

CLIMATE SMART AGRICULTURE, FOOD SECURITY AND SUSTAINABLE DEVELOPMENT

GLOBAL ISSUES & LOCAL PERSPECTIVES volume One

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CLIMATE SMART AGRICULTURE, FOOD SECURITY AND SUSTAINABLE DEVELOPMENT

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Preface

This book adopts an exegetical approach as well as a pedagogic model, making it attractive agriculture and environmental economics teachers, professional practitioners and scholars. It eschews pedantry and lays bare the issues in such clarity that conduces to learning. The book elaborates on contemporaneous **Climate Smart Agriculture, Food Security and Sustainable Development** issues of global significance and at the same time, is mindful of local or national perspectives making it appealing both to international and national interests. The book explores the ways in which climate smart agriculture (CSA) food security, Sustainable Development issues are and should be presented to increase the public's stock of knowledge, increase awareness about burning issues and empower the scholars and public to engage in the participatory dialogue climate smart agriculture, food security, and sustainable development necessary in policy making process that will stimulate increase in food production and environmental sustainability.

Climate Smart Agriculture, Food Security and Sustainable Development: Global Issues & Local Perspectives is organized in three parts. Part One deals with The Concept of **Climate Smart Agriculture**, Part Two is concerned with The Concept of **Food Security And** and Part Three deals with the Concept of **Sustainable Development**

Eteyen Nyong; October 2025

Chapter Eighteen

Climate Change and Food Production Threats in Nigeria: A Call for Action

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1.0	Introduction	

Climate change is a global threat to humanity and all that concerns it. Climate change entails changes in temperature, precipitation, wind, storms, and other indicators of the climate. Other key indicators, such as sea level rise, can also be used to track climate change. The average surface temperature is considered by experts to be the most significant indication of climate change.

Climate change can also be described as a long-term alteration in the global atmospheric condition. Such shifts, according to United Nations can be natural, due to alteration in the sun's activity or large volcanic eruptions; or human activities among which are the release of greenhouse gases (GHGs) such as Carbon dioxide, methane, and nitrous oxide into the atmosphere. These gasses trap heat from the sun to the earth, leading to global warming and negative impacts on weather, ecosystem, and human societies that hunt both the living and non-living component of the earth surface. United Nations further revealed that since the 1800s, human activities have been the main cause of [climate change](#), globally. These human activities primarily involve burning of fossil fuels like coal, oil and gas.

The burning of fossil fuels generates greenhouse gas emissions that act like a blanket wrapped around the Earth, trapping the sun's heat and raising temperatures. The main greenhouse gases that are causing climate change include carbon dioxide and methane. These come from using gasoline for driving a car or coal for heating a building. Also, other human activities like clearing land and cutting down forests can also release carbon dioxide. Agriculture, oil and gas operations are major sources of methane emissions. Energy, industry, transport, buildings, agriculture and land use are among the [main sectors](#) causing greenhouse gases. These and many more are all activities of humans.

Climate change (CC) is a major global challenge of our time, with high level negative implications for the environment, economies, and societies. The major negative implication of CC include, the impact on food production, which stands out as particularly critical. The rise in global temperatures, results in an increasing erratic weather patterns, and extreme events such as droughts, floods, and storms become more frequent, the stability of food systems is negotiated and adversely affected. This compromised condition threatens not only agricultural productivity but by extension food security, nutrition, and livelihoods, particularly in vulnerable regions that rely heavily on climate-sensitive crops or animals.

Sub-Saharan Africa, Nigeria, inclusive is particularly vulnerable to climate change because agricultural activities are mainly weather dependent. In this part of the world, CC poses significant threats to production of food and fibre due to socioeconomic, environmental, or political factors. These threats results in food insecurity, poverty and lose of livelihood among rural farmers, who are mainly smallholder.

There is a strong relationship between climate change and global food production. The interplay between the global climate change and food production is multi-dimensional, because it involves a multitude of factors such soil health, water availability, and pest dynamics, etc. As the world strives to feed a population that is growing geometrically, which is projected to reach nearly 10 billion by 2050, the urgency to address these threats becomes important.

2.0 Climate change scenario: The past, present and future

The average global temperature has increased by 0.65°C in the last 50 years. CC became more severe than before since 1993, as the pace of sea-level rise has more than doubled. The sea level has climbed by around 10mm, since year 2020, hitting a new height in 2024. The World Meteorological Organization (2023) revealed that the previous two and a half years accounted for about 10% of overall sea level increase since the commencement of satellite monitoring about 3 decades. According to the fifth report of the Intergovernmental Panel on Climate Change (IPCC) that was issued in 2014, it was predicted that the global mean surface temperature would rise by 0.85°C, between 1910 and 2010, while the highest increase in climatic activities occurred between 1951 and 2010. The report also noted an accelerated pace in the warming, with the mean rate from 1998 to 2012 being 0.05°C per decade greater than the average rate from 1951 to 2012.

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Since 2010, the mean global surface temperature has been rising, and the five-year period from 2014 to 2019 was the warmest on record. The mean rate of warming over this period was 0.14°C per decade, more than double the average rate from 1951 to 2012. If emissions of gasses are not drastically reduced, the IPCC predicts that the global average surface temperature will rise by 1.5°C over and above the pre-industrial levels by 2022. This rise is what has been witnessed globally.

Nigeria's situation on CC matter is not different from the global perspective, primarily due to the high vulnerability index of Nigeria and other low income or developing countries. The mean temperatures in Nigeria has been consistently increasing in the last five decades and has been rising significantly since the 1980s, with a change of 1.01°C (0.52 to 1.5°C) in the linear warming for the period 1951 – 2005 (Nigeria Agribusiness Group (NABG), 2025). The linear warming for the same period for 30-year averages on a decadal slice further revealed positive changes in temperature by an average of 0.2°C/decade (Nigeria Agribusiness Group, 2025). The Third National Communication on CC reported the anticipated future climatic trends for the years 2050 and 2070, that the minimum temperature increase could range from 1.48°C to 1.78°C and the maximum increase of about +3.08°C to +3.48°C compared to the baseline of 1990, could occur. A general increase in the number of days of rain and days with extreme rainfall events that may generate floods are projected over most ecological zones of the country except in the northeast Sahel zone, where the scenario analysis suggests fewer extreme events related to rainfall and flooding.

3.0 Global Drivers of Climate Change

The drivers of CC are classified into two, viz, human factors and natural factors.

A. Human factors

CC is driven by a variety of anthropogenic (human-induced) factors. These human-induced factors include:

a. Greenhouse Gas Emissions (GHGs)

The various GHGs emitted due to the activities of human beings include the following:

Carbon Dioxide (CO₂): CO₂ is mainly caused by two different activities of men. These are:

- i. Burning of fossil fuels: The burning of fossil fuels such as coal, oil, and natural gas for energy and transportation is the largest source of CO₂ emissions. This contribute mainly to CC and air pollution.
- ii. Deforestation: This refers to the indiscriminate felling of forest trees. This also contributes to an increased CO₂ levels as trees that absorb CO₂ are removed. The rate of deforestation today is high due to agricultural expansion, logging, infrastructural development, mining and wildfire.

Methane (CH₄): Methane is another GHGs that drive CC. It is released during the production and transport of coal, oil, and natural gas. It is also emitted by livestock and other agricultural practices, as well as by the decay of waste in landfills.

Nitrous Oxide (N₂O): This gas is released from agricultural and industrial activities, as well as during the combustion of fossil fuels and solid waste. N₂O is a serious GHGs that contributes greatly to CC.

b. Deforestation

Deforestation simple refers to the incessant removal of trees and forests cover, which results in damage to the quality of the land. It is a global environmental issue with an attendant negative consequences such as biodiversity loss, climate change, and human livelihood threat. The indiscriminate clearing of forests for agriculture, logging, mining and urban development reduces the number of trees that can absorb CO₂ from the atmosphere, hence, an increase in the level of CO₂ in the atmosphere which results in adverse climatic condition called CC.

c. Industrial Processes

Many industrial activities release greenhouse gases and other pollutants capable of depleting the ozone layer that can change the climate. For example, cement production industries emits significant amounts of CO₂, while chemical manufacturing industry can release various greenhouse gases. These are gasses that induce the CC.

d. Agricultural Practices

Agriculture contribute to CC and at the same time negatively affected by climate change. Agriculture contributes to CC through the use of fertilizers that release nitrous oxide and methane emissions from livestock waste and land-use changes associated with crop production such as deforestation.

e. Waste Management

Waste collection, transportation, processing, recycling, and disposal of waste materials contributes to CC. Such waste could be municipal, industrial, biomedical or electronic waste. Improper waste management practices significantly contribute to CC through the emission of GHGs such as methane and carbon dioxide. Also, landfills produce methane as organic waste decomposes anaerobically. Poor waste management practices can exacerbate greenhouse gas emissions.

f. Energy production

The use of fossil fuels in generating electricity and heat is a major source of greenhouse gas emissions. Addressing this requires the use of alternative sources (renewable energy sources) like solar, wind, and hydro that can help mitigate this impact.

g. Transportation

Global transportation is still being dominated by the use of cars, trucks, airplanes and ships. This means of transportation rely only on the use of fossil fuels. The burning of fossil fuels by the means of transportation contributes significantly to the emission of GHGs. Emission from transportation include CO₂, NO₂, particulate matter etc.

h. Land Use Changes

The major driver of land use changes is urbanization, mining, fires, industrialization and agricultural expansion. The above mentioned processes or activities are capable of disrupting local ecosystems and contribute to increased greenhouse gas emissions. Converting natural landscapes into urban areas or agricultural land or when natural landscapes are consumed by fires can lead to habitat loss and increased carbon emissions.

B. Natural Factors

Human activities have been identified as the primary drivers of climate change in the recent years. However, natural factors such as volcanic eruptions and variations in solar radiation are also capable of influencing the climate. It should be noted that these factors are generally not responsible for the rapid changes observed in recent decades. These major natural factors that drive climate change are:

i. Volcanic Eruptions

Volcanic eruptions is capable of causing climate change. When large volcanic eruptions occur, massive amounts of ash and aerosols are released into the atmosphere, reflecting sunlight and cooling the planet. However, this had not contributed to climate change that occurred in the recent years. E.g., the eruption of Mount Pinatubo in 1991 led to a global temperature drop of about 0.5°C (0.9°F) for approximately two years.

ii. Changes in Earth's Orbit

Changes in temperature occurs where there is changes in earth's orbit around the sun because such changes around the orbit affect the amount of solar energy the planet receives. Examples of such is variations in earth's eccentricity, axial tilt, and precession.

iii. Solar Variability

Solar variability occurs when there is change in the sun's energy output. This variation or alteration in sun energy output can impact earth's climate.

iv. Natural Climate Oscillations

Another natural factor of importance is natural climate oscillations. Natural climate patterns, such as El Niño and La Niña events, can impact global temperatures and precipitation patterns which induce climate change.

iv. Changes in ocean circulation patterns can impact regional climate conditions.

Changes in the pattern of ocean circulation can impact regional climate conditions because it will induces the elements of climate in such a region when the ocean is located.

4.0 Conceptual framework of the interplay between climate change and food production

Climate change has a lot of consequences on [agriculture](#), which had become a matter of grave concern for the global scientific community and scholars, pressure groups, governments, and policy makers. Climate change impacts in the forms of rising temperature, changes in precipitation, extreme weather, pests and diseases, soil degradation and water shortage had fuelled unprecedented biodiversity loss. These had created unprecedented negative impact on the agriculture sector, increasingly affecting food production and human systems worldwide. Countries from Africa region are the most vulnerable to the detrimental consequences of climate change in the form of outright crop failure caused by the positive nexus between intensifying temperatures and plants' lowering growth phases. The relationship between the causes and effects are schematized below (Fig. 1-appendix).

5.0 Impact of climate change on food production

Overview of Climate change impacts on food production

On the overall, the earth's temperature has risen by an average of 0.11° Fahrenheit (0.06° Celsius) per decade since 1850, or about 2° F. Since global records began in 1850, year 2024 was the warmest year. This figure was 2.32 °F (1.18 °C) above the 20th-century average of 57.0 °F (13.9 °C). It was also 2.62 °F (1.35 °C) above the pre-industrial average of 56.7 °F (1850-1900). The 10 warmest years in the historical record have all occurred in the past decade (2015-2024). These parameters and other pose significant impact on food and fibre production globally, and specifically, Nigeria.

5.1 Impact of climate change on crop production

Climate change significantly affect global food production in various ways, impacting crop yields, and ultimately, food security. Sub-Saharan Africa is one of the most affected region of the world. Crop production are greatly affected primarily because agricultural production are mainly weather dependent. For example, Maize and sugarcane yields have decreased by 5.8% and 3.9%, respectively, in Sub-Saharan Africa due to climate change. The World Bank projected

a very high emissions scenario that Nigeria is likely to experience a significant rise in temperatures, reaching between 2.9°C and 5.7°C by 2100. The country ranks 154th out of 181 in the ND-GAIN 2021 index, which assesses vulnerability and resilience to climate change. Nigeria's dependence on agriculture, which is mainly weather-dependent makes it particularly sensitive to climate disruptions.

The Nigerian Hydrological Services Agency (NIHSA), in 2022 recorded the worst floods in Nigeria and reported that the flood destroyed more than 440,000 hectares of farmland, affecting more than 1.4 million people, causing more than 662 deaths and displacing thousands of residents. Following these damages, the direct economic damage was estimated at a median value of USD 6.68 billion. Rising sea levels also threatened the Nigerian coast and had resulted in erosion and salinisation of land and flooding.

Climate change is accelerating the degradation of ecosystems in Nigeria, reducing the country's resilience to climatic shocks. Deforestation, driven by agricultural expansion, illegal logging and charcoal production, is leading to a loss of biodiversity, soil erosion and a reduction in the capacity of forests to absorb carbon. According to the Global Forest Watch (GFW) initiative, between 2001 and 2023, Nigeria lost 1.33 Mha of tree cover, equivalent to a 13% decrease in tree cover since 2000 and 724 Mt of CO₂ emissions.

The specific impact of climate change caused by its attendant effects are:

i. Temperature rise: Temperature rise causes heat stress. It causes heat stress in plants, especially during critical growth stages like flowering and grain filling, leading to reduced yields. It also shortened growing period by accelerating crop development, shortening the growing season, which can reduce the time for crops to accumulate biomass. Similarly, extreme temperature or shifts in the timing of planting, flowering, and harvest, impairs photosynthesis, limiting plant growth, reduces grain size, protein content and sugar levels in fruits. It in addition increases the range, reproduction rate, and survival of pests and diseases, causing more crop damage.

ii. Change in rainfall pattern

Climate change had caused incessant reduction in the rainfall pattern, resulting in drought that is caused by shortage of water. Drought occurs when an area gets rainfall that is much less than the usual, resulting in drying up of rivers, failing of crops, low water supply and food shortages.

iii. Pests, diseases and weeds

Warmer temperatures and increased humidity promote the spread of pests and diseases. There are pests that now survive winters or migrate to new regions. Weeds have the tendency of growing faster than crops under elevated CO₂ condition. These all together negatively affect crops yield and by extension food production.

iv. Extreme weather condition

Extreme weather condition causes stormy and frosty conditions. These conditions can destroy crops. Hurricanes and cyclones damage infrastructure, soil, and long-term crop productivity. This is a great condition against food crop production.

5.2 Impact of climate change on livestock production

Climate change also has significant impact on livestock production. The impact of climate on livestock production is multifaceted. Climate change affects livestock directly through heat stress and indirectly through changes in feed availability due low yield of cereal crops, water resources due to drought, and disease patterns. The specific impact of climate change caused by its effects are either direct or indirect.

5.2.1 Direct impacts of climate change on livestock production

i. Heat stress: A major effect of climate change in agriculture is heat stress. Heat stress refers to a condition where the body is unable to cool itself sufficiently and maintain a healthy temperature, typically due to prolonged exposure to high temperatures, high humidity, and often combined with physical exertion. It is a situation of where the body is not capable of adjusting it's to the minimum healthy temperature. Heat stress is caused by hot weather, high humidity, strenuous activity, inadequate hydration etc. However, the weather-induced heat stress is the most lethal to livestock production. Heat stress in livestock reduces feed intake, growth rate, milk production, fertility rate and overall productivity of farm animals. It in addition increases mortality in farm animals. These adverse effects of climate change on livestock production have significant effects on animal production and by extension protein food in humans, which in turn results in both food and nutrition insecurity.

ii. Water scarcity: Water scarcity is also an adverse effect of climate change. It means a situation where there is not enough clean and safe water available to meet the needs of people, agriculture, industry, and the environment in a certain area. It happens when the demand for water exceeds the supply, or when water quality is so poor that it can't be used. When this occurs, dried ponds cannot easily be filled, farm animals do not have access to good quality water and these result in mortality and overall poor performance of livestock industry. This condition results in food production in terms of animal.

5.2.2 Indirect impacts of climate change on food production

Apart of the direct impacts climate change has on livestock production, there are also indirect impact of the climate change on livestock production sub-sector. These indirect impacts are the multiplier impacts of climate change on what livestock needs to grow but not on the livestock directly. The major indirect impact on livestock is the direct impact of climate change on feed and forage availability. Climate change causes changes in temperature, rainfall patter, draught, water scarcity, shifts in growing seasons, changes in plant species composition and increased incidence of pest and disease. These adverse conditions result in low yield of feed making crops and forages which are fed to livestock. The change in climate also results in diseases and parasite burden that reduce livestock productivity, causes weight loss, mortality and reproductive problem in farm animals.

6.0 Climate change impact: A call for action

It has been established that climate change is having devastating effects on food production and by extension, food and nutrition security. In addressing the devastating effect of climate change on food production, a call for climate action becomes imperative. This call entails comprehensive laid down actions that will manage climate risks in food crop production for sustainable food security. This call for action is categorized into three, viz,

A. Adaptation action

An action of importance needed to minimizing the menace of climate change for the purpose of enhancing food production is known climate change adaptation action. This action entails:

- i. Breeding heat-tolerant and disease-resistant animals: It has been established that climate causes heat stress, build up and spread of pests and diseases that adversely affect livestock production. It becomes important to lunch an action that will ensure heat-tolerant and disease-resistant animals are stocked.
- ii. Develop climate-resilient crop varieties: The action above is also needed in the crop production sub-sector. Action or programme that will ensure the distribution of climate-resistant crops are developed and made available to crop farmers.
- iii. Diversify crops and farming practices: Actions or programmes that will promote enterprise diversification should also be lunched as a means of avoiding crop or livestock failure.
- iv. Others actions or programmes include improved shelter and ventilation technologies, efficient water use, alternative feed sources and adjusting livestock management practices (e.g., grazing timing, herd size) for livestock

sub-sector and promotion of climate-smart agriculture, improved water management and irrigation for livestock sub-sector for the purpose of enhancing food production and security in Nigeria.

B. Climate change mitigation action

Mitigating climate change involves taking actions that will address the causes of change. These mitigation actions include reducing methane emissions through feed additives and improved digestion, manure management to reduce greenhouse gas emissions through reduction in chemical fertilizer use and shift to renewable energy farming and Silvopastoral systems (integrating trees and pastures) to improve resilience and carbon sequestration.

C. Services action

Services are actions, mostly, institutional that are put in place but indirectly address the challenges of climate change. These services are the roles government and her agencies are performing. They include climate change financing and trainings by relevant regulatory bodies. This will assist stakeholders in taking appropriate actions that will either assist in adaptation and mitigation actions.

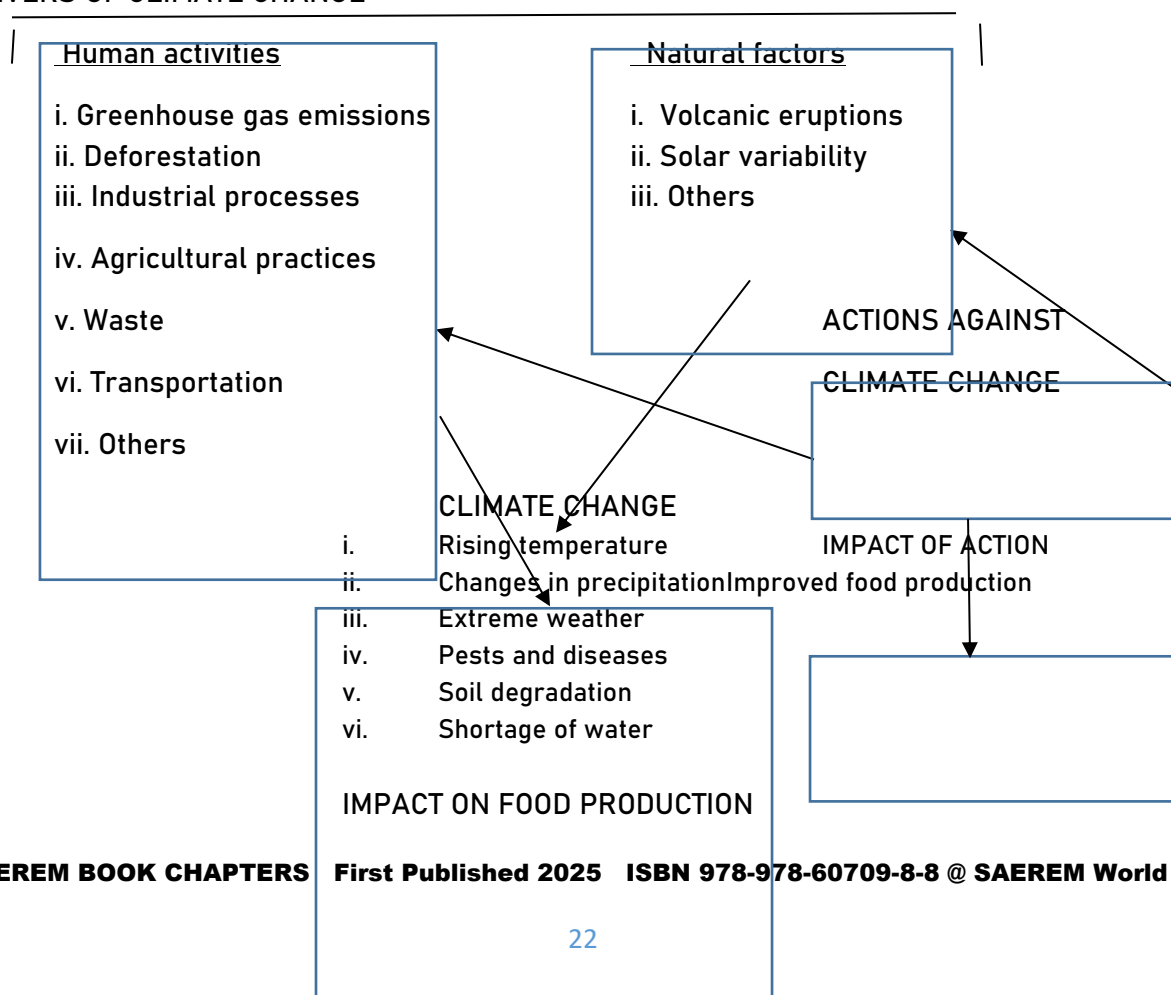
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Appendix

DRIVERS OF CLIMATE CHANGE



- i. Crop loss or failure
- ii. Low crop yield
- iii. Biodiversity loss
- iv. Low yield of animals
- v. Livestock mortality

Fig. 1: Conceptual framework of the interplay between climate change and food production.