Investigating the Adaptive Practices Implemented by Rural Communities in Nigeria to Alleviate the Impacts of Climate Change on Agricultural Sectors

Adamaagashi Izuchukwu Prince
Graduate of Enugu State University of Science and Technology in Nigeria.
adamaizuchukwu@gmail.com

Adedeji Oluwasayo Badewole
Graduate of University of Ibadan
abadewole4653@stu.ui.edu.ng

Jephthah Ayodele Omotoso
Graduate of University of Ilorin, Nigeria
jephthah.omotoso@fuoye.edu.ng

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Abstract
This study investigates the adaptive practices implemented by rural communities in Nigeria to alleviate the impacts of climate change on agricultural sectors. A thorough literature review is conducted to understand the social resilience strategies and adaptive practices employed by these communities. The study highlights the dependence of agriculture on weather and climate factors, and the environmental challenges posed by unsustainable land management practices. It emphasizes the disproportionate impact of climate change on Africa, particularly Nigeria, ranking it as one of the most vulnerable countries. Various climate change adaptation strategies are explored, including crop diversification, early planting, access to climate information, and climate-resilient infrastructure. The study recognizes the importance of education, awareness-raising initiatives, livelihood diversification, and international collaboration in enhancing resilience. Based on the findings, recommendations are provided to strengthen climate change adaptation strategies, such as improving climate information systems, enhancing sustainable agriculture practices, promoting crop diversification, investing in climate-resilient infrastructure, fostering community-based approaches, and strengthening international collaboration.

Keywords*: Climate change, social resilience, adaptive practices, rural communities, Nigeria*

Introduction

Climate change is a globally recognized phenomenon that poses significant challenges to various sectors of society, particularly in countries heavily dependent on agriculture for their economy and livelihood. Many rural communities in Nigeria heavily rely on agricultural practices to sustain their lives and communities. These communities face escalating threats from the impacts of climate change, including erratic rainfall patterns, increased temperatures, prolonged droughts, and severe weather events such as floods and storms. Adapting to climate change and building social resilience is crucial for the survival and sustainability of rural communities in Nigeria.

Social resilience refers to the ability of individuals, communities, and societies to anticipate and respond effectively to environmental, social, and economic changes. It involves the development of adaptive practices that enable communities to mitigate the adverse impacts of climate change on agricultural sectors and maintain their overall well-being.

According to Marrewijk (2011), vulnerability in the context of climate change refers to how a system is susceptible to and unable to cope with the negative effects of climate change, including extreme weather events. This necessitates the implementation of measures to adapt to and mitigate the impact of climate change. In agriculture, the main objective is to increase food production efficiently while reducing greenhouse gas emissions from the food sector. Adaptation can be defined as societal or environmental efforts to prepare for and deal with future climate change. These efforts can either be defensive, protecting against adverse impacts, or adaptable, taking advantage of beneficial effects of climate change (USEPA 2014). Under the UNFCCC, Nigeria and other developing countries are focusing on adaptation to cope with the changing climate conditions and to promote environmentally and economically sustainable development (Adesina and Odekunle 2011a). Developing countries argue that their economic growth is being hindered by the effects of climate change, even though they contribute a small fraction of the greenhouse gas emissions causing climate change. Due to their growing economies, these countries have limited capacity to adapt and are highly vulnerable to climate change impacts.

Nigeria is currently facing economic challenges, with its debt to GDP ratio standing at 23.27% and steadily increasing due to increased borrowing and a sluggish economy. Fitch Ratings has assigned Nigeria a B' sovereign credit risk rating, indicating the country's vulnerability to default on its debt obligations. Over the past five years, Nigeria's economic growth has been inconsistent, ranging from 0.8% to 3.6%, at times even dipping below zero. The country experienced its worst recession in two decades in 2020 as a result of the COVID-19 pandemic, which disrupted global trade and caused a decline in oil prices. As of 2021, Nigeria's GDP is valued at USD 440 billion or USD 2,085 per capita. However, the unemployment rate is estimated to be a staggering 33.3%, indicating a significant lack of job opportunities. Additionally, the country is grappling with a high inflation rate of 20.5%, eroding the purchasing power of its citizens. The issue of inadequate access to electricity is also a major concern, with only 54% of the population having access, leaving over 97 million people without electricity. Furthermore, the access to clean energy is pegged at 15%, meaning nearly 180 million individuals have no access to modern and clean cooking technologies. This current economic situation highlights the need for Nigeria to address its economic vulnerabilities and take steps towards sustainable growth and development. Efforts to diversify the economy, improve infrastructure, and enhance access to basic services such as electricity and clean energy are crucial for Nigeria's long-term prosperity and wellbeing.

Adger et al. (2007) point out that throughout history; human societies have demonstrated the ability to adapt to different climates and environmental changes through various means such as migration, improved crop varieties, and diversifying housing types. However, the current rate of global climate change is unprecedented and faster compared to past changes experienced by society. In today's increasingly interconnected world, the adverse effects of climate change on one community or economic sector can have global consequences (USGCRP 2009). Adaptation is crucial on a global scale because climate change is a long-term issue. Greenhouse gases remain in the atmosphere for extended periods, continuing to warm the Earth even if emissions

were to cease today. Therefore, preparations and responses to the impacts of climate change that are already happening and projected to occur in the future must be made (USCGRP 2009).

Continuous actions are needed to mitigate climate change as there are limits to adaptation alone. While adaptation is important, it may not be sufficient to cope with all projected impacts of climate change. This necessitates continuous efforts to reduce greenhouse gas emissions (IPCC 2007). The level of socioeconomic development of a country plays a role in its ability to adapt. The resilience and adaptive capacity of a country depend on its economic and political stability. To improve adaptation strategies, it is essential to understand local vulnerabilities and establish critical thresholds. Adaptation plans should be flexible to accommodate potential changes in climatic conditions and should be reviewed periodically.

Various adaptation strategies exist for agriculture, with Nigeria focusing on innovative indigenous technology options such as improved crop varieties, composting, recycling, improved cultivation techniques, and cover cropping (Eze and Osahon 2015). Adaptations can be reactive, occurring after the impacts of climate change are experienced, or anticipatory, undertaken before the impacts are fully felt. Planned adaptations are typically anticipatory but can also be reactive. Farmers have access to various adaptations depending on their local environments and specific farming systems. Some studies suggest that adaptations may involve the relocation of farmers, changes in farming practices, or the establishment of new farmers in different locations (Adesina and Odekunle 2011b). While individual farmers may make strategic adaptations, the term "planned adaptation" typically refers to actions taken by governments as a conscious policy response. These planned adaptations can include the reinforcement of technological adaptations, changes in land and water use, diversification or intensification of production, adjustments to financial support programs, and compensation measures.

The World Health Organization (WHO) has projected that CC has significant implications for human health, with at least 150,000 deaths each year attributed to its consequences. These deaths are expected to increase twofold by 2030, mainly as a result of flooding and water-related diseases (WHO, 2021). Research studies have supported this claim, demonstrating that climate change-related torrential flooding has been responsible for disease outbreaks in different parts of the world (Lisle, 1995; Rose et al., 2000). As a consequence, the population in Nigeria may be particularly vulnerable to these threats.

According to Maikasuwa (2013), the impacts of climate change (CC) in developed countries are relatively less severe compared to developing countries. This is attributed to the advanced adaptation technologies, productive research, and effective institutional policies that have been developed over time by developed countries. These measures have facilitated adequate adaptive responses and mitigation of the effects of CC (Jagtap, 2007; Enete & Amusa, 2010; Ebele & Emodi, 2016; Elum & Momodu, 2017).

However, in developing nations like Nigeria, the availability of modern adaptation technologies is limited. Hence, the present study aims to investigate the effectiveness and implications of CC adaptation strategies in Nigeria. The study emphasizes the need to understand CC impacts at different spatial scales and assess the evolution of research on the topic in Nigeria. By analyzing the trend, focus, spatial variability, and efficacy of CC research and adaptation strategies in Nigeria, the study aims to identify research gaps and provide a baseline for future studies. The

findings are expected to contribute to enhancing the resilience of food and environmental systems for sustainable development (APA Reference not applicable as this is a paraphrase and additional information has been added).

This research aims to investigate the social resilience and adaptive practices implemented by rural communities in Nigeria to alleviate the impacts of climate change on agricultural sectors. By understanding these practices and their effectiveness, policy-makers, researchers, and communities themselves can develop strategies and interventions that enhance resilience and reduce vulnerability to climate change.

Methodology

The methodology for this study involves conducting a thorough examination of various research studies, reports, and publications that focus on the social resilience strategies and adaptive practices of rural communities in Nigeria. The goal is to understand how these communities are mitigating the negative impacts of climate change on their agricultural sectors. A comprehensive literature review is carried out to gather a wide range of perspectives and approaches. A synthetic analysis approach is then applied to analyze and synthesize the data in a systematic manner, allowing for the identification of patterns, trends, and important insights. Ultimately, the researchers aim to provide recommendations and effective strategies to enhance the resilience and adaptation capacities of rural communities in Nigeria in dealing with the effects of climate change on agriculture.

Agriculture and Climate Change

Human cultivation methods and changes in weather and climate have placed the environment in a difficult situation known as climate change. Agriculture heavily depends on weather and climate, with factors like rainfall, sunlight, airstream, and temperature influencing the distribution and productivity of crops. Agriculture is one of the most demanding activities on land. However, land is constantly in short supply due to biophysical factors like rain, temperature, and topography, as well as unsustainable land management practices including deforestation, uncontrolled soil nutrient mining, and cultivation on steep slopes. These effects can lead to overgrazing, desertification, soil erosion, deforestation, and a shortage of available land for human activities. This persistence of land degradation contributes to concerns about the potential depletion of the ozone layer as the Earth warms up, primarily due to human activities that release greenhouse gases like methane, water vapor, nitrous oxide, and carbon dioxide, which trap heat in the atmosphere.

Climate, which represents long-term average weather conditions, plays a critical role in crop cultivation and livestock keeping. It directly or indirectly impacts farm events and governs decisions about which crops to plant, how to plant them, and the nature and yields of livestock in a particular location. Climate change refers to the long-term change in average temperature resulting from the Earth's warming, which could eventually lead to ozone layer depletion. Despite being an inconsistent phenomenon, climate change poses clear threats to various sectors, including agriculture, affecting all aspects of human activity. Higher concentrations of greenhouse gases in the atmosphere resulting from human and natural activities such as fossil fuel use, land use change, and agriculture contribute to the Earth's warming. Unfortunately, many

people in developed regions prefer to deny the reality of climate change rather than adjusting their lifestyles to mitigate its effects. Therefore, there is a need to increase farmers' awareness of climate change and adequately prepare for its mitigation. Research efforts focused on adapting to and mitigating the impacts of climate change are crucial for improving living conditions.

The planet's increasing temperature is causing frequent changes in rainfall patterns and extreme events like droughts. Agriculture, forestry, and changes in land use contribute up to 25% of human-induced greenhouse gas emissions, with agriculture being the main source of methane and nitrous oxide emissions, which are significant greenhouse gases. Climate change is undeniable, and its impacts can be observed through rising temperatures, reduced rainfall, desertification, water scarcity, health issues, and agricultural problems. Several million hectares of crops and livestock have already been destroyed due to climate-induced disasters. The economy of nations is greatly affected by climate change, with the agriculture sector accounting for approximately 22% of the overall damage in developing countries. Therefore, it is imperative for farmers to understand the extent of destruction that climate change can cause to their livelihoods, leading to better preparedness for mitigation. Instances of low humidity during the propagative stage of crops result in poor yields, and the crop sector is particularly vulnerable during unfavorable weather conditions, highlighting the need for farmers to be aware and prepared (Reuben and Barau, 2012; FAO, 2015).

It is important to recognize that countries will experience climate change impacts differently. While some areas may see beneficial effects, others may face negative consequences. Regardless of the measures taken to mitigate or prevent climate change, some degree of additional change and impact is unavoidable. Therefore, there is an unavoidable need to adapt agricultural systems to withstand resilient conditions. The two main approaches to address climate impact are mitigation and adaptation. Adapting agriculture to climate change and ensuring sufficient food production can help address current challenges. However, as greenhouse gas (GHG) levels continue to rise, climate change and its effects will present new challenges and hardships for people. Currently, agriculture and related sectors contribute approximately a quarter of GHG emissions caused by human activity. It is crucial to reduce these emissions and other adverse environmental effects. Often, reducing resource consumption and increasing efficiency aligns with efforts to mitigate emissions. By lowering GHG concentrations in the atmosphere, the severity of future extreme climate events can be significantly reduced, making adaptation to climate change easier.

The Impact of Climate change and Vulnerability on Agriculture in Nigeria

According to research, Africa is disproportionately impacted by climate change, with the rate of temperature increase and its associated effects, such as desertification, coastal erosion, loss of biodiversity, and saltwater intrusion, happening at a faster pace compared to the global average. In 2016, Nigeria was ranked as the 7th most vulnerable country in the world by Verisk Maplecroft. Similarly, in 2021, the Notre Dame Global Adaptation Initiative (ND-GAIN) rated Nigeria's vulnerability to climate disasters and its capacity to adapt as 161 out of 182 countries assessed. Nigeria has a higher susceptibility to climate impacts due to factors like its large population, extensive coastline, limitations in financial resources for climate initiatives from both public and private sectors, and a gap in knowledge about adaptation strategies.

At present, Nigeria is confronted with diverse challenges stemming from direct and indirect impacts of climate change, including food insecurity, forced displacement, conflicts, negative health outcomes, and more. These challenges collectively hinder climate action and economic growth. Notably, droughts and desertification in the arid and semi-arid regions of northern Nigeria disproportionately affect local communities engaged in rain-fed agriculture. This has led to the movement of nomadic animal-rearing communities from the north to the south, resulting in conflicts with indigenous crop-farming communities over increasingly scarce resources. Additionally, these migrating cattle herders bring with them zoonotic diseases that can be exacerbated by climate change.

According to Skoufias et al. (2011), climate variability can indirectly impact poverty reduction efforts in developing countries. Reducing climate variations can increase agricultural yields, leading to higher incomes for farmers and improved food security for the population. This suggests a potential for development experts to establish connections between climate vulnerabilities and development policies, addressing the impact of climate change on agricultural practices. Decreased climate variability can reduce vulnerability levels for farmers, while the effects of climate change can be felt across various sectors, including socio-economy, water resources, food security, human health, ecosystems, coastal zones, and related areas. Fluctuations in precipitation and glacier melting can result in water shortages, soil erosion, flooding, crop losses, and low profits for farmers (IPCC 2007).

Rising temperatures have forced Nigerian farmers to adjust crop growing seasons, affecting food availability and the spread of disease vectors (Odjugo 2010; Apata et al. 2009). Climate variations can increase vulnerability to diseases carried by vectors and potentially lead to species extinction and habitat loss. Pests and diseases can migrate in response to climate change, posing serious consequences for agriculture and the environment (IPCC 2007; Earth Journalism Network 2016). Erratic temperature patterns and pest movements can disrupt rainfall and sunshine patterns, resulting in crop instability. Land warming rates in Nigeria have been reported to be above the regional average (Boko et al., 2007).

According to Olayide et al. (2016), extreme rainfall patterns and variations in Nigeria pose a significant risk to the rain-fed agricultural production system, which is heavily relied upon by farmers. This vulnerability to seasonal variability affects the livelihood outcomes of farmers and results in substantial losses in grain yields such as rice, millet, sorghum, and maize (Sokoto et al., 2016). Furthermore, Bismark and Richard (2019) found that maize and other cereals in Nigeria are highly susceptible to climate variability, leading to negative consequences on yield. The yields and productivity of maize, millet, sorghum, and rice are negatively affected by unfavorable climatic conditions, including drought, excessive temperature, and low rainfall (Bamiro et al., 2020).

The climate change complications experienced in Nigeria vary across the country. Nkechi et al. (2016) and Akande et al. (2017) note that Nigeria has a tropical climate with different precipitation patterns between the north and south regions. The northern region experiences low precipitation and high temperatures, leading to ecological effects such as aridity, drought, and desert encroachment. On the other hand, the southwest and southeast regions have lower temperatures and higher rainfall. Vulnerability analysis shows that the northern states, especially in the northeast and northwest regions, experience higher vulnerability to climate change

compared to the southern states (Federal Ministry of Environment, 2014; Madu, 2016). These variations in the northern climate are exacerbated by desertification, loss of wetlands, and a decrease in surface water volume, flora, and fauna resources (Abdulkadir et al., 2017; Ebele & Emodi, 2016). Despite the relatively less vulnerability of the southern region, the Niger Delta region is highly susceptible to climate change impacts, including sea level rise, increased rainfall, coastal destruction, and flooding (Matemilola, 2019).

According to Madu (2016), vulnerability to climate change aligns with agronomic activities in specific locations, with the northern regions of Nigeria, which have higher levels of rurality, being more vulnerable. Therefore, the adoption of existing and new technologies to adapt to climate change and variability is a priority for most of Nigeria. Sokoto et al. (2016) found that farmers in Kwara State, located in the northern part of Nigeria, are already experiencing the impact of climate change, including increased production costs and reduced grain production, leading to decreased profits. Climate variability and change exacerbate heat and moisture stresses in developing countries like Nigeria (Earth Journalism Network, 2016). Thus, tropical countries face the challenge of dealing with the impacts of climate change. (172 words)

Even as early as 2012, Nigeria had already been facing climate variability and intense rainfall in its central and southern regions, resulting in devastating and recurring flood disasters that caused approximately USD 16.9 billion in losses and damages. Currently, floods (both river and urban) and other climate-related disasters in Nigeria are contributing to an increase in disease incidence, particularly vector-borne diseases like malaria. In 2021 alone, malaria caused 200,000 deaths in Nigeria, accounting for 32% of global malaria deaths, and impacting 60 million Nigerians. There is also a growing risk of waterborne diseases such as cholera. In other parts of the country, a combination of droughts, saltwater intrusion, and sea level rise have negatively affected crop yields and urban infrastructure, leading to higher food prices, increased development costs, and associated effects. Crop yields are particularly susceptible to climate variations as agriculture is predominantly rain-fed, with only 1% of farmland being irrigated nationwide. Subsistence agriculture, which accounts for nearly 23% of Nigeria's GDP, is practiced by over 70% of the population. Econometric analyses estimate that Nigeria could face losses ranging from USD 100 billion to USD 460 billion by 2050 if adequate climate adaptation measures are not implemented.

Despite Nigeria being a signatory to the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR), these vulnerabilities persist, and the well-being of Nigerians continues to be affected. The SFDRR is a comprehensive program aimed at reducing disaster risks and losses, promoting community and country health, and building resilience through measures such as understanding risk, strengthening governance, and investing in disaster risk reduction. However, there seems to be a discrepancy between the ongoing vulnerabilities and the effectiveness of projects designed and implemented across Nigeria, indicating a gap between signed agreements and the actual sufficiency of actions taken.

Climate Change Adaptation Strategies for Rural communities in Nigeria

Climate change presents numerous challenges for rural communities in Nigeria, impacting their livelihoods and overall well-being. Adaptation is a way for individuals to improve their ability to handle an uncertain future. To adapt to climate change, it is necessary to take effective actions to minimize its negative effects or take advantage of any positive effects. This involves making

necessary adjustments to avoid significant negative impacts. Developing countries, like Nigeria, often see developed countries as having less vulnerability and better strategies for adapting to climate change because they are better able to understand the opportunities presented by cold weather and can make informed decisions to strengthen their agricultural production. The international community, particularly through the UNFCCC, is actively discussing ways to combat climate change. It is important for the international community to include processes in their future decisions that assist developing nations with the transfer of knowledge, technology, and financial resources to adapt in all areas and sectors. To address these challenges, various adaptation strategies have been implemented to help communities cope with the effects of climate change and build resilience.

Promoting sustainable agriculture practices

Promoting sustainable agriculture practices is recognized as a key strategy in addressing the challenges posed by climate change in rural communities. Agriculture is not only crucial for the sustenance of these communities but also plays a vital role in their economic stability. However, the impact of climate change, characterized by unpredictable rainfall patterns, increased temperature, and prolonged droughts, poses a significant threat to crop yields and livestock production. In response to these challenges, farmers are embracing various strategies to enhance the resilience of their agricultural systems. One such strategy is conservation agriculture, which involves minimizing soil disturbance through reduced tillage or no-till farming. This practice helps to improve soil structure, moisture conservation, nutrient retention, and biodiversity, leading to increased resilience to drought and other extreme weather events.

Agro forestry is another sustainable agriculture practice that is gaining popularity in combating climate change impacts. It involves planting trees or shrubs alongside crops or livestock, creating a beneficial interaction between agricultural and forestry components. Agro forestry systems provide numerous benefits, such as improved soil fertility, increased water infiltration, regulation of microclimate, and diversification of farm production. These practices not only enhance the resilience of agricultural systems but also provide additional income streams through the sale of tree products, such as fruits, timber, or medicinal plants. Watershed management plays a crucial role in mitigating climate change impacts on agriculture. Climate change often intensifies water scarcity and leads to erratic water availability, making water management essential. Implementing watershed management techniques, such as constructing small-scale water-harvesting structures like check dams and contour bunds, helps to retain rainwater and replenish groundwater resources. This practice assists in meeting irrigation demands during dry periods and maintaining stable water availability for agricultural purposes.

Crop Diversification

The study highlighted that farmers in Africa, including those in Nigeria, have recognized the importance of crop diversification in building resilience in the agriculture sector. Crop diversification refers to the practice of growing different types of crops in rotation or simultaneously on a single farm. This approach helps mitigate the risks associated with climate change by reducing dependence on a single crop and increasing overall agricultural productivity. However, while crop diversification is seen as a crucial adaptation strategy for climate change, it is not favored by all farmers. Some farmers may resist implementing this practice due to various

reasons, such as the lack of knowledge about its benefits, perceived higher costs or limited access to suitable crop varieties. It is important to address these concerns and provide appropriate support to ensure that all farmers can benefit from crop diversification to build resilience against climate change impacts.

Besides crop diversification, other technologies have also been identified as effective measures to address climate change variability and impacts. The adoption of drought-tolerant and early-maturing crop varieties can help farmers mitigate the risks associated with changing weather patterns, such as prolonged droughts or unpredictable rainfall. Planting cover crops, which are grown to protect and enrich the soil, has also proven beneficial in terms of soil conservation and climate change adaptation. In Nigeria, both the government and non-governmental organizations have recognized the importance of supporting farmers in adapting to climate change. They provide assistance and resources to promote the adoption of these adaptive strategies. Agricultural extension services play a crucial role in this process, offering weather-related information, skills training, and guidance on implementing climate-smart farming practices.

Early Planting

In response to the unpredictable and changing climate patterns, farmers in Sub-Saharan Africa, particularly in Nigeria, have been implementing various adaptation strategies to maintain agricultural productivity and ensure food security. Early planting is one such strategy that farmers have employed to cope with climate change. Early planting involves sowing crops at a time when there is sufficient rainfall to support their growth. By taking advantage of early heavy rains in May and June, farmers can ensure that their crops receive enough water during critical development stages. This approach allows the crops to establish strong root systems and develop early, making them more resilient to drought conditions that may occur later in the season. Maize, a staple crop in Nigeria, has been commonly planted early as it is known to have a relatively shorter growing period compared to other crops. By planting maize early, farmers are able to exploit the initial rainfall and favorable growing conditions, ensuring better yields and reducing the risk of complete crop failure in case of delayed or inadequate rainfall later in the season.

There are challenges associated with this adaptation strategy. Climate change has led to irregular weather patterns, including inconsistent and reduced rainfall during the typical rainy season of July and August in some parts of Nigeria. As a result, even with early planting, some crops that would normally be planted later in July did not receive sufficient moisture and ultimately failed to survive, leading to significant losses for farmers. The absence of rain during the regular growing period poses a significant threat to agricultural activities in Nigeria. Reduced yields, food shortages, and increased vulnerability to poverty are common consequences that farmers face when crops fail or perform poorly. Moreover, limited access to irrigation facilities and other adaptive resources further exacerbate the challenges faced by farmers.

To tackle these challenges, it is crucial for farmers, policymakers, and stakeholders to work together. Investments in agricultural infrastructure, such as improved irrigation systems, can help farmers mitigate the impacts of climate change and reduce their dependence on rainfall alone. Additionally, providing farmers with access to climate information and promoting the adoption of climate-smart agricultural practices can enhance their resilience and enable them to make informed decisions. Supportive policies and financial assistance can also play a vital role in

enabling farmers to adapt to climate change. Measures such as providing affordable loans, insurance, and subsidies for adaptive practices can help farmers invest in climate-resilient technologies and techniques. Additionally, training and capacity-building programs can empower farmers with the knowledge and skills needed to implement effective adaptation measures.

Improved Variety of Crops

In addition to promoting sustainable agriculture practices, farmers are also resorting to the use of improved varieties of crops as an adaptation strategy to cope with the impacts of climate change. These improved varieties are specifically bred to have characteristics such as resistance to pests and diseases, reduced water requirements, and shorter maturity periods. By incorporating these varieties into their farming systems, farmers can enhance their resilience against the changing climatic conditions. One notable example of the adoption of improved crop varieties can be seen among rice farmers in Kwara State, Nigeria. These farmers have started cultivating a crossbred rice variety from Kebbi State, known for its shorter maturity period of just 12 weeks, compared to traditional rice varieties that take four or more months to mature. This shorter duration enables farmers to cultivate and harvest rice twice within a single growing season, especially when combined with early planting strategies. This not only increases their overall rice production but also provides an opportunity to maximize their income.

However, the use of improved crop varieties does come with certain challenges. One such challenge is the higher cost associated with purchasing these improved seeds. Farmers may need to invest more in acquiring the improved varieties initially. However, they can subsequently save costs in the next planting season by producing seeds from the current crop, thus reducing their dependency on purchasing seeds each season. Nevertheless, the viability of using improved varieties heavily relies on the availability of water resources. In regions with prolonged periods of rainfall shortage and limited access to irrigation facilities, the adoption of improved varieties may not be as feasible. Without adequate water supply, these varieties may not thrive and could lead to reduced yields and financial losses for farmers.

Crop Rotation

Farmers in Sub-Saharan Africa, including Nigeria, use crop rotation as a strategy to mitigate the effects of climate change. They do not limit themselves to planting one type of crop, but instead alternate between grains and legumes across seasons. By doing this, farmers can anticipate the upcoming planting season based on climate variation patterns and local indicators, although these predictions may not always be accurate. For example, if temperatures are high and rainfall is scarce in the current year, farmers may anticipate a favorable climate in the next growing season. In such cases, they can choose crops that require more precipitation and are less vulnerable to such weather conditions. In Kaduna State, when the rain returned at the end of August and beginning of September, farmers planted soybean as it requires less rainfall and can be harvested in November with the expected remaining rain.

Farmers may also rely on weather forecasts from government agencies to determine the upcoming growing season and prepare accordingly. This information can help them decide which crops offer a relative advantage and can be rotated in subsequent seasons. This planning

allows farmers to mitigate the impacts of climate change and make informed decisions. Additionally, farmers in Kwara State have also utilized crop diversification as an adaptation strategy. They have changed the crops they grow on previously cultivated land due to changing climatic conditions. For example, land that was previously used for rice production due to abundant water has now been converted to maize and sorghum cultivation as it has lost its water content due to prolonged droughts. These adaptation strategies, including crop diversification, the adoption of drought-tolerant crops, early-maturing varieties, and planting cover crops, are also being employed by farmers throughout Nigeria. (Federal Ministry of Environment 2014; Achike and Onoja 2014)

Cultivation of large areas of farmland

In the face of climate change challenges, farmers have been compelled to adopt various strategies to ensure their resilience and livelihood. One such strategy is the cultivation of larger areas of farmland, with the aim of increasing productivity and mitigating potential crop losses and damages caused by changing weather patterns. By expanding their cultivation areas, farmers can not only increase their production and income but also reduce their vulnerability to climate-related risks. This proactive approach allows them to distribute their crops across different areas, reducing the likelihood of complete crop failure in case one area gets adversely affected by extreme weather events such as droughts or floods. Moreover, by cultivating more land, farmers are able to diversify their crops, which further adds to their resilience against climate change impacts.

However, it is important to note that land ownership in Kwara State and several other parts of Nigeria is primarily under government control. Farmers generally do not own the land they cultivate and are required to obtain permission and pay special charges for registration. Despite these regulations and legal requirements, many farmers cultivate without permission, taking the risk of potential losses if the rightful owners of the land emerge. This practice of farming without proper land ownership may be a result of various factors. Farmers may not have the financial means to acquire or lease land legally, or they may face bureaucratic hurdles in obtaining the necessary paperwork. Additionally, there may be a lack of awareness or understanding among farmers regarding the importance of adhering to land ownership laws.

While this approach of cultivating without permission has become somewhat of a norm among farmers, it is worth acknowledging that it has its drawbacks. Farmers who do not have legal ownership of the land they cultivate are at risk of losing their crops and investments if their activities are challenged by the rightful owners. Such disputes can lead to interruptions in cultivation and financial losses for the farmers involved. Moreover, the expansion of cultivation areas, although beneficial in terms of potentially higher yields, also increases farmers' vulnerability to the impacts of climate change. With a larger cultivated area, farmers become more reliant on favorable weather conditions. If adverse weather events occur simultaneously in multiple areas, it can have a devastating impact on their overall productivity and financial stability.

Diversification of livelihoods

Diversifying livelihoods is a crucial strategy for rural communities in Nigeria to cope with the impacts of climate change. As climate-related events like droughts, floods, and erratic rainfall patterns become more frequent and severe, agriculture may no longer provide a stable source of income or food security for these communities. Therefore, exploring alternative sources of income becomes imperative for their survival and resilience. One of the alternative livelihood options that these communities are exploring is eco-tourism. Nigeria is blessed with a rich natural and cultural heritage, including beautiful landscapes, national parks, historic sites, and cultural festivities. By promoting eco-tourism, rural communities can attract tourists who are interested in experiencing unique cultural practices, exploring natural wonders, and engaging in sustainable activities. This not only generates income but also promotes the conservation and preservation of local ecosystems and traditional knowledge.

Handicrafts also offer potential economic opportunities for rural communities to diversify their livelihoods. Many rural areas in Nigeria are known for their traditional craftsmanship in areas such as pottery, weaving, woodcarving, and beadwork. By developing and marketing these traditional crafts, communities can generate additional income and tap into local and international markets. Moreover, promoting the uniqueness and authenticity of these handicrafts can contribute to cultural revitalization and preservation. Non-agricultural activities such as small-scale businesses, service-oriented enterprises, and skill-based professions are being explored as livelihood options. For instance, micro-enterprises like small grocery stores, tailoring shops, and local restaurants can provide employment and income diversification opportunities. Additionally, skill-based professions such as carpentry, plumbing, and masonry can address various needs within the community and beyond.

By diversifying their livelihoods, communities can reduce their vulnerability to climate change impacts. When communities rely solely on agriculture, their incomes and food security are highly susceptible to climate-related shocks. However, by embracing alternative sources of income, they become more resilient to these shocks. Income streams from eco-tourism, handicrafts, and other non-agricultural activities can act as a buffer when agricultural productivity is affected by climate change. Moreover, diversification also enables communities to adapt to changing market dynamics and gain a better bargaining position. It is important to note that diversifying livelihoods should not be seen as a complete shift away from agriculture. Agriculture will still play a crucial role in rural livelihoods, but it will complemented by other income-generating activities. By carefully integrating diversification strategies with sustainable agricultural practices, rural communities can achieve a balance between farming and alternative livelihood options. This integrated approach ensures that communities have multiple income streams while also sustaining the ecological integrity of their natural resources.

Increasing access to climate information and early warning systems

Increasing access to climate information and early warning systems is of paramount importance for rural communities in Nigeria to effectively respond to the impacts of climate change. In a country where agriculture is a major livelihood source, having access to accurate and timely climate information can significantly enhance farmers' decision-making processes and increase their resilience. Climate information services play a critical role in providing communities with

up-to-date weather forecasts, seasonal climate outlooks, and other relevant data. By receiving this information, farmers can make informed decisions about their agricultural activities, such as when to plant, irrigate, or harvest their crops. This allows them to align their farming practices with weather patterns, reducing the risk of losses due to adverse weather conditions. For instance, if farmers are aware of an upcoming dry spell, they can delay the planting of their crops or implement appropriate irrigation measures to mitigate potential water stress.

In addition to seasonal forecasts, access to real-time weather updates is essential for farmers to make timely decisions. By being informed about imminent weather changes, such as heavy rainfall or extreme heat, they can take necessary precautions and adapt their farming practices accordingly. For example, if heavy rainfall is predicted, farmers can protect their crops from flooding or erosion by implementing soil conservation practices or adopting resilient crop varieties. Early warning systems are another crucial component of climate information services. They provide real-time alerts and notifications about potential extreme weather events, such as floods, droughts, or storms. These warnings are essential as they allow rural communities to take preventive measures, prepare for potential disasters, and minimize the impact on lives and livelihoods. By receiving early warnings, communities can evacuate to safer areas, secure their homes and belongings, and protect their livestock and agricultural assets.

To ensure the effectiveness of climate information and early warning systems, it is essential to prioritize accessibility and delivery mechanisms tailored to the local context. This can include using simple and easily understandable language, utilizing local radio stations to broadcast weather updates, or employing mobile phone-based platforms for disseminating information. Furthermore, involving local community leaders, agricultural extension workers, and traditional knowledge holders can greatly enhance the uptake and utilization of climate information among rural communities. Moreover, capacity building for farmers and local communities is crucial to enable them to understand and effectively utilize climate information. Training programs, workshops, and demonstrations can help farmers interpret the climate data they receive, understand the implications for their agricultural practices, and make informed decisions accordingly. Building their capacity also involves promoting sustainable agricultural practices, such as conservation agriculture, agroforestry, and efficient water management techniques, which can further enhance their adaptation to climate change.

Building and improving climate-resilient infrastructure and Community base adaptation Approach

The community-based adaptation approach plays a crucial role in building and improving climate-resilient infrastructure in rural communities. Recognizing that local communities have valuable knowledge and experience, involving them in the planning, implementation, and management of climate-resilient infrastructure projects is essential for their effectiveness and sustainability. One key aspect of the community-based adaptation approach is conducting participatory vulnerability and risk assessments. By engaging with community members, local authorities, and relevant stakeholders, an understanding of the specific vulnerabilities and risks faced by the community can be developed. This information is vital for identifying the infrastructure needs and priorities, as well as the most appropriate adaptation measures to be implemented.

In the context of climate-resilient infrastructure, the community-based adaptation approach emphasizes the importance of incorporating traditional and local knowledge into the planning and design process. The communities themselves possess valuable insights on the local environment, including weather patterns, ecological systems, and sustainable land management practices. Integrating this knowledge can enhance the effectiveness and appropriateness of infrastructure projects, making them more resilient to climate change. Community-based adaptation encourages the use of local labor and resources in the construction and maintenance of climate-resilient infrastructure. This approach not only promotes local ownership and empowerment but also ensures that structures are built in a manner that is suitable for the local context. For instance, using locally available materials and traditional construction techniques can improve the longevity and functionality of infrastructure, making it more resilient to climate impacts.

Participatory governance and community engagement are also important components of the community-based adaptation approach. It involves creating platforms for dialogue and decision-making, where community members can actively participate in the planning, implementation, and monitoring of infrastructure projects. This ensures that the infrastructure is aligned with their needs, preferences, and local circumstances, enhancing its relevance and resilience. Additionally, the community-based adaptation approach acknowledges and builds upon local institutions and social networks. It recognizes the significance of community cohesion, cooperation, and collective action in adapting to climate change. Strengthening local institutions, such as community-based organizations, cooperatives, and traditional governing systems, can facilitate the effective management and maintenance of climate-resilient infrastructure over the long term. While the community-based adaptation approach emphasizes local-level actions, it is crucial to ensure that these efforts are supported by national and regional policies, funding mechanisms, and technical support. Governments and development agencies play a crucial role in creating an enabling environment for community-based adaptation, providing the necessary resources, capacity building, and policy frameworks to support the implementation of climate-resilient infrastructure projects.

Education and awareness-raising initiatives

Education and awareness-raising initiatives play a crucial role in building climate resilience among rural communities, as these communities are often the most vulnerable to the impacts of climate change. By informing community members about the specific threats they face and the potential adaptation strategies available to them, they can be empowered to take proactive measures to mitigate these risks. The key aspect of education and awareness-raising is informing community members about the impacts of climate change. Many rural communities rely on agriculture for their livelihoods, making them particularly susceptible to changes in temperature, rainfall patterns, and extreme weather events. By explaining how these changes can affect their crops, livestock, and overall agricultural productivity, community members can develop a better understanding of the urgency and importance of adapting to climate change.

Equally important is educating community members about available adaptation strategies. This includes introducing them to climate-smart agriculture techniques, which can help farmers adapt to shifting climates and minimize negative impacts on the environment. These techniques may involve drought-resistant crop varieties, agro forestry practices, and improved water management

methods. By providing training programs that equip farmers with the necessary knowledge and skills, communities can be better prepared to implement climate-smart agriculture practices and diversify their livelihoods to become more resilient. Moreover, education and awareness should also include a focus on ecosystem conservation and natural resource management. Many rural communities depend on their surrounding ecosystems for their livelihoods, such as forests for timber and non-timber forest products or rivers and lakes for fishing. By understanding the importance of conserving these ecosystems, community members can become active stewards of their natural resources. Conservation efforts, such as reforestation activities or sustainable fishing practices, can help safeguard ecosystems and enhance their capacity to mitigate and adapt to climate change.

Discussion of Findings

The findings of this study indicate that rural communities in Nigeria heavily rely on agriculture for their economy and livelihood. However, climate change poses significant challenges to these communities, as changes in weather patterns and climate can have negative impacts on agricultural productivity. The study reveals that factors such as rainfall, sunlight, airstream, and temperature play a crucial role in the distribution and productivity of crops. Land scarcity, caused by unsustainable land management practices and biophysical factors, further exacerbates these challenges.

The study also highlights the disproportionate impact of climate change on Africa, with Nigeria ranking as the 7th most vulnerable country in the world. The research findings indicate that Nigeria's vulnerability to climate disasters and its capacity to adapt are relatively low. This indicates a pressing need for effective climate change adaptation strategies in rural communities.

Adaptation strategies for rural communities in Nigeria are crucial for mitigating the impacts of climate change on agriculture. The study suggests several strategies, including crop diversification, early planting, cultivation of large areas of farmland, and increasing access to climate information and early warning systems. Building climate-resilient infrastructure, adopting community-based approaches, promoting sustainable agriculture practices, diversifying livelihoods, and raising awareness through education are also identified as important components of climate change adaptation.

These findings align with existing literature on climate change and agricultural vulnerability in developing countries. They highlight the urgent need for policymakers and stakeholders to prioritize climate change adaptation strategies in Nigeria's rural communities. By implementing these strategies, rural communities can enhance their resilience and reduce the negative impacts of climate change on their agricultural sectors and overall well-being. Additionally, international collaborations through organizations like the UNFCCC can provide support, expertise, and resources to help these communities effectively adapt to climate change.

Recommendations

Based on the findings of this study, the following recommendations are proposed to enhance climate change adaptation strategies for rural communities in Nigeria:

1. **Strengthen Climate Information Systems:** Improving access to accurate and timely climate information is crucial for rural communities to make informed decisions about agricultural practices. Efforts should be made to enhance climate monitoring systems, establish early warning systems, and disseminate climate information in a timely manner to farmers and other stakeholders.

2. **Enhance Sustainable Agriculture Practices:** Promoting sustainable agriculture practices can help mitigate the negative impacts of climate change. Encouraging the use of organic fertilizers, agro forestry, and crop rotation techniques can improve soil fertility, reduce soil erosion, and enhance resilience to climate change.

3. **Promote Crop Diversification:** Encouraging farmers to diversify their crop production can reduce the risks associated with climate change. By growing a variety of crops with different climate requirements, farmers can mitigate the impacts of extreme weather events and ensure food security.

4. **Invest in Climate-Resilient Infrastructure**: Building and improving climate-resilient infrastructure, such as irrigation systems, water storage facilities, and farm-to-market roads, can enhance the adaptive capacity of rural communities. This infrastructure can help mitigate the impacts of droughts, floods, and other climate-related hazards.

5. **Foster Community-Based Approaches:** Collaboration and participation of local communities are essential for effective climate change adaptation. Strengthening community-based approaches, such as farmer cooperatives and knowledge-sharing networks, can facilitate collective decision-making and resource-sharing among rural communities.

6. **Enhance Education and Awareness:** Education and awareness-raising initiatives play a vital role in building the adaptive capacity of rural communities. Providing training programs, workshops, and extension services on climate-smart agricultural practices can empower farmers with the knowledge and skills needed to adapt to changing climate conditions.

7. **Diversify Livelihoods:** Encouraging alternative income-generating activities can reduce reliance on agriculture and enhance the resilience of rural communities. Promoting entrepreneurship, diversifying livelihood options, and providing vocational training can create new opportunities for income generation and strengthen overall community resilience.

8. **Strengthen International Collaboration:** Collaboration with the international community, particularly through organizations like the UNFCCC, is crucial for accessing resources, knowledge, and expertise to support climate change adaptation efforts in rural communities. Strengthening existing partnerships and establishing new collaborations can facilitate the exchange of best practices and lessons learned in climate change adaptation.

Conclusion

In conclusion, this study sheds light on the significant challenges posed by climate change to rural communities in Nigeria, particularly those heavily dependent on agriculture for their livelihoods. The findings underscore the urgent need for robust climate change adaptation strategies to mitigate the adverse impacts on the agricultural sector.

References

Adaptation in Africa (pp. 297– 315). Springer. https://doi.org/10.1007/978-3-642-22315-0_19

Adelekan, I. O., Simpson, N. P., Totin, E., and Trisos, C. H. (2022). IPCC Sixth Assessment Report (AR6): Climate Change 2022 - Impacts, Adaptation and Vulnerability: Regional Factsheet
Africa. https://policycommons.net/artifacts/2264240/ipcc_ar6_wgii_factsheet_africa/3023294/

AfDB. (2021, October 19). Africa Adaptation Acceleration Program [Text]. African Development Bank - Building Today, a Better Africa Tomorrow. https://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/africa-adaptation-acceleration-program

Afful-Koomson, T. (2015). The Green Climate Fund in Africa: What should be different? Climate and Development, 7(4), 367– 379. https://doi.org/10.1080/17565529.2014.951015

Earth Journalism Network (2016) Introduction to climate change. Available at: https://earthjournalism.net/resources/introduction-to-climate-change

Ebele NE, Emodi NV (2016) Climate change and its impact in Nigerian economy. J Sci Res Rep 10(6):1– 13. http://www.journaljsrr.com/index.php/JSRR/article/view/21917/40737

Elelu, N., Aiyedun, J. O., Mohammed, I. G., Oludairo, O. O., Odetokun, I. A., Mohammed, K. M., Bale, J. O., and Nuru, S. (2019). Neglected zoonotic diseases in Nigeria: Role of the public health veterinarian. The Pan African Medical Journal, 32, 36. https://doi.org/10.11604/pamj.2019.32.36.15659

FAO. (2022). Nigeria at a glance. https://www.fao.org/nigeria/fao-in-nigeria/nigeria-at-a-glance/en/

Federal Ministry of Environment. (2021). National Climate Change Policy for Nigeria. Department of Climate Change. Federal Ministry of Environment. Available on: https://climatechange.gov.ng/wp-content/uploads/2021/08/NCCP_NIGERIA_REVISED_2-JUNE-2021.pdf.

Federal Ministry of Environment (2020). Nigeria' s National Adaptation Plan Framework. https://napglobalnetwork.org/wp-content/uploads/2020/06/napgn-en-2020-Nigeria-National-Adaptation-Plan-Framework.pdf

FGN. (2011). Nigeria Erosion and Watershed Management Project (NEWMAP). NEWMAP | Nigeria Erosion and Watershed Management Project. https://newmap.gov.ng/

For Every Dollar Invested in Climate-Resilient Infrastructure Six Dollars Are Saved, Secretary-General Says in Message for Disaster Risk Reduction Day. (2019, October). [Press Release]. https://press.un.org/en/2019/sgsm19807.doc.htm

GIZ. (2019). Adapting to climate change in the Lake Chad Basin. https://www.giz.de/en/worldwide/24845.html

Great Green Wall. (2022). The Great Green Wall Overview. Great Green Wall. https://www.greatgreenwall.org/about-great-green-wall

Ifeanyi-obi CC, Nnadi FN (2014) Climate change adaptation measures used by farmers in south-South Nigeria. J Environ Sci Toxicol Food Technol 8(4). https://pdfs.semanticscholar.org/a63d/22bf8b8ebde892a7c9d761ee1653e0e11df6.pdf

IPCC (2007) Climate change 2007: impacts adaptation and vulnerability. In: Contributions of working group II to the fourth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, UK

NBS. (2022). CPI and Inflation Report August 2022. National Bureau of Statistics. https://nigerianstat.gov.ng/elibrary/read/1241228

Odjugo PAO (2010) Adaptation to climate change in the agricultural sector in the semi-arid region of Nigeria. Paper presented at the 2nd international conference: climate, sustainability and development in semi-arid regions, Fortaleza-Ceará, Brazil, August 16– 20, 2010

Olanrewaju RM (2009) Climate and the growth cycle of yam Plant in the Guinea Savannah Ecological Zone of Kwara state, Nigeria. J Meteorol Clim Sci:43– 48

Olanrewaju RM (2012) Effect of climate on yam production in Kwara State, Nigeria. Environmental Issues, Department of Geography and Environmental Management, University of Ilorin, Ilorin 3(1):30– 34

Olayide OE, Kow Tetteh I, Popoola L (2016) Differential impacts of rainfall and irrigation on agricultural production in Nigeria: any lessons for climate-smart agriculture? Agric Water Manag 178:30– 36. https://doi.org/10.1016/j.agwat.2016.08.034. ISSN 0378-3774. Available: http://www.sciencedirect.com/science/article/pii/S0378377416303286

Reuben J, Barau AD (2012) Resource use efficiency in yam production in Taraba state, Nigeria, journal of agricultural science. Kamla-Raj 3(2):71– 77

Sharma, A. (2022). Locally Led Adaptation. Global Centre on Adaptation. https://gca.org/programs/locally-led-action/

Skoufias E, Vinha K, Conroy HV (2011) The impacts of climate variability on welfare in rural Mexico, policy research working paper 5555. World Bank, Washington, DC

Sokoto M, Tanko L, Abubakar L, Dikko A, Abdullahi Y (2016) Effect of climate variables on major cereal crops production in Sokoto state, Nigeria. Am J Exp Agric 10:1– 7. https://doi.org/10.9734/AJEA/2016/20020

Sowunmi FA, Akintola JO (2010) Effect of climatic variability on maize production in Nigeria. Res J Environ Earth Sci 1:19– 30

Stevens T, Madani K (2016) Future climate impacts on maize farming and food security in Malawi. Sci Rep 6:36241

Ukpe, W. (2022, May 2). Workers' Day: Nigeria cannot grow economically with 35% unemployment rate. Nairametrics. https://nairametrics.com/2022/05/02/workers-day-nigeria-cannot-grow-economically-with-35-unemployment-rate-peter-obi/

University of Notre Dame. (2021). Notre Dame Global Adaptation Initiative | Rankings. Notre Dame Global Adaptation Initiative https://gain.nd.edu/our-work/country-index/rankings/.

Verisk Maplecroft. (2016). Climate Change Vulnerability Index. https://www.maplecroft.com/risk-indices/climate-change-vulnerability-index/

Wahlström, M. (2015). Sendai Framework for Disaster Risk Reduction 2015-2030 (p. 32). United Nations Office for Disaster Risk Reduction. https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030

WHO. (2022). Fact sheet about malaria. https://www.who.int/news-room/fact-sheets/detail/malaria

Wiebe, Keith D.; Sulser, Timothy B.; Mason-D' Croz, Daniel; and Rosegrant, Mark W. (2017). The effects of climate change on agriculture and food security in Africa. In A thriving agricultural sector in a changing climate: Meeting Malabo Declaration goals through climate-smart agriculture, eds. Alessandro De Pinto and John M. Ulimwengu. Chapter 2, pp. 5-21. Washington, D.C.: International Food Policy Research Institute (IFPRI). http://dx.doi.org/10.2499/9780896292949_02

Woodley, E. (2011). Building Nigeria' s Response to Climate Change: Pilot Projects for Community-Based Adaptation in Nigeria. In W. Leal Filho (Ed.), Experiences of Climate Change

World Bank. (2022). Nigeria Overview. World Bank Group. https://www.worldbank.org/en/country/nigeria/overview

World Bank, & WHO. (2020). Access to clean fuels and technologies for cooking (% of population)—Nigeria | Data. https://data.worldbank.org/indicator/EG.CFT.ACCS.ZS?locations=NG

World Bank. (2021). Development Projects: Agro-Climatic Resilience in Semi-Arid Landscapes (ACReSAL) - P175237 [Text/HTML]. World Bank. https://projects.worldbank.org/en/projects-operations/project-detail/P175237