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Overview of Climate Change Impacts on Crop Production in Developing Countries

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Abstract*: Agriculture and fishing are both significantly influenced by the climate. Rising temperatures and carbon dioxide (CO2) concentrations may enhance crop production in some areas. To receive these advantages, other conditions such as soil moisture, nutritional levels, and water availability must also be met. Changes in the frequency and severity of floods and droughts may put food safety at risk, which might cause problems for ranchers and farmers. In general, climate change may make it harder to cultivate crops, rear animals, and fish in the same places and manners as in the past. together with other dynamic factors that affect agricultural production, like modifications to farming techniques and technological advancements. The effects of climate change must also be considered. The review concludes by recommending that people in developing nations find ways to respond to climatically hazardous events, trends, or disturbances that have an impact on crop production by adapting to or reorganizing in ways that preserve their fundamental functions, identities, and structures while also preserving their capacity for adaptation, learning, and transformation.*

Keywords*: Yields, Droughts, Precipitation, Diseases, Floods, Water, Interactions*

1. INTRODUCTION

Since the beginning of time, the climate has changed, and it is predicted that this trend will continue in the years to come. The yield of crops is being impacted by climate change globally, which is crucial for maintaining global food and nutritional security. In developing countries where the poorest populations are concentrated, the consequences are more noticeable. Therefore, it is anticipated that during the next several years, climate change will make it more dangerous for billions of people to live healthy lives, especially those living in middle-income countries (e.g. risks including shortages of food and water). Because they have the fewest social, technological, and financial resources to adjust to changing conditions, impoverished countries are more severely affected by the effects of climate change(UNFCCC, 2007).

The number of people on the earth is predicted to reach over 9 billion in 2050, which would increase the demand for food and other agricultural goods. By 2050, 2.12 billion people will reside in developing countries, with 1.1 billion of them in sub-Saharan Africa alone, according to the UNDP's 2019 forecast. Many problems now affecting the world include a lack of water and land, an increase in urbanization, and climate change and instability. The bulk of rural communities in developing nations rely on agriculture as their main source of income; there are 2.5 billion rural people who depend on it (World Bank, 2008). Climate change is expected to significantly reduce agricultural yields in Southern Africa and South Asia (up to 30% for maize output by 2030 and more than 10% for millet and maize, respectively) (Lobell et al., 2008).

Even while some crops may profit from the changing climate in specific regions of the world, the impacts on agriculture as a whole are anticipated to be detrimental (IFPRI, 2009). This is particularly relevant given how climate variability and the frequency of catastrophic climatic events like droughts and floods affect precipitation. Increased temperatures may harm harvests and encourage the growth of weeds and pests in agriculture. The productivity of agriculture is similarly impacted by rising sea levels in several areas. This results in failed crops and long-term productivity losses, especially in underdeveloped countries where the danger to food security is greatest.

2. INTERACTION BETWEEN CLIMATE CHANGE AND CROP PRODUCTION

The word "climate change" refers to shifts in the mean or average weather conditions that have occurred over a long period (*i.e.* more than thirty years). Climate change may be brought on by human activity that alters the makeup of the atmosphere. Variations in solar activity, volcanic eruptions, fluctuations in the earth's orbit, and changes in ocean and land formations, among other natural phenomena, have all been connected by scholars over time to climate change. Changes in land use, urbanization, and industrialization are examples of human-induced causes, or anthropogenic

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factors, which cause the emission of various greenhouse gases into the atmosphere (UNFCC, 2007). Over time, an excessive amount of warming of the earth's surface has been caused by the buildup of greenhouse gases in the atmosphere, most notably Carbon Dioxide, Sulfur Dioxide, Methane, and Nitrous Oxide. Droughts, storms, and floods have become more common as a result, which has eventually affected crop output throughout the world.

2.1. Crop Production

Due to the intimate connection between agriculture and universal processes, crop production and agricultural operations are impacted by climate change (IPCC, 2007). Crop productivity is directly impacted by the pace of climate change, which in turn puts global food security at risk. High temperatures decrease the ultimate yields of major crops while encouraging the establishment of new weeds, plant diseases, and pests.

2.2. Developing Countries

A low gross domestic product (GDP) per capita and a disproportionate reliance on agriculture as their primary industry are characteristics of developing nations due to their sluggish economic growth. Due to the risks it poses to the environment and agricultural productivity, the effects of climate change are quite alarming. The environment will be seriously threatened by global warming, which will interfere with agriculture. Higher atmospheric carbon dioxide concentrations are to blame for this. The average temperature is raised by carbon dioxide, which causes different types of rainfall patterns (FAO, 2010). The majority of developing countries are now more susceptible to food insecurity and nutritional insecurity as a result of variable rainfall patterns, which have a significant impact on crop productivity.

3. IMPACTS OF CLIMATE CROP PRODUCTION IN DEVELOPING COUNTRIES

In many regions of the world, the effects of climate change on agricultural productivity are already evident, with negative effects outweighing good ones and poor countries being especially vulnerable to additional negative effects (IPCC, 2014). For example, as maximum annual temperatures rise, wet regions become wetter, and dry regions become drier, resulting in poor cropping conditions, agriculture has the potential to increase food security and reduce poverty among low-income countries by increasing crop production, particularly in these countries' peripheries. The increased exposure to these dangers associated with climate change, which are already affecting many regions of the world, poses a severe threat to crop output.

3.1. Rising Temperatures Reduce Crop Yields

The global increase in temperatures is proof of the climate's ongoing changes. In recent years, days and nights have gotten hotter while cold periods have gotten milder and shorter over most land areas. Rising temperatures have adverse effects on crop production ashigh temperatures tend to alter plant physiology by shortening the growing season of various crops resulting in the lapse of some of the critical plant growth stages thereby reducing crop production. Information on regional variations in agricultural production potentials shows a significant gap between current yields and maximum achievable yields for developing countries, most notably Sub-Saharan Africa, whereas industrialized regions are already close to achieving their maximum potential yield (Mauser et al. 2015).

Even though certain regions near the equator benefit from a changing climate, Sub-Saharan Africa has the biggest absolute net reduction in areas suited for agricultural production. The developing nations most severely impacted by rising temperatures include those in Sub-Saharan Africa, Central America, and South Asia, and these nations are predicted to see severe impacts shortly. According to Tilman et al. (2011), by 2050, the mean yields of all crops will have decreased by 8% in both regions. Major food crops planted in South Asia and Sub-Saharan Africa suffer from the bulk of production losses, indicating that climate change will have a temperatures rise.

Figure1: Impacts of rising temperature. Cropwatch.unl.edu

3.2. Heavy Precipitation Damages Crops

Another expected consequence of climate change is an increase in the frequency of extreme weather, such as excessive precipitation that reduces crop production. Heavy rains can physically injure crops. Weather that is too wet today or tomorrow could prohibit planting or good harvests. According to Tubiello and van der Velde (2010), prolonged precipitation and droughts can be the sole cause of crop failure. Furthermore, as a result of the ongoing climate change, extreme weather events like hailstorms and high precipitation have been proven to play a significant role in lowering crop yields in poor countries, particularly in Sub-Saharan Africa.

The production of crops is also greatly impacted by changes in precipitation patterns. Depending on the phenological stage the crop has reached, this may result in various types of moisture stress. The consensus is that as a result of climate change, places that already receive a lot of rain will get even more, while places that are already dry will get even drier (Liu and Allan, 2013).

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Figure 2: Impacts of heavy precipitation. Tribuneindia.Com

Changes in precipitation patterns have a significant impact on crop productivity as well. When Farmers in emerging nations may no longer be able to rely on their seasonality of climatic variables as rainfall becomes more unpredictable. Farmers will find it more difficult to plan and control production as a result of changing planting seasons and weather patterns.

3.3. Drought Leads to Crop Failure

Current environmental circumstances, as well as methods for coping with the pressures these elements cause, have always had an impact on crop success and failure. As a result of the planet's increasing warming, one of the terrible conditions it is currently suffering is drought (IPCC, 2007). Drought has a significant impact on crop yield. In contrast to heat stress, which has different impacts on different crops depending on their phenological stage, drought stress has different effects on different crop species (Simpson, 2017). Each type of temperature stress has a varied effect on how long the crop lasts and how much the plant produces overall. The outcome will depend on how sensitive each crop species is at that particular time in their development to the temperature change. To adjust to these repercussions, different types of responses will be required. Long-lasting droughts have the potential to cause complete crop loss even though drought-affected crops are less able to fight weeds for soil moisture and nutrients (Tubiello and van der Velde, 2010). The most vulnerable populations and agricultural households in developing countries' drylands, where the economy is based on pastoralism and rain-fed agriculture, are particularly hard hit by the negative effects of drought.

Figure 3: Impact of prolonged drought. Croplife.Com

3.4. Floods Destroy Crops

Extreme sea level rise that causes floods in various regions of the world over time has been identified as a major concern associated with climate change. Over time, rising sea levels have been brought on by the melting of glaciers due to temperature rise. First, as the oceans warm due to an increasing global temperature, seawater expands taking up more space in the ocean basin and causing a rise in water level. The second mechanism is the melting of ice over land, which then adds water to the ocean.

About a third of all losses resulting from natural disasters are worldwide due to the risk of flooding. Several models have been created to evaluate the worldwide flood risk (IPCC, 2014), primarily focusing on building damage, especially in urban areas. However, because of how they affect agricultural output, floods can have a negative influence on rural communities (FAO, 2010). Approximately 60% of the damages are ascribed to floods, according to the FAO (2010), and crop production was the agricultural sector in developing countries that was most adversely affected by natural hazards from 2003 to 2013. The agricultural output of developing countries affected by floods is centered on West Africa. This area is heavily reliant on its food production and is frequently flooded. Flooding in this region damages crops and increases the vulnerability of rural residents by causing soil erosion, the loss of arable land, and the salinization of irrigation water (Dawson et. al, 2005).

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Figure 4: Impacts of floods on crops. Sydney.edu.au

Figure 5: Impact of Cyclone. FAO.Org.

3.5. Cyclones Damage Crops

The name "cyclone" refers to its cyclonic nature, where the wind blows in opposite directions depending on the hemisphere (clockwise in the southern hemisphere, counterclockwise in the northern) (Rautaray et. al, 2003). Cyclones in coastal locations have a significant negative impact on all aspects of the agriculture industry, including crop production since they directly harm crops through strong winds, heavy rain, and extensive floods. Saline water and sand mass may be brought in by the high tide, rendering the fields unusable for farming. Viruses and diseases that affect crops are indirect consequences of cyclones that could further diminish crop productivity. Beyond the most immediate and obvious effects of death, injury, loss of livelihood systems and property, and food insecurity at the local and/or national level, the influence of storm-related disasters extend to other areas of society as well (IFRC, 2000). The core of the economies of the majority of developing countries, the quality of the land and future land output, may also be harmed by storm-related calamities. They frequently result in the poor becoming further poorer. Storms can also put a stop to long-term development projects that would be too expensive. The global goal of eliminating poverty and undernourishment in developing countries is thus significantly hampered by the vulnerability of nations and communities to storm-related calamities.

3.6. Weed Infestation Reduces Crop Yield

The impact of storm-related disasters extends beyond the most immediate and evident repercussions of death, injury, loss of livelihood systems and property, food shortages, and

Figure 6: Impacts of weeds. Researchgate.net

food insecurity at the local and/or national level (IFRC, 2000). Storms can also halt development and cost-prohibitive long-term development initiatives. One most common dangerous invasive weeds are Striga, which grows well in temperatures of 30°Cto 35°C in semi-arid environments, and spreads under conditions where soil fertility is poorly managed and cereal monoculture is practised.

There are around 40 species of Striga, of which 11 species are crop parasites, and it is thought to be one of the largest barriers to food production in Africa (FAO, 2010). As a parasite, this weed invades the roots of other plants, taking their essential nutrients and stifling their growth. Weed is one

of the biggest barriers to sub-Saharan African producers of cereals and legumes. In sub-Saharan Africa, Striga can typically infest up to 40 million hectares of agricultural land. It can lead to yield losses of up to 100% and productivity losses of 12 to 25% on average (Ziska et al., 2010). It affects the livelihoods of around 300 million Africans (FAO, 2010).

3.7. Pest and Disease Outbreaks Damage Crops

Climate change affects how plants and their pests interact in space and over time. Plants are weakened by direct weather stress, which makes them more vulnerable to indirect weather stress (Simpson, 2017). The location of insect infestations is affected by temperature. As a result of global warming, insects, whose body temperatures depend on their surroundings, are most likely to migrate from polar regions to higher elevations (Bebber et al., 2013). Pest distribution will shift in response to modifications in cropping patterns intended to adapt to climate change. Among the insect pests of cereal, legume, vegetable, and fruit crops that may move to temperate zones are major cereal stem borers, major cereal pod borers, aphids, and whiteflies (Sharma, 2014). Food crops in underdeveloped countries are harmed by transboundary plant pests and diseases, which are expensive for farmers and put national food security at risk. In addition to putting poor farmers' livelihoods in peril, outbreaks and upsurges can simultaneously threaten millions of people's access to food and nutrition (World Bank, 2008).

Figure 7: Pest on Crop. FAO. Org

4. CONCLUSION

As evidenced by the warming of the planet brought on by increases in temperature, altered precipitation patterns, occurrences of drought and flooding, strange outbreaks of pests and diseases, weed growth, and tropical cyclone disasters, among other things, the modern world is still undergoing climatic changes. Although there are regional differences in the effects of these extreme weather events, developing countries are the hardest hit and suffer the most because of their sluggish economic development and paucity of technological advancements. Additionally, the fact that the majority of their rural populations—a total of 2.5 billion people—rely on agriculture for a living makes developing countries particularly vulnerable. People in underdeveloped countries must figure out how to react to or reorganize in ways that protect their essential purpose, identity, and structure while also preserving their potential for adaptation, learning, and transformation because agriculture and climate change are closely related.

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