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Climate Variability and Its Impacts on Crop Production in Ijebu-Ode, Nigeria

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Abstract
This paper examines the effects of climate variability on crop production in Ijebu-Ode, a key agricultural hub in Southwest Nigeria. The study analyses temperature trends, rainfall patterns, and their impact on major crops cultivated in the region, such as cassava and maize. Data were collected from meteorological records, field surveys, and farmers' interviews. The results show a clear relationship between climate variability and reduced crop yields, primarily due to irregular rainfall patterns and rising temperatures. Recommendations are proposed to enhance farmers' resilience, including improved irrigation systems, early warning systems, and adoption of climate-smart agricultural practices.

Keywords: Climate variability, crop production, rainfall, agriculture, climate resilience.

1. Introduction

1.1 Background

Agriculture is not only central to food production but also a key driver of socio-economic development, particularly in Sub-Saharan Africa where the majority of the population depends on it for their livelihood. In Nigeria, agriculture contributes significantly to national economic output and employment, especially in rural areas where smallholder farmers dominate the sector. According to the Food and Agriculture Organization (FAO, 2022), agriculture accounts for approximately 25% of Nigeria's GDP and remains the primary source of income for over 70% of households in rural communities. However, the sustainability of agricultural productivity in the country is increasingly being undermined by the growing threat of climate variability.

Climate variability refers to the short- to medium-term fluctuations in climate elements most notably rainfall and temperature that deviate from long-term averages. These fluctuations, which can occur on seasonal, annual, or decadal scales, are a defining feature of climate in West Africa and have become more pronounced in recent decades. In Nigeria, climate variability manifests through erratic rainfall patterns, delayed or early onset and cessation of rains, increased frequency of extreme weather events (such as floods and droughts), and rising temperatures. These shifts have profound implications for agricultural productivity, particularly in rain-fed systems that lack irrigation infrastructure and are thus more vulnerable to changing weather patterns.

In Southwestern Nigeria, where the study area of Ijebu-Ode is located, the impacts of climate variability on agriculture have become increasingly evident. Farmers in the region report changes in the timing of planting and harvesting seasons, increased incidences of crop failure, declining soil moisture levels, and the emergence of new pests and diseases—all linked to shifts in climatic conditions. The reliability of traditional knowledge and indigenous farming calendars is diminishing, making agricultural planning more uncertain and risky.

Ijebu-Ode, a prominent town in Ogun State, occupies a strategic location in the humid tropical rainforest zone of Nigeria. The area benefits from relatively fertile soils and moderate climatic conditions conducive to the cultivation of a wide range of crops including cassava, maize, yam, and vegetables. These crops not only support household food security but also contribute to local and regional markets. However, the agricultural potential of Ijebu-Ode is being increasingly threatened by the effects of climate variability. The changing patterns of rainfall and rising temperatures are disrupting farming cycles, affecting germination, pollination, and harvest periods, and ultimately reducing yields.

The effects of climate variability are particularly pronounced in staple crops such as cassava and maize, which are key to food security and rural livelihoods. Cassava, a drought-tolerant crop, is widely grown in Ijebu-Ode, but its yields are still susceptible to

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prolonged dry periods. Maize, on the other hand, is highly sensitive to water stress during its critical growth stages. The decline in productivity of these crops due to climate variability not only threatens food availability but also impacts farmers' incomes and the broader rural economy.

Despite the central role of agriculture in the socio-economic life of Ijebu-Ode and the growing evidence of climatic shifts, there remains a lack of localized studies that empirically assess the nature and extent of climate variability and its direct impacts on crop production in the area. Much of the existing research on climate impacts in Nigeria focuses on macro-level analyses at the national or regional scale, which may obscure important local dynamics and vulnerabilities. Without a clear understanding of how climate variability affects specific communities and agricultural systems, efforts to develop effective adaptation strategies and policies may be misguided or insufficient.

Moreover, there is an urgent need to integrate the perspectives and experiences of local farmers into the climate discourse. These farmers are often the first to notice and respond to climate signals, and their indigenous knowledge and adaptive practices can provide valuable insights into how agricultural systems are coping with change. Yet, their voices are often underrepresented in research and policymaking.

This study, therefore, seeks to fill this gap by investigating the patterns of climate variability in Ijebu-Ode and examining its impacts on crop production. Specifically, the research aims to analyze historical climate data (rainfall and temperature) over a multi-year period, assess how variations in these parameters affect the growth and yield of key crops, and document the coping and adaptation strategies adopted by farmers in response to climatic stress. Through a combination of quantitative and qualitative approaches, the study provides a comprehensive understanding of the climate-agriculture nexus in Ijebu-Ode.

The findings of this study will have significant implications for climate-resilient agricultural planning, policy development, and extension services in Ogun State and similar agro-ecological zones. By identifying the specific challenges posed by climate variability and highlighting local adaptive capacities, the study contributes to the development of context-sensitive interventions that can enhance the resilience of farming communities and promote sustainable agricultural development in the face of a changing climate.

1.2 Objectives of the Study

The primary objective of this study is to examine the relationship between climate variability and agricultural productivity in Ijebu-Ode, a region increasingly affected by shifts in weather patterns. Specifically, the study aims to assess the trends in temperature and rainfall over the past two decades, thereby establishing a climatic baseline for the area. In addition, the research seeks to analyze the impact of these climate variables on the yields of key staple and commercial crops, namely cassava, maize, and vegetables. Finally, the study explores the coping strategies adopted by farmers in response to these climatic challenges and proposes actionable recommendations to enhance resilience and promote sustainable agricultural practices.

2. Literature Review

2.1 Climate Variability in Southwest Nigeria

Climate variability refers to fluctuations in climatic elements such as rainfall and temperature over short and long time scales. In Southwest Nigeria, including Ogun State, these fluctuations have become more pronounced over the past two decades. According to the Nigerian Meteorological Agency (NIMET, 2019), the region has experienced a significant decline in rainfall reliability, with notable shifts in the onset and cessation of the rainy season. This unpredictability affects the timing of agricultural activities, particularly planting and harvesting, thereby posing challenges to rain-fed agriculture.

Recent studies reinforce this trend. Ogunseitan et al. (2021) examined the impact of climate variation on tomato production in Imeko Afon, Ogun State, and found that 88.4% of farmers observed delayed planting periods, while 68.0% reported a decline in yield due to changing weather conditions. Similarly, Durodola and Mourad (2020) modeled the effects of climate change on soybean production in the Ogun-Ona River Basin, showing that future climate scenarios would likely increase crop water demand and disrupt yield patterns. These studies underscore the need for adaptive strategies such as improved irrigation infrastructure and access to climate information services.

2.2 Impact on Crop Production

Variability in rainfall and rising temperatures have direct consequences for crop productivity in the region. Akinseye et al., (2018) highlighted that irregular rainfall patterns cause drought stress in crops such as maize and cassava, which are predominantly rain-fed. Increased temperatures further exacerbate the situation by accelerating evapotranspiration, leading to soil moisture deficits that hinder plant growth and reduce yields.

Iseyemi et al., (2023) conducted a study on the impact of climate variability on food crop production in the forest zones of Southwest Nigeria. Their findings revealed that cassava was the most affected crop, with a 44.0% reduction in productivity attributed to climate-related factors, followed by maize (16.7%) and yam (69.9%). These effects emphasize the urgent need for climate-resilient agricultural interventions, including the use of drought-tolerant varieties and efficient water management practices.

3. Methodology

3.1 Study Area

Ijebu-Ode is a prominent urban center in the southeastern part of Ogun State, located in the South-West geopolitical zone of Nigeria. Geographically, it

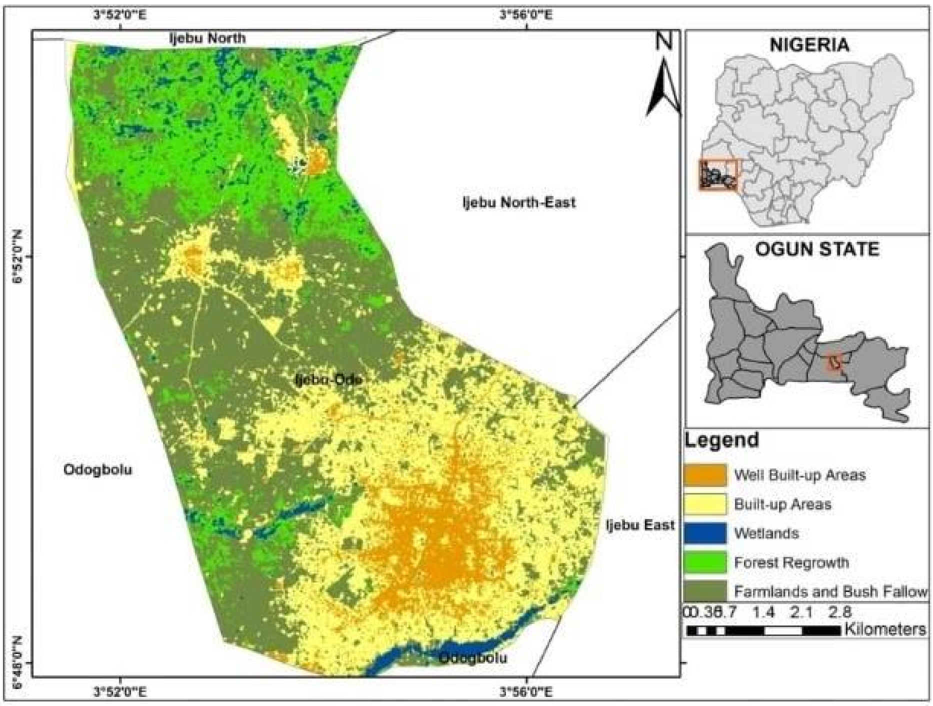

Figure 1: Map of the study area (Oderinde F. O., 2015)

lies between latitudes 6°49′N and 6°57′N and longitudes 3°55′E and 4°05′E as shown in Fig 1. The town serves as the headquarters of the Ijebu-Ode Local Government Area and is historically significant as part of the ancient Ijebu Kingdom. It is approximately 110 km northeast of Lagos and 45 km from the Ogun State capital, Abeokuta. The 2006 provisional census figure gives the population of Ogun State as 3,751,140 (National Population Commission, 2012).

3.1.1 Climatic Characteristics

Ijebu-Ode falls within the tropical wet-and-dry (Aw) climate zone according to the Köppen classification. The region experiences two distinct seasons: the wet season (April to October) and the dry season (November to March). Annual rainfall ranges between 1,200 mm and 2,000 mm, with peaks in June and September. The mean annual temperature is about 27°C, while relative humidity often exceeds 80% during the wet season. These climatic conditions make the area conducive for agricultural activities, especially the cultivation of rain-fed crops.

3.1.2 Topography and Soil

The terrain is generally flat to slightly undulating with altitudes ranging from 60 to 90 meters above sea level. The soil is predominantly ferruginous tropical soil, derived from crystalline rocks, and is suitable for the cultivation of cassava, maize, yam, vegetables, and fruits. However, these soils are vulnerable to leaching during periods of intense rainfall, which has become more frequent due to climate change.

3.1.3 Agricultural Activities

Agriculture is a key economic activity in Ijebu-Ode and its surrounding rural communities. Most farming practices are subsistence-based and rely heavily on rainfall. Crops commonly grown in the area include cassava, maize, plantain, cocoyam, vegetables, and citrus fruits. Climate variability, especially in the form of delayed rains, excessive rainfall, and occasional drought spells, has increasingly disrupted planting cycles, reduced yields, and contributed to food insecurity in the region.

3.2 Data Collection

This study utilized both quantitative and qualitative data to assess the impact of climate variability on agricultural productivity. Climate data, specifically monthly rainfall and temperature records spanning from 2003 to 2023, were obtained from the Nigerian Meteorological Agency (NIMET). These data were used to analyze temporal trends in key climatic variables affecting crop performance. Agricultural production data on cassava, maize, and vegetables were sourced from the State Ministry of Agriculture. These datasets provided annual crop yield records, which were essential for assessing correlations with climate variables.

To complement the secondary data, primary data were collected through field surveys and interviews. A total of 150 structured questionnaires were administered to farmers across purposively selected communities namely (Oke aje, Itorin, Isiwo, Itamapako and Odoegbo) to gather information on their perceptions of climate change, observed impacts on crop yield, and adaptation strategies. The respondents were randomly selected. In addition, key informant interviews were

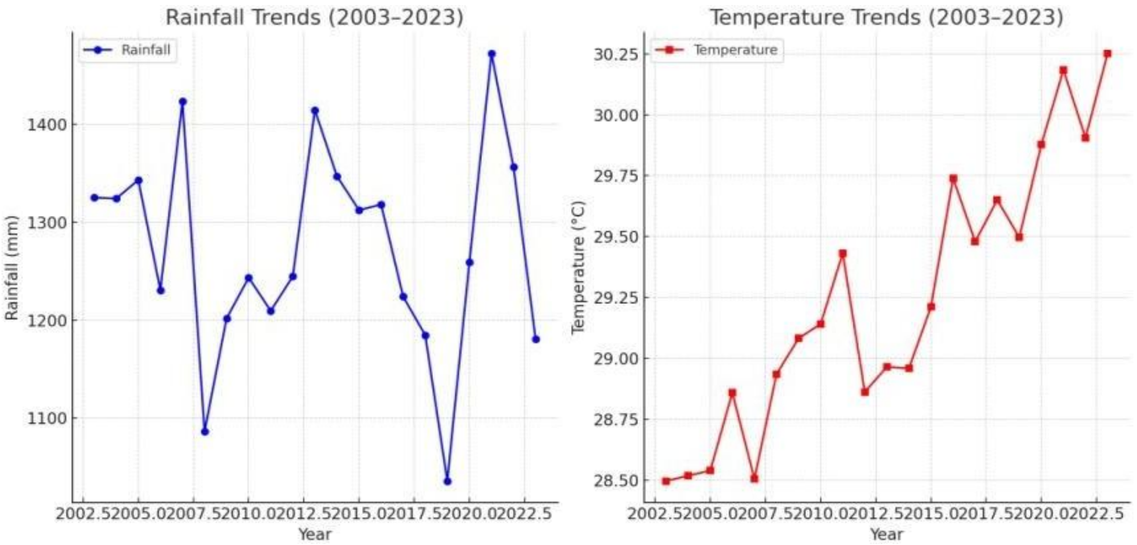

Figure 2: Temperature and rainfall trends (2003-2023)

Table 1: Percentage of yield loss

Crop	Yield Loss (%)	Key Observations
Cassava	12–15%	Sensitive to prolonged drought stress.
Maize	20%	Yields declined during late rains.
Vegetables	18%	Increased pests due to high temperatures.

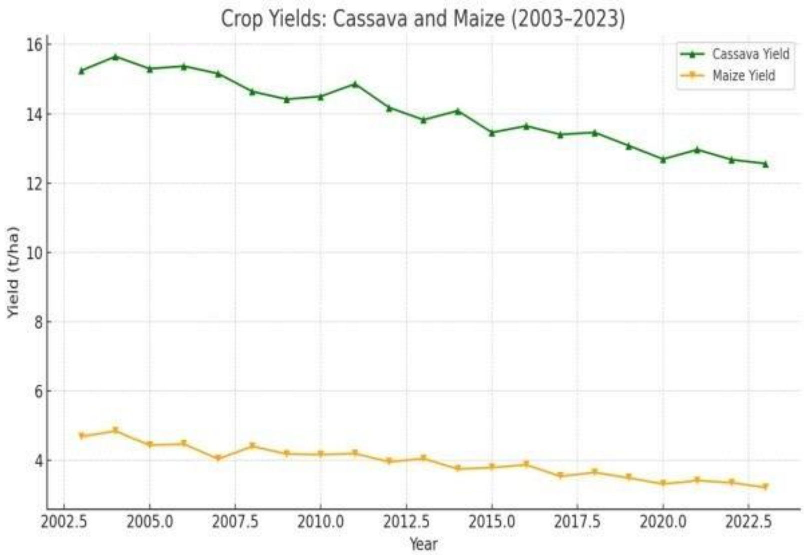

Figure 3: Crop yield (2003-2023)

conducted with agricultural officers and extension workers. These interviews provided contextual insights into institutional knowledge, support mechanisms, and policy frameworks influencing farmers' adaptive capacity. The combination of these data sources enabled a comprehensive analysis of both the biophysical and socio-institutional dimensions of climate impacts on agriculture.

3.3 Data Analysis

In this study, time series analysis trend detection using the Mann-Kendall test was conducted in R to examine long-term trends and seasonal variations in rainfall and temperature over the study period. This involved analyzing historical climate data to detect the presence and direction of trends, thereby providing insight into the progression of climate variables relevant to agricultural productivity. To assess the relationship between climate factors and crop yield, linear regression analysis was conducted using SPSS. This statistical approach enabled the quantification of how variations in rainfall and temperature influence crop outputs, revealing both the strength and direction of these relationships. Furthermore, data visualization techniques were utilized to enhance the interpretation and communication of results. Line graphs were developed to illustrate climate trends, crop yield fluctuations, and the responses of farmers to changing climatic conditions. These visual tools played a crucial role in conveying complex data in an accessible manner, thereby supporting evidence-based conclusions and policy recommendations.

4. Results and Discussion

4.1 Trends in Rainfall and Temperature

Rainfall Trends: Over the last 20 years, annual rainfall shows high variability. The mean rainfall has decreased from 1400 mm to 1200 mm, with increased dry spells between June and August (Fig. 2).

Temperature Trends: Average temperatures have increased by 0.6°C per decade, particularly during the growing season (March–September) (Fig. 2).

4.2 Impact on Crop Production

Regression analysis revealed a significant negative correlation between irregular rainfall patterns and crop yields ($R^2 = 0.72$).

4.3 Farmers' Perceptions and Adaptation Strategies

The majority of respondents reported observable changes in climatic conditions over the past two decades, particularly in rainfall patterns. Notably, 84% of the farmers indicated that the late onset of rains had significantly disrupted their traditional planting schedules. This shift has resulted in shorter growing seasons and increased uncertainty in crop planning, particularly for rain-fed agriculture.

In response to these challenges, farmers have adopted various adaptation strategies aimed at minimizing climate-related risks and sustaining crop production. One of the most commonly reported strategies was the use of drought-tolerant crop varieties, particularly improved cassava cultivars that require less water and mature earlier than traditional types. Additionally, crop diversification and mixed cropping were widely practiced as risk-spreading mechanisms. By cultivating a variety of crops simultaneously, farmers aim to buffer against the total loss of income or food in the event of crop failure due to erratic weather.

Another strategy employed, though on a smaller scale, involved minimal irrigation using manual techniques, such as watering with buckets or small-scale water harvesting systems. While not as efficient as mechanized irrigation, these practices provided supplemental moisture during dry spells, particularly for vegetable gardens and short-cycle crops. Overall, these adaptive responses highlight the resourcefulness of local farmers, even in the absence of significant institutional or infrastructural support.

4.4 Discussion

The findings align with previous studies (Adebayo *et al.*, 2021), confirming that climate variability is exacerbating food insecurity. The lack of affordable irrigation and agricultural extension services has limited farmers' ability to cope effectively. Also the reduction in crop yields (Table 1 and Fig. 3), particularly maize and cassava, is consistent with trends observed in other parts of Southwest Nigeria. A key factor contributing to these yield losses is the late onset of the rains, which shortens the growing season and affects crop growth cycles.

Additionally, the rise in temperature accelerates evapotranspiration, further stressing crops that are already dependent on unpredictable rainfall. Farmers' reliance on manual irrigation and traditional farming techniques limits their ability to adapt to these changes effectively. Financial constraints and lack of affordable irrigation infrastructure exacerbate the issue, making it difficult for smallholder farmers to transition to climate-smart agricultural practices.

The findings show the need for integrated approaches that combine technological interventions, such as early warning systems and irrigation, with farmer education and support.

Comparing these results to studies conducted in other regions, such as Northern Nigeria or parts of East Africa, shows that while the patterns of rainfall variability are similar, socio-economic factors play a critical role in determining adaptation capacity. For example, farmers with access to credit and extension services are better equipped to implement climate-resilient practices, such as crop diversification and irrigation.

The results also underline the importance of policy support. Governments and development agencies must prioritize investments in climate-resilient infrastructure, such as irrigation systems, and provide subsidies for drought-tolerant seeds. Strengthening agricultural extension services will ensure that farmers receive timely information on climate-smart practices, thus reducing their vulnerability to climate variability.

5. Conclusion and Recommendations

5.1 Conclusion

Climate variability in Ijebu-Ode, characterized by irregular rainfall and rising temperatures, has significantly reduced crop yields, particularly cassava, maize, and vegetables. Farmers' adaptation measures remain limited by financial and technological constraints.

5.2 Recommendations

Based on the findings of this study, several policy and practical recommendations are proposed to enhance the adaptive capacity of farmers and mitigate the adverse effects of climate variability on agricultural productivity.

First, there is a critical need to strengthen early warning systems and climate information services to ensure that farmers receive timely and reliable weather forecasts.

Access to such information would enable better planning of planting and harvesting schedules, thus reducing exposure to climatic risks.

Second, the promotion of low-cost, small-scale irrigation technologies is essential, particularly in areas that rely heavily on rain-fed agriculture. Technologies such as drip irrigation, treadle pumps, and rainwater harvesting systems can help ensure water availability during dry spells and improve crop yields.

Third, the adoption of climate-smart agricultural practices should be scaled up. This includes the use of drought-tolerant crop varieties, improved soil management techniques, and conservation agriculture. These practices can enhance productivity while building resilience to climate stressors.

Furthermore, the role of agricultural extension services must be strengthened to improve farmers' knowledge and capacity to implement sustainable and adaptive farming techniques. Regular training and field demonstrations can facilitate the diffusion of innovations and best practices among rural farmers.

Finally, government support through credit schemes and input subsidies is necessary to enable smallholder farmers to invest in adaptation strategies. Providing access to affordable financing and subsidized inputs such as seeds and fertilizers can significantly improve farm-level resilience and food security.

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