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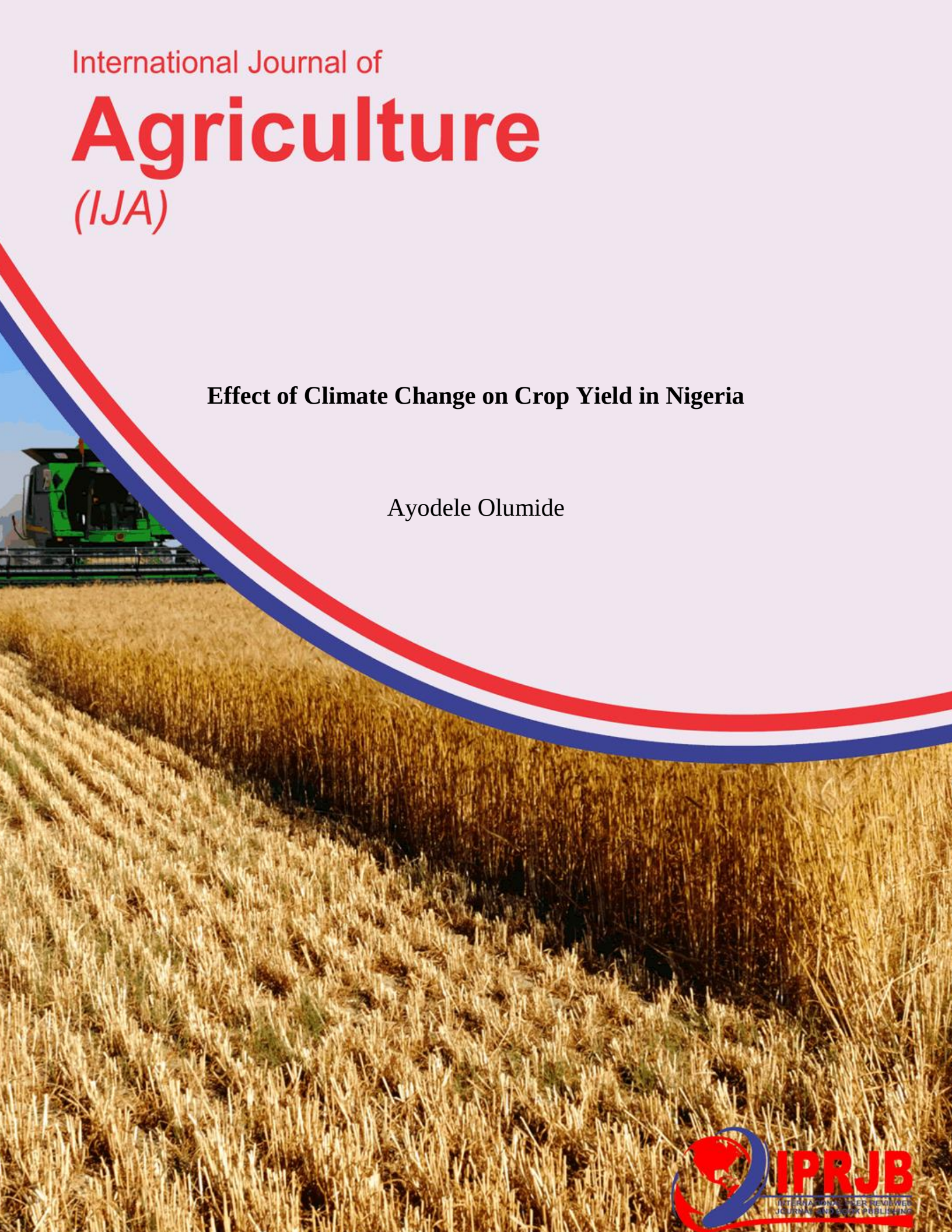

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Abstract

Purpose: The aim of the study was to analyze the effect of climate change on crop yield in Nigeria.

Methodology: This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

Findings: Climate change in Nigeria has caused declining crop yields due to rising temperatures, changing rainfall patterns, and increased frequency of extreme weather events like droughts and floods. This trend adversely affects staple crops like maize and rice, despite adaptation efforts through resilient crop varieties and better agricultural practices.

Unique Contribution to Theory, Practice and Policy: Environmental determinism, vulnerability theory & resilience theory may be used to anchor future studies on effect of climate change on crop yield in Nigeria. Encourage the adoption of climate-smart agricultural practices, such as conservation agriculture, agroforestry, and integrated crop-livestock systems, that enhance resilience to climate change while improving productivity and sustainability. Develop policies that support the adoption of climate-resilient agricultural practices, incentivize the use of climate-smart technologies, and facilitate access to climate information and advisory services for farmers.

Keywords: *Climate Change, Crop Yield*

INTRODUCTION

Crop yield, encompassing staple crops like maize, rice, and wheat, is a crucial measure of agricultural productivity. In developed economies like the United States, advancements in agricultural technology and practices have led to significant increases in crop yields over the past few decades. For instance, according to data from the United States Department of Agriculture (USDA), maize yields in the US have steadily risen from an average of around 90 bushels per acre in the 1960s to over 176 bushels per acre in recent years, reflecting the impact of innovations such as improved seed varieties and precision farming techniques (USDA, 2021). Similarly, in Japan, advancements in rice cultivation methods and genetic improvements have contributed to notable increases in rice yields. Research by Sasaki (2016) highlights how the adoption of high-yielding rice varieties and efficient water management practices has resulted in a substantial enhancement of rice productivity in Japan over the past few decades.

In developed economies like the United Kingdom (UK), maize cultivation is not as prevalent as in the US, but wheat and barley are significant crops. According to data from the UK Department for Environment, Food & Rural Affairs (DEFRA), wheat yields in the UK have steadily increased over the past few decades, with average yields surpassing 8 metric tons per hectare in recent years (DEFRA, 2020). This increase can be attributed to factors such as improved crop varieties, better soil management practices, and advancements in agricultural machinery technology. Similarly, in Japan, while rice remains a staple crop, wheat and barley are also important. Data from the Ministry of Agriculture, Forestry and Fisheries of Japan indicates that wheat yields have seen modest improvements over the years, with average yields approaching 4 metric tons per hectare (MAFF, 2020). This improvement is partly due to initiatives aimed at enhancing agricultural productivity and promoting sustainable farming practices.

In contrast, in developing economies such as India and Brazil, crop yield trends exhibit different dynamics influenced by factors such as landholding patterns, government policies, and technological adoption. In India, rice is a primary staple crop, and efforts to increase its productivity have been ongoing. According to data from the Ministry of Agriculture & Farmers Welfare of India, rice yields have shown an upward trend, with average yields exceeding 3 metric tons per hectare (MoA&FW, 2020). This improvement can be attributed to initiatives like the Green Revolution, which introduced high-yielding crop varieties and modern farming techniques. Similarly, in Brazil, maize and soybean are major crops, and advancements in agricultural practices have led to remarkable yield increases. Data from the Brazilian Institute of Geography and Statistics (IBGE) shows that maize yields in Brazil have nearly doubled over the past two decades, with average yields surpassing 5 metric tons per hectare (IBGE, 2020). This growth is fueled by factors such as expansion of agricultural land, adoption of genetically modified seeds, and improved infrastructure for transportation and storage.

Conversely, in developing economies, crop yield trends may exhibit different patterns influenced by various socio-economic factors. In Sub-Saharan African countries like Nigeria, for instance, maize, rice, and wheat yields have faced challenges due to factors such as limited access to modern agricultural inputs, inadequate infrastructure, and climate variability. According to a study by Jayne (2019), despite efforts to improve agricultural productivity, maize yields in Nigeria have remained relatively stagnant over the past decade, averaging around 1.5 metric tons per hectare. Similar trends are observed in other Sub-Saharan African nations, where agricultural productivity

growth has been constrained by issues like land degradation, pest infestations, and limited adoption of modern farming techniques (Jayne, 2019).

Turning to Sub-Saharan African economies like Kenya and Ghana, crop yield trends are shaped by a combination of factors including climate variability, access to inputs, and government support. In Kenya, maize is a staple food, but productivity levels have been volatile due to challenges such as erratic rainfall patterns and pest infestations. Data from the Kenya National Bureau of Statistics indicates that maize yields have fluctuated over the years, averaging around 2 metric tons per hectare (KNBS, 2020). Efforts to enhance productivity through initiatives like subsidized input programs and irrigation schemes have shown some success but are hindered by issues like land fragmentation and limited mechanization. Similarly, in Ghana, cassava and cocoa are key crops, but yield levels vary across regions. According to the Ghana Statistical Service, cassava yields have remained relatively stable, averaging around 10 metric tons per hectare, while cocoa yields have seen modest improvements, reaching approximately 0.5 metric tons per hectare (GSS, 2020). Challenges such as aging cocoa trees, low adoption of modern farming practices, and inadequate access to credit impede efforts to boost productivity in the agricultural sector.

In Nigeria, maize is a staple crop, and efforts to improve its productivity have been ongoing. However, challenges such as limited access to modern agricultural inputs, land degradation, and climate variability have hindered significant yield increases. According to data from the National Bureau of Statistics of Nigeria, maize yields have shown slight improvements but remain relatively low, averaging around 1.5 metric tons per hectare (NBS, 2020). Initiatives like the Growth Enhancement Support Scheme (GESS) aimed at subsidizing inputs have been implemented to support farmers, but the impact on overall productivity is still limited due to infrastructural constraints and inconsistent policies.

On the other hand, in Ethiopia, teff, maize, and wheat are key crops, and agricultural productivity is crucial for food security and economic development. Despite facing challenges such as land degradation and weather variability, Ethiopia has made significant strides in improving crop yields through various interventions. Data from the Central Statistical Agency of Ethiopia shows that maize and wheat yields have seen steady increases over the years, with maize yields reaching approximately 2 metric tons per hectare and wheat yields exceeding 3 metric tons per hectare (CSA, 2020). Initiatives like the Agricultural Transformation Agency (ATA), which promotes the adoption of improved seeds and farming practices, have contributed to these positive trends. However, there is still room for further improvement, particularly in addressing infrastructural constraints and enhancing access to markets for smallholder farmers.

In Zambia, maize is the dominant staple crop, and agricultural productivity plays a crucial role in food security and rural livelihoods. Despite possessing vast agricultural potential, Zambia faces challenges such as limited access to inputs, land degradation, and climate variability. Data from the Central Statistical Office of Zambia shows that maize yields have been relatively stable over the years, averaging around 2 metric tons per hectare (CSO, 2020). Efforts to improve productivity through initiatives like the Farmer Input Support Program (FISP) have been implemented, but their impact has been constrained by issues such as inefficiencies in input distribution and inadequate extension services.

In Tanzania, maize, rice, and cassava are key crops, and agricultural productivity is essential for poverty alleviation and economic growth. However, yield levels vary across regions due to factors

such as soil fertility, access to water, and adoption of modern farming practices. Data from the National Bureau of Statistics of Tanzania indicates that maize yields have shown slight improvements but remain relatively low, averaging around 1.5 metric tons per hectare (NBS, 2020). Initiatives like the Kilimo Kwanza (Agriculture First) initiative have been launched to promote agricultural transformation and enhance productivity, but significant challenges persist, including inadequate infrastructure and limited access to markets for smallholder farmers.

In Ghana, cocoa is a crucial cash crop, contributing significantly to the country's economy. However, cocoa yields have faced challenges due to aging trees, poor farming practices, and climate change impacts such as irregular rainfall patterns and increased pest infestations. According to data from the Ghana Statistical Service, cocoa yields have seen modest improvements but remain relatively low, averaging around 0.5 metric tons per hectare (GSS, 2020). Initiatives like the Cocoa Health and Extension Division (CHED) have been implemented to address challenges such as pests and diseases, but the overall impact on productivity has been limited by factors such as inadequate access to inputs and low adoption of modern farming techniques.

In Ivory Coast, which is the world's leading producer of cocoa, similar challenges exist in maintaining and improving cocoa yields. Factors such as aging cocoa trees, land degradation, and fluctuating global cocoa prices pose significant challenges to productivity. Data from the National Statistics Institute of Ivory Coast shows that cocoa yields have shown some improvements but remain below their full potential, averaging around 0.6 metric tons per hectare (INS, 2020). Initiatives like the National Cocoa Rehabilitation Plan have been launched to replant aging cocoa trees and promote sustainable farming practices, but widespread adoption and implementation remain key challenges.

Climate change indicators such as temperature, rainfall patterns, carbon dioxide levels, and extreme weather events play significant roles in influencing crop yields like maize, rice, and wheat. Firstly, rising temperatures due to climate change can have detrimental effects on crop growth and development. High temperatures during critical stages of crop development can reduce yields by affecting pollination, grain filling, and overall plant metabolism (Lobell & Field, 2007). Conversely, warmer temperatures might benefit certain crops in cooler regions, extending growing seasons and allowing for increased yields under specific conditions (Lobell & Gourdji, 2012). However, the overall impact of rising temperatures on global crop production is expected to be negative, especially in regions already experiencing high temperatures.

Secondly, changes in rainfall patterns, including shifts in timing, intensity, and distribution of precipitation, can profoundly impact crop yields. Alterations in rainfall patterns can lead to droughts, floods, or irregular moisture availability, all of which can negatively affect crop growth and productivity (Porter, 2014). For example, prolonged droughts can result in crop failure and yield losses, while excessive rainfall can lead to waterlogging and soil erosion, further reducing yields (Wheeler & von Braun, 2013). Additionally, changes in precipitation patterns can influence the prevalence and distribution of pests and diseases, posing additional challenges to crop production (Bebber, 2013). Overall, understanding the complex interactions between climate change indicators and crop yields is crucial for developing effective adaptation strategies to ensure food security in the face of climate change.

Problem Statement

Climate change poses a significant threat to agricultural productivity and food security in Nigeria, impacting crop yields and livelihoods of millions of people. Despite being one of the largest agricultural producers in Africa, Nigeria's agriculture sector remains highly vulnerable to the adverse effects of climate change. Recent studies have highlighted the increasing frequency and intensity of extreme weather events such as droughts, floods, and heatwaves, which are attributed to climate change (Ogunjobi, 2020). These extreme weather events disrupt agricultural activities, leading to reduced crop yields, post-harvest losses, and income instability for farmers (Adejuwon, 2019). Furthermore, changes in temperature and rainfall patterns, attributed to climate change, have resulted in shifts in planting seasons and increased incidences of crop diseases and pests, further exacerbating yield losses (Eze, 2021).

Theoretical Framework

Environmental Determinism

Originating from scholars like Ellsworth Huntington and Jared Diamond, environmental determinism posits that environmental factors, such as climate, terrain, and soil, shape human behavior and societal development. In the context of the suggested topic, environmental determinism highlights how changes in climate, particularly temperature and rainfall patterns, directly influence crop growth and productivity in Nigeria. The theory underscores the interplay between climatic variables and agricultural outcomes, emphasizing the vulnerability of crop yields to shifts in environmental conditions (Diamond, 2018).

Vulnerability Theory

Vulnerability theory, developed by scholars such as Neil Adger and Susan Cutter, focuses on understanding how socio-economic and environmental factors interact to create vulnerability to external stressors, such as climate change. In the context of Nigeria's agricultural sector, vulnerability theory elucidates how socio-economic factors, including poverty, limited access to resources, and inadequate infrastructure, exacerbate the impacts of climate change on crop yield. The theory underscores the importance of considering socio-economic vulnerabilities alongside climatic factors to develop effective adaptation strategies (Adger, 2018).

Resilience Theory

Resilience theory, championed by scholars like C.S. Holling and Brian Walker, explores the capacity of social-ecological systems to absorb disturbances and maintain function in the face of change. Applied to the suggested topic, resilience theory emphasizes the need to build resilience within Nigeria's agricultural systems to withstand and adapt to the impacts of climate change. This involves enhancing the adaptive capacity of farmers, promoting diversification of crops and income sources, and improving the resilience of agricultural infrastructure to climate-related risks (Walker & Salt, 2020).

Empirical Review

Ogunjobi (2018) assessed the impact of temperature and rainfall variability on maize production in Nigeria. Utilizing historical climate data and crop yield records, the researchers employed statistical analysis techniques to identify correlations between climatic variables and maize yields. Findings from the study revealed a significant negative relationship between increases in temperature and maize yields, particularly in regions experiencing higher temperatures.

Additionally, changes in rainfall patterns were found to influence maize productivity, with drought conditions leading to substantial yield losses. The study underscored the vulnerability of maize production to climate change impacts in Nigeria, highlighting the urgent need for adaptation strategies to mitigate risks and enhance resilience in the agricultural sector.

Ajayi (2019) investigated the influence of climate variability on rice productivity in Nigeria. Employing statistical models and climate data analysis techniques, the study examined the relationship between rainfall, temperature, and rice yields over a significant period. Results indicated that fluctuations in rainfall and temperature exerted significant effects on rice productivity, with extreme weather events such as droughts and floods leading to substantial yield reductions. The study emphasized the importance of implementing climate-resilient agricultural practices and water management strategies to enhance rice production under changing climatic conditions. Additionally, recommendations were made for policymakers to integrate climate adaptation measures into agricultural policies to ensure food security and livelihood sustainability for rice farmers in Nigeria.

Eze (2020) assessed the effect of climate change on cassava production in Nigeria. By combining field surveys and climate data analysis, the study investigated the relationship between temperature variability, rainfall patterns, and cassava yields. Results revealed that rising temperatures and changes in precipitation significantly impacted cassava productivity, with implications for food security and rural livelihoods. The study highlighted the need for implementing climate-smart agricultural practices and investing in adaptive strategies to mitigate climate risks and enhance cassava resilience. Recommendations included the development of early warning systems and the promotion of drought-tolerant cassava varieties to support sustainable production in the face of climate change challenges.

Adejuwon (2017) evaluated the impact of climate change on yam production in Nigeria. By employing a combination of field experiments and climate modeling techniques, the research assessed the sensitivity of yam yields to temperature variations and rainfall variability. Results indicated that changes in temperature and precipitation patterns significantly influenced yam productivity, with higher temperatures and erratic rainfall leading to yield reductions. The study underscored the importance of implementing adaptation strategies such as crop diversification and soil management practices to enhance yam resilience to climate change impacts. Additionally, recommendations were made for policymakers to integrate climate adaptation measures into agricultural development plans to support sustainable yam production and ensure food security in Nigeria.

Olaniyan & Tomori (2016) investigated the relationship between climate variability and wheat productivity in Nigeria, with a focus on Gombe state. Using remote sensing data and crop modeling techniques, the research analyzed the effects of temperature changes and rainfall variability on wheat yields over time. Findings revealed that rising temperatures and erratic rainfall patterns negatively impacted wheat production, particularly in the northern regions of the country. The study highlighted the vulnerability of wheat farming to climate change risks and emphasized the need for implementing adaptation measures such as the development of heat and drought-tolerant wheat varieties. Recommendations included the promotion of sustainable agricultural practices and the establishment of irrigation systems to support wheat cultivation in Nigeria.

Oguntunde (2018) examined the impact of climate change on millet production in Nigeria, focusing on Kano state. By employing field surveys and climate modeling approaches, the study assessed millet yield trends in response to temperature variations and changes in rainfall distribution. Results indicated that increasing temperatures and shifts in precipitation patterns adversely affected millet yields, with implications for food security and rural livelihoods. The study highlighted the importance of implementing adaptation strategies such as the promotion of improved agronomic practices and the development of climate-resilient millet varieties. Recommendations were made for policymakers to integrate climate change adaptation measures into agricultural policies and programs to support sustainable millet production and enhance resilience in the agricultural sector.

Anyadike (2019) explored the effect of climate variability on cowpea production in Nigeria. Utilizing a combination of field experiments and climate data analysis, the study investigated the relationship between temperature extremes, water stress, and cowpea yields. Results indicated that fluctuations in temperature and precipitation significantly influenced cowpea productivity, with extreme weather events leading to yield losses. The study emphasized the importance of promoting climate-resilient crop.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low-cost advantage as compared to field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

FINDINGS

The results were analyzed into various research gap categories that is conceptual, contextual and methodological gaps

Conceptual Gap: While existing study by Ogunjobi (2018) underscored the detrimental impact of climate variability on crops such as maize, rice, and cassava, there remains a dearth of research that delves deeper into the physiological responses of these crops to specific climatic variables. A more nuanced exploration of how temperature, rainfall, humidity, and other environmental factors directly affect crop growth, development, and yield formation is essential for devising targeted adaptation strategies that can effectively mitigate the adverse effects of climate change on Nigerian agriculture.

Contextual Research Gap: While existing study by Ajayi (2019) primarily focused on biophysical aspects, such as climatic variables and crop responses, there is a need to incorporate contextual factors such as access to resources, infrastructure, market opportunities, and government policies into the research framework. Understanding how these socio-economic factors interact with climatic stressors to shape farmers' adaptive capacity and resilience is crucial for designing contextually relevant and sustainable adaptation strategies. By integrating socio-economic analyses into the research agenda, scholars can provide insights into the institutional and governance mechanisms necessary to support effective climate change adaptation in Nigerian agriculture.

Geographical Research Gap: In the existing literature by Eze (2020) focused on specific crops and regions within Nigeria, leading to a fragmented understanding of the broader implications of climate change on agricultural systems across different agro-ecological zones. To address this gap, future research endeavors should adopt a more comprehensive and geographically representative approach that encompasses diverse crops and regions across Nigeria. By encompassing the full spectrum of climatic conditions, cropping systems, and socio-economic contexts prevalent in different parts of the country, researchers can generate insights that are more inclusive and region-specific, thereby facilitating the development of tailored adaptation strategies to enhance agricultural resilience to climate change.

CONCLUSION AND RECOMMENDATIONS

Conclusions

In conclusion, the effect of climate change on crop yield in Nigeria presents multifaceted challenges that require urgent attention and comprehensive strategies for mitigation and adaptation. The empirical evidence from various studies underscores the vulnerability of Nigeria's agricultural sector to the adverse impacts of climate variability, including changes in temperature, rainfall patterns, and extreme weather events. From maize and rice to cassava and yam, crops crucial to the country's food security are facing increasing risks of yield reductions and production losses due to climate change. However, amidst these challenges, there are opportunities for innovation and resilience-building in Nigerian agriculture.

It is evident that addressing the complex interplay between climate change and crop yield in Nigeria requires a multidisciplinary approach that integrates scientific research, socio-economic analyses, and policy interventions. By enhancing our understanding of the underlying mechanisms driving crop responses to climatic stressors and considering the socio-economic contexts in which agricultural systems operate, stakeholders can develop contextually relevant and sustainable adaptation strategies. These strategies should prioritize investments in climate-resilient crop varieties, adoption of climate-smart agricultural practices, enhancement of agricultural infrastructure, and strengthening of institutional capacities for climate change adaptation.

Moreover, fostering collaboration among researchers, policymakers, farmers, and other stakeholders is crucial for translating scientific knowledge into actionable policies and practices on the ground. By working together, Nigeria can build climate-resilient agricultural systems that not only ensure food security and livelihood sustainability but also contribute to broader goals of environmental sustainability and climate resilience. Ultimately, addressing the effect of climate change on crop yield in Nigeria requires concerted efforts at the local, national, and global levels to mitigate greenhouse gas emissions, adapt to changing climatic conditions, and build resilient agricultural communities for the future.

Recommendations

Theory

Encourage interdisciplinary studies that delve deeper into the mechanisms through which climate change affects crop yield in Nigeria. This includes exploring the physiological responses of various crops to specific climatic variables and identifying underlying mechanisms driving these effects. By advancing theoretical frameworks, such as environmental determinism and resilience theory,

researchers can contribute to a more nuanced understanding of the complex interactions between climate change and crop productivity. Promote collaboration among researchers, academics, and agricultural practitioners to facilitate the exchange of knowledge and expertise. Encourage the development of theoretical models and frameworks that integrate biophysical, socio-economic, and policy dimensions of climate change adaptation in Nigerian agriculture. By fostering collaboration and knowledge sharing, researchers can generate innovative solutions and contribute to the advancement of theory in the field of climate change and agriculture.

Practice

Encourage the adoption of climate-smart agricultural practices, such as conservation agriculture, agroforestry, and integrated crop-livestock systems, that enhance resilience to climate change while improving productivity and sustainability. Provide training and capacity-building support to farmers to facilitate the adoption of these practices and promote sustainable land management. Invest in research and development to breed and disseminate climate-resilient crop varieties that are adapted to the changing climatic conditions in Nigeria. Collaborate with agricultural research institutions, seed companies, and extension services to accelerate the adoption of these varieties among farmers. Additionally, promote the conservation and utilization of traditional crop varieties that exhibit resilience to local climatic stresses.

Policy

Mainstream climate change adaptation considerations into national agricultural policies and strategies. Develop policies that support the adoption of climate-resilient agricultural practices, incentivize the use of climate-smart technologies, and facilitate access to climate information and advisory services for farmers. Build the capacity of relevant government agencies, agricultural extension services, and farmer organizations to implement climate change adaptation measures effectively. Enhance coordination and collaboration among different stakeholders involved in agricultural research, extension, and policymaking to ensure coherent and integrated approaches to climate change adaptation in Nigerian agriculture. Develop early warning systems and risk management strategies to anticipate and mitigate the impacts of extreme weather events and climate variability on crop yield. Invest in the development of climate information and advisory services that provide timely and context-specific information to farmers, enabling them to make informed decisions and take proactive measures to safeguard their crops and livelihoods.

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