

Climate Change Impact and Agriculture of Bangladesh

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Abstract

Over the last period of years, it has been observed that climate change has become a major issue affecting the agriculture sector. Impacts of climate change in agriculture are global concern but for Bangladesh where lives and livelihoods depend on agriculture, it's becoming a great threat for national food security. Considering crop agriculture as the predominant factor in the national economy, this paper tries to focus on the climate change impact and vulnerability in Bangladeshi Agriculture; it also highlights various strategies that can be taken in response to climate change, ways to adapt to the altered situation and Bangladesh's saline tolerant, flood tolerant and shorter maturity varieties of rice and other crops. From this study it also found that these strategies will help in short run and to continue this extensive agricultural extension services need to make these varieties available to the farmers. One immediate need is to start multi-disciplinary human capability development planning and implementation for climate and environmental management.

Keywords: Bangladesh, Climate Change, Agriculture, Food Security, Vulnerability

1. Introduction

Bangladesh is one of the most vulnerable countries to climate change because of geographic exposure, low income and greater reliance on climate sensitive sectors, particularly agriculture. People, exposed to the most severe climate-related hazards are often least able to cope with the associated impacts due to their limited adaptive capacity and according to Islam *et al.* (2011), will become even more susceptible in future. Its experiencing different types of natural disasters almost every year because of the global warming as well as climate change impacts, these are: Floods / Flash Floods (Almost 80% of the total area of the country is prone to flooding). Cyclones and Storm Surges (South and South-eastern Parts of the country were hit by Tropical Cyclones during the last few years). Salinity Intrusion (Almost the whole Coastal Belt along the Bay of Bengal is experiencing Salinity problem). Extreme Temperature and Drought (North and North-western regions of the country are suffering because of the Extreme Temperature problem).

Climate change has already impacted on the life and livelihoods of the people in the coastal areas and in the arid and semi-arid regions of Bangladesh (MoP, 2011). In particular, the effects of climate change on agriculture and other sectors are already evident. The agricultural sector is most likely to face significant yield reduction in future due to climate variability (Islam *et al.* 2011). Most importantly, crop agriculture is the most vulnerable to climate change among different sectors of the Bangladesh economy. One major determinant of fluctuations in crop yield is year-to-year changes in climatic variables (Hazell, 1984; Anderson & Hazell, 1987). Over the last several decades, global warming has been observed on local, regional, and global scales (Boyles and Raman 2003; Du *et al.* 2004; Macdonald *et al.* 2005; Piao *et al.* 2010; Wu and Zhao 2010; Qiu *et al.* 2012). The IPCC (Intergovernmental Panel on Climate Change) (2007a) report presents a detailed evaluation of long-term worldwide observations on climate change and a sound physical analysis of the potential trends of change in climate. The report concludes that global climate is very likely to get warmer in the near future. As scientific evidence becomes more convincing that increasing concentrations of greenhouse gases will warm the planet (IPCC 2007a). It has become ever more important to understand the impacts of global warming. The impacts on agriculture are among the largest and the best documented. Bosello and Zhang (2005) stated that the relationships between climate change and agriculture are complex and manifold. They involve climatic and environmental aspects, social and economic responses. These last can take either the form of autonomous reactions or of planned economic or technological policies. This picture is complicated further: indeed climate change and agriculture interdependencies evolve dynamically over time, they often span over a large time and space scale and are still surrounded by large uncertainties.

2. Agriculture of Bangladesh and Climate Change Scenario

Agriculture plays a vital role in the economy of Bangladesh. The contribution of agriculture was 20% of GDP and the crop subsector alone contributed 12% to GDP at constant prices in 2009-10 (GoB, 2010). Almost 85% of rural population is directly or indirectly involved in agriculture. Of all crops, rice plays the leading role by contributing 95% of total food production (GoB, 2010). Huq *et al.*, 1996; Karim *et al.*, 1996; Yu *et al.*, 2010

stated that Climate is the most important factor in rice production and any changes in climate thus have a profound effect on rice crops. Rice, the dominant staple food in Bangladesh, is highly susceptible to climate change and climate related extreme events such as floods and droughts. Climate change, as has been estimated, will reduce overall rice production in Bangladesh by an average of 7.4% every year over the period 2005-2050 (Yu et al., 2010). One of the motivations of the study derived from high contribution of rice to the Bangladesh economy and its high vulnerability to the climate change.

Agricultural crop of Bangladesh is influenced by seasonal characteristics and different variables of climate such as temperature, rainfall, humidity, day-length etc. It is also often constrained by different disasters such as floods, droughts, soil and water salinity, cyclone and storm surges. The economy is based on Agriculture mainly, with two thirds of the population engaged (directly or indirectly) on Agricultural activities; although the country is trying move towards industrialization slowly during the last one and a half decade almost. So, the overall impact of Climate Change on Agricultural production in Bangladesh would be wide spread and devastating for the country's economy. Beside this, other impacts of Climate Change such as - Extreme Temperature, Drought, and Salinity Intrusion etc. are also responsible for the declining crop yields in Bangladesh. Temperature and Rainfall changes have already affected crop production in many parts of the country and the area of arable land has decreased to a great extent. The Salinity intrusion in the coastal area is creating a serious implication for the coastal land that was traditionally used for rice production.

Not only that but also the fisheries sector has also experienced an adverse effect because of the impacts of Climate Change. The coastal belt of Bangladesh where fresh water fish as well as marine water fish project located is mainly affected by the climate change. This sector now facing to a big challenge for its existence and maximum number of people who were engaged on it are now workless. This has become one threat to national economy

3. The Climate of Bangladesh and Climate Change Impact

Bangladesh lies in the northeast of the Indian subcontinent on the Bay of Bengal. It is a predominantly low-lying country with several major rivers located mainly in the large delta formed by the Brahmaputra and Ganges Rivers. The population density is about 1000 persons per square kilometer; some 150 million people live in an area of 148,000 square kilometers. Bangladesh has a tropical climate; it is humid and warm throughout the year with a year round average temperature of 25°C. Rainfall is moderate to high across the country and ranges from 1400mm along the eastern border to 5100mm in the northeast. Most of the rain falls during the monsoon season and from June to October flooding is common. There are two cyclone seasons which can bring devastating winds and tidal surges. The early season is in April and May whilst the late season lasts from September to November.

Bangladesh is extremely vulnerable to the impact of climate change, in part because it is a low-lying and very flat country, subject to riverine flooding and vulnerable to sea level rise. The confluence of three great rivers - the Ganges, the Brahmaputra, and the Meghna makes the country a great deltaic plain. The extensive floodplains are the main physiographic features of the country. Both riverine flooding and sea level rise can result in inundation of crops; sea water, in particular, can result in salinization, causing permanent loss of currently productive agricultural land.

Impacts of climate change are already occurring, as measured by increasing temperatures, variable rainfall and an increase in climate-related extreme events such as floods, droughts, cyclone, sea level rise, salinity and soil erosion (Asaduzzaman et al., 2010; Yu et al., 2010; Hossain and Deb, 2011). These extreme climate events occur in Bangladesh almost every year, and sometimes more than once a year, affecting the crop agriculture sector adversely, particularly rice production (MoEF, 2005; Yamin et al., 2005). The climate of Bangladesh is characterized by high temperatures, heavy rainfall, high humidity, and fairly marked seasonal variations. More than 80 percent of the annual precipitation of the country occurs during the southwestern summer monsoons, from June through September. In recent years the weather pattern has been erratic, with the cool, dry season having considerably decreased—a change probably attributable to climate change.

Climate change by definition will alter temperature and rainfall patterns. Since agriculture is dependent on weather and crops are known to suffer yield losses when temperatures are too high, there is concern that warming caused by climate change will lower crop yields. Changes in rainfall might also cause reductions in yields, though at least in some places, changes in rainfall could lead to increases in yields. Climate change in Bangladesh is an especially serious concern since agriculture is such an important sector in the country. It contributes roughly 20 percent to gross domestic product (GDP), with crops representing 11.2 percent, livestock 2.7 percent, fisheries 4.5 percent, and forestry 1.8 percent (GoB 2010). Furthermore, the sector provides employment and income to some of the poorest and most vulnerable members of society. Between 2000 and 2003, agriculture provided work to about 52 percent of the labor force (BBS 2004).

There are already many complex environmental problems facing Bangladesh including air, soil and water

pollution, depletion of natural resources, desertification, droughts, energy shortages and land contamination. Climate change is exacerbating the already stressed conditions. As temperatures rise there has been an increase in the frequency of heat-related conditions such as hypoxia and heat stroke. The higher temperatures have increased concentrations of ground level ozone; this has caused more respiratory conditions. There has been an increase in the incidence of disease carrying vectors which has seen more cases per capita of a wide range of diseases.

Instances of flooding have increased and this had led to crop destruction and water contamination, which in turn spreads diseases such as cholera and typhoid along with other water-borne diseases. One of the biggest threats facing Bangladesh comes from rising sea-levels. The extensive low-lying areas are more prone to flooding than ever before and large numbers of people have already been evacuated. An increase in seasonal flooding has already been observed, the annual floods now last longer, the land drains slower and ground water is becoming increasingly salinized; this trend is set to continue into the future. With rising sea-surface temperatures the threshold at which cyclones are spawned will be reached more frequently and it's highly likely that Bangladesh will suffer an increase in the frequency and intensity of tropical cyclones.

The impacts of higher temperatures, more variable precipitation, more extreme weather events, and sea level rise are already felt in Bangladesh and will continue to intensify (World Bank 2008). The impacts result not only from gradual changes in temperature and sea level but also, in particular, from increased climate variability and extreme events, including more intense floods, droughts, and storms. These changes are already having major impacts on the economic performance of Bangladesh and on the lives and livelihoods of millions of poor people. It has been seen that context of vulnerability varies across the country. Currently vulnerability of the country is related to draught, flood (riverine and flash flood), cyclone and storm surges, salinity, river bank and soil erosion which has been exasperated by climate change and sea level rise. The north-western region of Bangladesh is tending to seasonal drought where extreme temperature and unsettled behavior of rainfall are key issues related to climate change. Salinity intrusion, sea level rise, and cyclone and storm surges are key issues for the low lying coastal area. The floodplain ecosystem spread over mostly in the central region of the country face frequently and intense flood due to climate change and the north-eastern and hilly areas of the country with devastating flash flood. Summary of the characteristics of the climate related vulnerability context by major geographical regions and ecosystems showing in the table 1 and level of impacts of climate change on agricultural sector showing in table 2.

Table1: Characteristics of the climate related vulnerability context by major geographical regions and ecosystems

Types of Geographic al Areas with Dominant Ecosystems	Climate Change Vulnerability Context and Characteristics
Floodplain (freshwater aquatic ecosystem, fisheries, Transplanted Aman)	Changes in Flooding Characteristics
	Coverage of inundated area in monsoon season will increase (more flood vulnerable area)
	Changes in depth and duration of inundation (depth of water will be higher and period will be longer)
	Changes in recession period of flood water (water logging)
Drought Prone (dryness, moisture stressed condition)	Changes in flood frequency (more frequent and intense flood)
	Changes in Drought Characteristics
	Changes in drought intensity (more area under severe drought)
	Changes of extent of drought prone area (expansion of area)
Coastal Zone	Changes in timing of drought (erratic behavior of rainfall and temperature)
	Changes in Coastal Characteristics
	Expansion of salinized areas
	Increase in salinity intensity
Haor Basin (tectonically depressed area)	Increase drainage congestion and coastal flooding
	Cyclone and storm surges
	Changes in Haor Basin Characteristics
	Changes in timing of flash flood
Hilly Region	Changes in recession period
	Changes in distribution of rainfall and intensity
	Changes in erosion of top soil
	Increase possibility of landslide

Source: GoB and UNDP

Note: Aman - A term used in Bangladesh and east India for lowland rice grown in the wet season during June to November.

Description: Above mentioned vulnerability context of Climate change is likely to affect agriculture sector including crops, livestock and fisheries; freshwater for drinking and agricultural purpose; and rural infrastructure including water supply and sanitation, and rural roads.

Table 2: Impacts of climate change on agricultural sector

Physical Vulnerability Context								Sectorial Vulnerability Context
Extreme Temperature	Sea Level Rise		Drought	Flood		Cyclone And Storm Surges	Erosion and Accretion	
	Coastal Inundation	Salinity Intrusion		River Flood	Flash Flood			
+++	++	+++	+++	+	++	+++	-	Crop Agriculture
++	+	+	++	++	+	+	-	Fisheries
++	++	+++	-	-	+	+++	-	Livestock

Source: Adopted from NAPA

Description: Impacts of climate change on agricultural sector

4. Response of Bangladesh on Climate Change and Success

Bangladesh has taken a two-pronged approach to deal with climate change issue. One is vigorously participating in the international negotiations process for realisation of the goals under the Bali Action Plan (2007) and another one is preparing itself at home for necessary domestic action. Prepared National Adaptation Program of Action (NAPA) in 2005; identified 15 Priority projects, prepared Initial National Communication and preparing Second National Communication, made climate change an integral part of the new draft Poverty Reduction Strategy Paper (PRSP), developed Bangladesh Climate Change Strategy and Action Plan (BCCSAP 2009), and national Water Management Plan. The Climate Change Action Plan is a 10-year program (2009-2018) to build the capacity and resilience of the country to meet the challenge of climate change. The BCCSAP is designed as a 'living document' to continue to implement the nation's adaptation and mitigation programs, as well as to deepen understanding of the phenomenon. It has listed 44 different programs and 145 actions for implementation. In the first five year period (2009-13), the program will comprise six pillars: 1) Food security, social protection and health, 2) Comprehensive Disaster Management, 3) Infrastructure, 4) Research and knowledge management, 5) Mitigation and low carbon development, and 6) Capacity building and institutional strengthening.

The Climate Change Strategy and Action Plan (2009) confirmed that additional amount of allocation will be required for sustained adaptive measures. The Government of Bangladesh invested over 10 billion USD and adopts policies to combat climate change impacts (World Bank 2010). About 500 million USD is estimated to be needed to implement action plans of BCCSAP for first two years (MoEF 2009). A credible assessment is vital that must incorporate other sectors in a logical way. Costing for managing climatic disturbances in agriculture sector is calculated in terms of the amount of crop loss. However, more integrated approach considering issues for example - loss of agricultural land, damages lands, reduce employment, risk health, harms livestock, etc. to ascertain the total loss in figures. This is important in negotiations for funding in both home and abroad.

Climate change impacts are not unknown to the policy makers. The National Adaptation Program of Actions (NAPA) provides guidance for adaptation measures taken up to combat climate change impacts. The revised version of National Agriculture Policy of 2011 has included climate change as one of its three priority areas. Some issues related to the impact from temperature rise and variation in precipitation on agriculture needs further attention. The Agriculture Extension Policy of 1996 puts emphasis on sustainable agricultural however and explicit consideration extension of climate resilient variety or cropping pattern need incorporation. Similarly, the Integrated Pest Management Policy of 2002 need to provide guidance on climate change and disaster risk reduction issues. There is an implicit mentioning that the policy should increase self-reliance of farmers by promoting locally developed and crop management practices which eventually address adaptation to climate change and National Seed Policy (NSP) need to put the priority on seed production likely to be affected by climate change through technologies.

Bangladesh has already developed salinity tolerant, flood tolerant and shorter maturity varieties of rice. This will help in the short run. To continue this extensive agricultural extension services are needed to make these varieties available to the farmers. But this is only the beginning: more varieties and appropriate ecosystem-based agricultural system need to be developed and popularized. One immediate need is to start multi-disciplinary human capability development planning and implementation for climate and environmental management.

5. Conclusion

Climate change, which is largely a result of burning fossil fuels, is already affecting the Earth's temperature, precipitation, and hydrological cycles and its impacts heavily on Bangladesh, this concern should be seen as urgent and vigorous action called to stem the tide of a looming danger. The continual flood, droughts, temperature variation, erratic rainfall and salinity which results in crop losses calls for urgent attention. Despite some amounts of resilience shown by the population in the face of these with rice production target met and achieved, Price subsidy in agricultural inputs like fertilizer has contributed to make production cost bearable to

the farmer. Researches on stress tolerant technologies (seed, fertilizer, irrigation, agronomic practices) and their expansion acts as positive adaptive action against climate change. The Comprehensive and coordinated study on the real time impacts of climate change on crop production and assessment of the needs to avert the crisis must be carried out for making coherent policy decision.

Continuous research, monitoring and knowledge management and development and transfer of technology, are needed to manage climate change and its impacts. Intensive training program for climate displaced community to adapt and cope with new situation. The issue of climate change assumed special importance because of the accumulation of evidence of global warming and now it's become as a big challenge. Almost all nations are effected and some more than others. It has been a big threat for global development and for the country like Bangladesh which is one of the most proactive developing countries on global scenario to the address the challenges of climate change. Climate change and its adverse impact has become a block against all efforts to mitigate the effects of national poverty situation and to achieve the Millennium Development Goals (MDG).

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Keywords: Climate change Climate impacts Agriculture Bangladesh Rice Wheat Crop modeling DSSAT Floods Sea level rise Adaptation. **ABSTRACT.** Diverse vulnerabilities of Bangladesh's agricultural sector in 16 sub-regions are assessed using experiments designed to investigate climate impact factors in isolation and in combination. Climate information from a suite of global climate models (GCMs) is used to drive models assessing the agricultural impact of changes in temperature, precipitation, carbon dioxide concentrations, river flows, and sea level rise for the 2040–2069 period in comparison to a historical period. Climate change is one of the greatest environmental, social, and economic threats that the world faces today. With 160 million people, Bangladesh is one of the largest deltas in the world which is highly vulnerable to natural disasters because of its geographical location, flat and low-lying landscape, population density, poverty, illiteracy, lack of institutional setup etc. Moreover, the adverse effects of climate change – especially high temperature, sea-level rise, cyclones and storm surges, salinity intrusion, heavy monsoon downpours etc. has aggravated the overall economic development scenario of the country to a great extent. What is Climate Change? Climate change in Bangladesh is a critical issue as the country is one of the most vulnerable to the effects of climate change. In the 2020 edition of Germanwatch's Climate Risk Index, it ranked seventh in the list of countries most affected by climate calamities during the period 1999–2018. Bangladesh's vulnerability to climate change impacts is due to a combination of geographical factors, such as its flat, low-lying, and delta-exposed topography, and socio-economic factors, including its high population density. The climate of Bangladesh is changing, and its vital agricultural sector and groundwater resources will face the greatest impacts. Rising temperatures, high variability in rainfall, and seasonal shortages of rain will affect the local water balance and will be harmful for agriculture, as will the consequences of climate change such as floods, droughts, cyclones, tidal surges, and soil salinity changes. Therefore, country-level information about climate variability and changes, particularly temperature and rainfall changes, is needed. Moreover, the impacts of temperature and rainfall changes on agriculture and groundwater resources are discussed.