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Climate Change and Its Impacts on Crop Production and Food Security: An Introductory Analysis

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Abstract: *Climate change is a very crucial factor all over the world. It takes places in high table and become a burning issue for the whole globe. Now-a-days it is seen that climate change makes alarms and warning for immense destruction and damage of the human life, properties, infrastructures, livestock, agricultural production, environment and earth's surface. This destruction has been happened by different types of natural disaster and atmospheric negative changes.However, this paper tried to see the impacts of climate change on food systems. Generally, there are two objectives to prepare this paper. One of these is to know the reciprocal relationship between climate change crop production and another is to explore the impact of climate change on food security. This paper is qualitative in nature and secondary data also used.Climate change increases the temperature of surface and break out theice polar and as a result sea water level gradually increases high level. High sea level grabs the land surface and wiped out all the things in the coastal areas in the same time increasing temperature is also responsible fordamages of crops and livestock in the drought prone areas of surface. In spite of hot temperature, natural calamities like flood has devastated and wiped out crops, livestock, properties, infrastructure of the local people in the drought prone areas. Moreover, climate change immensely hampers the activities of agriculture and decreases the crop production.Limited crop production limits the food security. So, it should take appropriate initiatives for mitigating climate change and increases crop production as well as ensures food security.*

Key Words: *Agriculture, Climate change, Crop production, Food security, Temperature.*

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I. Introduction

Climate change isn't just threatening the agriculture sector in Asia, it's a global problem. Farmers are struggling to adapt to changing growing seasons and rainfall levels, and need significant support to feed an expanding global population and it is assumed that demand for food is due to nearly double by 2050 (Myers, 2017). Nearly a billion people are hungry today, and with yields set to drop 20% in some areas due to climate change. It is also seen that the industry is responsible for up to 30% of global greenhouse gas emissions and as a result the weather has been changing day by day badly. Bad weather is the most vital barrier for crop production (WEFR, 2017).Weather changes render climate change rapidly and become a burning issue in the recent years. Climate change is a condition of climate in which the components of climate has been changed and natural events are happened improper times and seasons. Changing climate will have a huge effect on the crops we grow and the livestock we raise. At first blush, it may seem that warmer weather farther north will increase growing seasons and open up more cold landscapes to agriculture. But a closer look reveals climate change's impacts on weather patterns will have many seriously adverse effects that will threaten crop production around the world (Logan, 2015). Climate change is causing more natural disasters and environmental problems, which make it harder to grow food. At the same time, agriculture is a major source of greenhouse gas emissions including carbon dioxide, methane, and nitrous oxide. As the world's population grows, societies need to adapt to the inevitable impacts of climate change, by for example by adjusting the sort of crops they grow (FAO, 2017).It is assumed that there is a relationship between climate change and agriculture but most of the times climate change hampers agriculture and as a result crop production has been decreasing day by day in the last few decades all over the world especially in Bangladesh. Bangladesh is the most vulnerable disaster affected country in the world (MDRD, 2017) and most of this country's areas are affected by different types of natural and manmade disaster such as cyclone, storm, flood, drought, earthquake, tidal wave, agricultural diseases and pests, damaging winds, emergency diseases, extreme heat, landslides and debris flow, tornadoes, Tsunamis, wildfire, winter and ice storm, hazardous materials, power service disruption and blackout, nuclear power plant and nuclear blast, radiological emergencies, chemical threat and biological weapons, cyber-attacks, explosion and civil unrest. This disaster immensely damages the properties and agricultural production every year in Bangladesh. It is assumed that these disasters are occurring abruptly due to the changes of climate.

II. Objectives and Methodology

Objectives: The major objective of this study is to know the reciprocal relationships between climate change and food security systems. More specifically, this study has two objectives which are below;

- To explore the impact of climate change on crop production systems.
- To know the effect of climate change on food security.

Methodology: This paper is entirely formulated on the basis of narrative manner. In this paper qualitative approach has been used to investigate the impact of climate change on crop production and food security systems. Mainly secondary sources for instance articles, books, journals, reports, online websites regarding climate and food security systems have been used for preparing this article meaningful and comprehensive.

III. Key Variable

Climate Change: Climate change is a change in the statistical distribution of weather patterns when that change lasts for an extended period of time (i.e., decades to millions of years). Climate change may refer to a change in average weather conditions, or in the time variation of weather within the context of longer-term average conditions. Climate change is caused by factors such as biotic processes, variations in solar radiation received by Earth, plate tectonics, and volcanic eruptions. Certain human activities have been identified as primary causes of ongoing climate change, often referred to as global warming (NRC, 2010). It also refers more frequent and intense floods, droughts and storms, accounting each year for up to 90 percent of all natural disasters**.** These can quickly spiral into full-blown food and nutrition crises. In the last decade, almost half of the World Food Programme (WFP)'s emergency and recovery operations have been in response to climate-related disasters, at a cost of US$23 billion (WFP, 2015).

Crop Production: Crop means cultivated plants or agricultural produce, such as grain, vegetables, or fruits, considered as a group, on the other hand, production means the act or process of producing (Pipes, 1974). In general, crop production means the process of producing or cultivating the plants or agricultural products like grain, vegetable or a fruit. It depends on the availability of arable land and is affected in particular by yields, macroeconomic uncertainty, as well as consumption patterns and it also has a great incidence on agricultural commodities' prices. Crop yields are the harvested production per unit of harvested area for crop products. The actual yield that is captured on farm depends on several factors such as the crop's genetic potential, the amount of sunlight, water and nutrients absorbed by the crop, the presence of weeds and pests. This indicator is presented for wheat, maize, rice and soybean. Crop production is measured in tons per hectare, in thousand hectares and thousand tones (OECD, 2018).

Food Security: Food security refers ensuring that all people at all times have both physical and economic access to the basic food that they need (FAO, 1983). FAO (2006) identified four key components of food security. First, Food security is Food Availability which means the availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports including food aid. Second, Food access which means access by individuals to adequate resources (entitlements) for acquiring appropriate foods for a nutritious diet. Entitlements are defined as the set of all commodity bundles over which a person can establish command given the legal, political, economic and social arrangements of the community in which they live. Third, Utilization that refers utilization of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met. This brings out the importance of non-food inputs in food security. And fourth, Stability which indicate to be food secure, a population, household or individual must have access to adequate food at all times. They should not risk losing access to food as a consequence of sudden shocks such as an economic or climatic crisis or cyclical events like seasonal food insecurity. The concept of stability can therefore refer to both the availability and access dimensions of food security. But the most acceptable definition is found at World Food Summit in 1996 and that is "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life"(World Food Summit, 1996).

Moreover, FAO (2006) report show that The State of Food Security in the World is now at a stake. About 850 million people in the world are undernourished and a number that has hardly changed since the 1990-92 base period for the World Food Summit and Millennium Development Goal commitments on reducing hunger by half by 2015. Of particular concern are hunger hotspots, marked by the widespread persistence and prevalence of food insecurity, especially in protracted crises. As of May 2006, 39 countries in the world were experiencing serious food emergencies and required external assistance for dealing with critical food insecurity: 25 in Africa, 11 in Asia and Near East, 2 in Latin America and 1 in Europe. FAO, 2006 report clearly indicates the importance of human agency in inducing crises, either directly (through wars and civil strife) or through interaction with natural hazards that would otherwise have been of minor importance.

IV. Climate Change and Crop Production

Climate change and agriculture are deeply interconnected. Globally, the agricultural sector is responsible for approximately 21 percent of greenhouse gas emissions (FAO, 2016). Agriculture is also incredibly vulnerable to the effects of climate change, as it is so dependent on temperature and precipitation patterns. While some regions may benefit from improved growing conditions, the negative effects worldwide are expected to far outweigh the positives. Global agriculture and crop production will be severely affected at a time when population is rapidly expanding (Chillrud, 2016). Agricultural sector greenhouse gas emissions include carbon dioxide, methane, and nitrous oxide. Carbon dioxide emissions come primarily from land use changes, cutting down trees, converting forests or grasslands to cropland. However, the forestry and agriculture sector has the ability to sequester large amounts of carbon in trees, biomass, and soil. Methane emissions can come from flooding lands to produce rice. Using more water-efficient methods can reduce methane emissions from rice production by up to 45 percent. Livestock are another large source of methane emissions. More sustainable livestock production practices can reduce methane emissions by 14 to 41 percent. Nitrogen fertilizer is a big factor in nitrous oxide emissions. The FAO report states that 50 percent of world food production is dependent on nitrogen from fertilizer. However, the report also states that the costs of environmental damage due to nitrogen leaching are as high as the benefits we receive from using nitrogen fertilizer. Sustainable nitrogen management has the potential to substantially reduce nitrous oxide emissions. As nitrous oxide has a global warming potential 265 times that of carbon dioxide, this is a vital mitigation strategy to reduce agricultural emissions (FAO, 2016). Thus, climate change is closely related with agriculture and crop production as well as food security.

V. Result and Discussion

Climate change and crop production are much linked and closure issue. For instance, a study summarized experimental findings on wheat and rice that indicated decreased crop yielding duration of wheat as a consequence of warming and reductions in yields of rice of about $5\%°C^{-1}$ rise above 32°C (Gregory et al, 1999). These effects of temperature were considered sufficiently detrimental that they would largely offset any increase in yield as a consequence of increased atmospheric carbon dioxide concentration. Many researchers have also revealed that the earlier-anticipated benefits of carbon dioxide fertilization would be largely offset by nutrient limitations, pollutants and further interactions with climatic factors (Amthor, 2001; Fuhrer, 2003 and Long et al, 2005). Similarly, simulations of maize production in Africa and Latin America using climate data from the Had CM2 model to generate characteristic daily weather data for 2055 predicted an overall reduction of 10% (Jones and Thornton, 2003). The aggregate result of Jones and Thornton (2003), though, hides considerable variability within and between countries, and, as they point out, also ignores the fact that maize is commonly used as fodder as well as food as part of a complex production system.

The specter of climate change, together with other global environmental changes such as changes in water availability, and land cover, and altered nitrogen availability and cycling, has increased concerns about achieving crop production and food security especially for poor people (Gregory and Ingram, 2000; Parry et al, 2001, Rosegrant and Cline, 2003).There is also concern that meeting the global demand for food resulting from higher population and changing dietary preferences will further degrade the environment both through additional destruction of native vegetation and increased intensification of cropped areas (Tilman et al, 2001). While there has been considerable progress in understanding the sensitivities of crop yield to climate change, assessments of climate change effects on food production remain rather limited. Food production is the indispensable part of food security and it is concerned not only with food availability but also with access to and utilization of, food so that studies, which focus only on crop production, provide only a partial assessment of food security.

In the poor countries like Bangladesh, food systems are most vulnerable to issues related to the availability of water; excessive irrigation has led to rising water tables and soil salinization in some areas while in others water shortage has resulted in falling water tables, rapidly increasing costs of pumping and shortage of drinking water. Moreover, resource poor farmers, who have very limited options to cope with and recover from external stresses, are most vulnerable to environmental changes such as rising sea-level, and climate change and climate variability leading to increased risk of flooding (Gregory et al, 2005). Overall, this analysis suggests that food insecurity concerns cannot be effectively addressed by a single region-wide policy.However, there are some natural events caused by climate change which are responsible and also threat to the agriculture and crop production as well as food securitywhich has been discussed below.

Drought: Drought is the most effect of climate change and it is already being seen in many regions around the world. For instance, In California, it is seen that home of a $46 billion dollar agriculture industry running on reserve water capacity (Logan, 2015). On the other hands, In Colombia, prolonged drought in the department of La Guaijira has caused under nutrition to reach unprecedented levels. Rivers in the region such as the Magdalena, Pence and Cauca have hit record lows of water levels (Logan, 2015). So, climate change increases the frequency of drought and drought hamper food security.Moreover, it is found that drought is also responsible for aquifer depletion (Logan, 2015).

Aquifer Depletion:A study showed that the level of groundwater has been going lower level of the surface and as a result aquifer depletionis seen as a serious problem in many regions of the earth surface due to acute drought (NASA, 2015).One coping mechanism farmers have for drought years is to keep their crops alive with groundwater. But, unlike relying on rain, pulling water from aquifers has serious long-term effects. For example, Ogallala Aquifer, a massive system that runs under the American Great Plains and provides water for people and agriculture from Texas to the Dakotas, has had the equivalent of two-thirds of Lake Erie depleted since 1940 (Logan, 2015). NASA warned that aquifer depletion is happening worldwide, threatening our ability to feed ourselves now and in the future (NASA, 2015).in spite of drought problem, storms, cyclone or other natural wind related natural events has been being seen as a problem for crop production and food security due to climate change (Logan, 2015).

Storms: While drought and aquifer depletion happens in the west regions of the surface, the eastern regions are expected to experience stronger storms especially in the United States. Large events, like Superstorm Sandy or Hurricane Irene, have obviously harmful effects, washing away crops and damaging infrastructure that enables farmers to get their products harvested and to consumers (Logan, 2015).These wash away topsoil, leaving the land less fertile, and delay planting times, both of which make the land less productive. So, climate change increases the frequency of storms and storms increase the food insecurity. However, there is another reason for less productivity of the land like spread of pests.

Pests:A study revealed that Carbon dioxide is to plants what oxygen is to humans. Unfortunately, that’s true for weeds, too. for example, In New Zealand, if left uncontrolled, weeds could invade more than half a million hectares of protected land within 15 years, posing a threat to one third of the country’s threatened plant species (Logan, 2015).Furthermore, scientists have found that as climates migrants, insects and fungi are moving toward the poles too. Researcher reveals that pests move an average of nearly two miles each year (Osborne, 2013). Already, the amount of crops lost to pests could feed nearly 650 million people and currently about nine percent of the world’s population (Logan, 2015). It is also found that climate change has been rendering the spread of pests in the land and crop productivity has been going marginal line which would be a big threat for food security. However, study focused that climate change affects the oceans and itsresources.

Ocean Acidification: One of the scariest and potentially most dangerous effects of global warming is ocean acidification. Our oceans absorb 30% of the carbon dioxide we produce and beneath the surface, carbon pollution is changing the chemical makeup of the seas (Logan, 2015). Many marine species can't survive in this critical environment. This harms both things we directly consume, like shellfish, and things we don't, like plankton, whose critical link in the food chain ripples up, putting tuna, cod and other seafood staples at risk of starving. Colder waters,like Alaska is particularly at risk (Rocha, 2014).Seafood is a large part of many people's diets around the world. According to the World Health Organization, fish and shellfish account for between proteins consumed by people. Most of third world countries, fish contribute closer to 20 percent of their animal protein (WHO, 2017). So, climate change increases the ocean acidification and ocean acidificationlimits sea food or ocean food resources .Finally, it can be said that climate change affects crop production by its different events such as drought, aquifer depletion, storms, spread of pests, and ocean acidification.

VI. Climate Change and Food Security

Climate change has a great impact on food security. In the recent year, it is seen that food production and reservation has been limiting due to the climate change (Campbell et al, 2016). Climate impact studies on crops pre-dominate, but impacts on fisheries and livestock production are no less serious (Creighton et al., 2015 and Herrero et al., 2015). Whereas slow changes, such as rising temperatures and sea level, will only have major impacts in the coming decades, farmers al-ready have to deal with changing weather patterns and rising frequency and intensity of extreme weather events, making farming even more risky (IPCC, 2012).However, there are four elements of food security, namely food availability that means manufacture and delivery, food access that means affordability, distribution, and preference, food utilization that means dietary value, social value, and food safety, and food stability that means government food security strategies (WFP, 2016 and Anik et al. 2012). One of the most damaging effects of diminishing food security is that the worst impact of the cascade of risks is borne by the most vulnerable groups of the population. The poorest segment of the population, who spend the largest share of income on food, are likely to be worst affected by any crisis in food availability (Mahmud, 2017). With the changing of climate, food quality, food availability, food access, crop and livestock, and ecosystems has been changing day by day.

VII. Result and Discussion

Climate Change and Food Quality and Varieties: Climate change impacts food utilization primarily through two dimensions: food safety through the supply chain, and health impacts from climate change that mediate nutritional outcomes (Campbell et al, 2016). In general, climate change is likely to reduce food safety due to higher rates of microbial growth at increased temperatures (Hammond et al., 2015); particularly in fresh fruit and vegetables (Liu et al., 2013) and fisheries supply chains (Marques et al., 2010). Climate affects health via myriad path ways, including vector-borne diseases, heat stress and natural disasters, which in turn affect people's nutrition, plus their ability to provide care for children and dependents' food security (Costello et al., 2009 and Campbell et al, 2016). Water related impacts of climate change, such as lower availability of water for sanitation (McDonald et al., 2011), or increased contamination of water due to increasing severity and frequency of floods (Uyttendaele et al., 2014), can also compromise food safety and health. Concern has been expressed that rising disease incidence will lead to overuse of pesticides and veterinary medicines, especially in fisheries (Tirado et al., 2010). Indirect effects of climate change on health, such as loss of jobs and livelihoods, or migration, or interrupted public health services, will disproportionately affect people who are already poor (Costello et al., 2009) and indigenous peoples (Ford, 2012), with negative outcomes for food security (Campbell et al, 2016).

Climate Change and Access in Affordability and Functioning Markets: Climate change will affect people's ability to access food chiefly via purchase. Studies can give important indications about macro-level impacts of climate change on affordability in the future: food prices are projected to increase across a wider range of scenarios, but there are considerable differences between the results of different macro-economic models (Nelson et al, 2014b and Campbell et al, 2016). Affordability also depends on purchasing power of households (White et al., 2010), which may be affected by climate, especially among agricultural households. Considerable research has been done on exploring how households and communities adapt to climate shocks (Rufino et al., 2013). Both macro and micro level analyses are needed to understand how local communities may be affected as well as the covariate risks of climate change that affect broad regions (Campbell et al, 2016). Climate change is also likely to affect the geography of production at large scales-shifts in areas of crop or livestock production suitability, for example (Havliketal, 2014) which could have substantial impacts on prices, trade flows and food access (Campbell et al, 2016). Physical access to food maybe affected by climate change via effects on transport systems and physical well-being (White et al., 2010). There are some issues as associated with the allocation of food within households, for example to women and children, and how such allocation may be affected in a more variable climate (Campbell et al, 2016).

Climate Change and Crops, Livestock and Fisheries: It is assumed that climate change impacts indicate near certainty that global crop production will decrease as a result of climate change (Porter et al., 2014). Based on a meta-analysis of 1700 model simulations, the most recent IPCC assessment demonstrated that, despite uncertainties, on average, global mean crop yields of rice, maize and wheat are projected to decrease between 3% and 10% per degree of warming above historical levels (Campbell et al, 2016, IPCC, 2012 and Challinor et al., 2014b). Consistent with this, a more recent global study estimated global wheat yield reductions of 6% per degree of warming (Asseng et al., 2014). Additionally, most evidence suggests reduced quality due to decreases in leaf and grain, protein and macro and micronutrient concentrations associated with increased CO_2 concentrations and more variable and warmer climates (Campbell et al, 2016 and DaMatta et al., 2010). Impacts on livestock systems will be mediated through reduced feed quantity and quality, changes in pest and disease prevalence, and direct impairment of production due to physiological stress. Growth and meat, egg and milk yield and quality decrease as temperaturesgobeyond 30°C due to reduced feed intake (Thornton and Gerber, 2010). It is seen that project 5–10% decreases in potential fish catch in tropical marine ecosystems by 2050 (Campbell et al, 2016 and Barange et al. 2014). Changes in the distribution of fish and plankton are also expected as suitable habitats shift with warming ocean temperatures, changes in winds, ice thickness, pH, and nutrient supply (Brander, 2010). Climate change will also change the prevalence of pests and increase the frequency of shock pest events, putting agricultural systems at greater risk during the 21st century (Campbell et al, 2016 and Bebber et al., 2013).

Climate Change and Ecosystems: Food security is linked directly and indirectly to ecosystems through provisioning (e.g. food, water, timber, genetic resources), regulating (e.g. Climate, flood, disease, pollination), and supporting (e.g. soil formation, water cycling, nutrient cycling) services (Millennium Ecosystem Assessment, 2005).Climate change exacerbates the pressures on ecosystems (Cabell and Oelofse, 2012). Campbell et al, (2016) reveals that increasing temperatures and extreme events are leading to decreases in biodiversity and shifts in relationships within community assemblages (Oppenheimer et al., 2014) and threatening productivity and resilience of current food systems (Khoury,2014). Climate change and variability are also seen to undermine social and economic components of agricultural systems. Resource-poor and marginalized populations are the most vulnerable to climate change and threats to these groups may undermine communal resource regimes and exacerbate conflict (Oppenheimer et al., 2014 and Campbell et al, 2016).

VIII. In Cases of Bangladesh

Bangladesh is among the most precarious and unpredictable countries due to climate risks (Bangladesh Country Study, 2013). It is regularly stricken by annual flooding, or shortage of water during dry seasons; it frequently suffers from cyclones, storm surges, along with changing groundwater aquifer situations (Mahmud, 2017). Climate change poses crucial impediments to sustainable development for Bangladesh (Mahmud, 2017). Sea level rise due to climate change could engulf 17 percent of the land area in Bangladesh by 2050, diminishing cultivatable areas and causing 35 million people to be landless (Ismail, 2016 cited in Mahmud, 2017). Most of the land mass comprises of floodplains, and up to 30 percent of the country experiences annual flooding during the monsoon season, while 60 percent of the country is susceptible to extreme floods (UNESCAP, 2013). Furthermore, agriculture sector is the contingent source of income and employment for most of the poverty-stricken rural residents of Bangladesh (Mahmud, 2017).

Agriculture sector in other word agricultural production is anticipated to be extensively harmed by the rapid expanse of soil salinity that arose from sea levels rising, tidal flooding, and intensifying storm gushes. More than half the area of Bangladesh is barely five meters above sea level, posing ominous threats to its coastal population. According to scientists, sea levels could soar 50 to 130 cm by the year 2100 (Ismail, 2016 cited in Mahmud, 2017). Despite the most effective measures, for example, the execution of the 2015 Paris Agreement, sea levels are predicted to surge by 20 to 60 cm by 2100.Food security will take a dark plunge because 30 percent of cultivable land is located in coastal areas. A study by the World Bank has suggested that increased soil salinity will lead to a 15.6 percent wane in the harvest of high-yield rice. It can potentially lead to a shortage of irrigation water for farming during the dry season and depleted source of revenue for farmers (World Bank, 2010).

Moreover, agriculture in Bangladesh is largely dependent on weather. One cyclone may destroy a significant volume of the seasonal harvest. Cyclone Sidr destroyed nearly 95 percent crops in coastal districts when it crashed into Bangladesh in 2007 (ADB, 2013). Food security will be immensely jeopardized due to frequent and intensified extreme weather incidents resulting from climate change. Smallholding farmers' sustenance of will suffer detrimental repercussions of the increasingly recurrent aridity due to decreased rainfall. For instance, the drought of 1994-95 led to a decline in the production of grains by about 3.5 million tonnes and led Bangladesh to import a substantial quantity of rice and wheat (Ismail, 2016 cited in Mahmud, 2017).

IX. Conclusion

Crop production mostly depends on the nature of climate. But it is regret thing is that climate has been changing day by day. As a result agricultural activities including crop production is being faced different types of obstacles and decreases crop production.It is also seen that climate change damages crop production and increases food insecurityall over the world. Government and various national and international organizations encourage the integration of a variety of technologies, services and tools to better equip communities to adapt to the impacts of climate change. This can include diversifying livelihoods, protecting assets, incomes and crops with insurance and access to financial services, improving access to markets, and rehabilitating land**.** It also means working with governments to ensure these initiatives can be incorporated into national systems, including early warning, social protection and financial or insurance mechanisms. United Nation's organs and organizations adopted initiatives to help the most food insecure people and countries to reduce the impact of climate change on food security and nutrition.

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