PROJECTED IMPACT OF CLIMATE CHANGE ON AGRICULTURE AND FOOD SECURITY IN AFRICA

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Abstract

Considerable attention has been given to climate change and its impacts on Africa. Agriculture is of special concern as it is the primary source of food and is dependent on weather, especially in sub-Saharan Africa (SSA). There is, therefore, a wide range of estimated climate change impacts for the 21st century over a large number of regions. The impact of climate change on agriculture is estimated to be large, even in the face of large uncertainties. In this prospect, several studies highlight the importance of adaptation mechanisms to limit the negative effects. This chapter discusses the literature on introduction; Africa's agriculture sector: an overview; climate change and crop yield; impact on crop yields in SSA; impact on food demand, prices and trade; impact on food production and malnutrition; mitigation and adaptation; and climate change and policy recommendations; and conclusion.

Keywords
Climate action, agriculture, food security, policy, Africa

Introduction

Agriculture is an important sector of the African economy despite its meagre contribution to the gross domestic product (GDP) in strict terms. The agriculture sector

contributes about 15% of the total GDP. The sector contributes 4 per cent annually to the GDP in South Africa and this figure appears minuscule at face value.
The Food and Agriculture Organization (FAO) of the UN has warned that hunger in Africa is being made worse by the impacts of climate change. 224 million people are now reportedly under-nourished on the continent, an increase of over 20 million in recent years. This very strongly is related to climate change. Climate change is emerging as a major challenge to agriculture development in Africa. The increasingly unpredictable and erratic nature of weather systems on the continent has placed an extra burden on food security and rural livelihoods (Climate change in Africa: The threat to Agriculture, 2009).

Africa's Agriculture Sector: An Overview

It is a primary sector concerned with the extraction of raw materials and is comprised of the crops, livestock, fisheries, and forestry subsector. With an estimated GDP of $2.6 trillion; $6.7 trillion (PPP; 2019), a population of 1.307 billion persons (16% of the world population), GDP growth of 3.7% and GDP per capita of $1,970 (2020; 6th).

Agriculture, food, and related industries contributed $1.109 trillion to the U.S. gross domestic product (GDP) in 2019, a 5.2 per cent share. The output of America's farms contributed about $136.1 billion of this sum (about 0.6 per cent of the GDP). Importantly, The West African region (ECOWAS), East Africa, Central Africa and Southern Africa (SADC) in particular, are expected to reach a combined GDP of $29 trillion by 2050.

Agriculture forms a significant portion of the economies of all African countries, as a sector it can therefore contribute towards major continental priorities, such as eradicating poverty and extreme hunger, boosting intra-Africa trade and investments, rapid industrialization, economic diversification and sustainability.

Peasant and subsistence farming can be referred to as the basic form of agriculture in most parts of the continent, and it is pertinent to note that agricultural practices in Africa are extremely varied. Two important crops produced in Africa are cassava, potatoes, banana and plantains. On the other hand, two other grain crops grown on a limited scale in Africa wheat and barley, are raised on a limited scale.

Examples of beverage crops successfully grown and exported from Africa are tea, coffee, cocoa, and grapes. Kenya, Tanzania, Malawi, Zimbabwe, and Mozambique are the largest producers of tea, while Ethiopia, Uganda, Côte d'Ivoire, Tanzania, and Madagascar are the major producers of coffee. Cocoa is essentially a tropical forest crop. However, it is pertinent to note that the top leading agricultural countries in Africa are Ethiopia, Uganda, Nigeria, Tanzania, Zimbabwe, Ghana, Kenya, Cote d'Ivoire, Mozambique, Senegal, Mali and Malawi.

Sub-Saharan Africa is much more vulnerable to climate change because Africa's adaptive capacity is extremely low, which is linked to acute poverty levels and poor infrastructure, as reflected in a high dependence on rain-fed agriculture (Brooks, Adger, & Kelly, 2005). The impact of climate change would be disastrous in Africa if not properly addressed due to the level of illiteracy of the majority of the farmers and farming operations in general of which about 70% of them rely on rain-fed agriculture for their livelihood. Again, about 80% of cultivated lands in

SSA is done by small-scale farmers on a subsistent level. This type of agriculture which is dependent on the weather entirely means that very little mechanized agriculture is practiced and a dearth of information and research that can lift agriculture to a level that it can be self-sustaining to withstand the impending consequences of climate change and the demands of the ever-increasing population.

The Intergovernmental Panel on Climate Change (Solomon, 2007) projected that climate variability and change would severely compromise agricultural productivity and access to food. Cropping systems, livestock and fisheries will be at greater risk of pests and diseases as a result of future climate change. Research programs on Climate Change, Agriculture and Food Security (CCAFS) have identified that crop pests already account for approximately 1/6th of farm productivity losses; and climate change will accelerate the prevalence of pests and diseases and increase the occurrence of highly impactful events (Dinesh, et al., 2015). The impacts of climate change on agricultural production in Africa will have serious implications for food security and livelihoods. Between 2014 and 2018, Africa had the highest levels of food insecurity in the world (The State of Food Security and Nutrition in the World 2019. Safeguarding against economic slowdowns and downturns, 2019).

According to the IPCC (Solomon, 2007), warming in sub-Saharan Africa (SSA) is expected to be greater than the global average, and in the parts of the region, rainfall will decline and these projections are generated by highly sophisticated General Circulation Models (GCMs) (Ringler, Zhu, Cai, Koo, & Wang, 2010). While the rate of precipitation will be high in some areas, other regions will see drought in many places and extremes of temperature, as well as high relative humidity whose effects on plants and animals are adverse. The impact of climate change is projected to affect agriculture in diverse following ways as elaborated in the following sections.

Climate Change and Crop Yield

Increased heat, drought and insect outbreaks, all linked to climate change, have increased wildfires. Declining water supplies, health impacts in cities due to heat, and flooding and erosion in coastal areas are additional concerns especially as it leads to reduced agricultural yields. In other words, climate change most likely causes an overall increase in crop yields.
Adjusting crop sowing dates and varieties leads to yield improvements. Sowing dates and varieties have less impact on economic and environmental outcomes. Technical progress has a higher impact on crop yields than climate change.

An increase in rainfall will result in high crop yields. Also, researchers have shown that high CO_2 levels associated with global warming can cause an increase in plant growth. Carbon is associated with certain house gases like carbon monoxide (CO) and chlorofluorocarbon (CFC) are important in global warming (Solomon, 2007). However, other factors such as a change in temperatures, flooding and drought in some places and characterized climate change can result in a drop in the yield of the agro commodity, as it were. For instance, if the temperature exceeds a crop's optimal level, if sufficient water and nutrients are not available, yield increases may be reduced or reversed. In other words, extreme climatic events such as flooding, extreme heat, and drought lead to soil degradation thereby resulting in low crop yields. Some African states are already having the negative impact of climate change; for instance, flooding in Burkina Faso destroyed farms and homes and the prolonged drought in Ethiopia. Comprehensive Climate

Change (CCC) scenarios integrate projections of 17 GCMs based on their relative performance in predicting temperature and precipitation across the SSA. The General Circulation Model (GCM) makes projections on temperature and precipitation on a global level. It is projected that the warming in SSA is expected to exceed the global average (Solomon, 2007). These have a direct effect on soils, which inadvertently cause a drop in crop yield. The drop in the yield of crops is a serious threat to food security for the teeming population in Africa.

Impact on Crop Yields in Sub-Saharan Africa

The Decision Support System for Agrotechnology (DSSAT) crop simulator model is used to assess the impacts of climate change from the CCC on crop area and yield. DSSAT is a detailed process model of the daily development of a crop from planting to harvest ready: and requires daily weather data, including maximum and minimum temperature, solar radiation and precipitation, a description of the soil physical and chemical characteristics of the field and crop management, including crop, variety, planting date, plant spacing, and inputs such as fertilizer and irrigation[6].

Climate change will affect crop area, yield, and production. Negative yield impacts are projected to be largest for wheat, followed by sweet potato, whereas overall yields for millet and sorghum are projected to be slightly higher under climate change. Although negative impacts are the largest for wheat, the region grows very little of it (about 4.3 million ha in 2000). In contrast, some more drought-tolerant crops have benefited from climate change. Yields of sorghum, which many people in the developing world use as a food grain, have increased by 0.7 per cent in sub-Saharan Africa and 0.9 per cent yearly in western, southern and southeastern Asia due to climate shifts since the 1970s.

There are several possible effects climate change could also have on crop pests and disease. These would include increased weed growth due to higher levels of atmospheric Carbon Dioxide (CO_2) and an increased prevalence of pests and pathogens in livestock and crops.

Impact on Food Demand, Prices and Trade

According to the IPCC (Solomon, 2007), agricultural productivity will decline from 21% to 9% by 2080 due to climate change in sub-Saharan Africa. In precipitation, rising temperatures are likely to reduce the production of stable food by up to 50%. However, under climate change, aggregate food demand for cereals in the SSA region declines by 3.6 million mt or 1.5 per cent by 2050. Among agroecological zones, declines are largest for Central and Southern Africa, at 2.5 and 2.1 per cent, respectively, and lowest in the Gulf of Guinea, at 0.9 per cent. These differences are due to the relative impacts on cereal area and yields in the regional food baskets, as well as relative changes in global food prices of individual cereals (Ringler, Zhu, Cai, Koo, & Wang, 2010).

At the same time, Africa and other developing regions are projected to experience a continuing increase in per capita incomes (Solomon, 2007) and a demographic shift from rural to urban areas, with two-thirds of the world's people living in urban areas by 2050. The population of Africa is projected to increase rapidly throughout the 21st century. This will place a high demand for food crops. Demand for traditional staples (excluding rice) is likely to slow in per capita terms as demand for purchased and processed foods increases (Keith, Timothy, Mason-D'Croz, & Mark, 2017).

The direct consequences of climate change on trade could become manifest in damages to trade from more frequent extreme weather events or rising sea levels. Supply, transport and distribution chains might become more vulnerable to disruptions due to climate change.

Impact on Food Production and Malnutrition

According to the IPCC (Solomon, 2007), agricultural productivity will decline from 21% to 9% by 2080 due to climate change in sub-Saharan Africa. The report indicates that rising temperatures in precipitation are likely to reduce the production of stable food by up to 50%. In SSA, cereal production is expected to double, but due to climate change, about 5% less production is projected in 2050 than what would have been obtainable without climate change.

Roots and tubers: there is a projection of roots and tubers increase from 1 million tons to 43 million tons by 2050. The projection for per capita consumption is that there will be no change, being around 150kg per capita per year.

Fruits and vegetables: the production of fruits and vegetables in sub-Saharan Africa is expected to increase by 1.6 times by 2050 and 0.5 per capita consumption.

Based on the combined effects of changes in population, income, climate, and productivity, the number of people at risk of hunger in Africa south of the Sahara is projected to decline from 209.5 million persons in 2010 to 188.7 million persons in 2050 in this scenario. Projected improvements are greatest in Central Africa, with slight increases in the number at risk in regions of east and west Africa. Climate change reduces the improvement that would be projected in the absence of climate change, leaving 38 million more people at risk of hunger in Africa south of the Sahara in 2050 than would otherwise be the case, most of them in eastern Africa. And the malnutrition rate for children younger than five years (as measured by wasting) is projected to rise from 21.7 to 24.4 per cent by 2050—an increase of more than 4 million children.

Climate change is one of the leading global causes of hunger. It means more frequent and intense extreme weather events that increase food insecurity and malnutrition by destroying land, livestock, crops and food supplies (Keith, Timothy, Mason-D'Croz, & Mark, 2017).

Mitigation and Adaptation

A recent study in collaboration with the fifteen (15) CGIAR Centers examined 3 sets of alternative investment scenarios for the developing world, each of which increases investment in one of the areas described in the previous section. A fourth comprehensive scenario combines elements from the first three:

(i**) Enhanced productivity through increased investments in agricultural research and development (R&D).**

Five scenarios explore the impacts of different levels of increased investment in research by CGIAR and national agricultural research systems, with different regional emphases, to help overcome the disparities in productivity growth, particularly in Africa south of the Sahara and South Asia.

(ii) Improved water resource management.

Three scenarios explore the impacts of increased investment to expand the irrigated area, increase water use efficiency, and increase the water-holding capacity of the soil.

(iii) Improved marketing efficiency through increased investment in infrastructure.

One scenario explores the impact of increased investment in transportation and marketing infrastructure to reduce price margins between producers and consumers.

(iv) A comprehensive scenario combining selected elements of 1–3

The agricultural practices in Africa need to be streamlined to current agricultural technology to adapt their agricultural practice to changing climatic conditions. This will require making some good policies that will guide the necessary changes in agriculture (Keith, Timothy, Mason-D'Croz, & Mark, 2017).

Climate Change and Policy

Climate change will increasingly impact Africa due to many factors. These impacts are already being felt and will increase in magnitude if action is not taken to reduce global carbon emissions. The impacts include higher temperatures, drought, changing rainfall patterns, and increased climate variability. Bottlenecks emanating from climate change require policies designed to reduce greenhouse gas emissions and air pollution and to prepare populations and infrastructure for the impacts of climate change through adaptation.

Travis Lybbert and Daniel Sumner suggest six policies principles (Lybbert & Sumner, 2012)

(i.) The best policy and institutional responses will enhance information flows, incentives and flexibility.

(ii.) Policies and institutions that promote economic development and reduce poverty will often improve agricultural adaptation and may also pave the way for more effective climate change mitigation through agriculture.

(iii.) Business as usual among the world's poor is not adequate.

(iv.) Existing technology options must be made more available and accessible without overlooking complementary capacity and investments.

(v.) Adaptation and mitigation in agriculture will require local responses, but effective policy responses must also reflect global impacts and inter-linkages.

(vi.) Trade will play a critical role in both mitigation and adaptation, but will itself be shaped importantly by climate change

Governments of African countries need to be educated and informed of the danger facing them concerning food insecurity and other bottlenecks associated with agriculture. The information should get to all levels of government and serious awareness created so that everybody will have good knowledge of the projected impact of climate change. Instances of current effects of the change should be cited to convince all and sundry. The government should also apply policies and practices that would help to alleviate the impact of climate change

One of the important agricultural practices to mitigate climate change and help our agricultural practice to adapt to climate change at the same time was launched in 2019 by the "Global EverGreening Alliance". The initiative was announced at the 2019 UN Climate Action Summit. The main method is Agroforestry agroforestry is a method of farming whereby food crops are grown alongside trees and shrubs. The trees and shrubs grow in the same piece of land with food crops this helps to place the farm in its natural ecosystem where the functions of the trees and

shrubs will combine with that of the food crops to have a balance. This will help sustain the soil body which will in turn cause a good yield for crops without any damage to the ecosystem. The usefulness is in utilizing the products of the forest trees and those of the food crops at the same time while sustaining zero damage to the ecosystem which would be in its natural state. Besides, it would not require much money as the planted trees do not require replanting yearly. The trees would also serve as a shield from the direct impacts of the elements, in this case, those of the climate. A large forest canopy is also a solution to climate change as the carbon dioxide will be used by the trees and oxygen released during photosynthesis.

Another important method is Conservation farming. Conservation farming according to FAO (The state of food and agriculture 2020: Overcoming water challenges in agriculture, 2020) is a farming system that promotes minimum soil disturbance (i.e. no-till farming), maintenance of a permanent soil cover, and diversification of plant species. It enhances Biodiversity and natural biological processes above and below the ground surface, which contribute to increased water and nutrient use efficiency and improved and sustained crop production.

The essence of the above practices is to sequester carbon in large quantities from the atmosphere. It is estimated that about 20 billion of carbon yearly would be sequestered by 2050. The intent is to recover an area of 5.75 million square kilometers with trees and achieve a tree-grass balance covering a territory of 6.5 million square kilometers. This led to the "Grand African Savannah Green Up" project. Already millions of families implemented these methods, and the average territory covered with trees in the farms in the Sahel increased to 16% (Hoffner, 2021).

Conclusion

The main long-term impacts of climate change in Africa include changing rainfall patterns affecting agriculture and reducing food security; worsening water security; decreasing fish resources in large lakes due to rising temperatures and overfishing; rising sea levels affecting low-lying coastal areas. Some of these problems are soil erosion from mechanization, water salinization from irrigation, accumulation of DDT in food and water and animal life from pesticide use, and water pollution from chemical fertilizers. Food production can be increased with more ecologically sound practices. It is noteworthy that some points to help mitigate climate change issues such as making an investment in climate change research; increasing financing for global health systems; eliminating coal as an energy source; Support cities that encourage healthy activities for individuals and the planet; clarifying carbon pricing; and to increase access to renewable energy in low to middle-income countries.

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