country Study

Case Study on Climate Compatible Development (CCD) in Agriculture for Food Security in Bangladesh

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Contents

List of Abbreviations	3
Executive Summary	4-6
1. Background and Introduction	7-11
1.1 Background of the Case Study in Bangladesh	
1.2 Conceptualization of CCD in Agriculture and Food Security	
1.3 Brief Overview of the Country	
2. National Climate Change Strategy and the State of Implementation	12-19
2.1 The Climate Change Strategies and Action Plan	
2.2 The State of Implementation	
2.3 The Key Responsible Institutions	
2.4 International Funding Opportunities related to UNFCCC	
3. Agricultural Development and Food security-related aspects in the National Climate Change Strategy	20-35
3.1 Agricultural Development and Food Security Situation in Bangladesh	
3.2 Impacts of Climate Change on Agriculture and Food Security	
3.3 Food Security in BCCSAP and NAPA	
3.4 Food Security in relevant Sectoral Policies	
3.5 Government's Investment to address Food Security	
4. Adaptation and Mitigation in Agriculture: Synergies and Key Barriers	36-42
4.1 Adaptation in Agriculture	
4.2 Mitigation in Agriculture and Food Systems	
4.3 R&D, Local Innovation and Knowledge Generation	
4.4 Potential Synergies, Barriers and Trade-offs	
5. Conclusions and Recommendations	43-44
References:	45-46



List of abbreviations

ACTS	African Centre for Technological Studies
ADB	Asian Development Bank
BCCRF	Bangladesh Climate Change Resilience Fund
BCCSAP	Bangladesh Climate Change Strategic Action Plan
BFRI	Bangladesh Forest Research Institute
BMD	Bangladesh Meteorological Department
BWDB	Bangladesh Water Development Board
CCD	Climate Compatible Development
CCTF	Climate Change Trust Fund
CCTF	Climate Change Trust Fund
CCU	Climate Change Unit
CDKN	Climate & Development Knowledge Network
CDMP	Comprehensive Disaster Management
CIDA	Canadian International Development Agency
DAE	Department of Agriculture Extension
DFID	Department for International Development
DOE	Department of Environment
DPHE	Department of public health and Engineering
ERD	Economic Relations Division
EU	European Union
FAO	Food and Agriculture Organization
FD	Department of Forest
FV	Fundacion Vida
GBM	Ganges-Brahmaputra –Meghna
GED	General Economic Division
LDC	Least Developed Country
LGED	Local Government and Engineering Division
MoA	Ministry of Agriculture
MoEF	Ministry of Environment and Forest
MoFDM	Ministry of Food and Disaster Management
NAP	National Agricultural Policy
NAPA	National Adaptation Program of Action
PPCR	Pilot Programme for Climate Resilience



Executive Summary

- 1. Located in South Asia, Bangladesh is a resource poor and densely populated country. It is one of the most vulnerable countries to impacts of climate change. With its growing economy, Bangladesh predominantly depends on agriculture, which is strongly dependent on seasonal weather patterns and climatic conditions. The country has made laudable progress in agricultural development and food production in the recent decades, but the emerging impacts of global climate change are posing serious threats to food security of the people, particularly of the poor and marginal sections of the society.*
- 2. Besides the climate variability and uncertainties (such as temperature rise and erratic rainfall), the major weather and climate related extremes are frequent floods and river erosion, cyclones and tidal surges, salinity, drought, heat waves, cold and fog and water logging. The key features relating to geophysical conditions and climate change interface are: about 10% of the country is less than one meter above sea-level while one-third is under tidal excursions; 32% of the country is situated along and near the coast, accommodating 28% of the country's inhabitants; a vast network of rivers, channels and floodplains; and high level of population and widespread poverty.*
- 3. Agriculture is the mainstay of majority people in Bangladesh. Agriculture contributes to about 20% of the GDP. Within the agricultural sector, the crop sub-sector contributes to 57%, followed by fisheries (22%), livestock (13%), forestry and fruits (8%). Rice crops cover 75% of the cropping areas and contribute over 95% to the total food grain production. Agriculture is one of the most impacted sectors by the impacts of climate change. Promoting climate resilient agriculture for maintaining productivity in the rapidly changing climate is a key challenge for Bangladesh to ensure food security of the growing population.*
- 4. CCD in agriculture could be promoted by increasing productivity sustainably, building resilience (adaptation), reducing GHG emission (mitigation) and enhancing achievement of national food security and development goals. CCD is crucial to address current and future food security of Bangladesh. Policy makers should aim to promote adaptation strategies for agriculture that have greater co-benefits in terms of agricultural productivity, mitigation and sustainable development of the sector.*
- 5. Over a dozen of ministries and their line agencies are involved in addressing climate change issues in Bangladesh. The Ministry of Environment and Forest (MoEF), Ministry of Food and Disaster Management (MoFDM) and Ministry of Agriculture (MoA) are the key national actors in relation to addressing climate change, agricultural development and food security. The government of Bangladesh has already formulated National Adaptation Programme of Action (NAPA) following the guide line of the UNFCCC. Bangladesh has also formulated the Climate Change Strategy and Action Plan (BCCSAP) to address climate change impacts as well as to promote climate resilient development in the country.*



6. *The Bangladesh climate change strategy aims to support the Bali Action Plan (2007) of the UNFCCC. The BCCSAP is built on six pillars (thematic areas of interventions) of which five are related to management of climate change impacts and one is related to mitigation through low carbon development. The pillars are: a) Food security, social protection and health, b) Comprehensive disaster management, c) Infrastructure, d) Research and knowledge management, e) Mitigation and low carbon development, and f) Capacity building and institutional strengthening. BCCSAP puts highest priority on food security. The first pillar encompasses various aspects of food security and social protection and has identified nine programmes to promote food security for the poorest and most vulnerable people of the country.*
7. *The government of Bangladesh has established the Bangladesh Climate Change Trust Fund (BCCTF) and allocated USD 100 million from the limited annual budget of the government to implement a number of projects of BCCSAP. Of the approved project, four are about food security and social protection. With support from the international development partners and donor agencies, the government has also established Bangladesh Climate Change Resilience Fund (BCCRF). The development partners and donors are contributing to this fund for technical capacity building and implementation of BCCSAP. The Climate Change Unit at the MoEF has estimated that the government would require about USD5 billion to implement the adaptation and mitigation projects of BCCSAP within next five years.*
8. *The government of Bangladesh has formulated and revising national policies and strategies considering many socio-economic and environmental factors including growing population, increasing demand of food and climate change into sectoral policies and strategies. The relevant policies and strategies are: National Food Policy (2006); National Agriculture Policy of 1998; Climate Management Plan for Agriculture Sector in Bangladesh; and Country Investment Plan for agriculture, food security and nutrition. The NAPA and BCCSAP have also attached highest priority to food security and social protection for the poor.*
9. *Adaptation is the priority area of action in Bangladesh considering the high level of vulnerability though mitigation is also suggested where appropriate. The key adaptation strategies in agriculture are: promotion of climate resilient crops (salinity tolerant, submergence and drought tolerant varieties); short duration and early crops; change in cropping patterns in the context of changes in seasons and weather patterns; better farm management through new information dissemination, motivation and technological innovation; water and disaster risk management; and improving R&D in agriculture.*
10. *Major mitigation strategies in the agricultural sector are: introduction of crops that take less water, which are drought, flood and salinity tolerant; local varieties of crops that take less chemical inputs; changes in tillage practices; efficiency in farming machineries; energy efficiency, reduce energy uses for irrigation, promote renewable energy for irrigation; efficient use of water and reuses of water; use of organic manure instead of chemical fertilizers; agro-forestry; increasing efficiency in post harvest activities and storage; local varieties of livestock that needs less feeds and emit less GHG; promotion of small family farms instead of large, mechanized commercial farms.*

11. *There is a growing interest among policy makers, experts and development practitioners to build up synergies between climate change strategies, agricultural policies as well as between adaptation and mitigation to promote climate resilient agriculture and food security in Bangladesh.*
12. *There are some perceptual, knowledge, technology, social and institutional barriers towards building effective synergy between adaptation and mitigation. Many policy makers and key actors still feel that Bangladesh being a least developed country (LDC), has little obligation to mitigate CO₂ and reduce GHG emission at this stage. In addition many do not see the potential in reducing GHG emissions within the agricultural sector. To overcome this there is the need for greater research to explore suitable adaptation and mitigation options for Bangladesh.*
13. *The country urgently needs to increase food production to feed the growing population. The yields in agriculture must be increased through introduction of cropping, modernization of farm technologies and better farm management with resilient seeds and better inputs. But the mitigation issues should be integrated in the agricultural sectors without undermining the country's development goals and food security.*
14. *R&D, local innovation and knowledge dissemination in agriculture and rural development must be improved to promote adaptation and mitigation as well as CCD in agriculture. In this regard effective partnerships, long term investment and collaboration for the development and implementation of climate change projects are crucially important in Bangladesh.*
15. *Key Policy Responses and Recommendations are:*
 - *Integration of climate change issues (impacts, risk, vulnerability, adaptation and mitigation) in agricultural policy, strategies and programmes*
 - *Improving knowledge generation, technology, scientific research, R&D and information dissemination structure at all levels*
 - *Improving capacity for planning and implementation of adaptation and mitigation projects in agriculture and food systems as well as find synergies and co-benefits*
 - *Improving negotiation capacity of the government delegations to access international funding and technology supports under the UNFCCC and multi-lateral funding mechanism*
 - *Increasing national investment in research and action on CCD, climate resilient and sustainable agriculture and food security*
 - *Developing and implementation of adaptation and mitigation programmes with the vulnerable communities living in climate hotspots, and*
 - *Reformulation of social protection and safety net programmes in the context of greater intensity of climatic disasters and strengthening the humanitarian aid and actions for the poor, marginal and vulnerable communities.*



1. Background and Introduction

1.1 Background of the Case Study in Bangladesh

For many developing countries ensuring food security remains a key development challenge. There are multiple aspects that constitute food security, from food production to access to markets and the resilience of food systems to external risks. Different sectors play a role, with, of course, agriculture being the most important.

There is a wealth of literature indicating that climate change will have severe negative effects on agriculture and broader factors constituting food security, especially in low-latitude countries (IPCC; 2007; Hoffmann, 2011). This is true even for moderate levels of temperature increase (2°C) and especially in smallholder systems with little adaptive capacity and high vulnerability (Vermeulen et al. 2010). At the same time, agriculture is a key source of greenhouse gas emissions (IPCC 2007; Hoffmann 2011). Thus, “modern food systems need to be adapted to enhance food security and minimise negative environmental feedbacks” (Eriksen et al. 2010: 115). A transformation of food systems towards more flexible approaches and through lifting the productivity of small-scale farmers can make agriculture become an essential part of the solution and bring about new opportunities for the rural poor (Hoffmann 2011, IFAD 2010).

In this context, Germanwatch and Perspectives are coordinating this project with the objective to conceptually support policymakers and stakeholders in developing countries. The project is financed by the Climate & Development Knowledge Network (CDKN) and exemplarily carried out in cooperation with partners from three low-income and food deficit countries: Bangladesh, Kenya and Honduras. The following three organizations are local partners from the respective country.

1. Bangladesh Centre for Advanced Studies (BCAS) in Dhaka, Bangladesh
2. African Centre for Technological Studies (ACTS) in Nairobi, Kenya
3. Fundacion Vida (FV) in Tegucigalpa, Honduras

The overall aim of the research is to provide conceptual support to policymakers and stakeholders on Climate Compatible Development (CCD) on agriculture and food security issues. Further, the project aims to examine how integrated adaptation and mitigation policies as well as food security-related strategies can harness international climate finance in an effective manner. The sub-objectives are:

- Advance the understanding of what CCD means for agricultural policies that aim at ensuring food security of vulnerable populations;
- Advance the understanding of how national climate change strategies can promote CCD in the area of food security, involving both adaptation and mitigation; and
- Development of recommendations for a host country national climate strategy “gatekeeper” to integrate climate funding streams for the agriculture sector in a way that mitigation and adaptation benefits of a given funding opportunities are maximized.



In the initial stage the study team examined the level of an integrated approach to adaptation and mitigation in the area of agriculture and food security through literature review, taking expert's views, meetings and consultations. The second task of the project are three country case studies to build up an understanding how national climate change strategies can promote CCD in the agricultural sector to promote food security. This will be followed by an assessment how food security-related elements of national climate change strategies can be harnessed in international climate finance in an effective manner (review and consultations with policy makers and stakeholders). Ultimately, it is intended to disseminate the research results to policymakers and wider stakeholders through holding a national seminar and through the publication of policy briefs. The case study focuses on country situation in terms of agricultural growth, productivity and food security; status of the implementation of national climate change strategies and actions; adaptation and mitigation options in agriculture and food systems, synergies between climate change strategies and agricultural policies and strategies, potentials and barriers of CCD in Bangladesh. The case study report has been prepared based on earlier work, reviewing documents, expert's consultation and stakeholder's meetings.

1.2 Conceptualization of CCD in Agriculture and Food Security

Climate compatible development (CCD) is a comprehensive approach of moving beyond the standalone conventional adaptation and mitigation initiatives, and focusing on long term resilient development considering the future projections on climate change. It is evidenced in recent studies and researches that the food security situation in Bangladesh is going to be challenged by the variability projected in climate indicators i.e., temperature, precipitation, sea level rise and subsequent salinity intrusion. The agricultural production including crop, livestock, poultry and fisheries has been projected to be decreased in near future. In the face of the adverse impacts on agriculture; adaptation has been widely accepted in Bangladesh. But despite enormous mitigation potential, agriculture sectoral policy and strategies have not put much focus on the issues.

FAO (2010) has defined climate smart agriculture, or CCD in agriculture that may increase productivity sustainably, build resilience (adaptation), reduces GHG emission (mitigation) and enhances achievement of national food security and development goals. Most estimates indicate that climate change is likely to reduce agricultural productivity and will affect the stability of food systems. Hence CCD is crucial to address current and future food security of the nations. In this context, adaptation, mitigation and rural development strategies should be formulated together recognizing that in some cases hard decisions need to be made among the competing goals. Policy makers should aim to promote adaptation strategies for agriculture that have greater co-benefits in terms of agricultural productivity, mitigation and sustainable development of the sector (Harmeling S, 2011). The key elements of adaptation and mitigation in agriculture and their co-benefits are discussed in the chapter-4.

Hence, there is no way to disagree that effective and eco-friendly mitigation measures are already available in agriculture sector but the challenges are three-fold: i) lack of clarity and understanding on mitigation potentials and options in crop agriculture and livestock;

ii) adaptation-focused policy, strategy and finance; and iii) poor institutional arrangement and capacity to carry out mitigation actions.

However, the traditional mind-set of only focusing on adaptation needs to be changed. The mitigation potentials in agricultural sector mainly through reducing GHG emission from inundated paddy field, enteric fermentation from livestock, chemical fertilizer management need to be understood from grassroots level to policy level. Despite being a LDC and one of the lowest GHG emitter of the world, Bangladesh can take the opportunity of promoting mitigation options which may result in long term sustainability of the sector as well as yielding multiple global environmental benefits.

1.3 A Brief Overview of the Country

Bangladesh is located in South Asia bounded by India in the West, North, East, the Bay of Bengal in the South and Myanmar in the Southeast. It is mainly alluvial deltaic plain divided into three zones, namely hills, terraces and flood plain based on geomorphology and physiographic. The country has an approximate area of 147,570 sq.km bounded between 20°34' to 26°38' N and 88°01' to 92° 41' E. It has a 4,685 km long boundary and has a unique geographical location in South Asia. It is situated at the lower part of the Ganges-Brahmaputra-Meghna (GBM) basin that emanates from mostly the Himalayans and is home to three mighty rivers, the Padma (Known as the Ganges in India), the Brahmaputra and the Meghna. Over 200 rivers and tributaries have made this country a land of rivers. Most of the rivers originate in the great Himalayan, flow through Bangladesh and flow into the Bay of Bengal.

Bangladesh has over 160 million inhabitants with a population density of more than 1000 per sq km. With its growing economy Bangladesh predominantly depends on agriculture, which is strongly dependent on seasonal weather patterns and climatic conditions. The poverty rate has improved in recent years with a number of around 32% of the people being considered as poor (it was 48% in the in late 1990s) (Source: BBS, 2011).

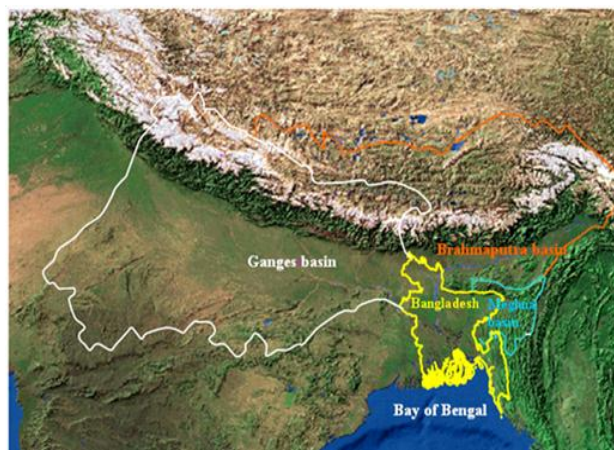


Figure-1: Location of Bangladesh in South Asia

Bangladesh made some progress in agricultural productivity in the last two decades and is approaching toward self-sufficiency in food grain (rice and wheat) production. Yet, the emerging impacts of global climate change are posing serious threats to food security of the country's inhabitants. Since independence in 1971, Bangladesh has achieved substantial improvements in some social indicators decreasing infant and maternal

mortality as well as illiteracy, and increasing life expectancy, access to safe water and sanitation. The economic performance of the country has been relatively strong since 1990, with an annual average GDP growth rate of 5%. Although half of the GDP is generated through the service sector, nearly two thirds of Bangladeshis are employed in the agricultural sector.

Increasing Climatic Events

Through its geographical location, coastal morphology, multiplicity of rivers and the annual monsoon rains Bangladesh is highly vulnerable to natural hazards (Figure-1: Source, GED, 2010). Especially in the south- western area, natural hazards increase the vulnerability of coastal dwellers and slow down the process of social and economic development. The major weather and climate related disasters include: floods and river erosion, cyclones and tidal surges, salinity, drought, heat waves, cold and fog and water logging. The country experienced devastating and prolonged floods in 1998, 2000, 2004 and 2007. Bangladesh was also hit by strong cyclones and damaging tidal surges in 1991, 2007 (Sidr) and 2008 (Aila). The country is also experiencing slow onset of climatic stresses such as salinity in coastal zone and drought in north western parts (Mallick, 2011).

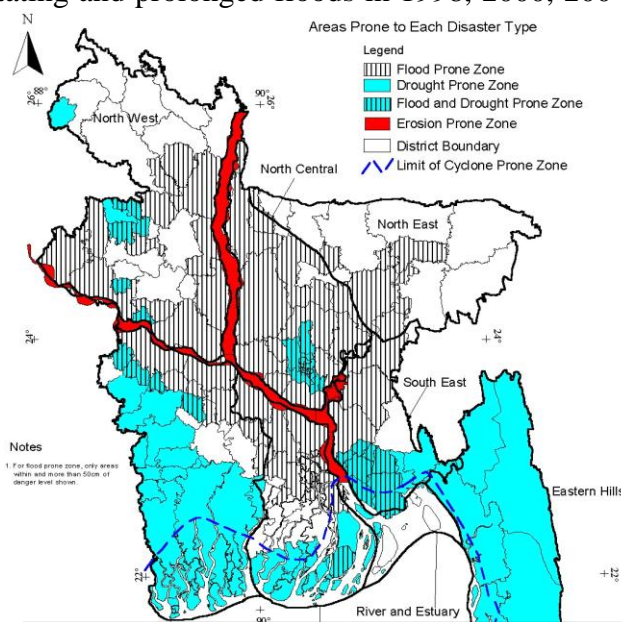


Figure-2: Map of Bangladesh showing major Climatic Disasters in Bangladesh

Significant country features include:

- About 10% of the country is less than one meter above sea-level while one-third is under tidal excursions
- 32% of the country is situated along and near the coast, accommodating 28% of the country's inhabitants
- There is a vast network of rivers, channels and floodplains
- An enormous discharge of water heavily laden with sediments
- A large number of islands within channels
- A shallow northern Bay of Bengal
- Strong tidal surges and winds across the coastal belt
- High population density
- High levels of poverty-specific vulnerable pockets

These features along with overwhelming dependence on nature, its resources and services have made Bangladesh to one of the most vulnerable countries susceptible to global warming and climate change.



The Ministry of Food and Disaster Management (MoFDM) and Disaster Management Bureau (DMB) along with the disaster management committees and NGOs are the key actors for disaster management in Bangladesh. The Comprehensive Disaster Management Programme (CDMP) of the MoFDM is exploring and creating opportunities to improve linkages with and synergies between disaster risk reduction and climate change adaptation. The Ministry of Environment and Forest (MoEF) is the focal point in Bangladesh to take for addressing climate change under the UNFCCC. The MoEF works with the MoFDM and other relevant ministries and government agencies to tackle climate change.

The Ministry of Agriculture (MoA) has formulated a National Agricultural Policy (NAP) in 1998 and has recently taken initiative to revise the NAP in the light of current development challenges and environmental dynamics including climate change. Further, the government has prepared a country investment plan in agriculture to enhance investment in agriculture, food security and nutrition. The MoA is also preparing a climate management plan for agriculture-related sectors in Bangladesh (BCAS, 2012: Stakeholder Consultation). Moreover, the MoEF has formulated the Second National Communication report to UNFCCC, which prepared an inventory of GHG emission from different sectors including agriculture and food production systems. The report has also indicated potential areas of applying mitigation measures in the field of agriculture.



2. National Climate Change Strategies and the State of Implementation

2.1 Climate Change Strategies and Action Plan

Bangladesh has played a key leading role in formulating the National Adaptation Program of Action (NAPA) following the UNFCCC guidelines. Formulated in 2005 the government identified 15 projects to build capacities among actors and stakeholders as well as to promote adaptation interventions in climate affected zones. Adaptation projects were identified for agriculture, fisheries, water, health and forestry sectors (MoEF, 2005) from which a couple of them are currently being implemented at the regional level. The NAPA has been revised in the light of new knowledge and evidences relating climate change impacts in the country.

The government has formulated the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) in 2008, which was revised in 2009 in the light of new scientific information and emerging demands at the community level. The aim of the strategy is to promote climate resilient development and low carbon economy in Bangladesh to support with the Bali Action Plan under UNFCCC. Key strategies and the action plan were presented at the UK-Bangladesh high level meeting held in London in 2008.

The BCCSAP is built on six pillars of which five are related to impact management and one is related to mitigation through low carbon development. These pillars are

- a) Food security, social protection and health,
- b) Comprehensive disaster management,
- c) Infrastructure development and protection
- d) Research and knowledge management,
- e) Mitigation and low carbon development and
- f) Capacity building and institutional strengthening.

Altogether the BCCSAP has 44 programmes and 145 projects under the above mentioned 6 thematic areas. It was prepared based on NAPA experiences using a methodology prepared by the Least Developed Countries Expert. A series of national level consultations with experts and stakeholders were carried out in the process of formulation of BCCSAP.

Food security has the highest priority within the BCCSAP. The first pillar encompasses various aspects of food security and social protection in Bangladesh and has nine programmes to promote food security for the poorest and most vulnerable people of the country. Those nine programmes are listed below:

1. Institutional capacity for research towards climate resilient cultivars and their dissemination
2. Development of climate resilient cropping systems
3. Adaptation against drought
4. Adaptation in fisheries sector
5. Adaptation in livestock sector
6. Adaptation in health sector
7. Water and sanitation program in climate vulnerable areas



8. Livelihood protection in ecologically fragile areas
9. Livelihood protection of vulnerable socio-economic groups (ibid).

The first pillar also highlights that the resilience of communities can be increased through the development of community-level adaptation measures, livelihood diversification, better access to basic services and social protection (e.g. safety nets and insurance) as well as scaling up.

2.2 The State of Implementation

With the limited resources, the government of Bangladesh has taken several steps to implement projects under the BCCSAP and NAPA. It has set up a Climate Change Unit (CCU) under the MoEF to deal with all matters related to climate change and the implementation of the BCCSAP. Further, the government established the Climate Change Trust Fund (CCTF) and allocated about US\$ 100 million in its budget for tackling climate change. A similar amount had been budgeted for 2010-11 as well. Early 2012 government has instituted a board for managing CCTF. So far the CCTF has approved a total of 66 projects from which 34 are under implementation: 4 on food security, social protection and health, 3 on comprehensive disaster management, 7 on infrastructure, 6 on research and knowledge development and 6 on mitigation and low carbon development (CCU, 2012). Moreover, the country has invested in some 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.

The governments of Bangladesh and the United Kingdom jointly organized a conference in London in September 2008 to highlight vulnerability of Bangladesh and need for international cooperation in the context of the climate change. At the 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. In May 2010 this led to the establishment of the Bangladesh Climate Change Resilience Fund (BCCRF) with a budget of US\$ 110 million. While the UK DFID committed US\$ 86.7 million, Sweden pledged US\$ 11.5 million, Denmark US\$ 1.6 million and the EU US\$ 10.4 million. Moreover, the World Bank Group and the Asian Development Bank are processing the Pilot Programme for Climate Resilience (PPCR) for US\$110 million to support the BCCSAP. Generally, most of the donors are contributing through Technical Assistance (TA) to the BCCSAP. A list of ongoing and committed projects is given below in table-1.

Table 1: Development Partner's Committed and Ongoing projects on Climate Change Adaptation, Mitigation and Capacity Building in Bangladesh

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	Euro 23.3 million
EU/FAO	Support to Assist Landless and Small Farmers in Impoverished Area	\$ 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

Source: General Economic Division, Planning Commission of the GoB, 2011



In addition to the ongoing projects listed above, the Government of Bangladesh and some development partners have invested in climate change related projects on agricultural development, food production, social safety net and disaster preparedness even before the BCCSAP had been established. Here are some examples:

- Flood management schemes to raise the agricultural productivity of many low-lying rural areas and to protect them from severe floods;
- Flood protection and drainage schemes to protect urban areas from rainwater and river flooding during the monsoon season;
- Coastal embankment projects, involving over 6000 km of embankments and polder schemes, designed to raise agricultural productivity in coastal areas by preventing tidal flooding and incursion of saline water;
- Over 2000 cyclone shelters to provide refuges for communities from storm surges caused by tropical cyclones and 200 shelters for the case of river floods;
- Comprehensive disaster management projects, involving community-based programmes and early warning systems for floods and cyclones;
- 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;
- 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; and
- Coastal 'greenbelt' projects, involving mangrove planting along nearly 9000 km of the shoreline.
- The Asian Development Bank (ADB) has provided a training for government officials in October 2011 in Dhaka focusing on planning and implementation of adaptation and mitigation projects in key sectors including agriculture, food, water, health, energy and livelihoods

It is estimated that \$500 million will be needed to implement climate change programmes in the next two years (e.g., for immediate actions such as strengthening disaster management, research and knowledge management, capacity building and public awareness programs, and urgent investments such as cyclone shelters and selected drainage programs). The total cost of programmes within the next five years however is estimated with US\$5 billion (Climate Change Unit, 2012). The government is trying to raise fund from own sources as well as from development partners and donors.

Apart from climate change finance Bangladesh has set up its sixth five-year development plan (2011–15) with 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 further 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 costs of natural disasters over the last 10 years were estimated to be between 0.5 and 1 per cent of GDP (while the social safety net budget is 2.1 to 2.8 per cent of GDP). For instance, the first phase of the Comprehensive Disaster Management Programme (CDMP) was successfully implemented by the MoFDM, having a budget of around US\$ 26 million.

This is to be also mentioned that considering the importance of agriculture and food security of the millions, the donor partners in Bangladesh have supported the project and programmes of the MoA, MoFDM and the BCCSAP project targeted to agricultural development. The USAID and EU are supporting the Bangladesh Country Investment Plan (CIP) of agriculture and food security.

2.3 The Key Responsible Institutions

A set of key ministries and associated agencies are involved in planning, implementation and monitoring of the projects under BCCSAP and NAPA. The Government of Bangladesh has recognised that an integrated approach involving different ministries and agencies, civil society and business sector is required to deal with climate change. Accordingly 12 government ministries are directly or indirectly involved in implementing climate change projects under the BCCSAP. Table 2 provides a list of the involved ministries and departments.

Table 2: List of government ministries and departments involved in climate change

Ministries	Departments/Insttutes/Agencies/
Ministry of Environment and Forests	Department of Environment
	Department of Forests
Ministry of Food and Disaster Management	Disaster Management Bureau
	Comprehensive Disaster Management Programme
Ministry of Water Resources	Bangladesh Water Development Board
	Flood Forecasting and Early Warning Centre
Ministry of Local Government, Rural Development and Cooperatives	Local Government Engineering Department
	Department of Public Health Engineering
Ministry of Agriculture	National Agricultural Research System
Ministry of Livestock and Fisheries	Department of Livestock
	Department of Fisheries
Ministry of Power, Energy and Mineral Resources	PETRO BANGLA
	Energy Regulatory Commission

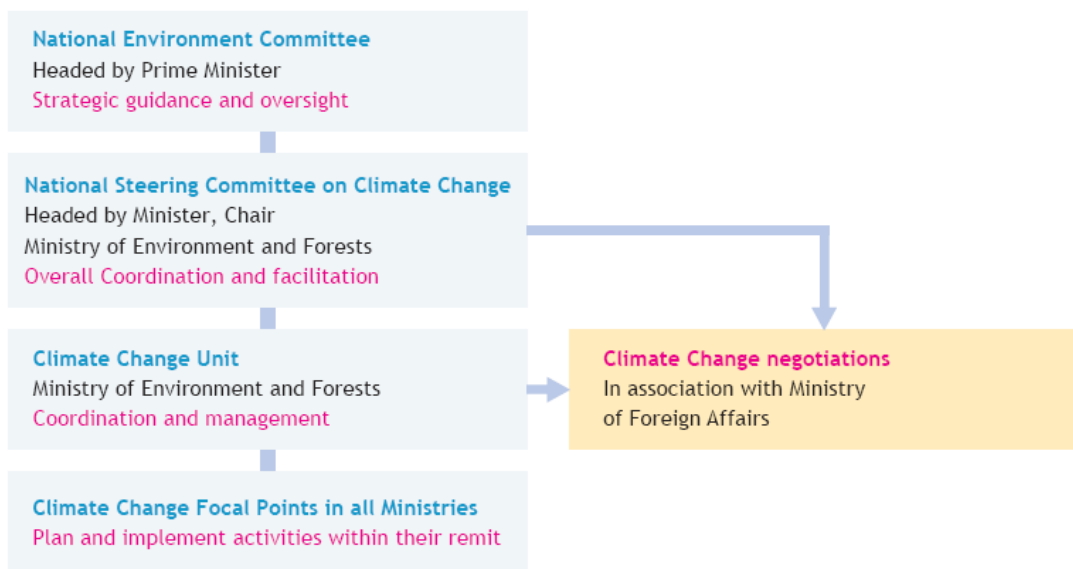
Ministry of Health and Family Welfare	Department of Health
Ministry of Communication	Roads and Highway Division
Ministry of Foreign Affairs	-
Ministry of Planning	Planning Commission
Ministry of Finance	General Economic Division (GED) and Economic Relations Division (ERD)

Source: BCCSAP, 2009 and Stakeholder Consultation conducted under this study

At present the MoEF is the focal point to deal with all types of climate change related activities under the government domain. It is guided by the National Environment Council, which is chaired by the Prime Minister. Under MoEF, the Department of Environment (DoE) is the lead agency to carry out the government initiatives on climate change. In face the multidimensional challenge of climate change however, two new institutions were established: First, there is the National Steering Committee on Climate Change, which has been established to coordinate and facilitate national actions on climate change. It reports to the National Environment Committee, Chaired by the Prime Minister.

Secondly, as mentioned earlier, the Climate Change Unit (CCU) was set up in the MoEF. The unit started functioning from January 2010 with the support from the project Strengthening Institutional Capacity of the Climate Change Units of the MoEF and the key ministries who keen to mainstreaming climate change into their sectoral policies and strategies. The institutional setup under BCCSAP is depicted below:

Figure 3: Climate Change Action Plan Organization Chart



Source: BCCSAP, 2009

Bangladesh has also successfully developed participatory and comprehensive disaster management programmes. The Comprehensive Disaster Management Programme



(CDMP) of the Ministry of Food and Disaster Management (MoFDM) has advanced risk reduction efforts with support from UNDP and EU. The CDMP has a focus on mainstreaming adaptation in sectoral development and disaster risk reduction.

2.4 International Funding Opportunities related to UNFCCC

The government is trying to access funding to implement the NAPA as well as activities identified in BCCSAP through UNFCCC funding mechanisms. As existing funding does not match the huge financial needs for adaptation and mitigation projects in the country, only a few have yet been realized.

Altogether, the updated version of NAPA has identified 45 adaptation measures among which 18 projects have been prioritized for short and medium term implementation. It has been estimated that those measures will require around US\$ 4 billion to be allocated within the next five years (NAPA 2009). Unfortunately, until now only 15 of 45 projects have been financially supported by LDCF/GEF.

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

Through another initiative the MDB held various consultations and meetings with all government agencies associated with the PPCR process as well as development partners (e.g. BWDB, DMB, BMD, MOFDM, MOEF, LGED, FD, ERD). The output, which was the SPCR, now offers a comprehensive package of plans, programs and actions for climate resilience. It is expected that activities under this process will be financed through PPCR. Moreover, the government has confirmed that priority interventions will be channelled through MDBs (ADB, IFC and WB) in line with the program design presented, which are presented in Table 4.

Table 4: Assessment of PPCR for climate change adaptations in 2010

Program	Objectives	Implementing agency	DPs	Amount million US\$
Promoting climate resilient agriculture and food security	<ul style="list-style-type: none"> - Livelihood diversification through adaptive agriculture - Scaling up of climate resilient varieties including efficient irrigation system - Early warning system for farming communities 	DAE, MOA and BMD	ADB, IFC and World Bank	13
Coastal embankment improvement and	<ul style="list-style-type: none"> - Embankment stabilization - Internal polder management 	BWDB, FD, BFRI	World Bank	130

afforestation				
Coastal climate resilient water supply and infrastructure improvement	<ul style="list-style-type: none"> - Improve safe drinking water supply and sanitation - 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	<ul style="list-style-type: none"> - Feasibility studies on individual climate resilient family housing in the coastal zone - 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

Source: Climate Change Unit, GoB, 2011



3. Agricultural Development and Food Security related Aspects in National Climate Change Strategies

3.1 Agricultural Development and Food Security Situation in Bangladesh

Agriculture is the mainstay of sales of the majority of people living in Bangladesh. Unsurprisingly the economy can therefore be characterized as primarily agrarian. During the last two to three decades the government has invested a lot in the agricultural sector: there has been crop intensification, diversification and continuous growth in the sector.

Agriculture contributes to about 20% of the GDP. Within the agricultural sector, the crop sub-sector contributes to 57%, followed by fisheries (22%), livestock (13%), forestry and fruits (8%). It generates employment for over 55% of the people living in Bangladesh. In fact, 65% of the people depend on agriculture for their subsistence livelihoods. Rice crops cover 75% of the cropping areas and contribute over 95% to the total food grain production. Together that provides 65% of the calorie needs of the population (Mainuddin et al, 2011; Rahman and Mallick, 2011). The increasing impacts of climate change pose a serious threat to the development of the sector and might have a devastating effect on food security of the millions of poor and marginal people living in different climate affected zones in Bangladesh.

Food security of a larger population depends on agricultural development, natural resources, policy, governance and effectiveness of a Public Food Distribution System (PFDS). In 2007 and 2008, many poor people suffered from food insecurity since agricultural practices and productivity was greatly hampered by prolonged flood and a super cyclone called Sidr. Further, the per capita availability of food has decreased as the population and thus the demand for food has increased (Consultation with Khandaker Mainuddin, Economist and Expert on Climate Change Adaptation). Moreover, a recent study of BCAS under the Climate Change Agriculture and Food Security Programme (CCAFS) of CGIAR says that agricultural practices and production have been badly affected by salinity, cyclone and tidal surges in coastal Bangladesh. Only 20% of the surveyed households are having adequate access to food throughout the year. In contrast, 50% of the households only have access to food from markets and PFDS and around 30% severely suffer from food insecurity (Mallick D. et al, 2011).

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 as well as between men and women at the household level.

According to experts, food security is the condition in which all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life (WFS, 1996). It encompasses three major dimensions: the availability of, the access to and utilization and nutrition of food. In effect this means that food security is dependent upon agricultural production, food imports and food aid,



employment opportunities and income earnings, intra-household decision making power and resource allocation as well as sanitation and health care practices. Food security, thus, is a multi-dimensional development issue that requires cross-sectoral and integrated interventions.

Food Availability

Bangladesh has made remarkable progress in domestic food production over the past three decades. Total annual food grain production increased from less than 10 million tons in early 1970's to more than 33 million tons by the year 2009-10. There has also been substantial improvement in the availability of food (see Table 5).

Table 5: Food-grain (rice and wheat) production and availability in Bangladesh

Year	Gross domestic production ('000 m.tons)	Net domestic production ('000 m.tons)	National availability ('000 m.ton)	Per capita availability	
				Kg/year	oz/day
1991-92	19317	17385	18714	165.60	16.00
1995-96	19056	17150	19373	165.50	15.47
2001-02	25905	23315	25006	188.30	18.17
2005-06	27268	24541	27105	192.23	18.60
2009-10	33158	29179	32492	220.00	21.26

Source : FPMU Database, MoFDM, Dhaka.

Although domestic production of food grains, particularly rice, persistently increased over the past decades, leading to apparent surplus situation, import constitutes a significant proportion (around 10%) of total availability of food grains in the country. While public import represented an important component of total import during 1990s, private import increasingly dominated total import over the last years of the current decade. The government, at its present tenure, has resorted to bring back the trend of agricultural growth: from 3.2% in 2007-08 to over 4.3% in 2009-10. With the exception of wheat, pulses and oilseeds, the production of fish, meat, milk, fruits and vegetables have increased. Yet, the production of those crops and non-crops are still below that of a nutritionally balanced food basket. Nonetheless the agricultural is deemed to be the engine of pro-poor growth.

Access to Food

Increased domestic production, supplemented by imports and public food management, contributed to a relatively adequate availability of food at national level over the last years. However, producing more food does not guarantee access to food. People must have the purchasing power to buy food. Therefore it is indispensable that the economy as a whole has to grow. This has been manifested in the fact that in spite of steady growth in agriculture, Bangladesh has been facing persistent challenges like poverty, seasonal fluctuation of food supply and seasonality of prices etc. leading to stresses in access to food by the poor and vulnerable section of the population.

Food security at household level is closely linked with poverty. These problems are massive, with approximately 40% of the population lacking the resources to acquire enough food and consequently remaining below the poverty line (BBS 2005). Table 6 shows the incidence of poverty from 1991-92 to 2005, as measured by the CBN method.

Table 6. Head count rate of incidence of poverty, 1991-92 to 2005 (CBN method)

Residence	Upper poverty line				Lower poverty line			
	2005	2000	95-96	91-92	2005	2000	95-96	91-92
National	40.0	48.9	50.1	56.6	25.1	34.3	35.1	41.0
Rural	43.8	52.3	54.5	58.7	28.6	37.9	39.4	43.7
Urban	28.4	35.2	27.8	42.7	14.6	20.0	13.7	23.6

Source: BBS, Household Income and Expenditure Survey 2005.

The table indicates that the incidence of poverty falling under both the upper and the lower poverty line decreased from 1991-92 to 2005. Further, both rural and urban poverty decreased during the period.

Although the report by HIES 2010 has not yet been published, preliminary estimates of the survey suggest that poverty at the national level decreased to 31.5% in 2010 compared to 40 % in 2005. In fact, this rate of decline is a positive indication towards achieving the MDG target of poverty reduction. Economic growth, especially in the labour intensive garment manufacturing sector, as well as remittance from abroad significantly contributed to the reduction of poverty.

Two consecutive floods as well as the cyclone ‘Sidr’ in 2007, compounded by the global food and fuel crisis of 2007-08, reduced food availability for the poor and contributed to a dramatic increase in the prices of food. Moreover, the prices of wheat started to rise in in June 2010 as a result of unfavourable weather conditions and export restrictions imposed by Russia and others. This exerted pressure on global and domestic rice prices (see figure 3 & 4 below) and created an array of macro and micro vulnerabilities in Bangladesh. Especially marginalised people were hit severely by the soaring food prices..

Figure-4: Rice price in domestic and international market

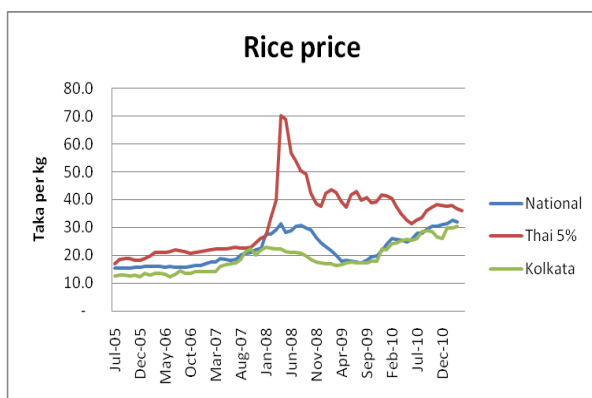
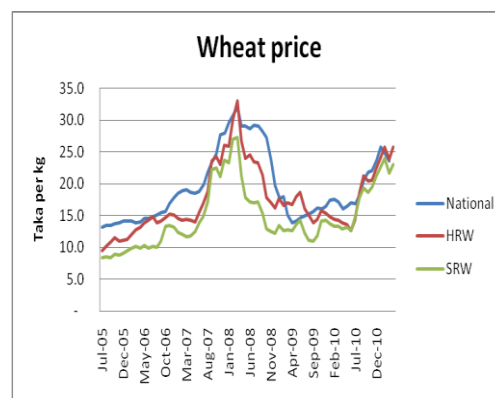


Figure -5 Wheat price in domestic and international market

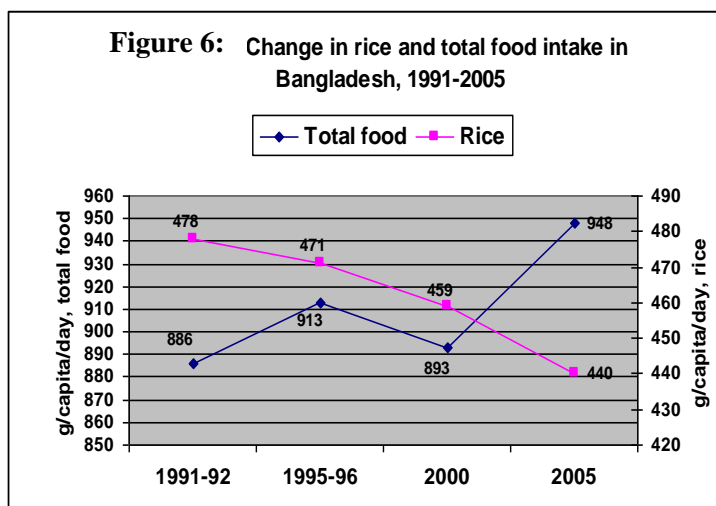


In the face of uncertainty on world market, Bangladesh's goal is not only to attain self-sufficiency in production of cereals but to sustain it. The country also needs to diversify agricultural production to enhance food diversification and improve the nutritional status of its population

Food utilization and nutrition

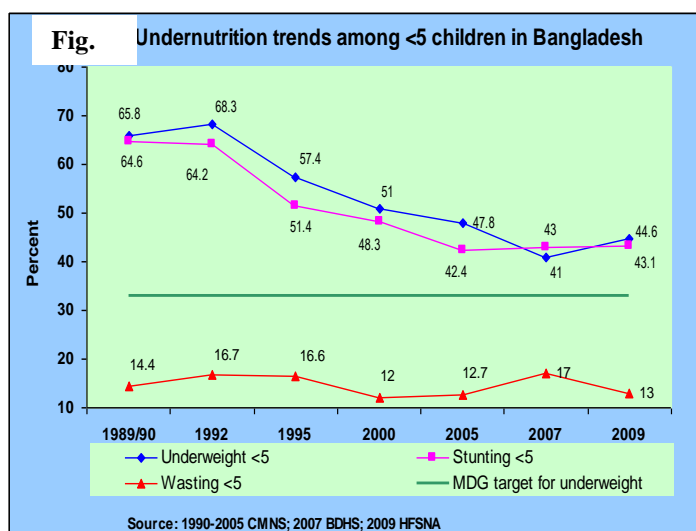
Successive Household Income and Expenditure Survey reports of the Bangladesh Bureau of Statistics (BBS) showed that per capita daily consumption of all foods increased from 1991-92 to 2005 for rural, urban and all households. Per capita calorie consumption decreased from 1991-92 to 2005 for rural, urban and all households, while per capita protein consumption remained constant during the period also for all categories of households. It is important to note that the levels of per capita calorie and protein consumption were well above the absolute poverty line calorie (2122 kcal) and recommended level of protein (58 grams) intakes respectively. But there exists a high degree of disparity in total food intake for the disaggregated classes of people. According to the HIES Report 2005, per capita daily total food consumption of the lowest expenditure group was about half the consumption of the highest expenditure group for rural, urban and all households of the country. The disparity was more pronounced for urban than for rural households, with lowest expenditure group consuming as low as 622 grams of food compared to 1403 grams consumed by the highest expenditure group.

The more objective function of food consumption is to improve and/or maintain nutritional status which is determined by the level and composition of food intake, general health status of people, and the sanitary and hygienic conditions under which food is prepared. Figure 6 shows that while total food consumption increased, consumption of rice decreased from 1991-92 to 2005. That means, a slow diet diversification is happening.



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High consumption of cereals, but low intake of edible oils, vegetable and fish result in a low level of absorption of micro-nutrients and a high level of anaemia and other deficiencies. The effects of poor nutrition are more severe among children and women. For example, under-five mortality rate is 102 and maternal mortality rate is 4.3 per 1000 live birth. Recent evidence from Demographic and Health Survey (2007) suggest that 43% children are stunted while 41% are underweight. Low birth-weight and poor nourishment of infants reduce their resistance power against infection. Roughly two-third of deaths among under-five children is attributed to malnutrition. About one-fourth of maternal deaths are associated with anaemia and haemorrhage. Apart from loss of lives, there is a heavy loss in work output associated with malnutrition.

Storage, processing and cooking practices also affect utilization of food. Food qualities are greatly affected by storage, depending on the methods used for storage and duration of storage. Utilization of food is also affected by cooking practices. Excessive washing of food often cause loss of nutrients. Also, too much of heating often impairs color, flavor and nutritional value of food.

After years of steady progress in addressing malnutrition in Bangladesh, the recent setbacks in the fight against food insecurity and malnutrition arising from the combined effects of high food prices and disasters have regressed the gains made in nutrition in the last decade. Malnutrition greatly impedes the socio-economic development while simultaneously affecting the country's ability to achieve and sustain the MDGs, particularly MDG 1 (eradicating extreme hunger and malnutrition), MDG 4 (reducing child mortality) and MDG 5 (reducing maternal mortality).

3.2 Impacts of Climate Change on Agriculture and Food Security

Impacts of climate change are visible in Bangladesh in the form of temperature extremes, erratic rainfall, and increased number of intensified floods, cyclones, droughts, prevalence of rough weather in the Bay. These phenomena will adversely affect the country's agricultural system through:- (a) reduction of crop productivity (quantity/quality) (b) changes of water use (irrigation); land use; migration (c) increased frequency/intensity of flooding, water logging, soil erosion and salinity and arsenic contamination (d) uncertainties on magnitude of climate change and (e) regional variations.

Crop Agriculture: It is predicted that climate change could have a devastating impact on Bangladesh's agriculture which is the key economic driver, accounting for nearly 20% of the GDP and 48% of the labor force. IPCC (2007) suggests that temperature rise of even 1 to 2 degree Celsius would reduce crop productivity significantly. World Bank (2009) predicts that national rice production will decline under all of the Climate Change Scenarios and that the annual growth rate will reduce from 2.71 percent under the Variability Scenario to 2.55 percent under the Average Climate Change Scenario during the period 2005-50. Rice production would be 5.243 million metric tons below what would have been achieved under existing variability and without the additional negative effects of climate change. This is equivalent to an average 8.0 kg per capita reduction in



rice production.

For wheat, grain weight declines by 16% for every 5°C increase beyond 25° C temperature (Abrol *et. al.*, 1996). The minimum temperature during January and Maximum temperature of February determine the wheat yield and wheat yield decrease by 400 kg/ha for a unit increase of 1°C maximum temperature and 0.5 hr. in sunshine. Wheat must have 60 days with minimum temperature <15°C as the minimum requirement for adequate tillering and panicle development. Any decrease in the length of this cool period will lead to a proportionate decrease in yield.

Early floods in April-June generally cause the most damage, as it affects the harvest of Boro rice and transplanted Aus. Transplanting of Aus seedlings starts immediately after harvest of Boro rice. Flash floods occurring within the monsoon season (mainly July-August) generally cause less crop damage, but exceptionally high floods damage the Aus (harvest stage) and Aman (vegetative stage) crops. Late floods in September-October cause serious damage to Aman yields. On the other hand, decreasing trend of rainfall in winter and pre monsoon reduce yields of both broadcast and transplanted Aman and delay the sowing of pulses and potatoes. Boro, wheat and other crops grown in the dry season are also periodically affected by this change of climate variables. In addition, use of inputs like fertilizers, pesticides, and irrigation may increase substantially due to the changing conditions, resulting in higher production costs.

Livestock: Livestock population is also not out of the risks induced by climate change. Analytical evidence on the impacts of climate change on livestock is relatively scanty in Bangladesh. Chowdhury and Karim (2009) indicated that livestock production could be affected by the climate changes due to reduction in the quality and availability of feed and water, heat and other environmental stresses, and preponderance of livestock parasites, pests, and diseases. The average temperature in Bangladesh is 18°C (64.4°F) in winter and 28°C (82.4°F) in the summer. If global warming causes Bangladesh temperature to rise further 2°C (35.6°F) by 2050, together with relative humidity of 60 to 95%, all most all species of livestock will be under heat stress conditions. As a result of heat stress, animals suffer from elevated body temperature, increased respiration rates, increased maintenance energy requirement, increased feed nutrient utilization, decreased dry matter intake, reduced milk production and hampered reproductive performance. Heat stress reduces disease resistance and increases morbidity and mortality of animal species. Reductions in milk production and reproductive performance are economic losses to cattle, goat and sheep producers. Crossbred cows will suffer more than the native cows, goat and sheep (Karim 2009).

Hot humid climatic conditions favor the heavy parasitic infestation of livestock population of Bangladesh. Further increase in temperature and precipitation related global warming will further intensify parasitic infestation. In addition to direct impact on animals, parasites induce an indirect form of protein under-nutrition. The presence of parasites increases the protein requirement of an animal by 40% even on a well-balanced diet.

Hahn *et al.* (1992) reported that in the east-central United States per animal milk production was found to decline. Moreover, Hahn (1995) also reported that conception

rates in dairy cows were reduced 4.6% for each unit change when the THI (Temperature Humidity Index: an index of heat stress) reaches above 70. Amundson *et al.* (2009) reported a decrease in pregnancy rates of Bos Taurus cattle of 3.2% for each increase in average THI above 70, and a decrease of 3.5 % for each increase in average temperature above 23.4⁰C. In Bangladesh, temperature and humidity is also at increasing rate which has a negative impact of heat stress on livestock population as well especially in summer. However, the sectoral growth of livestock is impeded by climate change factors in following ways:

Climate change factors	Adverse impacts
Flood /Cyclone/storm	Damage livestock farms and homestead production, huge death of animals; disruption of pasture land, increase diseases; salinity intrusion also damages feed stock in pastures; damages landing and marketing centres;
Drought	Reduce feed productivity, reduce feed intake of animals and metabolism, increase diseases exposures and thereby reduce livestock productivity; anthrax breaks out after drought; increases management costs.
High temperature	Virus infection; increased disease occurrence; high morality of poultry; loss of production
Cold/fogs	Affects reproduction; increase mortality due to low temperature; lower growth rate; increases bacterial and viral infection; high mortality and low production;

Source: Consultation with Experts, 2012

Fisheries: Climate change has both direct and indirect impacts on fish stocks. Direct effects act on physiology and behavior and alter the growth rate, development, reproductive capacity, mortality and migration. Indirect effects alter the productivity, structure, and composition of the ecosystem on which fish depend for food and shelter. Climate change stresses will have complex pressure on fisheries and aquaculture and threatened the fish production and livelihood of the communities.

During the early 1970s, inland open water capture fisheries contributed about 90 percent of total fish production, whereas in 2007–08 it contributed only up to 41 percent, a marked decline due to environmental degradation and species depletion. Among the 260 fin fish species, about 143 are termed as small indigenous species which was abundantly available in the past. Because of habitat destruction on/reduction and overexploitation, most of those species are not available in the market. Meanwhile, 21 fish species have become extinct in Bangladesh, and 54 have been listed as critically endangered and vulnerable in the red book of IUCN (2000).

In recent years, natural fish stocks have declined due to natural and manmade catastrophes, degradation of aquatic environments and reduction of many wetlands and water areas. The flood plain fisheries are the main sources of fish resources of

Bangladesh. But due to erratic behaviour of seasonal flood, these fish resources will be worst hit. There is a considerable threat of losing over 4 million metric ton of fisheries by the year 2030. Timing, extent and duration of rains and floods greatly influence reproduction, migration and growth of fishes. Delay in onset of rains and floods may affect the breeding and maturation success of fish, which in turn will result in the reduced fish production from rivers and floodplain (NAPA, 2005). Moreover, increased aridity, reduced dry season precipitation and extended dry spell, particularly in northwest region of Bangladesh, will lead to the drying up of or retain too little water (not adequate for survival of fish) in floodplain fish pits, depressions, ditches etc. As a flood plain area, inland open water fisheries of Dhaka region is suffering from reduced fish production. Every year hundred of culture ponds float due to floods resulting in loss of fish and poor fish farmers incur financial losses. This effect of climate variability is posing a great threat to the substance of pond fish culture as well. In particular, production of carp is likely to decline due to contraction of the fresh water zone in the river system. The summary of potential impacts of climate change on fisheries is as follows:

Climate change factors	Adverse impacts
Flood	Disruption of natural breeding; Acute aquaculture losses through severe damage of dykes, hatcheries, nurseries, embankments, ponds etc.; mass mortality due to sudden change of water quality; Siltration of water bodies etc
Drought	Reduce natural breeding grounds; reduce broods in natural fisheries; possibility of disease outbreaks and increased mortality; might change physiology and genetic character of fish
High temperature	Increased disease occurrence, possibility of virus infection; physiology and genetic character of fish
Cold/fogs	Affects reproduction; increase mortality due to depletion of dissolved oxygen; lower growth rate;

Source: Consultation with Experts, 2012

3.3 Food Security in BCCSAP and NAPA

Agricultural development, food security, social protection and disaster preparedness have the highest priorities in the National Climate Change Strategy and Action Plan. As noted earlier, food security issues have been addressed with highest priority in the BCCSAP and the Bangladesh NAPA. As the BCCSAP consists of six pillars and several programmes/measures belong to each pillar. For instance, there is the first pillar that mostly deals with food security and social protection issues. It consists of 11 programmes/ measures that all intend to ensure that poor people are protected from the climatic upheaval and that they get access to food, employment and basic services. Table 7 summarizes the major aspects of food security issues in BCCSAP.

Table 7: Various Aspects of Food Security addressed in the BCCSAP

Broad areas	Specific Measures
Awareness building	Specific extension and mass media programmes
Infrastructure	Construction and repairing of roads and embankments, river



development	training works
Disaster preparedness	Climate services, cyclone shelters, training and awareness
Disaster rehabilitation	Construction and management of food storage, silos, etc; distribution of inputs (seeds, fertilizers, saplings).
Research, Technology generation and knowledge management	Assess the impact of climate change on ecosystem, agriculture and food systems; Development of climate resilient varieties and farming system.
Crop agriculture	Varietal development: salt and drought 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.
Fisheries	Technology generation for increasing shrimp and fishery productivity, dredging of rivers, channels, community based management of water bodies and rehabilitation of fishers
Food and nutrition security	Comprehensive planning and investment to protect the income, employment and health of small farmers with special focus on women and children health and nutrition.
Wet land conservation	Dredging, development of mangroves, sanctuary management and alternative income generation activities
Biodiversity management	Develop participatory monitoring system to evaluate changes in eco-systems and biodiversity by involving local trained people such as school teachers, communities and academic researchers.
Reducing emission of green house gases from agriculture land	Support to research and on-firm trials of water and fertilizer management technology along with popularization of these and create awareness among farmers about nitrogenous fertilizers use in the rice field.
Agro-processing	Promoting climate resilient agro-processing technique, value chain management specifically HRD and post harvest loss minimization
Market infrastructure development	Creation of facilities at all stages from farm to fork, development of long term storage facilities and quality control
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
Agro-forestry	Improved nursery plantation and management practices, development of climate resilient species, training on nursery and plantation
Coastal zone management	Polder management, development of improved drainage, land suitability zoning, and agricultural intensification, need for improved irrigation and water distribution system, 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
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Source: BCCSAP, 2009

The objective of the first programme under the first pillar is to breed new climate change friendly cultivars under the headline '*Institutional capacity for research towards climate resilient cultivars and their dissemination*' (MoEF, 2009 p. 33). Climate change resilient crops that might be developed within seven to eight years would then be accessible for the low-income population living from agriculture (MoEF, 2009). A similar output is also anticipated for the second programme: '*Development of climate change resilient cropping systems, fisheries and livestock systems*'. It targets to increase food production as climate change resilient cultivars are able to withstand the climatic extremes such as drought, flood and temperature stress. Also different adaptive measures for fisheries and livestock are planned to protect and ensure local and national food security.

With the third programme under the first pillar '*Adaptation against drought*' it is to hope that the invention of climate resilient varieties of rice and non food crops and vegetables will increase the food production to ultimately meet the necessary demand and ensure food security. The ninth programme '*Livelihood protection for vulnerable socio-economic groups, through safety net programmes and insurance*' aims at increasing the food access to vulnerable people as they get necessary agro-inputs from the crop insurance which they can successfully use to raise food production. Apart from this, various safety net programmes that are run by the government, will also increase the people's social protection and resilience to climate change.

Besides those food security issues, the identification of agro-economic zones, piloting of adaptive measures in different regions, the identification of potential threats in various fishery sectors, the reduction of damage to livestock, the improvement of flood forecasting and early warning systems as well as preparatory studies for adaptation against sea level rise and its impacts have been considered with highest priority in terms of supporting projects under Climate Change Trust Fund.

Apart from the first pillar that directly deals with food security issues, there are other pillars which may not directly increase food security but may act as an additive measures in securing food access implicitly. Those pillars the Comprehensive Disaster Management pillar, the Climate Resilient Infrastructure Development pillar, the Capacity Enhancement and Research and Knowledge Management pillar as well as the Strategic Natural Resources Management as an Adaptation Response pillar.

For instance, the sixth measure of Comprehensive Disaster Management pillar '*Strengthening risk management and developing natural hazard insurance*' will provide the poor and small farmers with seeds, fertilizers and irrigation appurtenances and will thereby increase their ability to produce for an adequate livelihood and reduce the risk of food deficit in the events of natural hazards.



For the Climate Resilient Infrastructure Development, the government should undertake the second measure '*Repairing and rehabilitating existing hazard mitigation infrastructure*' to protect the agricultural lands from flood, erosion tidal surge etc. through the construction of inland river and coastal water embankments. In addition, the third measure of this pillar '*Planning, designing and constructing urgently needed new hazard mitigation infrastructure*' could help to implement the second measure in a planned and sustainable way. So both the measures are necessary.

The fifth pillar Capacity Enhancement, Research and Knowledge Management might come as an indispensable means to implement other measures. For instance, the first measure '*Building capacity of key government ministries and agencies*' is needed to build up capacity in terms of finance, human resource and technical availability as well as to mainstream the importance of climate change in sectoral plans and policies. It also assigns the responsibility of climate change adaptation and management to relevant political bodies.

For the Strategic Natural Resources Management as an Adaptation Response pillar, the government should increase the coastal area fish production and improve fisheries through its third programme '*Adopting measures to support adaptation of fisheries resources to the impacts of climate changes in the coastal ecosystem*'. Although only indirectly, this measure almost explicitly address the food security.

Lastly, it can be concluded that if the measures mentioned above are planned and implemented in a sustainable way and with due intervention of government of Bangladesh, then the national and local food security will be ensured to a greater extent.

3.4 Food Security in relevant Sectoral Policies

The Government of Bangladesh is quite aware of food security issues and has formulated national policies and strategies to internalise many internal and external factors including growing population, increasing demand of food and climate change into sectoral policies and strategies. Different National Policies directly address the agriculture sector and the inherent risk of climate change. However, the national policy documents that should be taken into account for promoting CCD in food security and agriculture can be subdivided into following four categories:

1. Policies related to food security
2. Policies related to agriculture sector
3. Policies related to natural resources (Environment, Land and Water)
4. Policies related to climate change

3.4.1 Policies related to Food Security

The National Food Policy (NFP) 2006 is the sole guiding document to ensure dependable food security for all people at all times. Ensure food security for all is one of the major challenges that Bangladesh faces today. In the face of the emerging challenges in ever

increasing food insecurity; the government has formulated this policy document to achieve three objectives: a) ensure adequate and stable of safe and nutritious food, b) enhance purchasing power of people for increased food accessibility and c) ensure adequate nutrition for all; especially for women and children. In line with the policy, the government has formulated a Plan of Action (PoA) to ensure the effective implementation of the policy over the period of 2008 to 2015. The PoA covers 26 areas of intervention for achieving the 3 core objectives of NFP

3.4.2 Policies related to Agriculture

There is a plethora of policy/strategy documents relevant to broad agriculture and rural development in Bangladesh. These can be classified in two sub-categories: crops and non-crops (see Table 8). As one would expect, about a half of the policy documents deal with crop issues, although the contents of these documents deal mainly with cereal crops, especially rice. Non-crop issues, covering fishery and livestock, appear less prominently both in terms of coverage and focus. Table 8 gives an overview of major thrusts and objectives of various policies to address food security.

Table 8: Agriculture Sector Related Policies

Sub-sector policies		Major goals and policy thrusts to address food security	Implementing ministry
A. Crop sub-sector			
1	National Agriculture Policy (NAP), 1999	Food security, profitable and sustainable production, land productivity and income gains, IPM, smooth input supplies, fair output prices, improving credit, marketing and agro-based industries, protecting small farmers interest	Ministry of Agriculture
2	New Agricultural Extension Policy (NAEP), 1996	Provision of efficient decentralized & demand led extension services to all types of farmers, training extension workers, strengthening research-extension linkage, and helping environmental protection	Ministry of Agriculture
3	Department of Agricultural Extension (DAE)-Strategic Plan, 1999-2002	Adoption of Revised Extension Approach, assessment of farmers' information needs, supervision, use of low or no cost extension methods, promotion of food and non-food crops, and mainstream gender and social development issues into extension service delivery.	Ministry of Agriculture
4	Agricultural Extension Manual, 1999	Annual crop planning, seasonal extension monitoring, participatory technology development and rural approval partnership, technical audit, attitude and practice surveys.	Ministry of Agriculture

5	Seed policy, 1993	Breeding of crop varieties suitable for high-input and high output agriculture, multiplication of quality seeds, balanced development of public and private sector seed enterprises, simplification of seed important for research & commercial purposes, provision of training and technical supports in seed production, processing & storage monitor, control and regulate quality and quantity of seeds.	Ministry of Agriculture
6	Seed Rules 1997	Delineation of rules and regulations regarding changing functions and of national seed board, registration of seed dealers, seed certification, marking truthful labels, and modalities of seed inspection.	Ministry of Agriculture
7	Plan of Action on NAP, 2003	Reviewing NAP and its implementation, setting out strategies and actions, and identifying institution and programme framework	Ministry of Agriculture
8	Actionable Policy Brief (APB), 2004	Prioritize immediate medium-term and long-term policy measures with respect to seed, fertilizer, land, irrigation, mechanization, marketing, agricultural research and extension with a view to increasing labor & water productivity, investment in agriculture and improve risk management.	Ministry of Agriculture
9	National Jute Policy, 2002	Keeping jute production at a desirable level, stabilizing supply and prices of jute, developing commercially viable jute industries, accelerating privatization of jute industries, and developing multiple uses of jute & jute goods.	Ministry of Jute and Textile
B. Non-crop sub-sector			
10	National Livestock Development Policy, 2007	Improvement of small scale poultry and dairy farming replicating CLDDP, reform of DLS, enforcement of low and regulations towards animal feeds, vaccines and privatization of veterinary services adoption of breeding policy, and establishment of livestock insurance development fund and livestock credit food	Ministry of Fisheries and Livestock

11	National Fishery Policy, 1998	Development of fishery resources, increasing fish production and self-employment, meeting demand for animal proteins accelerating fish exports, and improvement of public health.	Ministry of Fisheries and Livestock
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Source: MoA, GoB, 2012

3.4.3 Policies related to Natural Resources

Sub-sector policies	Major goals and policy thrusts	Implementing ministry
1 Environmental Policy and Implementation Programme (EPIP) 1992	Conservation of environment, wet lands, RAMSAR sites. Prevention of environmental degradation; air, water, soil and noise pollution and conservation of forests.	Ministry of Environment and Forests
2 Land Use Policy, 2001	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.	Ministry of Land
3 National Water Policy 1999	Promote optimum use of water resources across all sectors.	Ministry of Water Resources

3.4.4 Policies related to Climate Change

Sub-sector policies	Major goals and policy thrusts	Implementing ministry
1 National Adaptation Programme of Action (NAPA) 2009; revised in 2008	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.	Ministry of Environment and Forests
2 Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009	The BCCSAP is an integral part of national development policies, plans and programmes including the upcoming Sixth Five Year Plan. Under 6 thematic areas, BCCSAP has developed 144 action oriented projects where food security has got highest priority.	Ministry of Environment and Forests



Besides the abovementioned sector specific policies, there are some comprehensive government documents to guide the overall country development endeavours. The revised National Strategy for Accelerated Poverty Reduction II (December 2009) is one of those strategic documents which has proposed actions and indicative costs in support of poverty reduction, including for agriculture as a major contributor to pro-poor economic growth, food security and safety net as well as nutrition. Considering the overall country context, the current Government has adopted a plan called “Vision 2021” with an aim to make Bangladesh a middle income country. A National Strategy plan¹ is also developed to supplement this Vision 2021. The National Vision strategy has the goal of reducing poverty from 40 to 15 percent by 2021. The Sixth Five Year Plan for FY 2011- 2015 has been aligned with this vision plan 2021 with strong emphasis on reducing inequity, i.e. reducing vulnerability to natural disasters and strengthening governance. All of these policy and strategy documents have provided broader guidelines for poverty alleviation through promoting secured livelihood, income generation and agricultural development. But the recently developed Bangladesh Country Investment Plan (A Roadmap towards investment in Agriculture, Food Security and Nutrition) has given a light of hope through addressing food availability, food access and food utilization issues in the changing climatic and socio-economic context.

3.5 Government’s Investment to address Food Security

The government of Bangladesh has a thrust of ensuring food security for its growing population. In its Annual Development Programme (ADP) for the fiscal year 2011-12 US\$ 2.665,078 Billion have been allocated for different projects. It has been found that the highest allocation was made for infrastructure development (US\$ 726.69 Million) followed by market infrastructure development (US\$ 408.62 Million), irrigation and water management (US\$ 355.94 Million) disaster rehabilitation (US\$ 247.14 Million) and coastal zone management (US\$ 158.78 Million). But the amount allocated for agricultural extension (US\$ 91.75 Million), research, technology development and knowledge generation (US\$ 10.69 Million) and food and nutrition security (US\$ 118.31 Million.) eventually reveals that these areas were not addressed with strong importance during the fiscal year 2011-2012.

There is no way to disagree that public investment is one of the most direct and effective instruments that government can use to promote growth, food security, poverty and hunger reduction. There is considerable evidence that public spending on agricultural and rural development has the largest positive effects on growth and poverty reduction in developing countries, creating a win-win outcomes. Considering the adverse impacts of climate change, the pressure of a growing population as well as the current state of food insecurity in Bangladesh, a comprehensive policy framework is needed that sets focus on investment strategies in three major areas: (i) agricultural research and extension, (ii) improved access of farmers to well-functioning markets, and (iii) improved insurance and targeted social safety net programs for vulnerable groups, especially undernourished women and children.

¹This structure of this plan was used as Election Manifesto by the current govt before election.

The government of Bangladesh has formulated the Country Investment Plan (CIP) for addressing food security. This is basically a roadmap towards investment in agriculture, food security and nutrition. The CIP provides a set of 12 priority investment programmes to improve food security and nutrition in an integrated way. The total cost of the CIP is estimated at US\$ 7.8 billion. Of this, US\$ 2.8 billion are already financed through allocated domestic budget resources and contributions by development partners. The remaining financing gap therefore adds up to US\$ 5.1 billion, of which US\$ 3.4 billion have been identified as first priority requirements (MoFDM, CIP, 2011).

Table-9: Existing Resources and Financing Gaps in Food Sector

ID	Component	CIP Programme	Total CIP (m US\$) A = D + E	Existing Resources (m US\$)			Financing gap (m US\$)	
				GOB B	DPS C	Total D	Total E	Priority F
1	Food Availability	Sustainable and diversified agriculture through integrated research and extension	781.2	33.9	143.3	177.2	604.1	441.3
2		Improved water management and infrastructure for irrigation purposes	1,630.4	410.8	361.2	772.0	858.3	583.6
3		Improved quality of input and soil fertility	343.0	28.1	83.1	111.2	231.8	170.3
4		Fisheries and aquaculture development	392.9	19.7	17.0	36.6	356.3	211.6
5		Livestock development, with a focus on poultry and dairy production	835.1	22.1	38.0	60.1	775.1	439.7
		Subtotal - Availability	3,982.7	514.5	642.5	1,157.1	2,825.6	1,846.4
6	Food Access	Improved access to market, value addition in agriculture and non farm incomes	1,258.3	417.0	206.4	623.4	634.9	368.3
7		Strengthened capacities for implementation and monitoring of NFP and CIP actions	113.2	0.2	14.4	14.6	98.6	69.0
8		Enhanced public food management system	637.3	142.2	202.0	344.2	293.2	212.1
9		Institutional Development and Capacity Development for more effective safety nets	1,064.6	116.6	476.2	592.7	471.8	340.5
		Subtotal - Access	3,073.4	675.9	899.0	1,574.9	1,498.5	990.0
10	Food Utilization	Community based nutrition programmes and services	558.0	5.2	15.5	20.6	537.4	480.0
11		Orient food and nutrition actions through data	33.2	1.2	10.1	11.3	21.9	13.0
12		Food safety and quality improvement	186.5	1.3	7.6	8.9	177.5	90.8
		Subtotal - Utilization	777.7	7.7	33.1	40.8	736.8	583.9
		TOTAL	7,833.7	1,198.2	1,574.7	2,772.8	5,060.9	3,420.3

Source: CIP of GoB, 2011

4. Adaptation and Mitigation in Agriculture: Synergies and Key Barriers

There has been growing interest and awareness about adaptation and mitigation in agriculture and how to achieve the co-benefits of the two main responses in addressing climate change. Glantz et al (2009) in the work have suggested a number of adaptation and mitigation strategies and the underlying policy framework for agriculture. They have suggested the strategies such as adjustment in planting dates, new crop varieties, crop relocation, land, water and soil management, agro-forestry etc., as adaptation options, while improved crop and grazing land management to increase soil carbon storage, improved rice cultivation with conservation agriculture technologies, better livestock management and afforestation, water and irrigation with low energy and external input, energy efficiency and use of renewable have been suggested as the key mitigation options in agriculture. Referring to IPCC report of 2007 Harmeling (2011) has identified a number of co-benefits and inter-relationship between adaptation and mitigation in agriculture. He feels that creating synergies between adaptation and mitigation can increase the cost-effectiveness of actions and make them more attractive to the stakeholders including the funding agencies.

4.1 Adaptation in Agriculture

Considering high level of vulnerability, the government, policy makers, development practitioners as well as other actors have suggested that adaptation must be prioritized in different sectors, including agriculture for ensuring food security of the vast majority poor people. Adaptation measures are to be taken in the contexts of declining yields due to climate variability (temperature rise, changes in precipitation and erratic rainfall) and damages by extremes (flood, cyclones and tidal surge). The key adaptation strategies in agriculture are:

- promotion of climate resilient crops (salinity tolerant, submergence and drought tolerant varieties)
- short duration and early crops
- change in cropping patterns in the context of changes in seasons and weather patterns
- better farm management through new information dissemination, motivation and technological innovation
- disaster risk management
- improving R&D in agriculture

Water and irrigation management, the efficient use of water and ADW are suggested as good adaptation also having mitigation benefits (Rahman and Mallick, 2011 and World Bank, 2009). In their recent study Mainuddin et al. (2011) explored adaptation practices in agriculture of salinity affected coastal zone and have also estimated the costs of adaptation. It is reported that households in the study area are already practicing adaptation strategies to various extents, in order to cope with climate change-induced hazards and disasters. These include: excavating canals to conserve fresh water for irrigation as well as planting saline-resistant rice varieties. Furthermore, the use of



groundwater for irrigation and green manure are also common coping strategies to counter increasing salinity as a result of sea level rise and climate change.

In addition the study demonstrates that some adaptation technology, such as saline-resistant rice varieties, can have a net benefit (in this instance, higher yield potentials than the traditional rice varieties). Many farmers, however, are not fully aware of the advantages of these adaptation technologies due to their lack of relevant knowledge. However, farmers are generally willing to adopt saline-resistant varieties in the study area. Although conservation of freshwater for irrigation through excavating canals can be an effective adaptation strategy, it is often expensive and beyond the affordable capacity of marginalized smallholders. In fact, the lack of financial resources is also to find in governmental agencies and institutions. For instance, the Department of Agricultural Extension (DAE) would currently require an annual budget of about BDT 62.0 million (US\$ 0.82 million) to strengthen its extension activities in the salinity-affected study areas. The Department of Agricultural Marketing (DAM) would need an annual budget of BDT 41.55 million (US\$ 556,970) for its activities, including crop insurance and market promotion, and additional BDT 40.84 million (US\$ 547,453) for infrastructure – including grain storage facilities.

The estimated required budget for the Bangladesh Institute of Nuclear Agriculture (BINA) to develop new saline-resistant varieties is BDT 2.08 million per annum. The regional BINA at Satkhira (in the study area) would require BDT 4.42 million per annum, in addition to BDT 3.3 million for equipment costs. The estimated current costing for the BRRI (Bangladesh Rice Research Institute) is BDT 500 million (US\$ 6,578,947) including BDT 230 million (US\$ 3,026,315) for infrastructure and laboratory facilities.

The financial input currently required for the Bangladesh Agricultural Development Corporation (BADC) is BDT 199 million (US\$ 2.6 million) for installing power pumps and excavating canals in the coastal area. In addition, BDT 70 million (US\$ 0.9 million) will be needed for technological equipment to monitor salinity and groundwater management (ibid).

4.2 Mitigation in Agriculture and Food Systems

Agriculture and climate change share a two-way causal relation: agriculture is the most impacted sector in Bangladesh and at the same time also contributes to GHG emission through crop cultivation, livestock, chemical fertilizers, tillage, use of energy for irrigation and land use changes. Though adaptation has been prioritized in Bangladesh considering country vulnerability and food security issues, there is some scope of promoting mitigation in agriculture, which may provides a lot of environmental and ecological benefits and thus can contribute to a sustainable development of the sector. The Government of Bangladesh has prepared the Second National Communication (SNC) to the UNFCCC in 2010 and identified the potential sources of GHG from agriculture. The direct and indirect mitigation strategies in the agricultural sector are (Rahman and Mallick, 2011):

Table-10: Possible Mitigation Options with Effects and Benefits

Key Areas	Mitigation measures	Effects	
Crop management	Use of improved crop varieties that require less water and equally drought, flood and saline tolerant	Reduces direct emission per kg yield	
	Improve residue management, avoid biomass burning	Reduces direct emission	
	Reduce reliance on external inputs; inclusion of nitrogen fixing plants in crop cycle	Reduce direct and indirect emission	
	Local varieties of crops that take less chemical fertilizers, pesticides	Reduce direct emission	
	Introduce legumes into grasslands (to enhance productivity)	Reduce direct nitrous oxide emission	
	Farming system management	Well managed combined animal-grassland system	
	Optimized rice management through System of Rice Intensification	Reduce direct methane emission	
Fertilizer, manure and biomass management	Reduce use and production of synthetic fertilizers	Reduce direct and indirect emission	
	Reduce use of nitrogenous fertilizers because only 20% of N in fertilizers is finally used by plants	Reduce direct nitrous oxide emission	
	Avoid leaching and volatilization of N from organic fertilizers during storage and application	Reduce direct nitrous oxide emission	
	Optimize fertilizer application management, application of fertilizer adjusted to crop need, maintain right timing to ensure maximum uptake	Reduce direct and indirect emission	
	Compost production by adding of bulking material	Reduce direct nitrous oxide emission	
	Biogas production (methane capture)	Reduce direct methane emission	
	Prevent methane emission from manure heaps and tanks	Reduce direct methane emission	
	Compost manure	Reduce direct nitrous oxide emission	
	Soil Management	Use organic fertilizer	Increase soil organic carbon and indirectly reduce emission
		Use perennial in crop rotation	Increase soil organic carbon and indirectly reduce emission
	Use of cover crops and intercropping, avoid bare fallows.	Increase soil organic carbon and indirectly reduce emission	
	Reduced tillage or no tillage	Increase soil organic carbon and indirectly reduce emission	
	Avoid soil compaction	Reduce nitrous oxide emission	
	Agro-forestry	Increases soil organic carbon and indirectly reduce emission	
	Plant hedges		
Animal Husbandry	4-5% of lipids as feed additives	Reduce direct methane emission	
	Avoid use of concentrate feed	Reduce indirect emission	
	Breed and manage dairy cattle for lifetime efficiency	Reduce direct methane emission	

	Increase productivity: higher milk yields per animal	Potential for emission reduction
	Increase productivity: faster growth of meat animals	Potential for emission reduction
	Monogastric animals instead of ruminants	Reduce direct methane emission
	Use dual purpose cattle races which deliver both milk and meat	Reduce direct methane emission
Energy Use	Reduce energy uses for irrigation,	Reduce indirect carbon emission
	Promote renewable energy for irrigation	Reduce direct carbon emission
	Use of energy efficient machinery	Reduces fossil emission
	Optimize machinery use	Reduces fossil emission
	No use of synthetic biocides	Reduces fossil emission
	Pest resistant varieties with less spray cycle	Reduces fossil emission
	Use of bio-energy	Reduces fossil emission
Restoration of degraded land, maintenance of fertile land	Re-vegetate: improve fertility by nutrient amendment	Increases soil carbon
	Halt soil erosion and carbon mineralization by soil conservation technique	Increases soil carbon
Systemic	Change in food consumption pattern	Reduce indirect emission
	Reduction of wastage and storage losses	Reduce direct emission
	Switch to organic	Reduce direct emission

Source: Literature review, expert consultation, 2012

Considering the Bangladesh situation, the following are the potential key areas for mitigation options in agriculture and food systems.

- changes in crops that take less water, are drought, flood and salinity tolerant
- local varieties of crops that take less chemical fertilizers, pesticides and other external inputs
- changes in tillage practices (traditional tillage emits less GHG compared to modern mechanized tilling)
- increase efficiency in farming machineries
- energy efficiency, reduce energy uses for irrigation, promote renewable energy for irrigation
- efficient water uses and reuses of water
- water conservation
- avoidance of field burning of crop residues
- use of organic manure instead of chemical fertilizers
- improved cropland management (crop diversity and nutrient management, tillage and residue management, traditional pest management, water and irrigation management) can reduce emission of GHG along with improved grazing land and livestock management
- Afforestation and agro-forestry can contribute to carbon sinks

- increasing efficiency in post harvest drying and storage
- conventional methods of storage instead of energy intensive methods
- reduce post harvest losses
- local varieties livestock that needs less feeds and emit less GHG
- promotion of small family farms instead of large, mechanized commercial farms
- emission from enteric fermentation of cattle and livestock could be reduced through fodder change and cost-effectiveness; and
- emission from manure management could be reduced through organic fertilizer and bio-gas.

4.3 R&D, Local Innovation and Knowledge Generation

There has been some limited initiative for R&D and local innovation in agriculture in Bangladesh. The Bangladesh Agricultural Research Council (BARC), BARI and BRRI are have undertaken some research and knowledge dissemination in relation to development of drought and salinity tolerant varieties of crops. But the pace of ecological degradation due to climate change is faster than the effectiveness of R&D. There is the need for R&D in the contexts of impacts of climate change in different agro-ecological zones for developing adaptation options. Research is also needed for exploring mitigation options in agriculture and food production, processing, transportation and storage. There is also need for examining adaptation and mitigation options, synergies and co-benefits in the selected climate affected zones like salinity affected coastal area, floodplain and drought prone upland.

R&D and local innovations are to be done in participatory ways by involving farmers and local stakeholders. Information and knowledge dissemination about climate change impacts, adaptation and mitigation option is very important for promoting CCD in agriculture. These areas are very weak in Bangladesh.

Special focus should be put in small farmers and vulnerable groups in relation to local innovation and knowledge dissemination. Agricultural extension groups, media and NGOs can play a key role in this regard.

4.4 Potential Synergies, Barriers and Trade-offs

As climate change occurs as a global phenomenon, Bangladesh as a small developing country does not has the ability to prevent or modify it. The only appropriate option is therefore to develop country-specific adaptation options that also have mitigation benefits, based on available mechanisms and practices. In fact, there is a growing interest among policy makers, experts and development practitioners to build up synergies between climate change strategies, agricultural policies as well as between adaptation and mitigation to promote climate resilient agriculture and food security in Bangladesh.



The BCCSAP has identified names a number of issues to promote CCD in agricultural development. At the same time the Ministries of Agriculture, Food and Disaster Management are increasingly integrating climate change issues into their policies and strategies. In fact, the Climate Change Unit at the MoEF is helping relevant ministries and departments to mainstream climate change, particularly climate change adaptation in their respective policy papers and courses of action. From our point of view, this is a good initial step of synergy building. However, it is our perception that more government officials and policy makers need further training and know-how to effectively develop and implement climate change projects.

Moreover, it is our observation that many ministries are having difficulties to build up synergies between adaptation and mitigation measures. Many policy makers and key actors still feel that Bangladesh has no obligation to mitigate CO₂ and other GHG emission. In addition many do not see a great potential in decreasing emissions within the agricultural sector. To counter this there is the need for greater research to explore suitable adaptation and mitigation options for agriculture and food security in Bangladesh. Besides, it is important to promote co-benefits to convince respective policy makers of the importance of pairing mitigation and adaptation and at the same time to change peoples' minds about the country's responsibilities in the context of mitigation.

Further, we see the need to develop appropriate technologies for adaptation and mitigation such as new varieties of crops to cope with the adverse effects of climate change, AWD for water management, energy efficiency, renewable energy or technologies to promote local and organic input to reduce external and chemical inputs.

On top there is a number of technological, institutional and resource barriers towards synergy building in the context of climate change adaptation and mitigation. For instance, the fabrication of technology is constrained by the lack of skilled manpower, resulting from a lack of incentives provided through national policy regimes. Moreover technical and financial assistance for adaptation projects is hampered by the lack of transport and communication infrastructures, particularly in remote coastal and inland *char* areas.

The loss of biodiversity and its implications for nutrient and micronutrient supply as well as inadequate conservation and use of indigenous knowledge in food-related contexts are additional barriers to food security. Therefore strategies need to be people and community centred and their full potential must be utilized in conjunction with available and often limited resources.

To respond to the increased risk of food insecurity, efforts are needed to develop and implement a package of essential nutrition and health services based on the priority needs of the population through community based programmes and mechanisms. This means that inter-sectoral collaboration and coordination from the national policy makers to community level actors are to be made effective. The following are the priority areas for research and actions to promote CCD in agriculture and food security in Bangladesh.



- To ensure food security, agricultural adaptation has to be taken onto the priority agenda. Development, dissemination and extension of flood-, drought-, salinity- and disease-tolerant crop varieties should also be prioritized.
- Early warning system should be developed and strengthened to inform farmers about their roles in the impending adverse weather and climatic conditions. Further, information based on agro-meteorology and agro-climatic data about planting and harvesting times with possible yields of crops would be very beneficial.
- Adaptation to changing coastal fisheries through limited brackish water and salt tolerant fish species might be an important strategy to increase the availability of fish in the country.
- Coastal embankments including river banks need to be reconstructed to regulate saline water inflow into coastal areas.
- Integrated coastal zone management (incl. coastal afforestation) in a participative manner with bordering communities may also be an effective strategy to adapt to climate change.
- A disaster risk management plan was formulated by the government, however it may need some revision in the light of climate change.

In 2011 and early 2012, the UNDP and ADB have undertaken a few initiatives for local capacity and synergy building in Bangladesh. In fact, UNDP has recently supported a study for financial flow analysis for adaptation and mitigation in Bangladesh that has created lots of interest among respective policy makers and key actors. Moreover, the ADB has organized a training for high level government officials on mainstreaming climate change adaptation and mitigation in agriculture, water, food, health and energy sectors for promoting climate resilient development in Bangladesh. These will certainly help the government for moving towards better institutional integration and synergy building as well as utilizing hidden potentials for adaptation and mitigation in agriculture.

5. Conclusion and Recommendations

Climate change adaptation and mitigation have multiple short term and long term benefits on achieving sustainable development. The BCCSAP has included a low carbon development path as a key thematic area of intervention. However, mitigation measures are not properly reflected in agriculture and food policy strategies in Bangladesh. Moreover, the government and key actors in this field still see agricultural only connected to food security, poverty alleviation and livelihood promotion. Yet it is important to understand the linkages to climate change adaptation and mitigation. Therefore, adaptation options are to be developed for agriculture and its sub-sectors (incl. crop, fisheries and livestock) in a participative manner with local farmers and community representatives. Further, the country needs to increase food production to feed the growing population. At the same time, the yields in agriculture must be increased through modernising technologies and better farm management with resilient seeds and better inputs. Apart from adaptation, mitigation and the concept of CCD should be integrated in the agricultural sector without undermining the country's development goals and food security. Further for ensuring food security in the contexts of increasing climate risk, social protection and safety-net measures for the vulnerable communities are to be taken by government and actors, where supports (both resources and technical) would be required from the international development partners and donors.

Capacity building of the government agencies, research community, private sector and NGOs would be required for removing the barriers in knowledge, societal level, institutional and financial mechanism for accessing international support in promoting CCD in agriculture. Knowledge is an important input for adaptation, mitigation and CCD in agriculture. Since there is lack of understanding about the approach and potentials of CCD, more inter-disciplinary, participatory and applied research could be undertaken to generate new and applicable knowledge on the issues. There is a gap in scientific knowledge and prediction about climate change trends and impacts at regional and local level for taking adaptation and mitigation actions. Information and knowledge is to be generated for planning, decision making and implementation of adaptation, mitigation and social protection measures for addressing climate change and food security. Farmers and community people also need new and updated knowledge about climate change impacts, adaptation and mitigation measures for local action.

There is a lack of awareness at the community level about solutions of the problems (i.e., adaptation and mitigation). There is a need for social mobilization, motivation and capacity building at the local level for collective actions to cope with the impacts, reduce risks and vulnerability and ensure food insecurity as well as mitigation measures at individual, family and community level for offsetting carbon and GHG reduction. Technology support and linkage (horizontal and vertical with government agencies and scientists) can reduce these technological, institutional and social barriers. All the knowledge, institutional, social and resource barriers are to be removed immediately for promoting adaptation and mitigation as well as building synergies in these areas. Further, R&D, local innovation and knowledge dissemination is required to promote adaptation and mitigation as well as



CCD in agriculture. In this regard effective partnerships and the collaboration for the development and implementation of projects are also very important.

Policy Responses and Recommendations

- Integration of climate change issues (impacts, risk, vulnerability, adaptation and mitigation) in agricultural policy, strategies and programmes
- Improving knowledge generation, technology, scientific research, R&D and information dissemination structure at all levels
- Improving capacity for planning and implementation of adaptation and mitigation projects in agriculture and food systems as well as find synergies and co-benefits
- Improving negotiation capacity of the government delegations to access international funding and technology supports under the UNFCCC and multi-lateral funding mechanism
- Increasing national investment in research and action on CCD, climate resilient and sustainable agriculture and food security
- Developing and implementation of adaptation and mitigation programmes with the vulnerable communities living in climate hotspots, and
- Reformulation of social protection and safety net programmes in the context of greater intensity of climatic disasters and strengthening the humanitarian aid and actions for the poor, marginal and vulnerable communities.

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