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The Response of Agriculture in Bangladesh to Climate Change: A Review

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Abstract
Human activities are expected to result in significant temperature increases, which will primarily affect low-lying countries, particularly Bangladesh because of its agriculturally based economy. Bangladesh is a frequent victim of the pattern of climate change, which includes changing temperatures, rainfall patterns, the production of carbon dioxide (CO2), the destruction of the ozone layer (O3), melting ice and sea-level rise, natural calamities, and so on. Moreover, its geographical situation, population density, extreme poverty, and dependency on agriculture are also responsible for prolonging the stresses and slowing down the progress of agriculture cultivation, and achieving the desired food security by 2030, which was declared by the United Nations in September 2015. This is why I argue for a consideration of agricultural harm from the position of anthropogenic climate change. First and foremost, such a position allows for an understanding of Bangladeshi agriculture and its climate change. Secondly, this focus draws attention the climate change and its impact that affects the process of agriculture progression. Finally, a frontier concentration on the climate change adaptation strategies by the government.
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Introduction:

Climate change is frequently used to refer to anthropogenic climate change by human activities to raise global warming. Human action causes anthropogenic climate change, as opposed to changes in climate that may have occurred as a result of natural processes on Earth. Climate change has become identical to anthropogenic global heating in this logic. The World Meteorological Organization (WMO) adopted the term climatic change in 1966 to embrace all forms of climatic fluctuation on time spans greater than ten years, independent of the source. As it became obvious that human actions had the capacity to severely modify the climate, the term climate change became climatic change in the 1970s to emphasize anthropogenic causes (Mike. H, 2016). The Intergovernmental Panel on Climate Change (IPCC) and the UN Framework Convention on Climate Change (UNFCCC) both have included climate change in their names**.** According to IPCC (2012), "A change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal process or external forcing, or persistent anthropogenic changes in the composition of the atmosphere or in land use".

However, this anthropogenic climate change has a profound impact on Bangladeshi agriculture. For the rural population of Bangladesh, agriculture is the primary source of food and nourishment. Aside from the effects of climate change, agriculture plays an important role in guaranteeing food security for a growing population due to shrinking cultivable land. Agriculture is extremely important to Bangladesh's economy. Agricultural operations are carried out by almost 87 percent of Bangladesh's 164 million inhabitants, either directly or indirectly. In order to increase food production, food security and employment agriculture play a dynamic role. According to the estimated report of the Bangladesh Bureau of Statistics(BBS), agriculture contributed 13.47% to the GDP in the Fiscal year 2020-21(GOB,2021). In 2021 the total food grain production was 466.35 Lakh MT. Among them Aus. contributes 34.52 lakh MT, Aman added 156.11 lakh MT, while Boro avail 205.81 lakh MT and wheat 12.99 lakh MT roughly(GOB,2021). Always BORO is a bigger contributor to food production. However, anthropogenic climatic factors have a profound effect on rice production (Huq et al., 1996; Karim et al, 1996; Yu et al., 2010). Climate change is expected to reduce overall rice production in Bangladesh by 7.4% per year on average from 2005 to 2050 (Yu et al., 2010).

Seasonal features and climate variables such as temperature, rainfall, humidity, and day-length influence Bangladesh's agricultural production. Even though, the agricultural sector is also affected by different climatic disasters like cyclones, Strome, floods, drought, etc. Though the country is tirelessly trying to move its economy-based agriculture towards industrialization, nevertheless two-thirds of the total population is directly or indirectly dependent on agriculture. As a consequence, the changing climate has a widespread impact on Bangladeshi agriculture. Moreover, some indicators of changing climate like temperature rising, and salinity intrusion, are also accountable for deteriorating the agriculture sector of Bangladesh. Already Bangladesh has started to

experience the impact of high temperature and rainfall changes on crop production in the various region of the country. Heat stress, brought on by a combination of high temperatures, poor rainfall, and low humidity, destroyed hundreds of hectares of rice crops in Bangladesh which could jeopardize the food supply. According to the government's Bangladesh Rice Research Institute (BARRI), temperatures surpassed 36 degrees Celsius (97 degrees Fahrenheit) for two days in early April, 2021 affecting more than 36 districts. Moreover, the data showed that due to these two days' high temperatures more than 300000 farmers faced damages of a projected 3.3 billion taka while more than 68.000 hectares of rice were destroyed. The agriculture sector of Bangladesh is currently under a major threat, and this result is a serious danger to the country's economy.

2. Literature Review:

Climate change will have a considerable impact on crop productivity and efficiency, as well as agricultural outcomes (IPCC, 2014; Arshad et al., 2018). According to Rosenzweig *et al*, (2001), Extreme weather events, coastal soil salinity, and pest and disease outbreaks may all have negative consequences for the agriculture sector. Climate change is predicted to reduce crop yields by 17% for a variety of crops in various places throughout the world if CO2 fertilization is not taken into account (Nelson *et al*, 2014). Among the worst sufferers, Bangladesh was identified as one of the victims of anthropogenic climate change due to its geographical location, poor income, and dependent on environmentally sensitive sectors, especially agriculture. Agrawala *et al* (2003), studied that Bangladesh is one of the world's most vulnerable countries to natural disasters and climate change. The country is subjected to severe floods on a frequent basis as a result of its natural geographic design. The floods in 1974, 1984, 1987, 1988, and 1991 were particularly devastating, claiming many lives and causing significant damage to agricultural productivity (Agrawala *et al,* 2003). The country's location between the funnel-shaped Bay of Bengal in the south and the world's largest mountain range, the Himalayas, in the north has made it a hotspot for monsoon rains, cyclones, floods, storm surges, and other natural disasters.

Moreover, Bangladesh is becoming more vulnerable to dangerous climatic events such as drought, cyclones, rainfall, extreme weather, etc. Among the various types of natural disasters, about 80% of the total area were affected by floods/ Flash flood, the southern and south-eastern part of the country are victim part due to cyclone, and the Northwestern and northern part of the country is the extreme subject of erratic temperature, and rest of the coastal zone along with the Bay of Bengal is anguish the salinity problem (Sikder, R. and Xiaoying, J. 2014). The study of Bhowmic. J *et al* (2021), projected the economic loss and damage to individual families — in the housing, agricultural, and health sectors by the flood of 2020 ranging from US$ 568 to US$ 1054 per home per event, based on the most recent catastrophic climate occurrences. Because several risks were producing somewhat longer impacts on the coast, losses and damages were higher on the south-western coast than in the two flood-prone zones in the north and north-east. Most importantly, among the different economic sectors of Bangladesh, typically the agricultural sector is being jeopardized by these major climate-related issues. Islam et al. (2011), viewed that, in the future, a significant amount of yield drop in agriculture areas is projected by extreme climate hazards. Besides that, due to climatic variables, the production of crop yield is fluctuating for several years (Hazell, 1984; Anderson & Hazell, 1987). According to the World Bank report of 2012, erratic climate change reduced 3.1% of Bangladeshi agricultural GDP every year and resulted in a total loss of 36 billion dollars in value-added from 2005 to 2050.

The true threat posed by climate change is the rate at which it occurs. For an instant, the average global temperature has risen from 0.6 to 1.2 degrees Farenhight over the last 130 years (Change, C.2019). Likewise, the evidence suggests that the pace of future global temperature will maybe increase at a rate of 0.4 F (0.2 C) every single decade. Nevertheless, past changes happened at considerably slower rates and were consequently spread out over longer periods of time. As a consequence, most species had ample time to adjust to the new climate due to the sluggish rate of change. On the other hand, the current and expected rates of temperature rise may be damaging to ecosystems. This is due to the fact that these rates of temperature change are significantly faster than in the past. Because of shortness time many plant, animal, and microbe species could not adjust to the new changing environment. As a result, there is a possibility of extinction of these species. Furthermore, it is scientifically proven that greenhouse gases are responsible for warming the earth (IPCC 2007a). Understanding the effects of global warming especially the impacts of warming on agriculture is the most essential topic ever. The association between agriculture and climate change is intricate and diverse (Bosello. F and Zhang. J, 2005).

Taking these factors into consideration, it is important to discuss the determinants of climate change and its impacts on Bangladesh's agriculture. This research addresses the gap by examining how an erratic environment affects the agricultural sector and how Bangladesh can cope with this hazard-related environment.

3. Climate Changes and Its Impact on Agriculture

Climate change will have a negative influence on agricultural production in Bangladesh. While flooding has had a favorable impact on production in the past, with perennial floods delivering silt and nutrients to the soils, prolonged floods have had a negative impact on crop yields; in two major floods, 1974 and 1987, output

shortages were roughly 0.8 and 1.0 Mt, respectively (Rahman, A. & M. Alam, 2003). Floods caused Bangladesh to lose around 0.5 million tonnes of rice per year on average between 1962 and 1988, accounting for nearly 30% of the country's average annual food grain imports (Paul &Rashid,1993).

Bangladesh is predominantly vulnerable to the effects of climate change, owing to its low-lying and flat terrain, which is prone to riverine floods and at risk of sea-level upsurge. The country's deltaic plain is formed by the coming together of three big rivers: 'the Ganges, the Brahmaputra, and the Meghna'. The country's principal physiographic features are its vast floodplains. Submersion of crops can occur as a result of both riverine flooding and sea-level rise; sea water, in particular, can cause salinization, resulting in the eternal damage of currently viable agricultural land.

Bangladesh is experiencing vigorously the following impact of anthropogenic climate change. During the summertime, it becomes severe hot, erratic monsoons period, imbalanced rainfall sometimes heavy rainfall causes waterlogged while a shortage of rainfall causes drought. Sometimes crop production is being hampered by drought while high temperatures and extreme cold also are responsible for annihilating the agriculture sector as well. Bangladesh as a developing country has to bear the drastic activities of the developed country. Now it is globally recognized the vulnerable position of Bangladesh to climate change. In the 'Global Climate Risk Index' 2021, which is run from 1998, the country was also ranked the seventh position among the most climatic affected countries. Approximately 200 environmental-related disasters have struck the country over the past 30 years, including droughts, severe temperatures, overflows, and storms. Thousands of people have been massacred, houses and livelihoods have been demolished, and almost $16 billion has been lost as a result of these devastations (Oxfam International, 2011).

Increased temperatures, fluctuating rainfall, and proliferation of environmental extreme events such as 'floods, droughts, cyclones, sea-level rise, salinity, and soil erosion are all signs of climate change (Asaduzzamanet al., 2010; Yu et al., 2010; Hossain and Deb, 2011).

These dangerous environmental actions occur almost every year in Bangladesh, and often more than once, wreaking havoc on the crop agriculture sector, notably rice production (MoEF, 2005; Yamin et al., 2005). Bangladesh's climate is characterized by hot temperatures, erratic rainfall, excessive humidity, and periodic instabilities.

3.1 Impact of temperature on agriculture

The assorted climatic phenomena like temperature rising have a significant effect on the damage of food grain in Bangladesh. Over the last four decades, Bangladesh's average daily temperature has risen by 0.103°C(Shahid,2010). According to predictions, Bangladesh's temperature will rise by '1°C by 2030, 1.4°C by 2050, and 2.4°C by 2100' as a result of global warming (IPCC, 2007). The high temperature causes a negative effect on Boro rice production on an average decrease of around 2.6 to 13.5% for growing at 20C and 0.11 to 28.7% for 40C (Basak, J. *et al.*, 2014). Bsak (2009) and Basak et. al (2010) showed that the pace of Boro rice production will have fallen to a significant decrease of over 20% to 50% in place of the year 2050 and 2070 consequently.

3.2 Impact of Drought on agriculture

In the area where the evaporation rate is higher than rainfall, drought occurs there. Drought is defined as a disturbance of a crop's biological movement caused by a dearth of water at any phase of the crop's life rotation. Drought, which is one of the most prevalent natural calamities in agriculture, can occur if there is no rain for 25 days between April and November. It can damage the It is estimated that drought causes about 1.2-2.32 million hectares of land each year in Bangladesh. It affects the development period of the plant and even can harm the plant also. Aman paddy is grown on 60 percent of the country's 83 million hectares of drought-affected cultivable land. Indeed, drought affects all kinds of crops, including rice, kinds of wheat, potato, etc.

3.3 Impact of floods on agriculture

Flood is a common phenomenon that affects Bangladesh severally even every year. According to the GoB,2010 report, each year about 1400 kilometers and 4000sq km face flash floods in the southeastern and northeastern parts of the country. It is urgent to mention that flash floods are more harmful than general floods. The natural flood comes slowly and can be able to measure in the pace and extended time whereas a flash flood comes suddenly and lashed away at the cops and damages the land as well.

3.4 Impact of sea-level rise

According to the report of AIS (2010), sea-level rise along the Cox Bazar coast has been seen at a rate of 7.8mm per year. Around 3000 km2 of land under Bhola Island has been submerged in the Bay of Bengal over the last four decades. After studying multiple research papers, it is clear that by 2100, the sea level could rise one meter, submerging 18.3 percent of Bangladesh's total land area.

3.5 Impact of extreme weather

Changing climate has a profound impact on Bangladesh. During the cold season, it is remaining hot rather than cold. Furthermore, the temperature is too high in the summer season. As a result, in the warmer season, the insect gets a more advantageous situation to complete its reproductive cycle (Bale *et al.* 2002). The pests come back profoundly from the cold area to the warmer winter season resulting in a larger and earlier invasion the following crop season. Plant diseases may face a similar predicament, resulting in a rise in pesticide consumption (Salinari et al. 2006). Changes in climate adaptability will result in the invasion of weeds, pests, and diseases that have evolved to warmer climates.

4. Response of Bangladesh to climate change:

Though Bangladesh is very much blessed with bio-diversity, she has to face crucial challenges for her environmental degradation. The government adopted a number of development policies to tackle environmental threats**.** Emphasizing the issue of climate change Bangladesh government took initiatives mainly on two approaches. One is to participate actively in international negotiations to achieve the goals set out in the 'Bali Action Plan (2007)', while the other is planning for required domestic action at home. The government adopted the 'National Adaptation Programs of Action' (NAPA) in 2005; 15 Significance projects were recognized, arranged primary National Communication and prepare the Second National Communication, making a draft of the 'Poverty Reduction Strategy Paper' (PRSP), established 'Bangladesh Climate Change Strategy and Action Plan' (BCCSAP 2009), and build national 'Water Management Plan', etc. The BCCSAP was intended as a "living document" that implemented the adapted and mitigated plans to improve understanding of the issue. It tried to implement its listed 44 separate applications and 145 actions. The plan was a ten-year (2009-2018) program to mitigate the risk challenges of environmental degradation. However, during the first five years (2009-2013) the was divided into six thematic pillars: 1) Food security, and health safety; 2) Disaster Managing; 3) Structure; 4) Exploration and information management; 5) Alleviation and low-carbon growth, and 6) constructing a formal strengthened structure. Furthermore, with the government's self-reserve, the 'Bangladesh Climate Change Trust Fund' (BCCTF) was formulated in 2010 to combat the impact of changing climate. All initiatives funded by the BCCTF are based on the BCCSAP 2009's subject areas. BCCTF got a total grant of Tk. 3,900 crore and a total of 789 projects were approved under BCCTF from FY 2009-10 to FY 2020-21. Moreover, the Bangladesh government established 'The National Environmental Policy 2018' and started in 2019 with the goal of enhancing the country's overall environmental management. 'The National Adaptation Program of Actions'(NAPA) is a set of guidelines for adapting to the effects of climate change. Climate change is one of the three key areas in the 2011 revision of the 'National Agriculture Policy. Several topics relating to rising temperatures and changing precipitation in agriculture need to be addressed further. 'The Agriculture Extension Policy' of 1996 focuses on long-term agricultural sustainability; Similarly, the 2002 'Integrated Pest Management Policy' provides information on climate change and catastrophe risk reduction. However, 'The Ministry of Environment, Forest, and climate change has developed various dynamic and conscious programs for controlling the pollution while 'The Ministry of Disaster Management and Relief" is running to tackle the natural calamities.

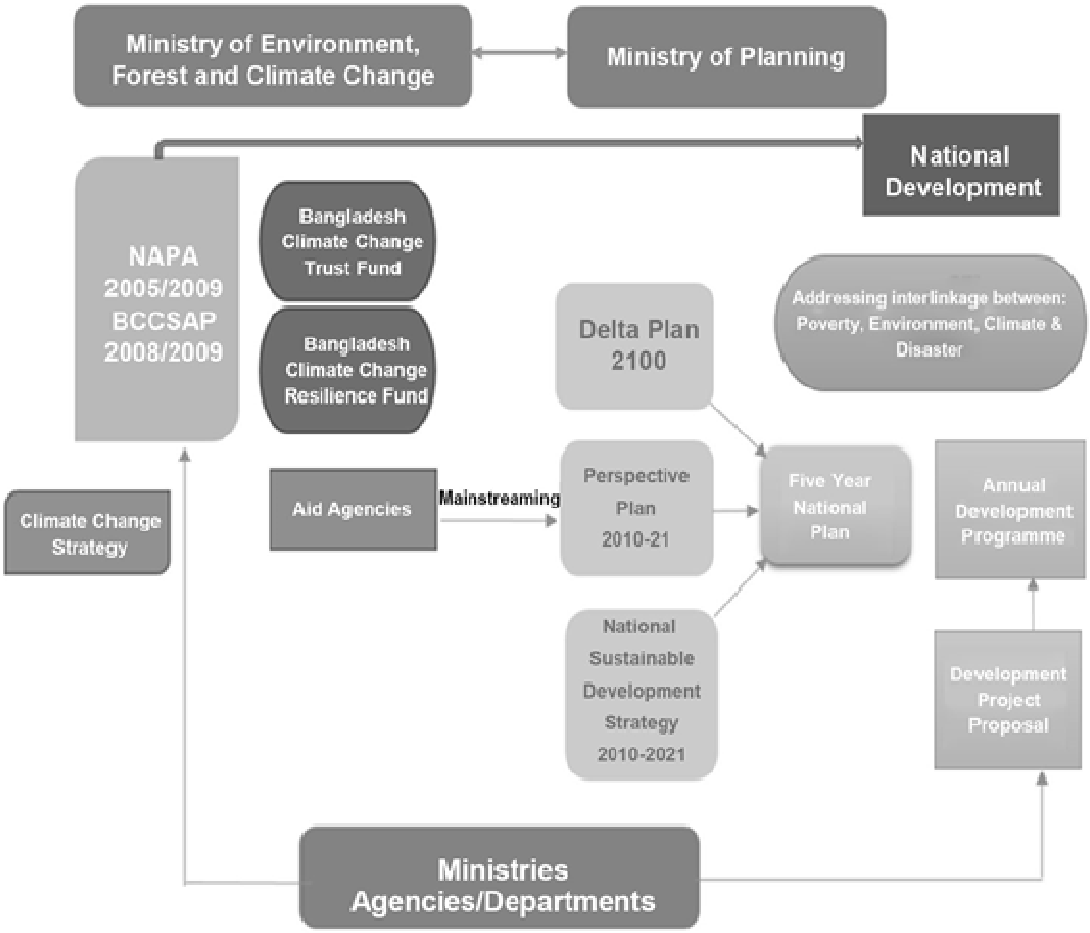

Figure 1. source (Ayers et al., 2014).

Conclusion

'Food, water, life, property, settlement, livelihoods', and other aspects of Bangladesh's economy are all threatened by climate change. Food and health security, as well as other challenges, are harmed as a result of environmental degradation and deterioration of land resources. Increased 'cyclones, storm surges, floods, and river-bank erosion' destroy and ruin people's properties, including land, houses, animals, and other livelihood assets and necessities of life. The damage and costs caused by many calamities are multiplied several times. Bangladesh has already been hit by climate-related extreme weather occurrences in the last decade. Since 2013, cyclonic storms with maximum wind speeds of 100 to 260 kilometers per hour have slammed the Bangladesh coast, including 'Mohashen/Viyaru (May 2013), Roanu (May 2016), Mora (May 2017), Fani (May 2019), Bulbul (Nov 2019), and Amphan (May 2020)'. In 2017, Bangladesh was hit by severe flooding that flooded 42 percent of the country, affecting 6.1 million people (Davis, 2017). July 25, 2020, flooding affected 24 percent of the country, affecting about 3.3 million people. Previously, in 2013, 2014, 2016, and 2018 floods affected 21 percent, 28 percent, 33 percent, and 23 percent of the country, respectively (Flood Forecasting and Warning Centre, n.d.).

The purpose of this research is to evaluate the effects of climate change on agricultural cultivation in Bangladesh. The discussion reveals that the agricultural sector, as well as farmers' existing livelihood, are climate-sensitive. Crop farming is being affected by temperature, flash floods, and rainfall. The study showed that different climatic disasters affected the different zones of the country in different ways. The southern part of the country will be affected by floods, storms, and cyclones whereas the northern parts of the country will be affected mainly by drought. The paper also illustrates the strategies taken by the government and its implication. Moreover, the study discussed the government policy and plan which are the suitable strategies for the country.

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