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Global Warming: Preparation in the Agriculture Sector of Bangladesh

Md. Mostafizur Rahman

Army IT Suppout Organization, Dhaka, Bangladesh

ABSTRACT

Global warming and energy resource depletion have received widespread attention over the past several decades. Understanding the need for mitigating and adapting to current changes in the globe has led to the global urgency to develop and deploy sustainable fuel alternatives. Biofuels have been recognized as a viable energy alternative. They have the potential to mitigate current global warming and energy resource depletion issues.

Keywords: Global, warming, agriculture, resources, ecosystems, biodiversity

1. Introduction

1.1 Bangladesh is an agriculture based country. It is a broad deltaic plain with maximum elevation less than 10 meters above the sea level. The main feature of the climatic condition and vulnerability of the country is cruelty of natural calamities and disasters because of flood, tropical cyclone, storms surges, tornadoes, Sidr and droughts. Erratic precipitation coupled with climate change regime has adverse effects on the wetland resources, ecosystems, biodiversity and eventually the livelihood of the people. Salinity intrusion due to sea level rise has serious impact on the estuarine area and all forms of life of it.

1.2 The empirical evidences indicated that this would continue to aggravate further following the upcoming more stress from the changed climate regime, unless it is addressed in time. Agriculture, industry and services are the major economic sector of the country. The contribution of Gross Domestic Product (GDP) of agriculture sector is 22.0%. About 70% of the export is

generated from agriculture. Against this backdrop, the study focuses on analyzing the implication of agriculture due to climate change. The soil of Bangladesh is very fertile and weather is suitable for agriculture. Having all the potentials, the agriculture sector of Bangladesh is not flourishing as expected. Effects of global warming are the main barriers of the agricultural development of Bangladesh.

2 Definitions.

2.1 Global warming is the observed and projected increases in the average temperature of Earth's atmosphere and oceans. Global warming refers to climate change that causes an increase in the average temperature of the lower atmosphere. Global warming can have many different causes, but it is most commonly associated with human interference, specifically the release of excessive amounts of greenhouse gases (GHG). GHG, such as carbon dioxide (CO_2), methane (CH_4), water vapor, and fluorinated gases, act like a greenhouse around the earth.

2.2 According to the International Penal on Climate Change (IPCC), global average temperature increase has reached 0.6 ± 0.2^0 C over the twentieth century. It is responsible for the conspicuous increase in storms, floods, draught, melting of glacier and sea level rise we have seen in the last ten years. Out of the 20 warmest years on record, 19 have occurred since 1980.

2.3 Based on these conclusions, most scientists agree that the average temperature of the Earth will continue to rise over the next 100 years. The actual projected temperature variations depend on the scientific model used to determine changes in GHG emissions. Despite the differences, most of the projections find that overall warming will raise sea levels and increase the intensity of extreme weather events.

3. Effects of Global Warming in the Agriculture Sector of Bangladesh

3.1 Global warming may be partially responsible for recent trends in extreme natural disasters. Based on future projections of climate change, the IPCC report makes a number of predictions. It is predicted that over most land areas, the frequency of warm spells/heat waves will very likely increase. It is likely that:

3.1.1 Increased areas will be affected by draught.

3.1.2 There will be increased intense tropical cyclone activity.

3.1.3 There will be increased incidences of extreme high sea level.

3.2 Bangladesh is most vulnerable to several natural disasters and every year natural calamities upset people's lives in some part of the country. UNDP has identified Bangladesh to be the most vulnerable country in the world to tropical cyclones and the sixth most vulnerable country to floods. Table showing most vulnerable countries to floods or cyclones is given at Annex A. The major disasters concerned here are the occurrences of flood, cyclone and storm surge, flash flood, drought, tornado, riverbank erosion, and landslide.

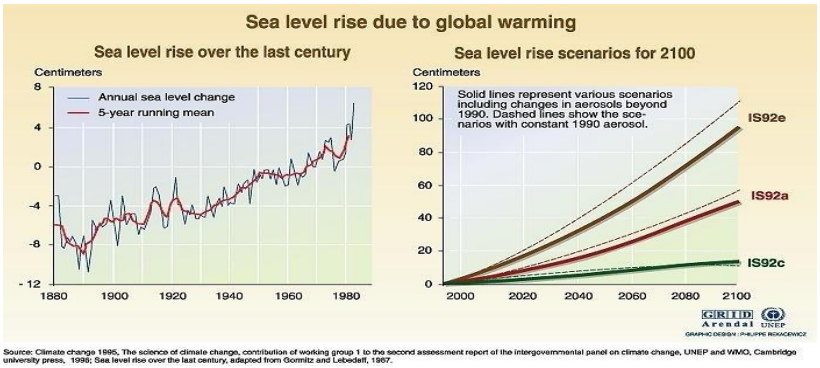
3.3 **Increased Flood**. Most of Bangladesh lies in the delta of three of the largest rivers in the world – the Brahmaputra, the Ganges and the Meghna. The topography of the country is mostly low and flat. Two-thirds of the country is less than 5 meters above sea level and is susceptible to river and rainwater flooding and, in lower lying coastal areas, to tidal flooding during storms. Physiography of Bangladesh showing major floodplains is given at Annex B. In an 'average' year, approximately one quarter of the country is inundated. It is predicted that climate change will result in increasingly frequent and severe floods in the central part of the country; flash floods in the north-eastern and eastern parts of Bangladesh, adjacent to Meghalaya and Tripura.

3.4 **Change in Frequency and Intensity of Cyclones**. Bangladesh currently has extreme vulnerability to cyclones due to its unique geographic location. Cyclones originate in the deep Indian Ocean and track through the Bay of Bengal where the shallow waters contribute to huge tidal surges when cyclones make landfall. Storm surges contribute to flooding and loss of life and livelihoods far beyond the coast. The intense precipitation that usually accompanies the cyclone only adds to the damage through inland and riverine flooding. With the global warming frequency and intensity of cyclone will increase.

3.5 **Precipitation.** In winter, low-flow conditions in the rivers are often observed. Water demand will be more and farmers usually react to ensure irrigation by exploiting groundwater resources. Low-flow conditions cause economic hardship to the poor farmers. Precipitation will be less, and thus recharge of ground water will suffer. Due to fall in rainfall, surface water flow will be less and will be greater backward thrust of sea water towards inland. For this reason most

of the suitable agricultural land will be turned unfertile or less productive. In summer, increasing rainfall will result in greater surface water flow and thus flooding. Due to flooding, agricultural production loss will be more pronounced. Flood of 1998 resulted a loss of over 50% of the standing crops. With the global warming, summer rainfall will be increased by 11% and decreasing winter rainfall by 3% by the year 2030.

3.6 **Sea Level Rise (SLR)**. One of the direct and major consequences of climate change is the sea level rise. There are two mechanisms to take it place: thermal expansion of near surface ocean water and melting of snow fields, ice sheet and glaciers. The most important impacts of sea level rise are the loss of land use due to inundation. All the impacts have the negative consequences on agriculture and economy of the country. Most of the grazing lands in the coastal belt will be lost. For this reason loss of production in crop, fishery and livestock in the coastal zone will create pressure for more intensive cultivation and will be an adverse effect on the soil fertility and agricultural land productivity of the country.



Source: Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996; Sea level rise over the last century, adapted from Gornitz and Lebedeff, 1987.

Figure 1: Global Sea Level Rise over the Last Century and Scenario for 2100

3.7 **Temperature Rise.** Temperature rise will induce higher evapo-transpiration. As such, more water will be needed for the plants and on the other hand there will be scarcity of surface and ground water. Performance of irrigation equipment will be less. So, crop land will suffer from water stress. There will be loss in crop yield as well as crop and forestry spices. Fish production will suffer due to temperature rise.

3.8 **Temparature Potential Effect on Growing Period** . Duration of crop growth cycles are above all, related to temperature. An increase in temperature will speed up development. In the case of an annual crop, the duration between sowing and harvesting will shorten. The shortening

of such a cycle could have an adverse effect on productivity because senescence would occur sooner.

3.9 **Erosion and F ertility**. With global warming, soil degradation is more likely to occur, and soil fertility would probably be affected. However, because the ratio of carbon to nitrogen is a constant, a doubling of carbon is likely to imply a higher storage of nitrogen in soils as nitrates, thus providing higher fertilizing elements for plants, providing better yields. The average needs for nitrogen could decrease, and give the opportunity of changing often costly fertilization strategies. Due to the extremes of climate that would result, the increase in precipitations would probably result in greater risks of erosion, whilst at the same time providing soil with better hydration, according to the intensity of the rain.

3.10 **Potential Effects on Pests, Disease s**. Global warming would cause an increase in rainfall in some areas, which would lead to an increase of atmospheric humidity and the duration of the wet seasons. Combined with higher temperatures, these could favor the development of fungal diseases. Similarly, because of higher temperatures and humidity, there could be an increased pressure from insects and disease vectors.

3.11 **Increased Glacier Melt**. Change in the climate will cause the melting of ice which will result an increase of intensity and severity of monsoon in the south – west of the country. This will bring about catastrophe ravages like erosion of topsoil and siltration of rivers and landslides in hill areas caused flash flood and overflowing of the agricultural land. The growth of the plant is hindered by the flood due to excessive moisture at the root zones, resulting in an overall decline in production of the crop. Transplanted aman paddy does not grow well under submerged conditions of over 90 cm water depth.

3.12 **Salinity.** A sea level rise causes salt water intrusion into rivers and estuaries resulting infiltration of salt water into coastal aquifers. In Bangladesh underground water is used for domestic use and irrigation purposes. Sea level rise also causes to increase in salinity in underground water that has resultant impact on human health and agricultural productivity. The

southwestern part of the country already has a suffering of salinazation due to reduction of the flow of Ganges. Pressure of seawater towards inland will induce greater and extended salinity towards inland of the country. Forestry, fisheries and crop will suffer much including the mangrove forest in Sundarbans. As a result, a large area in the coastal districts is virtually unsuitable for a number of crops, while the production of other crops will yield less due to salt injury.

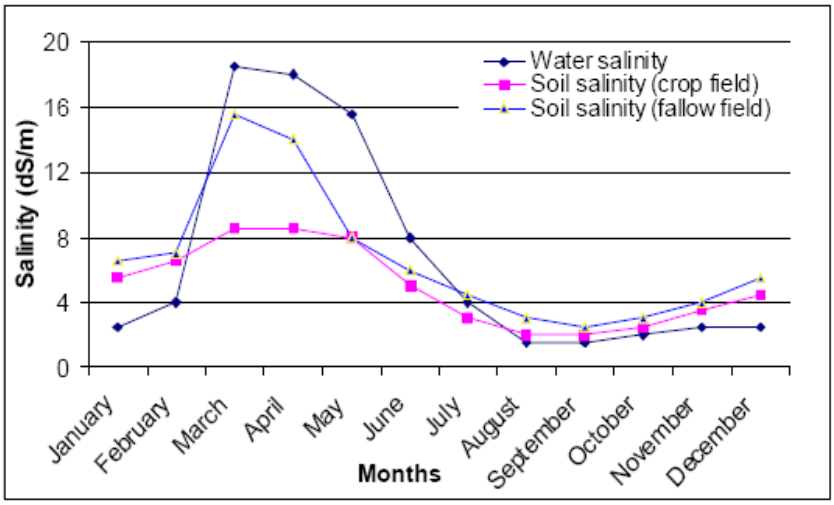


Figure 2: The Soil and Water Salinity Dynamics at Benarpota Farm, Satkhira, During 2001-04

3.13 **Drought.** Agricultural drought refers to a condition when the moisture availability at the root zone is less than adequate. This is how; aman cultivation suffers from periodic drought conditions during Kharif II season. Similar conditions are often observed in early pre-Kharif period; affecting Boro and in Rabi season, wheat cultivation in the northeast and central-east regions of the country. Dry season drought affects the production of wheat, potato, mustard and Aus Paddy.

3.14 **Sedimentation.** The influence of sedimentation on the total agricultural areas expected to be disturbed by the climate change. Average accretion in Bangladesh is close to one thousand hectares per year, which is, need to develop for production purpose about 15 years. At the same time land lost caused by erosion of valuable land with agricultural products. There is an expert opinion about sedimentation that deposition of sedimentation's range is 0.5-1.8 billion ton

per year. The cost of the loss for the economy needs to be estimated. The monsoon river currents also some times erode river banks, and wash away fertile land from the adjoining plots.

3.15 **Deposition of Sandy Over-wash on Agricultural Land.** Deposition of sandy materials on agricultural land is frequent in the lower part of the piedmont areas of greater Mymensingh and valleys of Sylhet and Chittagong Hill Tracts. This is the net result of deforestation in the hills of the upper catchment areas. During the monsoon season, when heavy rainfall occurs in the upper hill areas, it causes flash floods in the lower plains. With the runoff, the water carries sandy sediments that spread over agricultural lands.

3.16 As a consequent of global warming, the intensity of natural disaster has increased in the recent decades. IPCC report predicted that with the global warming increased areas will be draught affected, intensity and magnitude of natural calamities will take more devastating shape, sea level will rise inundating huge coastal land. Bangladesh is located in a disaster prone region. UNDP has identified it to be the most vulnerable country in the world to tropical cyclones and the sixth most vulnerable country to floods. The major disasters concerned here are the occurrences of flood, cyclone and storm surge, flash flood, drought, tornado, riverbank erosion, and landslide. It is predicted that climate change will result in increasingly frequent and severe flood in the central part, flash flood in the north-eastern and eastern part of Bangladesh.

4. Suggested Adaptation Options for the Agriculture Sector of Bangladesh

4.1 By the end of 21st century food grain demand of Bangladesh would be double due to the population growth. Climate variability makes crop agriculture in Bangladesh highly vulnerable. Although the agricultural vulnerability will be very high and adaptation needs are paramount, very little efforts have so far been taken in the agriculture sector. Though Bangladesh Government has prepared National Adaptation Programme of Action (NAPA) as a response to the decision of the Seventh Session of the Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC), but not yet materialized. To ensure the food security of our 156 million people, immediate measures should be adopted in our agriculture sector.

4.2 **Development of Climate Resilient Cropping System.** It is predicted that climate change will result in increasingly frequent and severe floods in the central part of the country; flash floods in the north-eastern and eastern parts of Bangladesh, adjacent to Meghalaya and Tripura; and droughts and low and erratic rainfall in the north-western and western Bangladesh. Salinity is likely to increase in the south-western and south central parts of the country; rainfall is likely to become more erratic in the Chittagong Hills; and the coastal islands will face increased salinity and cyclone weather.

4.3 Research and development should be undertaken by BRRI, BARI and other national research institutes and their regional research stations in partnership with selected NGOs. Ministry of Agriculture should ensure the following:

4.3.1 Identify likely changes in agro-economic zones and probable climatic parameters.

4.3.2 Develop climate resilient cropping patterns suited to different regions of the country.

4.3.3 Field level trials of climate resilient cropping patterns and associated water management systems.

4.3.4 Develop seed supply and extension mechanisms.

4.4 **Modify the Threat to Crop Production**. This appears to be the mostly practiced option in Bangladesh. Vulnerability analysis may provide important lessons concerning the nature and extent of the threats to crop production under a given climate regime. Development of drought and/or salinity tolerant varieties, switching to alternative cropping patterns with respect to altered agro-ecological zones etc could modify the threat to a significant extent.

4.5 **Change of Land Use**. In case it becomes extremely risky to continue agricultural activities under an altered climate scenario, an alternative land use might be considered as the next available option. If the suitability of Aus5 paddy in pre-Kharif months (March-June) appears to be too low, farmers should alter the land use and in its place may grow other suitable

crops. Such alterations should ideally lead to acceptable economic returns, optimizing social goods and services.

4.6 **Drought Tolerant Crops/Vegetable**. Traditionally the main crop was aman, which was planted in the monsoon and harvested in the post-monsoon period. It currently accounts for over 40% of rice production. Since aman can suffer from draught stress, farmers developed indigenous methods of supplementary irrigation. Since independence, major irrigation projects were developed to provide supplementary irrigation in the worse affected parts of the country.

4.7. **Promoting Adaptation to Coastal Crop Agriculture to Combat Salinization**.

Significant part of the coastal area is facing salinity problems due to tidal surge flooding. It is anticipated that salinization and tidal surges would be distinct under warmer climate particularly due to sea level rise. Affected community needs food, fodder, fuel and feed earlier than the next rice crop (Boro rice, wheat, potato, etc). To adapt with this situation following methods may be adopted:

4.7.1 Maize may be cultivated before next Boro rice crop for tidal surge flood affected community after loss of Aman rice crop.

4.7.2 Produce selected vegetables and fruits on raised bed to meet day-to-day demands of the affected households.

4.7.3 Motivate the affected community to adapt the above technologies to combat with coastal inundation due to tidal surge after loss of crops.

4.8 **Cultivation of Short Growing Period Crop**. One of the main impacts of global warming will be the increased frequency and intensity of natural calamities. The floods in 1995, 1998, 2004 and 2007 either exceeded the previous highest water level or rose very close to such levels. High floods are likely to be more common with the climate change. Considering this fact, farmer should cultivate such variety of crops which can effectively avoid the probable natural calamity prone season.

4.9 **Storage of Rain Water.** Large area of Bangladesh is draught affected. The main crop aman is highly affected by draught. With the effect of global warming, draught prone area

will be increased. At present the irrigation is dependent on underground water but day by day underwater level is going down.

4.10 **Floating Garden/ Raising of Seeds Bed**. North east and central region of the country are prone to flood and will become more vulnerable under anticipated future climate change. Crop field and homesteads are inundated by flood, crops and seedlings are damaged/lost, water recession is delayed, and water logging is prolonged. In this scenario, community needs immediate and/or early harvest of vegetables/crops before a regular vegetable/crop.

4.11 **Adaptive and Diversified Fish Culture Practices.** Flood is an annual phenomenon in Bangladesh. However, recent experiences show that both frequency and intensity of flood has increased and every year hundreds and thousands of culture ponds float due to floods resulting in the loss of fish and the poor fish farmers incur financial losses. Therefore, adaptation to the changing hydrodynamic phenomena should be developed and practiced in order to avoid or reduce the devastating effect of floods. The projected increase in rainfall will further aggravate the situation. Presently, culture fisheries contribute more than 50% to the total fish production from inland waters in the country and are mainly represented by pond culture of fish.

4.12. **Crop Insurance Strategy**. In the recent years, natural disasters have increased both in frequency and magnitude. These are the consequences of the global warming. Gradually these will take more devastating shape and magnitude. Agriculture sector is the most vulnerable to the extreme weather events. So farmers are hit hardest. In our country, structural measures for management of disaster risk and its consequences of them were found to be less effective.

4.13 **Concept of Aquaculture**. Sea level rise will mainly inundate the coastal belt. People of this area will suffer severely due to loss of adable land. In this region water might be utilized for cultivation of crops, may be on the floating platforms. Aqua fisheries culture may be adapted in this region to compensate the economic loss which ultimately will contribute to our national calories requirement.

4.14 **Crop Diversification and Food Habit Change Techniques**. Diversification contributes to nutrition, poverty elevation, employment generation and sustainable natural

resources management. In the face of the threat from climatic change and sea level rise to ensure the food security diversification of crop is urgent. Land elevation affects the annual extent and duration of flooding. About 71% of the adable land is in the high and medium land where shallow flooding occurs. In these areas two or three crops are grown. The remaining 29% area is in the low land, where one or two crops are produced. 63% of the rice production is monsoon related.

4.15 Establishment of a Centre for Research, Knowledge Management and Training on Climate Change. Although Bangladesh has been in the forefront of awareness raising on adaptation and on-the-ground adaptation research, the knowledge and information generated remains scattered. A comprehensive move towards adaptation and mitigation supported by technology transfer and financial flows (as envisaged in the BCCSAP) requires an up-graded system of knowledge creation, dissemination and training. Bangladesh has already suggested that an International Adaptation Research and Training Centre should be established in the country as an international public facility for all to draw upon.

4.16 **Repair and Maintenance of Existing Flood Embankment**. Earthen embankments have been constructed by the Bangladesh Water Development Board (BWDB), along most major and medium-sized rivers in the country and also some minor rivers. In many places the embankments are cut by local people to drain water from the land into the rivers. Although these gaps are filled in again, these points remain susceptible to breaches. Ministry of Water Resources and its agencies should take the following steps:

4.16.1 Assess the condition of all existing flood embankments and prepare GIS maps.

4.16.2 Immediate repair and rehabilitation of existing embankments and appurtenant structures taking future forecast flood levels into account.

4.17. Repair and Maintenance of Existing Coastal Polders. The coastal belt of Bangladesh faces severe cyclonic weather and storm surges at regular intervals. It is predicted that such natural calamities will hit the coastal belt with increasing frequency and intensity. For over 25 years, much of the coastline of Bangladesh has been protected by over 7,000 kms of

earthen embankments in the form of polders. Ministry of Water Resources and its agencies should take the following steps:

4.17.1 Survey of the condition of coastal polders and preparation of GIS maps with present coverage of areas protected by these polders.

4.17.2 Plan, design and cost immediate repairs of existing dykes, based on future projected sea level rises and storm surges.

4.17.3. Reconstruction and repair of polders/embankments to design height and section.

5 Coastal Afforestation with Community Participation.

5.1 The location of Bangladesh has made it prone to natural calamities like flood, draught, storms, cyclones and tidal surges. Frequency and occurrence of storm surges is projected to increase as a consequence of climate change in the coastal areas of Bangladesh. The presence of forest plays a vital role in stabilizing shorelines and providing protection against cyclones and other extreme events. The coastal areas of Bangladesh especially the Meghna estuary are exposed to cyclone and tidal surges.

6. Adaptation Against Sea Level Rise (SLR) and its Impacts.

6.1 One of the main threats of climate change is sea level rise (SLR) caused by the thermal expansion of sea water and the melting of snow and ice. These factors may be compounded locally by tectonic activities. The 4 IPCC Report predicts that, over the next 100 years, sea levels will rise by up to 79 cms along the Bangladesh coast though some scientists consider this a conservative estimate. The sea level rise threatens the low-lying coastal belt and small islands.

7. Conclusions

7.1 Global warming is the increase in the average temperature of the Earth's near-surface air and oceans and its projected continuation. The IPCC concludes that most of the observed temperature increase was caused by increasing concentrations of GHG resulting from human activity such as fossil fuel burning and deforestation. GHG maintain sustainable temperature in

the atmosphere for the living being. With excessive GHG buildup, the earth's atmosphere warms to unnatural temperatures.

7.2 Bangladesh is critically vulnerable to climate induced hazards. It is probably the only country in the world with most of its territory lying on the deltaic flood-plain of three major rivers and their numerous tributaries. Due to the geographic location it is highly vulnerable to the effects of global warming. The country is already suffering out of climate catastrophes. Bangladesh is an agricultural country. Agriculture plays key role to the GDP. The global climate change and frequent change in the variability of the climatic condition of the country have direct impacts on agriculture sector. Agriculture sector is highly vulnerable to the effects of global warming.

7.4 Bangladesh is an over populated country. The effects of global warming pose a threat to our food security. To ensure the food security of our 156 million people immediate adaptive measure should be implemented in the agriculture sector of Bangladesh. Considering this fact Bangladesh Government has prepared 'The National Adaptation Programme of Action (NAPA), in 2005. But this programme is not yet implemented. To cope up with the effects of global warming, Bangladesh Government should adapt crop production, research and development, and infrastructural development strategy. Crop production strategy may include, cultivation of climate resilient crop, implementation of saline tolerant cropping system in the coastal areas, cultivation of crops with short growing period, crop diversification and food habit change techniques.

8. Recommendations

8.1 Bangladesh government should implement National Adaptation Programme (NAPA) immediately.

8.2 Extensive research to be carried out to develop climate resilient cropping system. Research and development should be undertaken by BRRI, BARI and other national research institutions and their regional research station in partnership with selected NGOs.

8.2 Bangladesh Water Development Board in consultation with Ministry of Agriculture should construct community based water reservoirs.

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