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Review Article

EFFECT OF CLIMATIC CHANGES ON AGRICULTURE AND FOOD SECURITY

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ABSTRACT
Food security is determined by the options, people have to secure access to own agricultural production and exchange opportunities. These opportunities are influenced by access to water. Climate change induced crop yield change affects food production of countries to varying degrees, depending on the location of the farming activities. food security 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. Climate change will act as a multiplier of existing threat to food security; it will make natural disasters more frequent and intense, land and water more scarce and difficult to access and increase in productivity even harder to achieve. More extreme weather events will have serious impacts on livelihood assets in both rural and urban areas and threaten the stability of food supply. Many countries are already dealing with the climate change impacts resulting from irregular, unpredictable rainfall pattern, increased incidence of storms and prolonged drought. Climate change will affect all four dimensions of food security: Availability, Accessibility, Stability and Utilization. It will reduce food availability because it negatively affects the basic elements of food production- soil, water and biodiversity. Rural communities face increased risks including recurrent crop failure, loss of livestock and reduced availability of fisheries and forest products. Developed countries are mostly located in higher latitudes and climate change benefits the crop yield of these areas. In contrast, developing countries of the lower latitudes suffer from the reduction in crop yield being induced by climate change. Changing temperature and weather patterns furthermore create conditions for the emergence of new pests and diseases and affect animals, trees and crops. This has direst effects on the quality and quantity of yield as well as the availability and price of food, feed and fiber. Decreasing availability of water and food will also increase sanitation and health problems and increase the risk of disease and malnutrition. Climate change and increased water demand for agriculture in future decades is anticipated to be an added challenge to transboundary framework agreements, increasing the potential for conflict. Present paper will highlight the major issues related with the climatic changes and its impact on the agriculture, fishery and diversity of crop species.

Keywords: *Climate Change, Food Security, Agriculture*

INTRODUCTION
Achieving food security under a changing climate requires substantial increase in food production on the one hand, as well as improved access to adequate and nutritious food and capacities to cope with the risks posed by climate change on the other hand (Agarwal and Perrin, 2008).
The Food and Agriculture Organization (FAO) defines food security 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’’. This definition comprises four key dimensions of food supplies: Availability, Stability Access, and utilization. The first dimension relates to the availability of sufficient food, i.e., to the overall ability of the agricultural system to meet food demand. Its sub dimensions include the agro-climatic fundamentals of crop and pasture production and the entire range of socio-economic and cultural factors that determine where and how farmers perform in response to markets. The second dimension, stability, relates to individuals who are at high risk of temporarily or permanently losing their access to the resources needed to consume adequate food. An important cause of unstable access is climate variability, e.g., landless agricultural laborers, who

almost wholly depend on agricultural wages in a region of erratic rainfall and have few savings, would be at high risk of losing their access to food. However, there can be individuals with unstable access to food even in agricultural communities where there is no climate variability, e.g., landless agricultural laborers who fall sick and cannot earn their daily wages would lack stable access to food if, for example, they cannot take out insurance against illness. The third dimension covers access by individuals to adequate resources (entitlements) to acquire appropriate foods for a nutritious diet.

Impacts on Food Production and Availability

Climate change affects agriculture and food production in complex ways. It affects food production directly through changes in agro-ecological conditions and indirectly by affecting growth and distribution of incomes, and thus demand for agricultural produce (Alexandratos, 1995). Impacts have been quantified in numerous studies and under various sets of assumptions. A selection of these results is presented in Quantifying the Impacts on Food Security. Here, it is useful to summarize the main alterations in the agro-ecological environment that are associated with climate change.

In temperate latitudes, higher temperatures are expected to bring predominantly benefits to agriculture: the areas potentially suitable for cropping will expand, the length of the growing period will increase, and crop yields may rise. A moderate incremental warming in some humid and temperate grassland may increase pasture productivity and reduce the need for housing and for compound feed. These gains have to be set against an increased frequency of extreme events, for instance, heat waves and droughts in the Mediterranean region or increased heavy precipitation events and flooding in temperate regions, including the possibility of increased coastal storms; they also have to be set against the fact that semiarid and arid pastures are likely to see reduced livestock productivity and increased livestock mortality. In drier areas, climate models predict increased evapotranspiration and lower soil moisture levels. As a result, some cultivated areas may become unsuitable for cropping and some tropical grassland may become increasingly arid. Temperature rise will also expand the range of many agricultural pests and increase the ability of pest populations to survive the winter and attack spring crops. Another important change for agriculture is the increase in atmospheric carbon dioxide (CO_2) (Arnell *et al.,* 2002).

Impacts on the Stability of Food Supplies

Global and regional weather conditions are also expected to become more variable than at present, with increases in the frequency and severity of extreme events such as cyclones, floods, hailstorms and droughts (Parry *et al.,* 2004). By bringing greater fluctuations in crop yields and local food supplies and higher risks of landslides and erosion damage, they can adversely affect the stability of food supplies and thus food security (Ante and Capalbo, 2010).

Neither climate change nor short-term climate variability and associated adaptation are new phenomena in agriculture, of course. Areas subject to high climate variability are likely to expand, whereas the extent of short-term climate variability is likely to increase across all regions. Furthermore, in semiarid areas, droughts can dramatically reduce crop yields and livestock numbers and productivity. Again, most of this land is in sub-Saharan Africa and parts of South Asia, meaning that the poorest regions with the highest level of chronic undernourishment will also be exposed to the highest degree of instability in food production. How strongly these impacts will be felt will crucially depend on whether such fluctuations can be countered by investments in irrigation, better storage facilities, or higher food imports. In addition, a policy environment that fosters freer trade and promotes investments in transportation, communications, and irrigation infrastructure can help address these challenges early on.

Impacts of Climate Change on Food Utilization

Climate change will also affect the ability of individuals to use food effectively by altering the conditions for food safety and changing the disease pressure from vector, water and food-borne diseases. The IPCC Working Group II provides a detailed account of the health impacts of climate change in chapter 8 of its fourth assessment report (Intergovernmental Panel on Climate Change, 2000). It examines how the various forms of diseases, including vector borne diseases such as malaria, are likely to spread or recede with climate change. The main concern about climate change and food security is that changing climatic conditions can initiate a vicious circle where infectious disease causes or compounds hunger, which, in

turn, makes the affected populations more susceptible to infectious disease. The result can be a substantial decline in labor productivity and an increase in poverty and even mortality. Essentially all manifestations of climate change, be they drought, higher temperatures, or heavy rainfalls have an impact on the disease pressure, and there is growing evidence that these changes affect food safety and food security. The recent IPCC report also emphasizes that increases in daily temperatures will increase the frequency of food poisoning, particularly in temperate regions (Intergovernmental Panel on Climate Change, 2007). Warmer seas may contribute to increased cases of human shellfish and reef-fish poisoning (ciguatera) in tropical regions and a pole ward expansion of the disease. However, there is little new evidence that climate change significantly alters the prevalence of these diseases. Several studies have confirmed and quantified the effects of temperature uncommon forms of food poisoning, such as salmonellosis. These studies show an approximately linear increase in reported cases for each degree increase in weekly temperature.

Moreover, there is evidence that temperature variability affects the incidence of diarrhea disease. Number of studies found that rising temperatures were strongly associated with increased episodes of diarrheal disease in adults and children. Several studies report a strong correlation between monthly temperature and diarrheal episode. Extreme rainfall events can increase the risk of outbreaks of water-borne diseases particularly where traditional water management systems are insufficient to handle the new extremes. Likewise, the impacts of flooding will be felt most strongly in environmentally degraded areas, and where basic public infrastructure, including sanitation and hygiene, is lacking. This will raise the number of people exposed to water-borne diseases (e.g., cholera) and thus, lower their capacity to effectively use food.

Impacts of Climate Change on Access to Food

Access to food refers to the ability of individuals, communities, and countries to purchase sufficient quantities and qualities of food. Over the last 30 years, falling real prices for food and rising real incomes have led to substantial improvements in access to food in many developing countries. Increased purchasing power has allowed a growing number of people to purchase not only more food but also more nutritious food with more protein, micronutrients, and vitamins.

At the regional level, the importance of agriculture as a source of income can be much more important. In these regions, the economic output from agriculture itself (over and above subsistence food production) will be an important contributor to food security (Darwin *et al.*, 1995). The strongest impact of climate change on the economic output of agriculture is expected for sub-Saharan Africa, which means that the poorest and already most food-insecure region is also expected to suffer the largest contraction of agricultural incomes.

Climate Change will Increase Hunger and Malnutrition

Climate change will worsen the living conditions of farmers, fishers and forest-dependent people who are already vulnerable and food insecure. Hunger and malnutrition will increase. Rural communities, particularly those living in already fragile environments, face an immediate and ever-growing risk of increased crop failure, loss of livestock, and reduced availability of marine, aquaculture and forest products. More frequent and more intense extreme weather events will have adverse impacts on food availability, accessibility, stability and utilization, as well as on livelihood assets and opportunities in both rural and urban areas. Poor people will be at risk of food insecurity due to loss of assets and lack of adequate insurance coverage. Rural people's ability to cope with climate change impacts depends on the existing cultural and policy context, as well as on socio-economic factors like gender, household composition, age, and the distribution of household assets.

New Patterns of Pests and Disease will Emerge

Humans, plants, livestock and fish will be exposed to new pests and diseases that flourish only at specific temperatures and humidity. This will pose new risks for food security, food safety and human health.

Fishing and Aquaculture are Threatened by Climate Change

Climate change is having an impact on oceans, seas, lakes and rivers and on the animals and plants that are found and/or cultured in them. Climate change will affect the approximately 200 million people and their families worldwide whose livelihoods depend on fishing and aquaculture. Some fish resources will

become less abundant while important species may move to other areas where they are less available to the fishers. Aquaculture practices may be threatened, among other factors, by increased extreme weather events, droughts, and the warming of waters. This will make it harder for many fishing communities to continue to make a living from fish or to provide fish for feeding their families. Coastal communities may also be displaced by rising sea levels and will be forced to find new places to live and new ways to earn a living.

Agriculture Contributes to Climate Change, but is also Part of the Solution

Greenhouse gas (GHG) emissions from the forest and agriculture sectors contribute over 30 percent of the current annual total emissions (deforestation and forest degradation 17.4 percent, agriculture 13.5 percent). Agriculture, however, can also contribute to reducing GHG emissions and their impacts through managing ecosystem services, reduction of land use change and related deforestation, more efficient crop varieties, better control of wildfires, improved nutrition for ruminant livestock, more efficient management of livestock waste, organic soil management, conservation agriculture and agroforestry systems. As well as reducing GHG emissions, well managed crop and pasture land can sequester significant amounts of carbon. Forty percent of the land biomass, and thus, the biological carbon are directly or indirectly managed by farmers, foresters or herders. It is in their interests to adopt management systems that combine mitigation and adaptation, thereby improving both local and global food security.

Sustainable Livestock Management can Reduce GHG Emissions

Land used for livestock production, including grazing land and cropland dedicated to the production of feed, represents approximately 70 percent of all agricultural land in the world. Overgrazing is the greatest cause of degradation of grasslands. Improved land management practices would help to achieve a balance between competing demands for animal food products and environmental services. Improved pasture management and silvopastoral systems are effective ways to conserve the environment and mitigate climate change. Recent linking of pasture regeneration policies and programmes to no-till based integrated crop/pasture/livestock systems in Brazil appears promising for both farmers and the environment. Sustainable intensification and improved manure management are further options to reduce GHG emissions per unit of livestock product, and the use of biogas from animal waste can reduce dependence locally on fossil energy.

Adapting to Climate Change for Food Security

Disruption or decline in global and local food supplies due to climate change can be avoided. Through more efficient irrigation and watershed management, improved crop varieties, improved land cultivation, farm and livestock management and the development of crop varieties and breeds that are adapted to changing climatic conditions. An effective use of climate data and forecasts, through early warning systems, can assist in analyzing the impacts of climate change on agricultural production and the entire food chain.

Water is Key

Raised productivity from improved agricultural water management will be essential to buffer the anticipated volatility of rain fed production. Managing the production risk in the face of increasing aridity and more variable rainfall events will require both rain fed and irrigated agricultural systems to become much more responsive and flexible in approach. Progressive adjustment of large-scale irrigation schemes will be essential to maintain and grow output in line with demand and improved local water management practices will allow vulnerable groups to adapt livelihoods.

Soils Hold Significant Climate Change Mitigation Potential

The global soil carbon pool exceeds biomass pools by a factor of four or five, without taking into account that recent soil degradation has led to losses of between 30 percent and 75 percent of their antecedent soil organic carbon. Globally, therefore, a soil carbon increase offers great mitigation potential. The restoration of wastelands, degraded/desertified soils and ecosystems (e.g. forest restoration, improved pastures) and adoption of improved farm management practices, can enhance and restore soil organic carbon, control and reduce GHG emissions, and improve soil quality and soil health. Such management practices can at the same time improves food security as well as soil-related environmental services.

Agricultural Biodiversity

Agricultural biodiversity will be an important element in the development of production strategies to meet the challenges of climate change, by increasing resilience to changing environmental conditions and stress (drought, salinity, flooding). Ecosystem services (such as genetic resources, soil formation or nutrient cycling) build important measures of resilience and risk mitigation into agriculture – elements that are increasingly important under changing climates.

Adaptation and Mitigation through Sustainable Forest Management

Around 13 million hectares of forests are lost annually due to deforestation. Sustainable management of forests, reducing emissions from deforestation and forest degradation (REDD), afforestation/reforestation and forest restoration, as well as sustainably produced wood products that replace more carbon-intensive materials and fuels, are important mitigation options. Climate change is affecting the health of forests through an increase of forest fires, pests and diseases. Adaptation measures not only reduce the vulnerability of the world's forests and forest dependent people, but can help to protect water and soil resources and biodiversity. Without economic or other incentives and without political will, however, it will be difficult to reduce deforestation and forest degradation and achieve long-lasting adaptation and mitigation measures.

Sustainable Food Production and Climate Change Responses Go Hand in Hand

Sustainable food production practices and climate change adaptation and mitigation strategies are mutually supportive. Many climate and weather risk management strategies fit squarely into sustainable agriculture and fisheries practices and can, therefore, be promoted through several of the programmes and policies targeting environmentally responsible production. Integration is a key feature for both practicing and promoting sustainable food production and for developing climate change adaptation policies.

CONCLUSION

Climate change will affect all four dimensions of food security, namely food availability (i.e., production and trade), access to food, stability of food supplies and food utilization. The importance of the various dimensions and the overall impact of climate change on food security will differ across regions and over time and most importantly, will depend on the overall socio-economic status that a country has accomplished as the effects of climate change set in. Essentially all quantitative assessments show that climate change will adversely affect food security. Climate change will increase the dependency of developing countries on imports and accentuate existing focus of food insecurity on sub-Saharan Africa and to a lesser extent on South Asia. Within the developing world, the adverse impacts of climate change will fall disproportionately on the poor. Many quantitative assessments also show that the socio-economic environment in which climate change is likely to evolve is more important than the impacts that can be expected from the biophysical changes of climate change. Less is known about the role of climate change for food stability and utilization, at least in quantitative terms.

However, it is likely that differences in socio-economic development paths will also be the crucial determinant for food utilization in the long run and that they will be decisive for the ability to cope with problems of food instability, be they climate-related or caused by other factors. Finally, all quantitative assessments we reviewed show that the first decades of the 21st century are expected to see low impacts of climate change, but also lower overall incomes and still a higher dependence on agriculture. During these first decades, the biophysical changes as such will be less pronounced but climate change will affect those particularly adversely that are still more dependent on agriculture and have lower overall incomes to cope with the impacts of climate change. By contrast, the second half of the century is expected to bring more severe biophysical impacts but also a greater ability to cope with them. The underlying assumption is that the general transition in the income formation away from agriculture toward nonagricultural will be successful.

How strong the impacts of climate change will be felt over all decades will crucially depend on the future policy environment for the poor. Freer trade can help to improve access to international supplies; investments in transportation and communication infrastructure will help provide secure and timely local

deliveries; irrigation, a promotion of sustainable agricultural practices and continued technological progress can play a crucial role in providing steady local and international supplies under climate change.

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