NIGERIAN JOURNAL OF PUBLIC SECTOR MANAGEMENT (NJPSM)

Impact of Climate Change on Agriculture in Nigeria

YAU SAUWANU
Department of Public Administration, Federal University Wukari
Phone: 0807-675-1290 Email: sauwanu2014@gmail.com
Corresponding Email: *sauwanu2014@gmail.com*

Abstract
Climate change has emerged as a major threat to agricultural productivity in Nigeria, disrupting traditional farming patterns and undermining food security across the country. Erratic rainfall, rising temperatures, desertification and flooding have significantly altered growing seasons and reduced crop yields, particularly affecting smallholder farmers who depend on rain-fed agriculture. This study explores the multifaceted impact of climate change on Nigeria's agricultural sector, highlighting regional vulnerabilities and adaptation challenges. Utilizing a qualitative research design, the study draws on secondary data from scholarly articles, government policy documents, climate reports, and NGO publications. The data were analyzed using thematic analysis to identify key climate-agriculture interactions and coping strategies. Findings show that climate change has led to increased crop failure, livestock loss, and land degradation, contributing to rural poverty and food insecurity. The study concludes that without effective adaptation policies and technological innovations, climate-induced disruptions will continue to threaten Nigeria's agricultural sustainability. It recommends the integration of climate-smart agricultural practices, investment in irrigation infrastructure, and strengthening of early warning systems. Additionally, it advocates for farmer education and policy reforms that prioritize resilience and environmental sustainability. A proactive, climate-responsive approach is essential to safeguard the future of agriculture and national food security in Nigeria.

Keywords: Climate Change, Agriculture, Desertification, Flood, Food Security

Introduction

Climate change has become a critical global issue, affecting virtually every aspect of human life and natural ecosystems. Across the world, the effects of global warming and climate variability - such as rising temperatures, sea level rise, unpredictable rainfall, droughts, and flooding - have become more evident and damaging. According to the Intergovernmental Panel on Climate Change (IPCC, 2021), human-induced climate change is accelerating at an alarming rate and poses significant risks to global food security, water supply, public health, and economic development. In developing countries, including Nigeria, the adverse effects are even more pronounced due to high levels of poverty, weak infrastructure, and limited capacity for climate resilience. Nigeria, in particular, is experiencing increasingly erratic climate patterns that threaten its natural resource base and overall development trajectory.

Agriculture is one of the most climate-sensitive sectors in Nigeria and also one of the most vital. It employs over a third of the labor force and contributes substantially to the nation's GDP and food supply (National Bureau of Statistics [NBS], 2022). The sector is the primary source of livelihood for the majority of rural dwellers and serves as a critical driver of poverty alleviation, income generation, and economic diversification. However, Nigeria's

agriculture is largely rain-fed and heavily dependent on stable climatic conditions. This dependence makes the sector extremely vulnerable to climate change-induced stressors, such as prolonged dry spells, flooding, desertification, and reduced soil fertility (Ayanlade, Radeny, & Morton, 2017). These changes not only affect productivity but also undermine food security and increase the risk of hunger and malnutrition among vulnerable populations.

The rising frequency and intensity of climate events have heightened concerns about the sustainability of agricultural systems in Nigeria. Recent years have witnessed recurring floods in states like Benue and Kebbi, displacing thousands of farmers and destroying large hectares of farmland. In the northern parts of the country, advancing desertification and water scarcity have significantly reduced the availability of arable land, leading to farmer-herder conflicts and displacement (Olanrewaju, Olaniyan, & Adeniyi, 2019). Similarly, unpredictable rainfall has disrupted planting and harvesting cycles, resulting in decreased crop yields and income losses. These environmental changes pose severe threats not only to food availability but also to rural stability, economic growth, and national development.

Given these growing concerns, the central problem this study seeks to address is how climate change is impacting agricultural productivity and food security in Nigeria. While various policies and adaptation strategies have been initiated at the national level, the effectiveness of these interventions remains limited due to poor implementation, inadequate funding, and weak institutional coordination. There is a pressing need for a comprehensive assessment of how climate change affects different agro-ecological zones, the coping strategies adopted by farmers, and the policy frameworks supporting resilience. This work, therefore, aims to provide evidence-based insights into the linkages between climate change and agriculture in Nigeria, and to recommend sustainable approaches for improving climate adaptation and agricultural development.

Conceptual Framework

Climate Change

Climate change refers to significant and lasting alterations in global or regional climate patterns, particularly those that have become apparent from the mid-20th century onwards, due to increased levels of atmospheric carbon dioxide produced by the use of fossil fuels. According to the Intergovernmental Panel on Climate Change (IPCC, 2021), climate change encompasses both natural and anthropogenic changes in temperature, precipitation, sea levels, and the frequency of extreme weather events over a prolonged period. The IPCC emphasizes that human activities - especially the burning of fossil fuels, deforestation, and industrial emissions - are the primary drivers of global warming and related climatic disruptions. These changes are not only altering weather patterns but also intensifying environmental hazards that negatively impact ecosystems, economies, and human health.

Scholars have expanded on this understanding by emphasizing the socio-economic and ecological implications of climate change, particularly for vulnerable countries. Oreskes (2018) describes climate change as a "multifaceted global crisis" with the potential to exacerbate poverty, food insecurity, water scarcity, and conflict, especially in low-income

regions such as Sub-Saharan Africa. In Nigeria, the manifestations of climate change are evident in persistent droughts in the north, coastal erosion in the south, and erratic rainfall across the middle belt, all of which affect livelihoods and national development (Ayanlade, Radeny, & Morton, 2017). The concept, therefore, extends beyond environmental change to include the complex interactions between human systems and climate variability.

Agriculture

Agriculture is broadly defined as the science, art, and business of cultivating soil, growing crops, and raising animals for food, fiber, fuel, and other products used to sustain and enhance human life. According to the Food and Agriculture Organization (FAO, 2022), agriculture includes not only crop production and animal husbandry but also aquaculture, forestry, and agro-processing activities. It plays a fundamental role in national economies, especially in developing countries, by serving as a source of employment, income, and food security. In Nigeria, agriculture contributes about 23% to the Gross Domestic Product (GDP) and employs more than one-third of the labor force (National Bureau of Statistics [NBS], 2022).

Beyond its economic relevance, agriculture is intricately linked to environmental sustainability, rural development, and social stability. As Adedipe (2020) notes, agriculture in Nigeria is mostly subsistence-based and highly dependent on seasonal rainfall patterns, making it extremely vulnerable to climate variability. Changes in temperature and precipitation affect planting and harvesting times, crop yields, and pest and disease prevalence. Thus, agriculture is not just a productive sector - it is also a climate-sensitive one, deeply affected by both natural and human-induced environmental changes. Understanding agriculture in this broader context is critical for evaluating the impact of climate change and developing effective adaptation strategies.

Theoretical Framework

The theory on which this work is anchored on is the environmental determinism theory. The theory of environmental determinism traces its origins to classical antiquity, with early expressions found in the writings of Greek philosophers such as Hippocrates and Aristotle, who suggested that the physical environment - especially climate - had a significant influence on the behavior, health, and development of human societies. However, the theory gained prominence in modern scholarly discourse during the late 19th and early 20th centuries, especially through the works of geographers like Friedrich Ratzel (1844–1904), a German geographer who argued that the natural environment constrained human activity. His student, Ellsworth Huntington, further popularized the idea in the United States by linking climate with the progress and decline of civilizations (Huntington, 1915).

The central assumption of environmental determinism is that the physical environment, particularly climate, topography, and natural resources, shapes the culture, behaviour and economic development of societies. According to this view, people in temperate regions are more industrious and innovative due to favorable climate conditions,

while those in tropical regions are perceived as less productive because of environmental hardships. The theory suggests that human actions are largely conditioned by environmental circumstances rather than by free will, culture, or social factors (Peet, 1985). This deterministic perspective posits that societal development and agricultural productivity are closely aligned with environmental suitability.

One of the main strengths of environmental determinism is its emphasis on the undeniable influence of natural conditions on human life, particularly in agriculture, where rainfall, temperature, and soil quality directly affect production. The theory helps to explain why certain regions are more agriculturally productive than others and why some societies may face greater challenges in achieving food security. It provides a useful foundation for analyzing climate-related constraints and for exploring regional differences in development patterns. For instance, understanding how desertification in Northern Nigeria affects food crops can be linked to the core ideas of environmental determinism.

However, the theory has also been heavily criticized for its over-simplistic and ethnocentric conclusions. Critics argue that it ignores the role of human agency, technological innovation, and socio-political structures in shaping development outcomes. Environmental determinism has also been accused of promoting geographical and racial stereotypes, particularly in colonial discourses that portrayed tropical peoples as inherently inferior (Livingstone, 1992). In contemporary academic circles, the theory has largely been replaced or modified by more nuanced frameworks like possibilism, political ecology, and human-environment interaction theories, which acknowledge the complexity of environmental influences without denying the importance of cultural and political dynamics.

Despite its criticisms, environmental determinism remains relevant - especially when analyzing climate-sensitive sectors such as agriculture in Nigeria. The country's agricultural sector is predominantly rain-fed and highly vulnerable to climate variability, droughts, and flooding—factors that align with the theory's premise that environmental conditions can limit human productivity. By situating agricultural challenges within the broader environmental context, the theory aids in understanding the structural vulnerability of Nigerian farmers to climate change. Thus, while it may not provide a complete explanation, environmental determinism offers a valuable lens for interpreting how climate directly and indirectly impacts agricultural sustainability.

Climate Change Trends in Nigeria

Climate change in Nigeria has become increasingly evident over the past two decades, with observable shifts in temperature, rainfall patterns, and the frequency of extreme weather events. According to the Nigerian Meteorological Agency (NiMet), Nigeria has experienced an average temperature increase of approximately 1.1°C between 2000 and 2020, with projections indicating further increases if mitigation measures are not implemented (NiMet, 2020). This warming trend is accompanied by erratic rainfall patterns, characterized by shorter rainy seasons and longer dry periods in several parts of the country. The Intergovernmental Panel on Climate Change (IPCC, 2021) also reports that the West African region, including

Nigeria, is experiencing heightened vulnerability to climate variability, particularly in the agriculture and water sectors.

The evidence of climate change is further reinforced by the increasing frequency and severity of droughts and floods across Nigeria. For instance, major flood events in 2012 and 2022 displaced hundreds of thousands and caused significant damage to farmland and infrastructure. The 2022 floods alone affected over 2.5 million people, with more than 600 fatalities and widespread destruction of agricultural lands (National Emergency Management Agency [NEMA], 2022). Similarly, states in the northern and northeastern zones such as Borno, Yobe, and Katsina have witnessed recurring droughts, desertification, and water scarcity, which have negatively impacted both crop and livestock production (UNDP, 2023). These environmental changes align with broader global warming trends and reinforce Nigeria's exposure to climate-related risks.

Regional variations in climate change impacts across Nigeria are stark, with different ecological zones experiencing diverse climate stressors. The Sahelian and Sudanian regions in the north are characterized by increasing aridity and desert encroachment, threatening traditional livelihoods such as nomadic herding and millet farming. Conversely, the Middle Belt experiences unpredictable rainfall patterns and flash floods, while the coastal and Niger Delta regions suffer from rising sea levels, coastal erosion, and saltwater intrusion. These regional disparities underscore the need for localized climate adaptation strategies tailored to the ecological and socioeconomic conditions of each zone (Adejuwon, 2016).

Data from global and national climate monitoring organizations confirm these worrying trends. According to World Bank (2023) data, Nigeria's mean annual temperature has increased by 1.2°C between 2000 and 2022, with rainfall variability increasing by over 20% during the same period, especially in central and southern regions. The Global Climate Risk Index (Germanwatch, 2022) ranked Nigeria among the top 20 countries most affected by extreme weather events in recent years. These statistics highlight how climate change has moved from a future concern to a current crisis in Nigeria, with implications for agriculture, water resources, human health, and national development.

The persistent changes in Nigeria's climate between 2000 and 2024 have led to economic, social, and ecological disruptions. Smallholder farmers, who produce over 70% of the nation's food, are particularly vulnerable, as their livelihoods depend heavily on stable climate conditions. The disruption in the onset and cessation of rains has reduced crop yields and increased post-harvest losses. Consequently, food insecurity is on the rise, and rural-urban migration is increasing as people abandon unsustainable agricultural lands. These trends underscore the urgent need for comprehensive climate resilience strategies, early warning systems, and investments in climate-smart agriculture across all geopolitical zones in Nigeria.

Agriculture in Nigeria: An Overview

Agriculture remains a cornerstone of Nigeria's economy, providing a significant share of the country's Gross Domestic Product (GDP), employment, and rural livelihoods. As of

2023, the agricultural sector contributed approximately 24.1% to Nigeria's GDP, making it the second-largest contributor after services (National Bureau of Statistics [NBS], 2023). It also employs about 70% of the rural labor force, serving as the primary source of income and food security for millions of Nigerians (World Bank, 2022). The sector plays a critical role in reducing poverty, especially in rural communities where alternative livelihood opportunities are limited.

Nigeria's diverse agro-ecological zones support a wide range of crops and livestock across its six geopolitical regions. The northern region is well-known for grain production, especially millet, sorghum, maize, and cowpeas, while the Middle Belt produces yam, cassava, rice, and sesame. The southern region, with its humid climate, supports cocoa, oil palm, rubber, and plantain cultivation. In terms of livestock, cattle, goats, sheep, and poultry are commonly raised, especially in the north and middle zones (International Food Policy Research Institute [IFPRI], 2021). These zones reflect the geographical and ecological diversity of the country, making agriculture both a national and regional economic engine.

Despite its potential, Nigerian agriculture remains largely rain-fed and climate-sensitive, leaving it highly vulnerable to climatic shocks. Most farmers depend on seasonal rainfall due to limited access to irrigation - only about 1% of Nigeria's total cultivated land is irrigated (Food and Agriculture Organization [FAO], 2021). Consequently, variations in rainfall and temperature often lead to poor crop yields, delayed planting, and crop failures. For instance, the increasing unpredictability of rainfall has adversely affected rice and maize production, particularly in the north-central region where floods and droughts have become more frequent.

Traditional farming systems such as shifting cultivation, mixed cropping, and nomadic pastoralism dominate Nigeria's agricultural landscape. These practices are deeply climate-dependent and increasingly unsustainable under modern climate conditions. Nomadic pastoralists, for instance, often migrate in search of pasture, but their movements are now constrained by droughts, land-use conflicts, and shrinking grazing areas, exacerbating tensions with crop farmers (Ayanlade & Radeny, 2020). Similarly, shifting cultivation, once effective for soil fertility restoration, is now less viable due to population pressure and shorter fallow periods, leading to land degradation.

Efforts to modernize Nigerian agriculture and reduce its climate sensitivity have been uneven and underfunded. Although government initiatives like the Agricultural Transformation Agenda (ATA) and National Agricultural Technology and Innovation Policy (NATIP) have aimed at improving productivity, progress remains slow due to infrastructural deficits, poor access to credit, and weak extension services. Addressing these challenges requires climate-smart agriculture, which integrates sustainable land management, improved seed varieties, and weather-based advisories to help farmers adapt to changing climatic conditions. Without urgent intervention, the sector's vulnerability to climate change may undermine national food security and rural livelihoods.

Impact of Climate Change on Agriculture

Climate change has emerged as a major threat to agricultural systems in Nigeria, disrupting ecological patterns, production cycles, and food availability. Its impacts are felt across all segments of agriculture - from crops and livestock to fisheries - affecting both productivity and sustainability.

i. Crop production: Crop production in Nigeria has become increasingly vulnerable to climate-induced stressors such as droughts, floods, erratic rainfall, pest infestations, and soil degradation. For example, maize and rice yields in northern and middle-belt regions have declined due to prolonged dry spells and flash floods (Ayanlade & Radeny, 2020). A study by the Nigerian Meteorological Agency (NiMet) reports a 20–30% yield reduction in rain-fed cereal crops between 2010 and 2020 in semi-arid zones (NiMet, 2021). Climate change has also encouraged the proliferation of crop pests like fall armyworms, which have devastated maize farms in states such as Kaduna and Niger (FAO, 2020). Additionally, rising temperatures accelerate soil nutrient loss and degradation, further reducing productivity.

ii. Livestock production: Livestock production is similarly affected by climate change through increased heat stress, disease outbreaks, and pasture loss. High temperatures reduce animal feed intake, growth rates, fertility, and milk production. For example, heat stress has been linked to a 15–25% decline in cattle productivity in northern Nigeria (Rojas-Downing et al., 2017). Water scarcity exacerbates these effects, especially during the dry season when rivers and ponds dry up, leading to competition over water between herders and farmers. Pastoralists, particularly Fulani herders, face limited grazing options as desertification expands the Sahel belt, reducing the availability of pastureland and fueling resource conflicts (Aliyu et al., 2021).

iii. Fisheries and aquaculture: Fisheries and aquaculture have not been spared, as climate change alters aquatic ecosystems, impacting fish stocks and breeding cycles. Rising water temperatures, reduced oxygen levels, and increased acidity in rivers and lakes affect fish habitats and productivity. In Lake Chad, for instance, fish yields have declined by over 60% between 2000 and 2020 due to shrinking water volumes, increased evaporation, and climate-induced inflows (World Bank, 2021). Similarly, flood events disrupt fish farms in southern Nigeria, destroying infrastructure and spreading waterborne diseases. These impacts threaten a critical source of income and protein for millions of Nigerians.

iv. Food security and nutrition: The overall consequence is a growing threat to food security and nutrition. Climate-induced declines in crop and animal production limit food availability and raise market prices, making essential food items unaffordable for vulnerable households. A 2023 report by the World Food Programme (WFP) estimated that over 25 million Nigerians were at risk of food insecurity due to climate-related shocks and insecurity in the agricultural belt (WFP, 2023). Furthermore, the nutritional quality of diets has suffered as families reduce food variety and protein intake due to cost and availability constraints. The cyclical relationship between climate change and undernutrition is thus becoming more entrenched in rural Nigeria.

Coping Strategies and Adaptation Measures

In the face of increasing climate variability, many Nigerian farmers have turned to indigenous knowledge and traditional farming practices as adaptive strategies. These include early warning signals based on local environmental indicators (e.g., bird migrations, wind patterns), shifting planting dates, intercropping, crop rotation, and using drought-tolerant local seed varieties. In northern Nigeria, farmers in Katsina and Kano states adapt by combining millet, cowpea, and sorghum to hedge against total crop failure (Ogunsemi et al., 2020). Such strategies are not only cost-effective but rooted in generations of experience with environmental uncertainty. Despite their efficacy, these approaches often receive little formal recognition in national policy frameworks, leading to their underutilization in larger adaptation programs (Nnadi et al., 2019).

Governments and NGOs have also initiated a range of climate adaptation programs aimed at strengthening farmers' resilience. For example, Nigeria's Federal Ministry of Agriculture and Rural Development (FMARD) has collaborated with the International Fund for Agricultural Development (IFAD) to implement the Climate Adaptation and Agribusiness Support Programme (CASP), targeting over 100,000 farmers in northern states (IFAD, 2022). NGOs such as Oxfam and the Nigerian Climate Change Policy Response and Strategy (NCCPRS) have also promoted climate education, early warning systems, and support for agroforestry. In 2021, the World Bank supported a $700 million Agro-Climatic Resilience in Semi-Arid Landscapes (ACReSAL) project focused on ecosystem restoration and climate-smart agriculture across 19 states in the Sahel belt (World Bank, 2022). However, the reach of these initiatives remains limited, often constrained by political will, funding gaps, and bureaucratic bottlenecks.

Technological innovations are playing a critical role in enabling climate adaptation in Nigerian agriculture. The introduction of climate-smart agriculture (CSA) practices—such as drip irrigation, drought-resistant seeds, and precision farming—is improving productivity in regions prone to climate shocks. Research institutions like the International Institute of Tropical Agriculture (IITA) have developed improved maize and cassava varieties that are more tolerant to heat and pests (IITA, 2021). Additionally, the use of mobile phones for weather forecasts and market information is gaining traction among rural farmers, particularly in Benue and Ebonyi states (Ayanlade & Radeny, 2020). However, access to such technologies is still uneven, with poorer and remote farmers often excluded due to high costs or lack of training.

Despite these efforts, significant barriers continue to hinder widespread adaptation across Nigeria. Chief among them are limited access to finance, low literacy levels, inadequate extension services, and poor infrastructure. According to the Nigerian Bureau of Statistics (2023), over 70% of rural farmers lack access to formal credit, making it difficult to invest in irrigation systems or improved inputs. Furthermore, many farmers are not fully aware of changing climate patterns or available adaptation options due to low education levels and inadequate outreach by government agencies (Ozor et al., 2021). Gender disparities also present a barrier, as female farmers, who constitute a large proportion of the agricultural

workforce, often face exclusion from training programs and land ownership, reducing their adaptive capacity.

Policy and Institutional Responses

Nigeria has developed a number of climate change policies aimed at mitigating the impacts of climate variability on agriculture and other key sectors. Central to these is Nigeria's Nationally Determined Contributions (NDCs), which articulate the country's commitments under the Paris Agreement to reduce greenhouse gas emissions and enhance climate resilience. Additionally, the National Adaptation Strategy and Plan of Action on Climate Change for Nigeria (NASPA-CCN), developed in 2011, outlines adaptation strategies with a strong focus on agriculture, water resources, and health (Federal Ministry of Environment, 2011). The Agriculture Promotion Policy (2016–2020), though primarily targeted at improving productivity, also recognizes the role of climate-smart agriculture and environmental sustainability in ensuring food security. Despite these frameworks, the alignment between national policies and grassroots implementation remains weak, especially in climate-vulnerable rural areas.

Institutional actors play a critical role in the formulation and implementation of climate and agricultural policies in Nigeria. The Nigerian Meteorological Agency (NIMET) is at the forefront of providing weather and climate data to support early warning systems and seasonal farming decisions. The Federal Ministry of Environment coordinates overall climate policy and represents Nigeria in international climate negotiations, while the Federal Ministry of Agriculture and Rural Development (FMARD) is responsible for integrating climate adaptation into agricultural policy. Other agencies, such as the National Emergency Management Agency (NEMA) and the Nigeria Hydrological Services Agency (NIHSA), also contribute by responding to climate-induced disasters and managing water resources respectively. Despite these mandates, institutional overlap, poor coordination, and insufficient funding have limited the effectiveness of these bodies in addressing climate risks holistically.

However, opportunities for reform and improved implementation abound. Strengthening inter-agency collaboration and establishing a central climate data repository can enhance planning and resource allocation. There is also a need to improve capacity at the sub-national level, where most climate impacts are felt but institutional response is weakest. Investing in technology transfer, farmer education, and decentralised decision-making can help local communities adapt more effectively. International support, especially through climate finance mechanisms like the Green Climate Fund, offers potential for scaling up successful pilot projects. Ultimately, effective implementation of Nigeria's climate change policies will require strong political will, consistent funding, and inclusive stakeholder engagement that integrates both scientific knowledge and traditional practices.

The Way Forward: Recommendations

To address the worsening impact of climate change on agriculture in Nigeria, there is a pressing need to strengthen and enforce climate-resilient agricultural policies. This involves revising existing policies like the Agriculture Promotion Policy (APP) to integrate updated climate adaptation strategies, and ensuring their effective implementation at federal, state, and local levels. Emphasis should be placed on sustainable land management, afforestation, and promoting climate-smart agriculture practices tailored to regional ecological needs. Stronger monitoring and evaluation frameworks are also necessary to track progress and ensure compliance with policy targets.

Early warning systems and accurate weather forecasting are critical tools in climate adaptation, particularly for smallholder farmers who depend on rainfall patterns. Strengthening the capacity of institutions like the Nigerian Meteorological Agency (NIMET) to deliver localized, real-time climate data can greatly enhance farmers' ability to plan for planting, harvesting, and mitigate the risks of floods or droughts. Collaboration with telecoms and media to disseminate weather alerts in local languages will also improve accessibility and usability of this information for rural communities.

Investments in agricultural research and extension services are essential for developing and disseminating climate-resilient crop varieties and farming technologies. Institutions like the Nigerian Institute for Agricultural Research (IAR) should be adequately funded to conduct region-specific studies on soil conservation, pest control, and irrigation practices. Similarly, expanding rural infrastructure - such as roads, storage facilities, and irrigation systems - will reduce post-harvest losses and improve market access, thereby increasing farmers' resilience to climate shocks.

There is an urgent need to integrate climate change education into agricultural training programs and rural extension services. Farmers must be equipped with knowledge and skills to understand climate risks and adopt adaptive techniques, such as mulching, intercropping, and efficient water usage. Capacity-building initiatives should prioritize vulnerable groups, including women and youth, and use participatory approaches that respect local knowledge systems. This can be supported through partnerships between government, NGOs, and local cooperatives.

Adequate and sustained financing is a cornerstone of effective climate change adaptation in agriculture. Nigeria should explore innovative funding mechanisms such as green bonds, climate risk insurance, and performance-based financing. Access to international funds like the Green Climate Fund and Adaptation Fund must be improved through transparent proposal processes and inter-agency coordination. In addition, targeted donor support and public-private partnerships can support climate-resilient projects in high-risk zones, ensuring that finance reaches small-scale farmers who are most affected.

Conclusion

Climate change poses a profound and escalating threat to agriculture in Nigeria, affecting crop yields, livestock health, fisheries, and overall food security through erratic rainfall, rising temperatures, and extreme weather events. While agriculture remains vital to Nigeria's economy and livelihoods, it is highly vulnerable to climatic shifts, especially in ecologically fragile zones like the Sahel and coastal regions. Despite various coping strategies, including indigenous methods and government-led adaptation programs, several barriers such as limited finance, weak infrastructure, and poor policy implementation hinder effective response.

Reaffirming the urgency of climate adaptation is essential for ensuring agricultural sustainability and national food security. A multi-stakeholder approach involving government institutions, research bodies, farmers, NGOs, and international partners is required to foster climate-resilient agricultural practices. Without effective adaptation policies and technological innovations, climate-induced disruptions will continue to threaten Nigeria's agricultural sustainability.

REFERENCES

Adedipe, N. O. (2020). Agricultural transformation and climate-smart development in Nigeria. *Journal of Agricultural Policy and Development*, 15(3), 45–58.

Adejuwon, S. A. (2016). Food security, climate variability and climate change in Sub-Saharan West Africa. *International Journal of Climate Change Strategies and Management*, 8(3), 328–345.

Aliyu, A. S., Modu, B., & Tan, C. W. (2021). Climate change and pastoral conflicts in Nigeria: Causes, patterns, and policy implications. *Environmental Research*, 196, 110935.

Ayanlade, A., & Radeny, M. (2020). COVID-19 and food security in Sub-Saharan Africa: Implications of lockdown during agricultural planting seasons. *NPJ Science of Food*, 4(13), 1–6.

Ayanlade, A., Radeny, M., & Morton, J. F. (2017). Comparing smallholder farmers' perception of climate change with meteorological data: A case study from southwestern Nigeria. *Weather and Climate Extremes*, 15, 24–33.

Federal Ministry of Environment. (2011). *National Adaptation Strategy and Plan of Action on Climate Change for Nigeria* (NASPA-CCN). Federal Government of Nigeria.

FMARD. (2016). *The agriculture promotion policy* (2016–2020). Federal Ministry of Agriculture and Rural Development.

Food and Agriculture Organization (FAO). (2020). *Fall armyworm in Nigeria: Situation report*. https://www.fao.org

Food and Agriculture Organization (FAO). (2021). *Irrigation in Africa: Facts and Figures*. https://www.fao.org

Food and Agriculture Organization (FAO). (2022). *The State of Food and Agriculture 2022*. Rome: FAO. https://www.fao.org/publications/sofa

Germanwatch. (2022). *Global climate risk index 2022*. https://germanwatch.org/en/cri

Huntington, E. (1915). *Civilization and Climate*. Yale University Press.

IFAD. (2022). *Climate Adaptation and Agribusiness Support Programme (CASP)*. https://www.ifad.org/en/web/operations/-/project/2000000905

Intergovernmental Panel on Climate Change (IPCC). (2021). *Climate Change 2021: The Physical Science Basis*. https://www.ipcc.ch/report/ar6/wg1/

Intergovernmental Panel on Climate Change (IPCC). (2021). *Sixth Assessment Report (AR6): Climate Change 2021 – The Physical Science Basis*. https://www.ipcc.ch/report/ar6/wg1/

International Food Policy Research Institute (IFPRI). (2021). *Nigeria Agriculture Public Expenditure Review*. Washington, DC: IFPRI.

International Institute of Tropical Agriculture (IITA). (2021). *Climate-resilient maize and cassava varieties for Sub-Saharan Africa*. https://www.iita.org

Livingstone, D. N. (1992). *The Geographical Tradition: Episodes in the History of a Contested Enterprise*. Blackwell.

National Bureau of Statistics (NBS). (2022). *Labour force statistics: Employment by sector report*. Abuja: NBS.

National Bureau of Statistics (NBS). (2023). *Nigerian Gross Domestic Product Report Q4 2023*. https://nigerianstat.gov.ng

National Emergency Management Agency (NEMA). (2022). *2022 Flood Situation Report in Nigeria*. Abuja: NEMA Press.

Nigerian Bureau of Statistics (NBS). (2023). *Annual Agricultural Survey Report 2023*. https://www.nigerianstat.gov.ng

Nigerian Meteorological Agency (NiMet). (2020). *State of the Climate in Nigeria 2020*. Abuja: NiMet Publications.

Nigerian Meteorological Agency (NiMet). (2021). *Impact of Climate Variability on Rain-fed Agriculture in Nigeria: Technical Report*. Abuja: NiMet.

NIMET. (2022). *Annual Climate Report*. Nigerian Meteorological Agency.

Nnadi, F. N., Akwiwu, C. D., & Eze, S. O. (2019). Indigenous adaptation practices to climate change in Sub-Saharan Africa: A review. *African Journal of Environmental Science and Technology*, 13(4), 142–149.

Ogunsemi, B. T., Oluwatayo, I. B., & Akinrinde, A. (2020). Indigenous climate adaptation practices in northern Nigeria: Evidence from smallholder farmers. *Agricultural and Resource Economics*, 20(3), 45–60.

Olanrewaju, R. M., Olaniyan, A. T., & Adeniyi, A. A. (2019). Climate change and food security nexus in Nigeria: The empirical evidence from agricultural sector. *African Journal of Environmental Science and Technology*, 13(4), 148–157.

Oreskes, N. (2018). *Why Trust Science?* Princeton University Press.

Ozor, N., Cynthia, U., & Enete, A. A. (2021). Barriers to climate change adaptation among smallholder farmers in Nigeria. *Journal of Agricultural Extension*, 25(1), 20–30.

Peet, R. (1985). The Social Origins of Environmental Determinism. *Annals of the Association of American Geographers*, 75(3), 309–333.

Rojas-Downing, M. M., Nejadhashemi, A. P., Harrigan, T., & Woznicki, S. A. (2017). Climate change and livestock: Impacts, adaptation, and mitigation. *Climate Risk Management*, 16, 145–163.

UNFCCC. (2022). Nigeria's Updated Nationally Determined Contributions (NDCs). https://unfccc.int/documents/273892

United Nations Development Programme (UNDP). (2023). *Climate Vulnerability and Impact Assessment in Northern Nigeria*. UNDP Nigeria Report.

World Bank. (2021). *Lake Chad Region Recovery and Development Project: Environmental Assessment*. https://www.worldbank.org

World Bank. (2022). *Agro-Climatic Resilience in Semi-Arid Landscapes (ACReSAL)*. https://www.worldbank.org/en/news/feature/2022/06/16

World Bank. (2022). *Nigeria: Agricultural Sector Risk Assessment*. Washington, DC: World Bank Group.

World Bank. (2023). *Climate Data for Nigeria*. https://climateknowledgeportal.worldbank.org/country/nigeria

World Food Programme (WFP). (2023). *Hunger Hotspots: Nigeria Situation Report*. https://www.wfp.org/publications/hunger-hotspots