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IMPACTS OF GLOBAL CLIMATE CHANGES ON FOOD SECURITY IN INDIA: A REVIEW

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Abstract: Today, the world is facing great challenges to produce adequate food, fiber, feed, industrial products, and ecosystem services for the Earth's 6.4 billion people. Climate changes and agriculture are interrelated processes, both of which take place on a global scale. Climate change is affecting the food quality because of the increasing temperature and decreasing crop growth period. With nearly 80 million added every year, we must develop ecosystem goods and services to meet the needs of 8 billion by the year 2025 and over 10 billion by 2050. Global warming is a major and controversial issue all over the world, it affects many aspects of life; agriculture, plant and animal biodiversity, environment and socio-economic well being. Environmental changes have important implications, some positive and others negative, for future crop yield and production. Global warming will bring about heat stresses on plants that will even affect the types of crop grown; hence plant breeding programmers need to make necessary changes to adopt environment-specific approaches to crop improvement for fulfilling additional demands on crop production.
Keywords: Climate changes; Crop yield; Food security; agriculture; Temperature variation.
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INTRODUCTION

Today global warming is a major and controversial issue all over the world. It affects many aspects of life; agriculture, plant and animal biodiversity, environment and socio-economic well being. Temperature stress (high and low) is one of the important environmental factor that may affect morphology, anatomy, phenology and plant biochemistry at all levels of organization (Shakibhossain and Nurulmohammadzayed, 2013).Climate change will affect the food quality because of the increasing temperature and decreasing crop growth period. Climate changes and agriculture are interrelated processes, both of which take place on a global scale. Global food security threatened by climate change is one of the most important challenges in the 21st century to supply sufficient food for the increasing population while sustaining the already stressed environment (Yinhong Kang *et al.,* 2009). Food security is defined by the Food and Agriculture Organization (FAO) as a "situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meet their dietary needs and food preferences for an active and healthy life".

1. Climate changes and agriculture

Climate is an important factor of agricultural productivity. The fundamental role of agriculture in human welfare, concern has been expressed by many organizations and others regarding the potential effects of climate change on agricultural productivity. Climate change is expected to agricultural and livestock production, hydrologic balances, input supplies and other components of agricultural systems. Agricultural facilities contribute approximately 20% of the annual increase in anthropogenic greenhouse gas emissions. This sector contributes to global warming through carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) gas emissions.

The main gas sources are nitrogen fertilizers, flooded rice fields, soil management, land conversion, biomass burning and livestock production and associated manure management. The livestock industry accounts approximately from 5% to 10% of the overall contribution to global warming (Intergovernmental Panel on Climate Change).

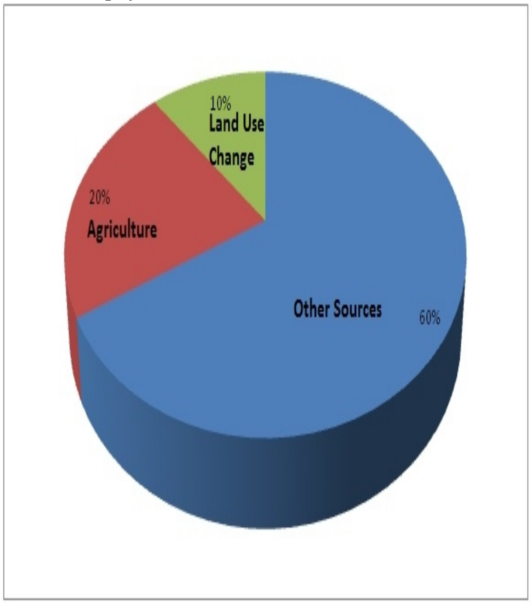

Figure 1. Contribution to global warming

1.1 Causes of climate changes

1.1.2 Effects of Green house Gases on temperature variation -

Some greenhouse gases occur naturally in the atmosphere, while others result from human activities. Naturally occurring greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Certain human activities, however, add to the levels of most of these naturally occurring gases during the Industrial Revolution, Before the Industrial Revolution, human activity released very few gases into the atmosphere, but now through population growth, fossil fuel burning, and deforestation, affecting the mixture of gases in the atmosphere. Carbon dioxide is released to the atmosphere when solid waste, fossil fuels burned to run cars and trucks, heat homes and wood and wood products are burned. This gas has been increasing steadily over the past century due to the increased burning of fossil fuels. Power factories are responsible for about 98% of U.S. carbon dioxide emissions, 24% of methane emissions, and 18% of nitrous oxide emissions. Increased agriculture, deforestation, landfills, industrial production, and mining also contribute a significant share of emissions.

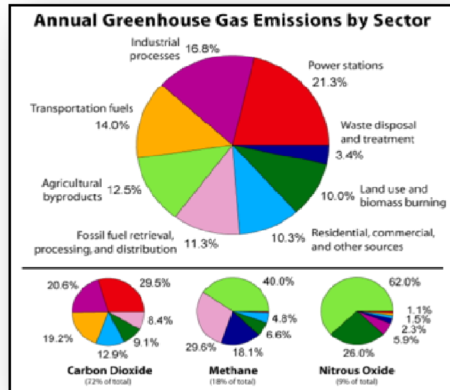

Figure 2: Annual greenhouse gas emissions by sector

1.2 The climate changes could affect agriculture in several ways

1.2.1 Effect on agricultural surfaces and climate changes

As well as temperature increases the amount of arable land in high latitude region by reduction of the amount of frozen lands. A rise in the sea level would be result in an agricultural land loss as well as salinity of the water would be increased could mainly affect agriculture through inundation of low-lying lands.

1.2.2 Effect on quality of crops production

Studies have shown that higher CO_2 levels lead to compact plant uptake of nitrogen resulting in crops with lower nutritional value, this would primarily impact on populations in poorer countries less able to recompense by eating more food, more various diet, or possibly taking supplements. Rice, the amylase content of the grain—a major determinant of cooking quality—is increased under elevated CO_2 Cooked rice grain from plants grown in high-CO_2 environments would be firmer than that from today's plants. However, concentrations of minerals such as irons and zinc which are essential nutritional contents, would be lower, the protein contents of the grain decreases as well as temperature and CO_2, Studies have shown that increases in CO_2 level lead to decreased concentration of micronutrients in crop plants.

1.2.3 Effect on quantity of crops production

The Intergovernmental Panel on Climate Change (IPCC), published in 2001, concluded that the poorest countries would be hardest hit, with reductions in crop yields in most tropical and sub-tropical regions due to decreased water availability, and In Africa and Latin America many rain fed crops are near their maximum temperature tolerance, so that yields are likely to fall sharply for even small climate changes; falls in agricultural productivity of up to 30% over the 21st century are projected. Marine life and the fishing industry will also be severely affected in some places. In India, the second-most populous country in the world, According to a 2004 article from the BBC, China, the world's most populous country, is suffering people have been added to the ranks of the hungry and 46% of children are under-weight .Low lying areas such as Bangladesh, India and Vietnam will experience major loss of rice crop if sea levels rise as expected by the end of the century. Heat induced yield reduction was documented in many cultivated crops including cereals (e.g., rice, wheat, barley, sorghum, maize), pulse (e.g., chickpea, cowpea), oil yielding crops (mustard, canola) (Kalra et al., 2008).

Figure 3.Impact of Temperatures on Crop Yield

Adverse Impact of Temperatures on Crop Yield

Climate change has been causing a drastic change in weather patterns both in summer and winter resultantly adversely affecting the crop yields. Large variability has been observed in the precipitation and thermal regimes but discussion will be focused on thermal one here. Some recent examples in Pakistan and other parts of the world are stated below;

While studied the causes of reduction in wheat yield in Ludhiana Province of India while the visible crop condition was the best. They pointed out that the occurrence of mild heat wave (13 days above normal (2-3ºC)) temperatures in early spring at reproductive stage caused 28% reduction in the grain yield of wheat (Goswami et al., 2005).

Soybean *(Glycine max L.) Merrill* has become the major source of edible vegetable oils and high protein feed supplements for livestock in the world. About 90% of the world's soybean production occurs in the tropical and semi-arid tropical region, which are characterized by high temperature and low or erratic rainfall. In the tropic, most of the crops are near their maximum temperature tolerance; therefore crop yield may decrease even with minimal increases in temperature (Thuzar M., 2010). Due to higher night temperatures during 2003, the respiration over ruled the photosynthesis causing reduction in net gain. Rice grain yield declined 10% for each 1ºC increase in minimum temperature (Shaobing Peng .,2004). Yield increased up to 29ºC for corn, 30ºC for soya bean and 32ºC for cotton. Higher temperatures are harmful 30-46% reduction for B1 scenario by the end of 21st century predicted (Smith S., 2008).

Extreme temperatures can cause premature death of plants. Among the cool-season annuals, guar is very sensitive to high day temperatures with death of the plant occurring when air temperature exceed about 35^{0}C for sufficient duration, although its vegetative development may exhibit abnormalities such as leaf fasciations. For monocotyledons, including both cool-season and warm-season annuals, high daytime temperatures can cause leaf firing which involves necrosis of the leaf tips and this symptom also can be caused by drought **(**Suwa, R and Hakata, 2010).Climate change impacts on food security.

1.3 Effects on livestock

Climate change could affect livestock and dairy production. The pattern of animal husbandry may be affected by alterations in climate, cropping patterns, as well as ranges of disease vectors. The higher temperatures would likely result in a decline in dairy production, reduced animal weight gain and reproduction and lower feed-conversion efficiency in warm regions. More mixed impacts are predicted for cooler regions. If the intensity and length of cold periods in temperate areas are reduced by warming, feed requirements may be reduced; survival of young animals enhanced and energy costs for heating of animal quarters reduced. Climate change could also affect livestock by disease. Incidence of diseases of livestock and other animals are likely to be affected by climate change, since most diseases are transmitted by vectors such as ticks and flies, the development stages of which are often heavily dependent on temperature. Cattle, goat, horse and sheep are also vulnerable to an extensive range of nematode worm infections, most of which have their development stages influenced by climatic conditions. Livestock production may also be affected by potential changes in grain prices brought on by changing yields in some areas, or by changes in rangeland and pasture productivity. For developing countries, livestock are better able to survive severe weather events such as drought than are crops and therefore a better option in terms of income protection and food security.

1.4 Climate change impacts on food security

Food security is defined by the Food and Agriculture Organization (FAO). The state of food insecurity in the world 2001.Food and Agriculture Organization, Rome, 2002 as a "situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". The definition involves four aspects of food security, namely, food availability, food stability, food access and food utilization (Schmidhuber and Tubiello, 2007) However, the existing studies are focused on the climate change impacts on food availability, scarcely referring to the impacts of potential increase in climate variability, frequency and intensity of extreme events on food stability.
(FAO. World agriculture; towards 2015/2030 summary report. Food and Agriculture Organization, Rome., 2002) mentioned that biotechnology can be an approach to improve food security and reduce the environmental pressure. Meanwhile, modified crop varieties, resisting drought, water logging, salinity and extreme climate, can expand the crop planting area such as in the degraded soils, consequently, to increase food availability in the future.

Climate change will affect the food quality because of the increasing temperature and decreasing crop growth period. Droogers (2004) analyzed the climate change impacts on food security with the HadCM3, SWAP and water-salinity basin model to simulate the evapotranspiration and available water in field scale thus to decide the relationship between the irrigation depth, crop area and food quality. The result is that in order to increase total grain production, there is a need to extend the crop area otherwise, it would decrease the food security. Alcamoa *et al.* (2007) evaluated present and future climate scenario impacts on food securityand water availability in 2020 and 2070s and provided some measures to enlarge potential crop production such as diversifying crops and expanding the rainfed and irrigated agriculture areas. (Proogers and Aerts**,** 2005) analyzed climate change impacts on food quantity and security with ADAPT and SWAP models and pointed out that increasing crop area can improve food quantity but will degrade food security, while reducing water allocation for irrigation and decreasing the crop area can improve environmental quantity and security. Luo et al (2003) combined Global Climate Models with DSSAT 3.5 CERES-Wheat to discover the potential effects of climate change on South Australian Wheat with different CO_2 concentration levels, and the result showed that climate change can degrade the wheat quality at drier sites, while the drier sites can benefit more than the wetter sites under climate change scenarios. Khan *et al*. (2009) reviewed water management and crop production for food security in China, who pointed out that it is necessary to integrate climate, energy, food, environment and population together to discuss future food security in China, and in the world as well. This is because climate change has many uncertainties in water management and other water-related issues. Food security is increasingly important for human beings all over the world. Food availability and food quality still are the big challenges for scientists due to changing climate. Food security is always studied with CO_2 effects under changing climate scenarios. Further research on food security needs to integrate population, crop production, climate change and water availability, consequently, to evaluate food security completely and systematically.

CONCLUSION

Future population growth will place additional demands on crop production. There is scope for both increase yield and expanded cropland area, though that scope varies among regions. In addition to increasing food demand, both population and standard of living increase are bringing with them environmental changes at local, regional, and global spatial scales, and across temporal scales ranging from years to centuries. Many of those environmental changes have important implications, some positive and others negative, for future crop yield and production. Global warming will bring about heat stresses on plants that will even affect the types of crop grown; hence plant breeding programmers need to make necessary changes to adopt environment-specific approaches to crop improvement.

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