

Impact of Climate Change on Agricultural Productivity: Challenging Global Food Security

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Abstract

Global climate change as in the 21st century, is climate variability characterized by the long-term shift in the temperature, precipitation levels and extreme weather events. It is one of the most concerning global challenges, with severe natural, climatic and socio-economic repercussions. This poses a serious threat to the agricultural productivity as a whole and also challenges the global food security. With the changing global climatic conditions, the crop yields of various staple food crops like paddy, wheat, maize etc. have decreased over the decades. These crops are essential for feeding the majority of the world population. However, with the ever-changing global climatic conditions, the crop yields have reduced drastically in due course of time. The reduction in the crop yields, largely affects the global food security and the SDG 2 due to shortages of food supply, increase in the prices of food and also the market availability of food.

1. Introduction:

Climate change has been described as the most significant environmental threat of the 21st century. Global climate change as in the 21st century, is climate variability characterized by the long-term shifts in the temperature, precipitation levels and extreme

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weather events. It is one of the most concerning global challenges, with severe natural, climatic and socio-economic repercussions. Agriculture being heavily dependent on suitable climatic conditions, is greatly influenced by the rapid change in the climatic conditions (Gornall et. al. 2010). This poses a serious threat to the agricultural productivity as a whole and also challenges the global food security. With the changing global climatic conditions, the crop yields of various staple food crops like paddy, wheat, maize etc. have decreased over the decades. These crops are essential for feeding the majority of the world population. However, with the ever-changing global climatic conditions, the crop yields have reduced drastically in due course of time. The reduction in the crop yields, largely affects the global food security and the SDG 2 due to shortages of food supply, increase in the prices of food and also the market availability of food. The challenge to meet global food security is compounded by the impact of climate change on agriculture (Onyutha C., 2018).

In addition to longer-term, more permanent shifts in seasonal climatic patterns are near term increases in the frequency and intensity of weather extremes. These are already disrupting agriculture, fisheries, and the natural resources. Developing nations with largely rural economies and limited agricultural variety face the greatest vulnerability, as they lack the adaptability to cope with significant changes in their production systems (ICWG-CC, 2008).

In many nations where farming output is already minimal and resources to handle challenges are scarce, climate change is predicted to further decrease productivity and increase instability in production. Over time, shifts in temperature and rainfall patterns due to climate change are anticipated to alter growing seasons, influence pest and disease trends, and change which crops can be grown, impacting production levels, costs, earnings, and, in the end, people's livelihoods and well-being.

2. Empirical Review:

Climate change, agriculture, and food security have become a topic of worldwide attention.

With the global shifts in temperature, precipitation levels and other climatic factors, agricultural yields have been decreasing

rapidly over the years. The following section discusses the impact of climate change induced natural hazards on agricultural productivity and the rising pressure on achieving food security.

2.1 Impact of flood on food insecurity

As a consequence of rising temperature, floods have become more frequent and devastating because of raised temperatures not only change rainfall patterns but also increases the frequency and severity of flood (Oskorouchi R. and Sousa-Poza, 2020). In the long run, climate change is going to affect agriculture in terms of productivity, growth rate and yield. The overall agricultural productivity for the entire world is projected to decline between 3 and 16% by 2080 (Mahato, 2014). Despite extensive evidence that flood exposure reduces household calorie consumption, (eg., Del Ninno et al., 2003), neither floods nor climate change in general influence food security solely through short-term availability and food prices; floods may also be responsible for lowering household income and assets (Del Ninno et al., 2003). One very important mechanism through which flood affects food security in the longer term is their effect on income and poverty (Oskorouchi R. and Sousa-Poza, 2020).

Flooding affects food security negatively, which ultimately affects the SDG2. With floodwaters washing away the standing agricultural crops in every flood event, there stands a big threat to food security in both global and household level. Food security has been understood by many as the availability of food in the world marketplace (FANTA, 2003). However, global food availability does not translate into household food security. This is because food in the world market may not be affordable to the poor and the vulnerable, especially in the developing countries (Akudugu A. et al., 2012). The reasons for the high percentage of extreme food insecurity recorded by the households were the decrease in the household food supply with associated reduction in children's and adult's food intake as a result of inadequate resources to acquire food (Akukwe et al., 2020). To achieve food security, water must be available at the right place, at the right time, in the right quantity and be of the right quality. Water related disasters negatively affect the agricultural areas and crop production which can threaten food security (Pratiwi et al., 2020).

Flood affecting the agricultural lands directly triggers food insecurity. Majuli world's largest inhabited riverine island with an area of 1256 km² has been shrinking over the years primarily due to river bank erosion rendering hundreds homeless especially during floods. This has also decreased the amount of agricultural land and has affected the quality of land used for agricultural produce (Chaliha et al., 2011). Loss of agricultural produce leads to the shortage in the food supply which results in the rise in price of food. The shortage and unavailability of food makes it inaccessible for the poor. The poor people living in the rural areas have to live on insufficient food or starvation. Mandal and Sarma, (2020) in their study have found that around 28% of the household in the country are food insecure.

After every flood event there was basic food scarcity and the growth and development of the crops are affected when flood washes away farmland. The ability of the plants to absorb nutrients necessary for growth greatly decreases due to flood leading to poor plant produce. This results in increased food insecurity and unavailability of staple food (Week and Wizar, 2020). Flood results in acute food insecurity which affects the livelihood of the residents. Individuals and households are also found pilfering other person's food without permission.

Households with poor access to land and markets and those relying on casual labour are most likely to be food insecure. The farming communities were found to be most sensitive to the impacts of erratic land degradation, poor access to quality inputs and unsupportive agricultural policies (Boori et. al., 2017). In a similar study by Amrah et al., 2010 found that the levels of diseases in the communities depend on the nutrition standard, the general standard of living, and environmental tragedies like flood. Floods also directly limit the access to food resources either distributed through aid, sold in distant markets or available from relatives in areas not affected by flood.

Access to adequate food for many households varies over time due to the household's proneness to shocks and other risks such as floods, land degradation due to flooding, extreme climatic conditions and their capacity to recover (Sileshi et. al.2019).

Emergency food aid has been talked about by Devereux, 2007. He has mentioned that, food aid apart from saving lives during emergencies can help address in reducing vulnerability. Hoddinott et al., (2003) has noted the importance of food aid in smoothing consumption and protecting assets among households facing food stress. One limitation of food aid is the high transaction cost. Barrett and Maxwell (2005) estimate that more than half (53%) the value of the U.S food aid in 2000 was spent on shipping and handling costs. Clay et al., (1998) claim that whenever it is systematically analysed, financial aid is more cost-effective than food aid. Cash transfers are often more preferable because they are cheaper to administer and avoid risks associated with commodity transfer. They also provide flexibility to choose for the use of cash (Devereux, 2007).

2.2 Climate change and challenges of food security and agricultural productivity

According to the Intergovernmental Panel on Climate Change (IPCC, 2007), agriculture accounted for approximately 14% of global human-induced greenhouse gas (GHG) emissions in 2004. Agriculture is highly susceptible to the effects of climate change. Forecasts for 2050 indicate rising global average temperatures and greater weather unpredictability, which will influence the nature and geographic spread of agricultural production worldwide (Shaw et al, 2007). Climate change exacerbates hardships for many already at-risk populations, especially in developing nations, where limited resources and insufficient insurance amplify vulnerabilities. It affects all four pillars of food security: availability, stability, access, and utilization. Climate change directly impacts the availability of agricultural goods by altering crop yields, increasing crop pests and diseases, and affecting soil fertility and water retention. Indirectly, it influences availability through its effects on economic growth, income disparities, and demand for agricultural products. Furthermore, erratic weather patterns destabilize crop yields and food supplies. Climate change also hinders physical, economic, and social access to food as production drops, food prices climb, and purchasing power diminishes. Additionally, it jeopardizes food utilization by impacting human health and expanding the reach of diseases into previously unaffected regions. By 2080, agricultural production

in developing countries could fall by 20% due to climate change, compared to a 6% decline in industrialized nations. Yields in developing countries may also drop by an additional 15% on average by 2080 as a result of these changes (FAO, 2008).

3. Potential Options to Manage Food Security and Climate Change

Various approaches can be employed to tackle the challenges of food security and climate change. These include expanding agricultural land, adopting enhanced crop varieties or species, and implementing advanced production techniques (such as adjusting planting schedules, utilizing precision and smart farming methods, upgrading irrigation and water supply systems, optimizing inputs and management practices, and refining tillage methods).

Cropping systems might need adjustments, such as adopting suitable crop varieties to address shortened growth periods, boosting crop intensity (the number of crops grown per area annually), or switching to alternative crop types. Enhancing productivity could involve diversifying crops by introducing new varieties, hybrids, or plant types in place of existing ones and tweaking the cropping schedule by altering sowing, planting, and harvesting times. Farmers could also adapt by modifying irrigation schedules or the application of inputs like fertilizers. Adjusting planting timing and incorporating cultivars from various maturity groups could serve as a practical approach to increase yields. To achieve consistent and high productivity, extending the growing season is key to optimizing a crop's output.

Likewise, better short term and long-term climate forecasts can pinpoint weaknesses in current farming systems exposed to extreme weather, aiding in risk reduction. Additionally, the resilience of innovative agricultural strategies to address food security and climate change could be simulated to guide policymakers. As a result, sophisticated methods to safeguard food security could be precisely evaluated using models. Furthermore, collaboration among diverse research teams and facilities is essential for crafting a national adaptation strategy to counter climate change. In the same vein, effective communication can deliver research findings to key stakeholders (such as policymakers and farmers), helping to address food insecurity.

4. Threats of climate change for developing countries and food insecure people

Climate change poses a greater danger to developing nations, partly because of their geographic locations. Many poorer countries lie in tropical and subtropical areas, which are highly susceptible to increasing temperatures, as well as in semi-arid regions where water scarcity is a growing concern. By 2080, climate change could reduce agricultural production in developing countries by 20 percent, compared to a 6 percent drop in industrialized nations (Cline, 2007). Additionally, crop yields in developing countries might fall by an average of 15 percent by 2080 due to climate effects (Fischer et al. 2005). In Sub-Saharan Africa, the number of malnourished individuals could triple between 1990 and 2080 as a result of these changes. Furthermore, climate change disruptions may hinder long-term human development prospects and widen inequality gaps within nations (UNDP 2007).

Climate change influences all four essential aspects of food security—availability, stability, access, and utilization (e.g., Schmidhuber and Tubiello 2007). It directly reduces the availability of agricultural goods by affecting crop yields, increasing crop pests and diseases, and altering soil fertility and its capacity to retain water. Moreover, the stability of crop production and food supplies suffers due to unpredictable weather patterns. Access to food—whether physical, economic, or social—is diminished as climate change lowers agricultural output, drives up food costs, and weakens purchasing power. Finally, food utilization is threatened as climate change impacts human health and extends the reach of diseases into regions previously unaffected.

5. Policy Direction

Agriculture plays a vital role in food security by supplying the food people consume and, perhaps more crucially, serving as the main livelihood for 36 percent of the global workforce (FAO 2008). To safeguard and improve food security, agricultural systems must evolve toward greater productivity and reduced output fluctuations despite climate-related and agro-ecological or socio-economic risks. For output and income stability, these systems need to become more resilient, meaning they must better withstand disruptive events. Achieving more productive

and resilient agriculture demands changes in managing natural resources—like land, water, soil nutrients, and genetic materials—along with more efficient use of these resources and production inputs. Shifting to such systems could also yield significant mitigation advantages, such as enhancing carbon sinks and cutting emissions per unit of agricultural output. Von Braun et al (2008) emphasized that addressing climate change and other emerging threats requires a swift, coordinated, and multidisciplinary response tailored to specific local conditions, while also considering non-climatic factors affecting food security, such as rising energy and food prices and biofuel production. This response should integrate adaptation measures to lessen the vulnerability of impoverished populations to climate change and other shocks, alongside mitigation efforts to temper climate change impacts after they occur.

6. Conclusion

Addressing the problem of declining agricultural productivity and food insecurity is the need of the hour. Amid the current global issue of climate change and its negative impact on food security and farming output, steps must be taken to adapt and lessen its effects. One effective approach is to enhance agricultural production. Projections based on population growth and food consumption trends suggest that by 2050, agricultural output will need to rise by at least 70 percent to meet demand. Most forecasts also suggest that climate change will likely lower agricultural productivity, stability, and incomes in regions already struggling with food insecurity. Therefore, developing climate-smart agriculture is essential for ensuring future food security and meeting climate change objectives. Every country should create and carry out a practical national action plan that considers future development trajectories, anticipated climate change effects, and the costs of adaptation and mitigation. National governments can significantly contribute to climate mitigation and adaptation in five key ways: offering information and guidance on climate risks and strategies, providing training and support for designing and applying measures, encouraging effective adaptation through public policies, requiring adaptation to protect public health and safety, and establishing adaptation capacity and policies while fostering collaboration across government departments (Yohe, Burton, and Rosegrant, 2008).

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