

Climate Change and its Threat to Food and Human Security: A Focus on Nigeria

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Abstract

This study investigates the profound implications of climate change on agriculture and human security in Nigeria. Employing a qualitative research methodology, the research conducts a meticulous literature review, revealing the direct and indirect impacts of climate change on food security. The vulnerability of the agricultural sector to changing weather patterns is underscored, anticipating reduced crop yields and livestock productivity. While the subtle nature of climate change initially downplays its direct threat to human security, the study recognizes its severe consequences globally and particularly in Nigeria. The effects exacerbate existing vulnerabilities, impacting the well-being of the population. Adaptation and resilience strategies, including climate-smart agriculture and drought-resistant crops, have been implemented in response to climate challenges. The conclusion emphasizes climate change as a significant threat to food and human security in Nigeria, necessitating comprehensive policies. Recommendations include strengthening agricultural resilience, improving smallholder farmers' access to inputs, enhancing climate information availability, and investing in climate-resilient infrastructure. Proactive measures are essential for mitigating climate change impacts, ensuring the well-being of Nigeria's citizens amid a changing climate.

Keywords: Climate change, Food security, Human security, Nigeria.

Introduction

Climate change has become a pressing issue worldwide due to its severe consequences on ecosystems, biodiversity, and human livelihoods (IPCC, 2021). One of the most vulnerable sectors to the impacts of climate change is agriculture, which heavily depends on weather patterns and natural resources for food production (Adger et al., 2007). The adverse effects of climate change on agriculture can have far-reaching implications for food security and human well-being, particularly in developing countries like Nigeria (FAO, 2020). Nigeria, as a developing country, faces significant risks from climate change, including extreme weather events, changing rainfall patterns, and rising temperatures (World Bank, 2020). These environmental changes can lead to reduced crop yields, soil degradation, and loss of biodiversity, ultimately affecting the country's food production and overall food security (IFAD, 2021). Furthermore, the agricultural sector in Nigeria is predominantly made up of smallholder farmers who rely on rain-fed agriculture, making them particularly susceptible to climate-related hardships (UNDP, 2019).

In response to these challenges, the government of Nigeria and various international organizations have implemented strategies to mitigate the effects of climate change on agriculture. These measures include promoting climate-smart agricultural practices, developing drought-resistant crop varieties, and improving water management systems (FAO, 2021). Additionally, efforts to enhance the resilience of smallholder farmers through capacity building, access to credit, and climate information services are being undertaken to address the vulnerabilities of the agricultural sector to climate change (World Bank, 2021). The agricultural sector in Nigeria is highly vulnerable to the adverse effects of climate change, with potential implications for food security and human well-being. Addressing these challenges requires coordinated efforts from the government, civil society, and international partners to implement adaptation and mitigation strategies that can safeguard the country's agricultural productivity and ensure the well-being of its population.

The ongoing phenomenon of global warming, a key aspect of climate change, is caused by the retention of heat emitted from the earth into space by greenhouse gases like nitrous oxide, carbon dioxide, methane, and chlorofluorocarbons. These gases normally help maintain the earth's atmosphere at a suitable temperature for life, but human activities such as industrial and agricultural operations have significantly increased their release into the atmosphere, resulting in an intensified greenhouse effect and a rise in global temperatures. Human activities such as burning fossil fuels and clearing land for agriculture have notably increased carbon dioxide levels in the atmosphere, while the release of synthetic compounds like CFCs has contributed to the depletion of the ozone layer, further exacerbating global warming.

Likewise, alterations in the natural composition of greenhouse gases amplify the greenhouse effect, causing the Earth to warm. This warming leads to increased evaporation and varying

precipitation patterns across regions. The greenhouse effect also warms oceans, causing partial melting of glaciers and ice sheets, contributing to rising sea levels. Studies indicate that elevated atmospheric carbon dioxide levels have both positive and negative impacts on crop yields, with certain crops thriving and others struggling. Climate change consequences such as floods, droughts, and extreme temperatures have resulted in crop losses, threatening farmers' livelihoods and food security, especially in developing countries. The global concern over climate change's impact on human security has prompted initiatives like the Kyoto Protocol, aimed at regulating greenhouse gas emissions from industrial processes worldwide.

Climate change is expected to have profound impacts on agriculture in Nigeria, as it is already experiencing the effects of climate variability and extreme weather events. The country's reliance on rain-fed agriculture makes it particularly vulnerable to changing precipitation patterns and more frequent droughts, which can lead to decreased crop yields and food shortages (Fasona and Olanrewaju, 2012). Additionally, rising temperatures and changes in seasonal patterns can also disrupt planting and harvesting schedules, further impacting agricultural productivity (Adefolalu et al., 2018). The potential consequences of decreased agricultural productivity and food insecurity are significant for Nigeria, where a large portion of the population is already living in poverty and facing malnutrition. The country's economy depends heavily on agriculture, as it is the main source of employment and income for the majority of its citizens (Olayide and Heidhues, 2005). Any disruptions to the sector could result in widespread job losses and increased poverty, exacerbating social and economic inequalities.

Furthermore, food insecurity can have far-reaching effects on public health, as malnutrition and hunger can lead to an increase in diseases and a decrease in overall well-being. In particular, children and pregnant women are at a higher risk of suffering the negative impacts of food insecurity, which can have long-term consequences for their physical and cognitive development (Akombi et al., 2017). In order to address these challenges, Nigeria will need to implement effective adaptation strategies to mitigate the impacts of climate change on its agricultural sector. This includes investing in climate-resilient agricultural practices, improving water management and irrigation infrastructure, and diversifying crops to increase resilience to changing environmental conditions. Additionally, there is a need for policies and programs that support smallholder farmers, who are particularly vulnerable to the effects of climate change due to their limited resources and ability to adapt (Ogundari and Awokuse, 2018).

Nigeria is not isolated from global climate change effects, with impacts evident in its vegetative regions. Research underscores climate change as a significant threat to agricultural productivity in Nigeria, causing flooding in previously well-drained plains and adverse effects in the Sahel and Sudan savannah belts (Ojo & Adebayo, 2012). Climate change outcomes, including heavy precipitation, irregular rainfall patterns, increased temperature, and shifts in humidity, negatively affect agriculture and food systems in Nigeria. These alterations disrupt the seasonal food production and distribution patterns, resulting in supply shortages, escalating food prices, and restricted access to food (Oyinloye et al., 2018). This study explores the repercussions of climate change on food security and human security in Nigeria.

Methodology

This research employs a qualitative research methodology to collect and analyze data from secondary sources, encompassing peer-reviewed journals, books, and reports. A meticulous literature review was undertaken, employing keywords such as climate change, food security, human security, and Nigeria. The study systematically assessed the literature within the framework of the research objectives, identifying pertinent findings that illuminate the ramifications of climate change on both food security and human security in Nigeria.

Review of literature

This part of the study explores the findings previous scientific studies on the correlation between climate change and food and human security. Most of these empirical researches employed statistical approach and draws their conclusions through simulation models with a focus on the linkage between the varying climatic condition and food production performance. Also, literatures that focus on the relationship between climate variability and human security situation are equally explored.

Climate change and food security in Nigeria

Climate change is a significant threat to food security in Nigeria, as it is expected to have both direct and indirect impacts on agricultural production. Changes in temperature and precipitation patterns will likely lead to reduced crop yields and livestock productivity. A study by Tiamiyu et al. (2020) showed that rising temperatures have a negative impact on the growth and development of crops in Nigeria. Furthermore, extreme weather events such as droughts, floods, and heatwaves are expected to become more frequent, further disrupting agricultural activities. These events can result in crop failures, decreased livestock productivity, and the loss of agricultural infrastructure.

Nigeria, identified as a vulnerable sub-Saharan African state to changing climatic conditions (Ughaelu, 2017), has experienced intensified environmental disasters, exacerbating food productivity challenges and human suffering in the past decade (Ayinde et al., 2011; Ughaelu, 2017; Ikem, 2018). Unprecedented flooding in 2012 caused significant losses in human lives, crops, livestock, and displacement (Ogbuchi, 2020). Climate change-induced environmental changes affect Nigeria's six vegetative zones disparately: reduced rainfall, drought, and desertification in the semi-arid Sudan and arid Sahel Savannah; altered rainfall patterns, delayed onset, and prolonged dry seasons in the Northern and Southern Guinea savannah belt; severe flooding along shorelines; delayed rainfall onset, extended dry seasons, heat waves, and coastal flooding in the Rain Forest zone; and flooding of dry plains and rising sea levels affecting farming in the Mangrove Swamp, with adverse impacts on fishing due to increased water temperature (Ughaelu, 2017; Ikem, 2018; Berhanu & Wolde, 2019).

The impacts of climate change on food security in Nigeria extend beyond just agricultural production. A study by Adeniyi et al. (2019) highlighted that changes in climate could result in increased food prices, reduced access to food, and heightened food insecurity for vulnerable

populations. Additionally, climate change and its associated impacts can lead to rural-urban migration, as smallholder farmers may be forced to leave their farms in search of alternative livelihoods. In order to address the potential impacts of climate change on food security in Nigeria, it is crucial for the government to implement adaptation and mitigation strategies. These strategies could include the promotion of climate-resilient agricultural practices, investment in agricultural infrastructure, and the development of early warning systems for extreme weather events. Furthermore, it is important for policymakers to prioritize the needs of smallholder farmers, who are particularly vulnerable to the impacts of climate change on food security.

Numerous studies highlight the severe consequences of extreme climatic conditions, including desertification, high rainfall, and flooding, on food production (Tirado et al., 2010; Wossen et al., 2018; Uwazie, 2020). Climate has been identified by researchers as a subtle yet crucial causative factor for the current food security and human security crises in Nigeria (Uwazie, 2020). The persistent decline in rainfall gradients in northern Nigeria has rendered affected areas increasingly unsuitable for crop and animal production using natural resources (Wossen et al., 2018). Furthermore, continuous flooding of coastlines and the southernmost part of Nigeria has resulted in crop damage, soil fertility loss, soil toxicity, and disruption of soil ecosystems (Wossen et al., 2018). Warning of ongoing threats, both the World Bank and the Food and Agricultural Organization emphasize in their publications that climate change continues to pose a serious danger to sustainable food production in Nigeria (World Bank, 2016; FAO, 2017).



Source: World Bank Climate Knowledge Portal (climateknowledgeportal.worldbank.org)

Numerous research findings underscore the adverse impact of climatic variations induced by climate change on agricultural productivity in Nigeria, resulting in diminished output and disruptions in food supply, consequently leading to escalated food prices. The heightened era of food insecurity in Nigeria is attributed to climatic factors that constrain agricultural productivity. Alterations induced by climate change, such as droughts, heavy precipitation, farmland flooding, rising temperature, increased aridity, soil acidity, changes in humidity, and enhanced evaporation, have deleterious effects on agricultural systems. Adishi and Oluka (2018) emphasize the growing intensity and frequency of environmental issues like floods, droughts, rising temperatures, and extreme weather events disrupting agricultural activities. Onuoha and Ezirim (2010) highlight the threat to the livelihood of approximately 15 million pastoralists in northern Nigeria due to decreasing water access and pasture shortages linked to climate change.

Ayo et al. (2014) observe that climate change is progressively worsening food insecurity, particularly in regions already vulnerable to hunger and malnutrition. They anticipate that climate variability and extremes will pose significant challenges to food stability, potentially leading to persistent increases in food prices that render basic food unaffordable for low-income earners. Fasona and Omojola (2005) reveal that increasing aridity in the Sahel and Sudan savannah regions renders vast areas of land unproductive, triggering food security crises in densely populated affected areas. They predict a steady rise in the number of malnourished children in Nigeria due to climate change threats. Idumah et al. (2016) explore the short-term and long-term relationship between climatic variables (rainfall, temperature, relative humidity) and agricultural output in Nigeria, finding a significant correlation in both timeframes, aligning with similar investigations in the field.

The global concern surrounding climate change is significantly driven by its profound threat to agricultural production. Empirical studies indicate that the observed higher and variable temperatures, along with shifting rainfall patterns in Nigeria over the past decade, are altering the traditional agricultural production landscape (Ikem, 2018; Wossen et al., 2018). The recurrence of extreme climatic events, such as droughts and floods, has precipitated crises in the agricultural productive system (Ogbo et al., 2019). Recognizing the pivotal role of food sufficiency in human survival, researchers have delved into the intricate relationship between climate change and food security. Many of these studies employ direct observation, surveys, and weather data analysis (Oyinloye et al., 2018; Ayinde et al., 2020). Some researchers utilize modeling approaches to extrapolate future climatic scenarios, providing valuable insights for policymakers to mitigate forthcoming climate change consequences (Zwedie, 2014; Wossen et al., 2018).

Empirical evidence consistently demonstrates that climatic variability adversely affects agricultural productivity (Jung and Kunstman; Kralovec, 2020). Muringai et al. (2020) explored the impact of declining water resources, higher temperatures, and increasing CO₂ emissions on food production, establishing a significant link between changing climatic conditions and poor crop performance. Scientific literature emphasizes that climate change, particularly its impact on the initial phase of the food supply chain—production—inevitably ripples through every element in the chain. The fishery sector's supply chain is also affected by climate variability, with drought negatively impacting environments dependent on natural water resources (Muringai et al., 2020).

Climate change-induced water resource shrinkage in Nigeria's Lake Chad area has drastically impacted once-thriving fishing activities, disrupting the fish supply chain and rendering many fishermen jobless (Anyika, 2020). Additionally, Oyinloye et al. (2018) highlight the perilous consequences of climate change for aquatic life, with rising water temperatures disrupting fish habitats, potentially causing death, low productivity, or contamination with harmful bacteria. Researchers commonly agree that increasing desertification leads to the loss of water bodies and aquatic animals.

The Nigeria Meteorological Agency (NIMET) has observed significant changes in climatic parameters, including rainfall, temperature, and extreme weather events, across various ecological zones in Nigeria, with adverse effects on agricultural activities (NIMET, 2005). Ethan (2015) conducted a comprehensive analysis of Nigerian climatic data spanning different periods, revealing alterations in the onset and cessation of rainfall that impact the country's food system pattern.

Despite the subtle nature of climate change, its devastating effects on human lives are evident, prominently manifesting in food insecurity. Physiologically, crops and livestock are adversely affected, experiencing changes in soil nutrients, reduction of water resources, shifts in relative humidity, increased temperatures, and heightened weed and pest occurrences. Climate change induces conditions such as desertification, erosion, and ecological devastation, thereby posing threats to human security in affected regions. It also triggers droughts, floods, and environmental extremes that curtail agricultural production, persistently threatening agricultural development in Nigeria. The loss of farmlands to floods and increasing aridity in Sahel and Sudan vegetative zones has severe consequences for agricultural productivity, contributing significantly to a major food security crisis in the country. The disruptions in the usual food production and distribution systems have led to supply shortfalls and a steady rise in food prices.

The rapid population growth in Nigeria coupled with unmatched agricultural productive output exacerbates the food security crisis. This situation is linked to the stresses associated with climate change, which undermine the ability of developing countries to achieve targeted agricultural output. The persistence of this shortfall signals an intense food security crisis. Additionally, climate change adversely affects aquatic ecosystems, with sea warming, changes in sea salinity, and increasing sea acidity being notable physical changes. Incidents of mass aquatic deaths in the Niger Delta serve as alarming indications of the severe consequences of climate change, threatening the livelihoods of riverine communities heavily dependent on food and trade.

In addition to the direct impacts on food production, climate change is also expected to affect food distribution and access, which can further exacerbate food insecurity in Nigeria. As highlighted by the United Nations Development Programme (UNDP) in Nigeria (2020), infrastructure such as roads and storage facilities are vulnerable to the effects of climate change, including increased rainfall, flooding, and extreme weather events. These vulnerabilities could hamper the transportation and storage of food, leading to spoilage, supply chain disruptions, and reduced access to nutritious food for vulnerable populations. The potential impacts of climate change on food distribution and access are a pressing concern, particularly in rural areas where

access to markets and transport infrastructure is already limited. A study by Oluwatobi and Ajisehiri (2017) emphasized that climate-related disruptions to transport infrastructure in Nigeria can impede the timely and efficient movement of food from production areas to markets, resulting in higher transportation costs and decreased availability of fresh produce.

Furthermore, as highlighted by Boko et al. (2018), the vulnerability of storage facilities, such as grain silos, to extreme weather events and waterlogging poses a significant risk to food security. Inadequate storage infrastructure and the lack of access to modern storage technologies could lead to post-harvest losses and decreased availability of food in the market, ultimately driving up food prices and reducing access to nutritious food for vulnerable communities. Addressing the potential impacts of climate change on food distribution and access in Nigeria requires a combination of infrastructure investment, sustainable resource management, and policy innovation. For example, promoting climate-resilient infrastructure and implementing improved post-harvest storage techniques can help mitigate the effects of climate change on food distribution and storage efficiency.

Climate change and human security in Nigeria

Climate change appears to not pose a significant threat to human security because of its subtle nature. There is evidence that climate change has had a negative impact on peaceful human beings found all throughout the earth. A people-centered concept of security, human security, according to the United Nations, "seeks to integrate the numerous determinants of well-being such as economic, food, health, environment, personal, political and communal security Human Security Network (1999) states that "constructing Establishing human security is crucial to creating a compassionate society in which people can live free from need, hopelessness, and fear of desire, in safety and dignity. The United Nations Human security was divided into immediate threats from unforeseen interruptions like natural catastrophes as well as enduring dangers like hunger, illness, and violence.

The conventional notions of national and international security are incomplete without considering human security, which complements both. Human security is fundamental to the broader concept of security at both national and international levels, offering a more comprehensive and detailed approach to security discourse. According to the United Nations' General Assembly Resolution 66/290, human security is an approach aimed at helping member states identify and address widespread and cross-cutting challenges to the survival, livelihood, and dignity of their people. This approach calls for people-centered, comprehensive, context-specific, and prevention-oriented responses that strengthen the protection and empowerment of all individuals.

Climate Change and Human Security in Nigeria

Climate change represents a significant threat to human security globally, with its impacts ranging from environmental degradation to socioeconomic instability. In Nigeria, the effects of climate change have been particularly severe, exacerbating existing vulnerabilities and undermining the well-being of its people. This section seeks to explore the interplay between

climate change and human security in Nigeria, providing an overview of the challenges and potential solutions. One of the key impacts of climate change in Nigeria is the exacerbation of natural disasters, including floods, droughts, and extreme weather events. These events have the potential to cause widespread destruction of infrastructure, displacement of populations, and loss of livelihoods, all of which contribute to the erosion of human security. For example, in 2012, flooding in Nigeria affected over 7 million people, leading to extensive damage to homes, farms, and infrastructure, and resultant food insecurity (Owoeye et al., 2013). Similarly, recurrent droughts and desertification have led to decreased agricultural productivity and increased food insecurity, further undermining human security.

In addition to the direct impacts on physical infrastructure and livelihoods, climate change in Nigeria has also contributed to the exacerbation of social tensions, conflicts, and insecurity. For example, competition over natural resources, such as water and land, has resulted in intercommunal conflicts and violence in rural areas, further threatening the security of vulnerable populations (Nwankwoala, 2020). Furthermore, the displacement of populations due to climate-related disasters has led to increased urbanization and the proliferation of informal settlements, which are often associated with high levels of crime and insecurity (Adelekan, 2010). All of these factors contribute to the erosion of human security in Nigeria, undermining the well-being of its people and exacerbating existing vulnerabilities. Addressing the challenges posed by climate change to human security in Nigeria requires a comprehensive, multi-faceted approach. This includes efforts to build the resilience of communities to climate-related disasters through the implementation of early warning systems, disaster preparedness measures, and infrastructure development (Onyenechere et al., 2018). In addition, there is a need to invest in sustainable agriculture and natural resource management practices that can help mitigate the impacts of climate change on food security and livelihoods (Olukosi, 2015). Furthermore, addressing the root causes of social tensions and conflicts over natural resources, including issues of land tenure and resource governance, is critical to promoting human security in Nigeria (Nmadu & Ogah, 2018).

Climate change emerges as a significant threat to human security in Nigeria, manifesting through various impacts that trigger violent conflicts, disrupting public safety and stability. Idumah et al. (2016) note that climate change-induced vagaries in climatic conditions have reduced agricultural productivity prospects, leading to increased aridity in pasture areas in northern Nigeria. This forces pastoralists southward, creating competition with local farmers for scarce resources and sparking conflicts. Barnett and Adge (2007) highlight that climate change undermines human security by limiting access to crucial natural resources and weakening states' capacity to promote human security. Floods, droughts, and desertification contribute to population displacement and a decline in agricultural output, linking to violent conflicts and insurgency in various parts of Nigeria. Researchers like Odo (2012), Folami (2013), Oladele (2010), and Adishi and Oluka (2018) establish connections between climate change and farmer-herder conflicts.

The continued environmental degradation in parts of Northern Nigeria, leading to the loss of grazing fields, prompts a southward movement of pastoralists. This migration pattern results in

violent clashes between farmers in host communities and herders, disrupting agricultural activities, causing human losses, and destroying settlements and communities. This conflict pattern increases arms trafficking across countries, with some herders resorting to using acquired weapons for crimes such as kidnapping, armed robbery, and rape, further exacerbating the security situation in the country. Climate change is considered a key factor in the exacerbation of existing challenges related to land degradation and desertification in Nigeria. Land degradation refers to the deterioration of the land's quality and productivity, while desertification refers to the process by which fertile land becomes desert, typically as a result of drought, deforestation, or inappropriate agriculture practices (United Nations, 1994). Both of these environmental issues are of great concern for Nigeria, as they have the potential to significantly impact food production and human security in the country.

According to the Intergovernmental Panel on Climate Change (IPCC), climate change is expected to lead to increased temperatures and altered precipitation patterns in many regions, including Nigeria (IPCC, 2014). These changes are likely to result in more frequent and severe droughts and floods, which can contribute to land degradation and desertification. As a result, Nigeria may experience reduced arable land and decreased water availability for agriculture, further compromising food production and human security in the country. The impact of climate change on land degradation and desertification in Nigeria is a cause for concern, as agriculture is a major source of livelihood for many Nigerians, and the country heavily relies on food production for its population. Therefore, it is essential for Nigeria to prioritize efforts to mitigate and adapt to the effects of climate change on land degradation and desertification in order to ensure food security and sustainability of the country's agricultural sector.

Adaptation and Resilience Strategies:

In response to the challenges posed by climate change, Nigeria has developed several adaptation and resilience strategies. These include the promotion of climate-smart agriculture, the development of drought-resistant crops, and the improvement of water management practices (Adefolalu, 2019). The government has also initiated projects to strengthen the resilience of smallholder farmers and improve food security in vulnerable communities (Olatinwo, Awotide, & Manyong, 2018). These strategies are important in addressing the impact of climate change on agricultural productivity and food security in Nigeria.

In addition to its domestic efforts, Nigeria is also involved in international agreements and initiatives aimed at mitigating climate change and its impacts. Nigeria is a signatory to the Paris Agreement, which was adopted under the United Nations Framework Convention on Climate Change (UNFCCC) and aims to limit global warming to well below 2 degrees Celsius. The country has also committed to working towards the Sustainable Development Goals (SDGs), particularly Goal 13, which emphasizes the need to take urgent action to combat climate change and its impacts.

The Paris Agreement and the SDGs place a strong emphasis on the need to address climate change and its effects on food security, recognizing the fundamental relationship between

climate change, agriculture, and food production. By being a part of these global agreements, Nigeria is demonstrating its commitment to collaborating with the international community to scale up efforts in building climate resilience, reducing greenhouse gas emissions, and promoting sustainable agricultural practices.

Furthermore, Nigeria's engagement in these international agreements also provides an opportunity for the country to access financial and technical support for climate change adaptation and mitigation measures, as well as to participate in knowledge-sharing and capacity-building initiatives with other nations facing similar challenges. Overall, Nigeria's participation in international agreements and initiatives underscores the recognition of the interconnectedness of climate change, food security, and sustainable development, and the importance of global cooperation in addressing these critical issues.

Discussion of Findings

This study emphasizes the critical impact of climate change on agriculture and human security in Nigeria. It highlights the vulnerability of the agricultural sector to changes in temperature and precipitation, which could lead to reduced crop yields and livestock productivity. The study also acknowledges the indirect effects on food security, extending beyond production.

While the study initially downplays the direct threat of climate change to human security due to its subtle nature, it later recognizes the severe consequences globally and particularly in Nigeria. The effects exacerbate existing vulnerabilities, affecting the well-being of the population.

Adaptation and resilience strategies, such as climate-smart agriculture and drought-resistant crops, have been developed in response to climate challenges. Policy recommendations include strengthening agricultural resilience, improving smallholder farmers' access to inputs, providing climate information, and investing in climate-resilient infrastructure.

Conclusion:

Climate change is a significant threat to food and human security in Nigeria, with potential implications for the well-being of its citizens. It is essential for the government, in collaboration with other stakeholders, to implement comprehensive policies and measures to address the challenges posed by climate change to food security. This should include the promotion of climate-smart agriculture, the improvement of water management practices, and the strengthening of resilience in vulnerable communities. By taking proactive measures to mitigate the impacts of climate change on food security, Nigeria can enhance its resilience and ensure the well-being of its citizens in the face of a changing climate.

Policy Recommendations:

To address the threats posed by climate change to food and human security in Nigeria, it is essential to implement a comprehensive set of policies and measures. These should include:

1. Strengthening the resilience of Nigeria's agricultural sector to climate-related risks is crucial

for ensuring food security and sustainable development in the face of a changing climate. One key recommendation for achieving this is through the promotion of climate-smart agriculture practices and the development of drought-resistant crops. Climate-smart agriculture encompasses a range of practices and techniques that not only increase agricultural productivity and incomes but also contribute to climate change adaptation and mitigation. These practices may include the use of agroforestry, conservation agriculture, improved water management, and diversified crop and livestock systems. By adopting climate-smart agricultural approaches, farmers can better cope with the increasing frequency and intensity of extreme weather events, such as droughts and floods, while also reducing greenhouse gas emissions from agricultural activities.

In addition to promoting climate-smart agricultural practices, the development and adoption of drought-resistant crops are essential for building resilience in the face of climate-related risks. As precipitation patterns become more unpredictable and water resources become scarcer due to climate change, the availability of crops that can withstand water stress and thrive in drought conditions will be critical for ensuring food production and security. Investing in research and development to breed and distribute drought-resistant crop varieties, along with promoting the use of water-efficient irrigation technologies, can help farmers adapt to changing climate conditions. Furthermore, supporting smallholder farmers with access to these resilient crop varieties, training in sustainable agricultural practices, and financial resources can catalyze the adoption of climate-resilient farming methods across Nigeria's agricultural landscapes.

2. Smallholder farmers are often at a disadvantage when it comes to accessing agricultural inputs such as seeds and fertilizers. Limited access to these essential resources can significantly hamper their productivity and resilience to climate change, leading to decreased yields and increased vulnerability to environmental stressors. Improving access to agricultural inputs for smallholder farmers is crucial for enhancing their productivity and resilience to climate change. By providing smallholder farmers with better access to high-quality seeds and fertilizers, they can improve their crop yields, leading to increased food security and income generation. Additionally, access to improved agricultural inputs can help smallholder farmers adapt to and mitigate the impacts of climate change, such as droughts, floods, and erratic weather patterns.

One way to improve access to agricultural inputs for smallholder farmers is through the establishment of input subsidy programs. These programs can provide subsidies for seeds and fertilizers, making them more affordable and accessible to smallholder farmers. Additionally, agricultural extension services can be strengthened to provide farmers with the knowledge and skills needed to effectively use these inputs, increasing their productivity and resilience. Furthermore, partnerships between governments, private sector companies, and international organizations can play a crucial role in improving access to agricultural inputs for smallholder farmers. These collaborations can help ensure that high-quality seeds and fertilizers reach smallholder farmers in remote and marginalized areas, where access to agricultural inputs is often the most limited.

3. Climate change is having a significant impact on agricultural practices, and farmers are facing challenges in adapting to changing weather patterns and extreme events. In order to help farmers

make informed decisions about their agricultural practices, it is essential to enhance the availability and accessibility of climate information and early warning systems. One way to achieve this is through the development and implementation of technology-driven solutions. For example, mobile apps and online platforms can provide real-time weather forecasts, climate data, and early warning alerts to farmers, helping them to better understand and prepare for weather-related risks. Additionally, the use of remote sensing and satellite technology can provide important information about soil moisture, crop health, and other key factors that can affect agricultural production.

Furthermore, it is important to prioritize the engagement and capacity-building of local communities and farmers in using climate information and early warning systems. Training programs and workshops can be organized to help farmers understand how to interpret and use weather and climate information to make practical decisions about their agricultural practices. This can empower farmers to take proactive measures to mitigate climate-related risks and improve their resilience to extreme weather events. In addition, partnerships between governments, research institutions, NGOs, and private sector organizations can play a crucial role in enhancing the availability and accessibility of climate information to farmers. By working together, these stakeholders can develop and implement innovative solutions, leverage resources, and build capacity to support farmers in adapting to climate change.

4. Investing in climate-resilient infrastructure is essential for ensuring the efficient production and distribution of food, particularly in the face of changing weather patterns and more frequent extreme weather events caused by climate change. One crucial area for investment is in irrigation systems. With more erratic rainfall patterns and prolonged droughts in some regions, ensuring access to water for crops is increasingly important. Climate-resilient irrigation systems, such as drip irrigation and micro-sprinklers, can help conserve water and reduce the impact of water scarcity on agricultural production. Investing in modernizing and expanding irrigation infrastructure can also improve water efficiency, reduce reliance on rain-fed agriculture, and support the cultivation of a wider range of crops.

Another critical aspect of climate-resilient infrastructure is the development of storage facilities. With increased variability in weather patterns, farmers face challenges in managing the post-harvest stages of their crops. Climate-resilient storage facilities, including grain silos, cold storage, and warehouses, can help protect harvested crops from weather-related damage and spoilage. Investing in such infrastructure can help farmers access markets more effectively, reduce food waste, and ensure a more reliable food supply in the face of climate-related disruptions. Furthermore, investing in climate-resilient transportation and distribution infrastructure is also key. Improved roads, bridges, and transportation networks can enhance the efficient movement of agricultural products from farms to markets, ensuring that food reaches consumers in a timely and reliable manner, even in the face of extreme weather events. Additionally, cold chain infrastructure for temperature-sensitive products, such as perishable fruits and vegetables, can help maintain product quality and freshness over longer distances and periods, reducing food loss and promoting food security.

Governments, development agencies, and the private sector can all play a role in investing in climate-resilient infrastructure. Public-private partnerships and innovative financing mechanisms can mobilize the necessary resources to improve infrastructure and build resilience in the agricultural sector. Moreover, incorporating climate resilience into infrastructure planning and development can yield long-term benefits, not only for agricultural production but also for overall economic development and food security. Ultimately, investing in climate-resilient infrastructure is a crucial step toward building a more resilient and sustainable food system. By improving irrigation, storage, and transportation infrastructure, we can enhance the efficiency and reliability of food production and distribution, ultimately ensuring food security in the face of climate change.

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