Impact of Climate Change on Food Production in Nigeria (A Case Study of Bekwarra, Obudu and Obanliku Local Government Areas of Cross River State)

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Abstract

Climate change poses a significant threat to food production in Nigeria, affecting crop yields, livestock health, and fisheries. Rising temperatures, erratic rainfall patterns, prolonged droughts, and increased flooding have led to reduced agricultural productivity, food insecurity, and economic instability. Smallholder farmers, who form the backbone of Nigeria's agricultural sector, are particularly vulnerable due to their reliance on rain-fed farming and limited access to climate adaptation resources. Soil degradation, pest infestations, and declining water availability further compound the challenges. In this research, a mixed-method research design was adopted, combining both quantitative and qualitative approaches. Primary data were collected through structured questionnaires administered to 400 randomly selected households across ten farming communities, while secondary data on climate variables such as temperature and rainfall were obtained from the Nigerian Meteorological Agency (NIMET). The paper examines the impact of climate change on food production in Nigeria and explores adaptive strategies such as climate-smart agriculture, improved irrigation systems and policy interventions. Addressing these challenges requires a multi-sectoral approach involving government support, technological innovation and community participation to ensure sustainable food production and national food security. It recommended the adoption of climate-resilient farming practices, improved water management systems, and enhanced infrastructure to mitigate the effects of climate change on agriculture.

Key words; Climate change, Food, Drought, Rainfall, Adaptation

Introduction

Climate change has emerged as one of the most critical challenges affecting global food production, particularly in developing countries where agriculture is the backbone of the economy. In Nigeria, agriculture contributes significantly to national food security, employment, and economic growth, yet it remains highly vulnerable to climate variability (Food and Agriculture Organization [FAO], 2020). Rising temperatures, irregular rainfall patterns, increased frequency of droughts and floods, and the proliferation of crop pests and diseases have led to declining agricultural productivity, threatening food security and rural livelihoods (Intergovernmental Panel on Climate Change [IPCC], 2021).

Cross River State, located in southeastern Nigeria, is known for its diverse agricultural activities, including the cultivation of staple crops such as maize, cassava, yam, rice, and plantain, as well as livestock farming. Within the state, Bekwarra, Obudu, and Obanliku Local Government Areas (LGAs) play a crucial role in food production due to their fertile lands and favorable agro-climatic conditions. However, these areas are increasingly experiencing the adverse effects of climate change, including erratic rainfall, prolonged dry spells, and increased soil degradation, which negatively impact agricultural productivity (Nigerian Meteorological Agency [NiMet], 2022). Existing research highlights that smallholder farmers, who constitute the majority of food producers in these LGAs, are particularly vulnerable due to their dependence on rain-fed agriculture and limited access to climate adaptation strategies (Eboh, Ujah, & Ogbonna, 2020). Studies by Nwafor, Okonkwo, and Ezeh (2019) and Okon, Essien, and Akpan (2021) have shown that changes in precipitation patterns and temperature fluctuations have led to poor crop yields, reduced farm income, and food shortages in various parts of Cross River State. Despite the growing recognition of climate change effects, adaptation measures such as irrigation, improved seed varieties, and climate-smart farming techniques remain inadequate due to financial constraints, limited government support, and low awareness among farmers (Ozor & Nnaji, 2018).

Climatic change is the continual alteration of global or regional climatic patterns caused by anthropogenic greenhouse gas emissions. Modern climate change is caused by the combustion of coal, gas, and other fossil fuels, which release large amounts of CO2 and other greenhouse gases. Greenhouse gasses trap heat in Earth's atmosphere, raising its average temperature. Alongside artificial influences, natural processes affect climate change. Long-term temperature swings are caused by Earth's orbit, axial tilt, and rotation, which affect solar energy intake. Ocean currents and atmospheric circulation, such as the El Niño-Southern Oscillation, may impact regional and worldwide weather patterns. The Earth may momentarily cool due to volcanic aerosols reflecting sunlight. Global warming has serious consequences. Rising sea levels from rising temperatures are flooding and eroding coastal regions. Extreme weather occurrences including heat waves, droughts, and severe storms are increasing. Innovative technologies are altering ecosystems, harming biodiversity, and influencing health and food supply. Climate change exacerbates social and economic inequities by disproportionately affecting poor and emerging countries. Climate change mitigation requires global efforts to reduce greenhouse gas emissions, promote sustainability, and strengthen environmental resilience. Policy changes, technical advances, and human conduct must be combined to mitigate and adapt to climate change (IPCC, 2014). Agriculture has various challenges from climate change, including food security and productivity. Agricultural growth is directly affected by rising global temperatures. Due to shorter growth periods, higher temperatures may reduce agricultural production (Lobell et al., 2011).
Due the increased frequency and intensity of extreme weather events, climate change also threatens agriculture. Hurricanes, cyclones, and strong storms may quickly and severely damage agricultural infrastructure, animals, and crops. These occurrences may also affect soil quality, water availability, and agricultural ecosystem services, affecting food production (Ziska et al., 2016). Due to nitrogen depletion and soil erosion, intense storms may gradually reduce soil fertility

and productivity. Developing nations suffer the most from climate change's impacts on agriculture. Their inflexibility, poor infrastructure, and rain-fed crops explain the scenario. In sub-Saharan Africa, rising temperatures and changing precipitation patterns are expected to reduce agricultural production, threatening food security (FAO, 2010).

Cross River State has a tropical climate with two seasons: April–October for rainy season and November–March for dry season. The northern areas get 1,800 mm of yearly precipitation, while the southern coastal districts receive around 3,500. Average maximum temperatures range from 27°C to 35°C all year-round (NIMET, 2015). The diverse biodiversity and varied climate of Cross River State make it crucial for agriculture. Agriculture provides jobs for a large portion of Cross River State's population and boosts food security and economic stability. The region grows yam, cassava, and maize as well as cocoa, oil palm, and rubber. Farmers can cultivate subsistence and commercially due to the excellent land and moderate environment. Besides grain production, Cross River State has a robust livestock industry with chicken, pig, and cow breeding, which boosts the local economy (Cross River State Ministry of Agriculture 2019). Furthermore, agricultural activities in these areas bolster local markets by selling surplus produce, so providing income for farming families and ensuring the availability of fresh food for the community. The revenue generated from cash crops enables farmers to obtain goods and services, therefore stimulating local businesses. Barriers to agricultural production and livelihoods arise from inadequate infrastructure, limited access to advanced agricultural inputs, and the impacts of climate change. Enhancing agricultural productivity and ensuring sustainable development in Bekwarra, Obudu, and Obanliku Local Government Areas necessitates addressing the challenges identified by the International Food Policy Research Institute (2010) and the National Bureau of Statistics (2012).

Multiple empirical studies demonstrate that temperature fluctuations substantially influence crop productivity and agricultural output. Zhao et al. (2017) project a decline of no less than 3.1% in primary crops for every one degree Celsius increase in temperature. Minor increases in the world average air temperature may lead to substantial reductions in agricultural productivity. Unusual temperatures during the grain maturation phase in Pakistan resulted in the yield of smaller and lighter grains, despite the crops being healthy (Rasul et al., 2012). In addition to basic crops, more than 70% of global agricultural production by area is adversely affected. Rice, maize, and wheat exhibit yield reductions of 2.8%, 2.6%, and 2.4%, respectively, with each 1°C rise in temperature (Agnolucci et al., 2020). Increased temperatures accelerate crop maturity, hinder photosynthesis, enhance respiration, and disrupt critical reproductive activities such as pollination (Smith, 2011). Furthermore, elevated temperatures exacerbate the difficulties presented by pests and diseases, hence reducing agricultural productivity. The findings highlight the critical need for robust agricultural policy and adaptable methods to mitigate the increasing impacts of temperature fluctuations on global food security and sustainable agricultural production.

Climate change has significantly altered precipitation patterns, resulting in considerable impacts on agricultural practices. The National Academy of Sciences (2020) and the U.S. Global Change Research Programme (Wuebbles et al., 2017) demonstrate that historical and current data indicate fluctuations in precipitation patterns, influencing the timing and duration of planting seasons. The region has a short wet season from May to October, crucial for agricultural activities. A dry season occurs from November to April, marked by low humidity and arid conditions. Alterations in precipitation patterns have impeded these seasons, impacting farmers' ability to accurately predict and schedule their planting dates. Research linking fluctuations in precipitation to alterations in agricultural productivity within the same regions has shown that this unpredictability directly influences crop production (Met Office, n.d.). The restricted water supply in the dry season intensifies soil degradation and erosion caused by unsustainable agricultural practices and increasing land demand, hence exacerbating bushfires during that period (NRDC). To address these challenges, it is essential to implement adaptation strategies specifically designed to mitigate the impacts of altered rainfall patterns on agricultural productivity and sustainability in the Bekwarra, Obudu, and Obanliku Local Government Areas (LGAs). The adoption of climate-smart agricultural methods is imperative danger and ensures food safety.

The adoption of effective adaptation strategies by farmers in the region has been hindered by various socioeconomic and institutional barriers, limiting their resilience to the changing climate. In Addressing the impact of climate change on food production in these LGAs is crucial not only for the well-being of the local communities but also for the broader economic development of Cross River State and Nigeria as a whole. Enhancing the resilience of the agricultural sector can contribute to food security, poverty alleviation, and the overall stability of the economy. It is Due to the above stated problems researcher intends to investigate the impact of climate change on food production in Nigeria.

Problem statement

Climate change is a global phenomenon with far-reaching consequences for food production and security, particularly in developing countries like Nigeria. The impacts of climate change on agriculture are multifaceted and can be observed through changes in temperature, rainfall patterns, and the increased frequency and intensity of extreme weather events. At the global level, rising temperatures have led to shifts in climatic zones, disrupting traditional growing seasons and altering the suitability of certain regions for the cultivation of various crops (Molua & Lambi, 2006). This has resulted in reduced agricultural productivity and threatened the food security of millions of people, especially in the tropics and sub-tropics. In Nigeria, the agricultural sector is a crucial component of the economy, contributing significantly to the country's GDP and employing a large portion of the population, particularly in rural areas (MOFINEWS, 2004). However, the impacts of climate change on food production in the country have been severe. Increased temperatures, erratic rainfall patterns, and the occurrence of extreme weather conditions, such as floods and droughts, have had a detrimental effect on crop yields and overall agricultural productivity (Pant, 2009).The specific challenges faced by farmers are representative of the broader climate change-related issues affecting food production in Nigeria. These areas are heavily dependent on rain-fed agriculture, making them particularly vulnerable to changes in temperature and precipitation (Elijah et al., 2018). The unpredictable onset and cessation of rainfall, as well as the increased frequency of extreme weather events, have disrupted traditional planting and harvesting calendars, leading to reduced crop yields and post-harvest losses. .Furthermore, the vulnerability of rural farming households to food insecurity has been exacerbated by the impacts of climate change, as their ability to access and utilize nutritious food has been compromised. The adoption of effective adaptation strategies by farmers in the region has been hindered by various socioeconomic and institutional barriers, limiting their resilience to the changing climate. In Addressing the impact of climate change on food production in these LGAs is crucial not only for the well-being of the local communities but also for the broader economic development of Cross River State and Nigeria as a whole. Enhancing the resilience of the agricultural sector can contribute to food security, poverty alleviation, and the overall stability of the economy. It is Due to the above stated problems researcher intends to investigate the impact of climate change on food production.

Materials and methods

This study adopted the mixed-method research design. This design combines both quantitative and qualitative approaches, allowing the researcher to gather comprehensive data and gain a deeper understanding of the subject. The use of questionnaires typically provides quantitative data, which can be analyzed statistically to identify patterns, trends, or correlations. On the other hand, climate data observation allows for the collection of quantitative data over time, which is essential for understanding the impact of climate variables on the research subject. The mixed-method approach is beneficial in this context because it enables the integration of numerical climate data with respondents' perceptions or behaviors captured through the questionnaires, this research is particularly effective in environmental studies as it enables a comprehensive understanding of complex issues. Creswell and Plano Clark (2011) emphasize that combining quantitative and qualitative approaches can enhance the validity of research findings by providing multiple perspectives on the same phenomenon.
The population of the study is made up of all the residents of Bekwarra, Obudu andObanliku LGA is 573,600. Here are the current population projections for each Local Government Area (LGA) in Cross River State as of 2022:

Local Government Area	Population Projection (2022)
Bekwara	160,700
Obanliku	167,000
Obudu	245,900
Total	573,900

Total Population of Cross River State: 4,406,200
These projections assume a consistent growth rate across all LGAs within the state, reflecting demographic trends and changes since the last census in 2006.

The projected population for the study area in 2022 is 573,600 at 3% growth rate (NPC, 2021). The sample size for this study was statistically determined from the target population using Taro

Yamane formula. This statistical technique was created by Taro Yamane in 1967 for statistical analysis in the social sciences. The formula is given as:

$\frac{N}{I+N}$ N (e^2)

Where N = Population

I = constant

N = total population

e^2 = level of significance $(0.05)^2$

Thus population of selected settlements

$= \frac{573,600}{1+573,600} (0.05)^2$

$= \frac{572,600}{572601} (0.0025)$

$= \frac{45440}{113.60} = 400$

Therefore the sample size is 400

The study using a mixed-method research design involves using both questionnaires and climate data observation. The secondary Data was on rainfall measured in millimeters and temperature measured in degree Celsius data covering the period of 2015 to 2023, which was obtained from the archival records of the Nigerian Meteorological Agency (NIMET) while for the questionnaires ten farming communities were purposively sampled in the three LGA, and structured questionnaire named (ICCFPQ) was then administered to one hundred randomly elected head of households in the study area by the help of two trained research assistants who provided an overview of the study's purpose to participants. Ethical considerations were upheld by obtaining informed consent from all respondents before distributing the questionnaires.
The deceptive statistical techniques such as simple percentage and frequency distribution, Table will be used to analysis the data collected from the field work using the four point likert scale of Strongly Agreed (SA) - 4 point, Agree (A) -3 points, Disagreed (DA)-2 point, Strongly Disagreed (1) point. Rainfall and temperature data were subjected to descriptive statistical analysis of mean and standard deviation to decipher patterns in air temperature and yearly rainfall in the study area. The results of the analysis were presented in tables and charts while Questionnaire administration tables, charts and descriptive tools of percentages were used to present and describe the results.

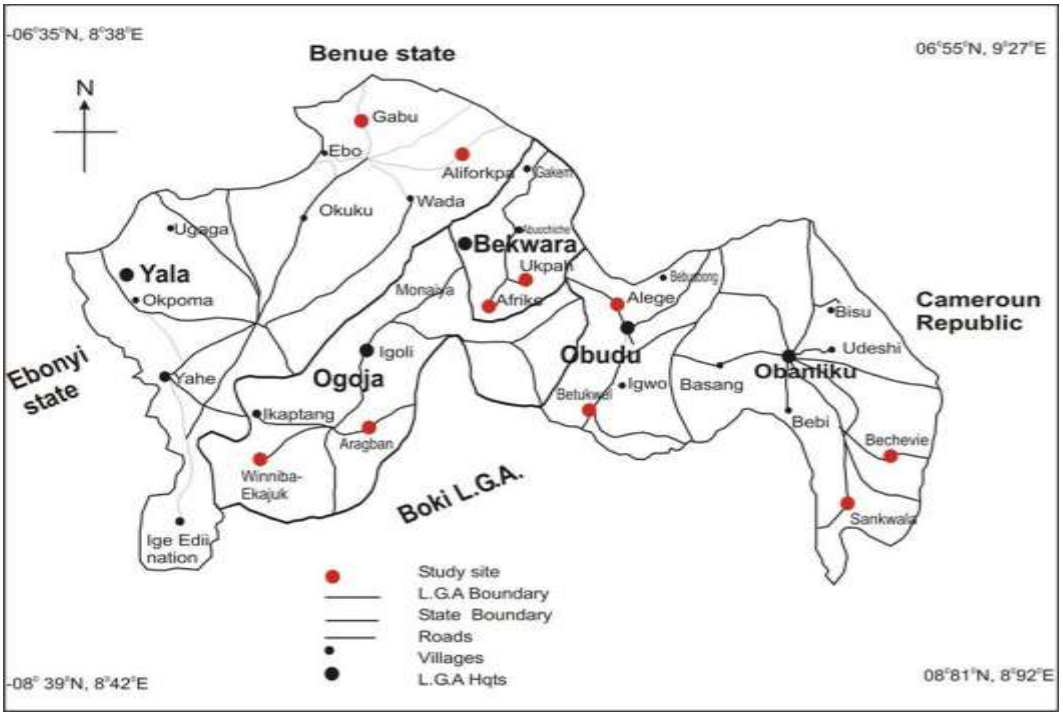


Figure 1.1: Map of Northern Cross River showing Bekwarra, Obudu, and Obanliku Local Government Area

Source: Ministry of Lands, Housing and Urban Development, Calabar (2017)

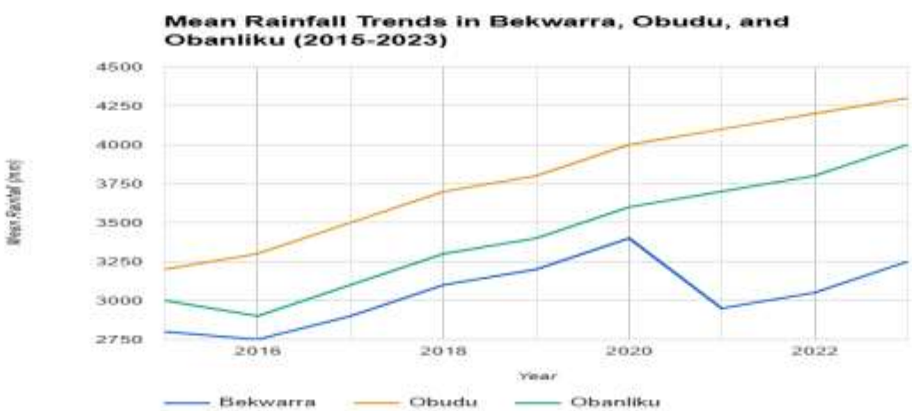
What is the impact of altered rainfall patterns on the planting seasons in Bekwarra, Obudu, and Obanliku Local Government Areas of Cross River State?

Table 4.2: Mean of Altered Rainfall in Bekwarra, Obudu, and Obanliku Local Government Areas from 2015 to 2023.

Year	Bekwarra (mm)	Obudu (mm)	Obanliku (mm)
2015	2,800	3,200	3,000
2016	2,750	3,300	2,900
2017	2,900	3,500	3,100
2018	3,100	3,700	3,300
2019	3,200	3,800	3,400
2020	3,400	4,000	3,600
2021	2,950	4,100	3,700

Year	Bekwarra (mm)	Obudu (mm)	Obanliku (mm)
2022	3,050	4,200	3,800
2023	3,250	4,300	4,000
Mean	**3044.4**	**3788.9**	**3422.2**
Standard Deviation	**215.7**	**395.1**	**380.1**

Table 4.2 illustrates the mean rainfall trends in Bekwarra, Obudu, and Obanliku Local Government Areas from 2015 to 2023 and their potential impact on planting seasons. Obudu recorded the highest mean rainfall (3,788.9 mm) with the greatest variability (standard deviation of 395.1 mm), suggesting more pronounced alterations in rainfall patterns. Obanliku follows with a mean rainfall of 3,422.2 mm and variability of 380.1 mm, while Bekwarra experienced the lowest mean rainfall (3,044.4 mm) and the least variability (215.7 mm). These fluctuations in rainfall directly influence planting seasons by disrupting traditional agricultural calendars. For instance, irregular or delayed rainfall in Bekwarra may shorten planting periods, affecting crop germination and yields. In contrast, excessive rainfall in Obudu and Obanliku could lead to water logging, soil erosion, and reduced soil fertility, further complicating planting schedules.



The observed trends emphasize the need for adaptive agricultural practices, such as water conservation, soil management, and reliance on weather forecasts, to mitigate the challenges posed by altered rainfall patterns in these areas.

Research Question 3; How do extreme weather events affect storage / losses food in Bekwarra, Obudu, and Obanliku Local Government Areas of Cross River State?

Table 4.3 Percentage and Frequency of Extreme Weather Events Affect Storage / Losses Food

S/N	STATEMENT	SA(%)	A(%)	D(%)	SD(%)

1	Extreme weather events such as flooding significantly damage food storage facilities in your area.	168 **(43.07)**	159 **(40.76)**	30 **(7.69)**	33 **(8.46)**
2	Prolonged drought periods lead to increased post-harvest food losses in your locality.	120 **(30.76)**	164 **(42.05)**	56 **(14.35)**	50 **(12.82)**
3	Strong winds and storms often destroy stored food or farming infrastructure.	180 **(46.15)**	120 **(30.76)**	57 **(14.61)**	33 **(8.46)**
4	Variability in rainfall patterns negatively impacts the proper storage of harvested crops.	170 **(43.58)**	114 **(29.23)**	50 **(12.82)**	56 **(14.35)**
5	Extreme weather events result in a significant loss of perishable farm produce in your area.	154 **(39.48)**	182 **(46.67)**	31 **(7.94)**	23 **(5.89)**

able 4.3 reveals the significant impact of extreme weather events on food storage and losses in Bekwarra, Obudu, and Obanliku Local Government Areas. The highest percentage of respondents (43.07%) strongly agreed that flooding damages food storage facilities, while 40.76% agreed, highlighting flooding as a major issue. Similarly, 46.15% of respondents strongly agreed that strong winds and storms frequently destroy food storage or farming infrastructure, with 30.76% agreeing, indicating that these weather events severely disrupt food security. Prolonged drought periods were also a concern, as 42.05% of respondents agreed that droughts lead to increased post-harvest food losses. Variability in rainfall patterns was cited by 43.58% of respondents as negatively affecting the storage of harvested crops, with some indicating moderate concerns (29.23%). Additionally, 39.48% strongly agreed that extreme weather events result in significant losses of perishable farm produce, and 46.67% agreed, further emphasizing the vulnerability of food supplies to extreme weather. These findings underline the need for effective weather-resilient storage solutions and risk management strategies to mitigate food losses caused by extreme weather events.

Discussion of Findings

The findings from this study on the impact of changes in temperature on crop yields and agricultural productivity align with existing research that underscores the adverse effects of rising temperatures on agriculture. Table 4.1 shows an increase in average temperatures in Bekwarra, Obudu, and Obanliku over the years, with Bekwarra experiencing the highest temperatures. Similar findings were observed in a study by Lobell et al. (2011), which reported that temperature increases negatively impacted crop yields, particularly in tropical regions, by reducing soil moisture and increasing evapo - transpiration. High temperatures, as seen in Bekwarra, can lead to drought stress, which limits crop growth, particularly in rain fed agricultural systems. In contrast, Obudu, with relatively lower temperatures, may be somewhat less impacted, but the overall trend suggests that temperature variations influence crop health and farming cycles. Recommendations from Lobell et al. (2011) emphasized the need for crop adaptation through improved irrigation systems and drought-resistant crop varieties, which resonate with the findings of this study.

Altered rainfall patterns, as shown in Table 4.2, significantly influence planting seasons in the study areas. Obudu, with higher rainfall but more variability, faces challenges of either waterlogging or drought, which disrupt planting cycles. Similar findings were documented in the study by Cline (2007), who observed that unpredictable rainfall patterns led to shorter growing seasons and increased crop failure risks, particularly in Africa. These rainfall variations have a direct impact on crop germination and growth. Cline’s recommendations included investing in rainwater harvesting and water-efficient irrigation systems to mitigate these issues. The findings of this study reflect these concerns, particularly in areas like Obudu, where excessive rainfall and its variability make farming increasingly difficult. Thus, there is an urgent need for better water management practices in these regions.

The effects of extreme weather events, such as flooding and storms, on food storage and post-harvest losses are clearly reflected in Table 4.3. Extreme weather events in Bekwarra, Obudu, and Obanliku have caused significant damage to food storage infrastructure, leading to substantial post-harvest losses. A similar study by Parry et al. (2007) found that extreme weather events, including flooding, droughts, and storms, have severely impacted food storage and preservation systems, especially in sub-Saharan Africa. In line with this, the findings of this study point to the vulnerability of food storage systems, which are easily destroyed by flooding and strong winds, especially in regions with poor infrastructure. Parry et al. (2007) recommended improving disaster-resilient storage systems and enhancing infrastructure to reduce losses, a suggestion supported by the study's findings.

Table 4.4 highlights the vulnerability of rural farming households to food insecurity due to climate change. The study found that many households in Bekwarra, Obudu, and Obanliku are increasingly vulnerable to food insecurity, with many reporting food shortages and crop failures due to erratic weather patterns. This is consistent with findings by Deressa et al. (2009), who found that rural households in sub-Saharan Africa are highly vulnerable to climate-induced food insecurity. The study revealed that households lack sufficient resources to cope with the impacts of climate change, further exacerbating their vulnerability. Deressa et al. (2009) recommended strengthening social safety nets and improving access to alternative livelihoods as strategies to reduce food insecurity. This study’s findings echo these recommendations, underscoring the need for improved support systems to address food insecurity in rural areas.

The climate change adaptation strategies outlined in Table 4.5 reflect a proactive approach by farmers in Bekwarra, Obudu, and Obanliku to mitigate the effects of climate change. Similar strategies, such as crop rotation, irrigation, and the use of climate-resilient crop varieties, were discussed in a study by Thornton et al. (2014), which found that farmers in Kenya adopted these strategies to cope with changing climatic conditions. The use of early warning systems, as reflected in this study, was also highlighted by Thornton et al. (2014) as a key adaptation strategy. Furthermore, the diversification of income sources, including non-farming activities, was identified as a strategy to enhance resilience in rural communities. The recommendations from Thornton et al. (2014) emphasize the importance of community-based initiatives, such as cooperative farming, which was also identified in this study as a valuable strategy for building climate resilience. These adaptation strategies are crucial in reducing the negative impacts of climate change on agricultural productivity and food security in these regions.

All these findings from this study on the impact of climate change on agriculture and food security in Bekwarra, Obudu, and Obanliku align with existing empirical research, demonstrating the significant challenges posed by climate change. The recommendations from previous studies, such as the implementation of better water management systems, improved storage infrastructure, and the adoption of climate-resilient crops, provide valuable insights for addressing these challenges in the study areas.

Major Findings of the Study

1. The study found that rising temperatures over the years in Bekwarra, Obudu, and Obanliku have negatively impacted crop yields, especially in Bekwarra, where higher temperatures have led to reduced soil moisture and increased evaporation.
2. The study revealed that changing rainfall patterns, including more variability in Obudu, have disrupted planting seasons in all three areas, indicating that Excessive rainfall or droughts have affected crop germination and growth, with Bekwarra experiencing shorter planting seasons due to lower and more stable rainfall.
3. The study revealed that Extreme weather events have caused significant damage to food storage facilities and contributed to high post-harvest losses, particularly for perishable crops.
4. The study revealed that Rural farming households in the areas are highly vulnerable to food insecurity due to climate change, which has ;led'/. Many households reported increased food shortages, crop failures, and difficulty accessing food during adverse climate conditions. The lack of resources to cope with these challenges exacerbates food insecurity in the region.
5. The study revealed that Farmers have employed various adaptation strategies to cope with climate change.

Summary

This study aimed to assess the impact of climate change on food production in the three LGA of Cross River State, Nigeria. The focus was to understand how climate change factors, such as rising temperatures, altered rainfall patterns, extreme weather events, and other related phenomena, affect agricultural productivity and food security in these regions. The study also explored the adaptation strategies employed by farmers to mitigate the challenges posed by climate change.

Key Findings:

1. The study found that over the years, temperatures have risen in all three Local Government Areas, with Bekwarra experiencing the highest increases. These temperature rises led to reduced soil moisture, increased evaporation, and, consequently, drought stress. This has significantly impacted crop yields, particularly in rainfed agricultural systems.
2. The findings revealed that rainfall patterns in the study areas have become increasingly erratic, with Obudu facing the most variability. This variability led to either waterlogging or drought, both of which disrupted planting and growing seasons. As a result, crop germination, growth, and yields were negatively affected. Bekwarra experienced shorter planting seasons due to relatively lower and stable rainfall patterns.
3. The study highlighted the damaging impact of extreme weather events, such as flooding and storms, on food storage facilities. These events led to significant post-harvest losses, particularly for perishable crops. Extreme weather has also caused damage to infrastructure, which exacerbates the challenges faced by farmers in storing and preserving their produce.
4. Rural farming households in the study areas reported significant food insecurity due to climate-induced disruptions in food production. Many households experienced crop failures and food shortages, and lacked the resources to cope with the economic challenges posed by climate change. This heightened their vulnerability to food insecurity.
5. Despite the challenges posed by climate change, farmers in the study areas have adopted various strategies to cope with these changes. These included crop rotation, the use of climate-resilient crop varieties, improved irrigation practices, the adoption of early warning systems, and diversifying income sources through non-farming activities. These strategies aim to increase resilience and mitigate the negative effects of climate change on agriculture.

The study contributes valuable insights into the specific impacts of climate change on food production in Local Government Areas. It underscores the vulnerability of rural farming households to food insecurity and the need for proactive adaptation strategies. The study also aligns with global findings on the negative effects of climate change on agriculture and offers context-specific recommendations for the region.

Conclusion

This study confirms the significant impact of climate change on food production in the Bekwarra, Obudu, and Obanliku Local Government Areas of Cross River State. Rising temperatures, erratic rainfall patterns, extreme weather events, and the subsequent impact on food storage and crop yields have made agriculture increasingly challenging in these areas. These challenges have contributed to heightened food insecurity, especially among rural farming households that lack the necessary resources to adapt to these changes. The study also emphasizes the importance of adopting climate change adaptation strategies to mitigate these impacts. Farmers in the study areas are already employing strategies such as crop rotation, the use of climate-resilient crop varieties, and irrigation systems, but there is still a need for more widespread adoption and support. Enhancing disaster-resilient infrastructure for food storage, investing in better water management systems, and providing financial and technical support to farmers are crucial steps to bolster resilience to climate change. Based on the findings, it is clear that addressing climate change in agriculture requires a multi-faceted approach, involving both government and community-based interventions. Policy recommendations include strengthening rural infrastructure, improving early warning systems, promoting sustainable farming practices, and providing adequate support to vulnerable farming households.

Recommendations

The following recommendations are made based on the findings of this study.

1. The government should develop and implement policies that promote climate-smart agriculture, such as supporting the adoption of climate-resilient crops and farming practices.
2. Farmers should be encouraged to adopt adaptive strategies, such as crop rotation, irrigation, and the use of drought-resistant crop varieties, to cope with changing temperature and rainfall patterns.
3. Research institutions should conduct further studies on climate-resilient agricultural practices tailored to the unique needs of the study areas, by includes developing and testing new crop varieties and farming techniques that can withstand the challenges of changing weather patterns.
4. NGOs and community-based organizations should continue to support initiatives like cooperative farming, shared storage facilities, and community awareness programs.
5. Local governments should work with national agencies to establish or improve early warning systems that provide timely information about extreme weather events.

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Rainfall Data Summary

Year	Bekwarra (mm)	Obudu (mm)	Obanliku (mm)
2015	2,800	3,200	3,000
2016	2,750	3,300	2,900
2017	2,900	3,500	3,100
2018	3,100	3,700	3,300
2019	3,200	3,800	3,400
2020	3,400	4,000	3,600
2021	2,950	4,100	3,700
2022	3,050	4,200	3,800
2023	3,250	4,300	4,000

The National Population Commission (NPC) in the 2006 census, broken down by each Local Government Area (LGA):

Local Government Area	Population (2006)
Abi	144,317
Akamkpa	149,705
Akpabuyo	272,262
Bakassi	31,641
Bekwarra	105,497

Local Government Area	**Population (2006)**
Biase	168,113
Boki	186,611
Calabar Municipal	183,681
Calabar South	191,515
Etung	80,036
Ikom	249,300
Obanliku	109,633
Obubra	172,543
Obudu	161,457
Odukpani	192,884
Ogoja	171,574
Yakurr	196,271
Yala	211,557

Total Population of Cross River State: 2,892,988This data provides a detailed view of the population distribution across the various local government areas within Cross River State as recorded in the 2006 censusTop of Form

AVERAGE RAINFALL PATTERN (2015-2023)

General Climate Context

Cross River State experiences a tropical climate with high humidity and significant rainfall, contributing to its lush vegetation.

The average temperature in these areas typically ranges from 15°C to 30°C (59°F to 86°F), with variations influenced by elevation and local geographical features.

Temperature Data Summary

Year	**Bekwarra (°C)**	**Obudu (°C)**	**Obanliku (°C)**
2015	27.5	26.0	27.3
2016	27.7	25.8	27.4
2017	27.9	25.5	27.6
2018	28.0	25.4	27.8
2019	28.1	25.6	27.9
2020	28.2	25.7	28.0
2021	28.0	25.9	28.1
2022	28.3	26.1	28.2

Year	Bekwarra (°C)	Obudu (°C)	Obanliku (°C)
2023	28.5	26.3	28.4

Below is a questionnaire with five questions for each research question, designed to be answered with **Strongly Agree (SA)**, **Agree (A)**, **Disagree (D)**, and **Strongly Disagree (SD)**.

Questionnaire

	Extreme weather events and food storage/loss	**Response (SA, A, D, SD)**
3.1	Extreme weather events such as flooding significantly damage food storage facilities in your area.	
3.2	Prolonged drought periods lead to increased post-harvest food losses in your locality.	
3.3	Strong winds and storms often destroy stored food or farming infrastructure.	
3.4	Variability in rainfall patterns negatively impacts the proper storage of harvested crops.	
3.5	Extreme weather events result in a significant loss of perishable farm produce in your area.	
4.	**Vulnerability of rural farming households to food insecurity**	
4.1	Climate change has made your household more vulnerable to food shortages.	
4.2	Increased crop failure due to erratic weather patterns has heightened food insecurity in your household.	
4.3	Rural farming households in your community struggle to access alternative food sources during adverse climate conditions.	
4.4	Your household often lacks sufficient resources to cope with climate-induced food shortages.	
4.5	Climate change has caused a noticeable decline in the overall availability of food in your community.	
	Climate change adaptation strategies employed by farmers	

	Extreme weather events and food storage/loss	**Response (SA, A, D, SD)**
5.1	You have adopted new farming practices (e.g., crop rotation, irrigation) to adapt to changing climatic conditions.	
5.2	Using early warning systems has helped reduce the negative impact of climate change on your farming activities.	
5.3	Switching to climate-resilient crop varieties has improved your ability to cope with climate change.	
5.4	You have diversified your sources of income (e.g., engaging in non-farming activities) to mitigate the effects of climate change.	
5.5	Community-based initiatives (e.g., cooperative farming, shared storage facilities) have helped in adapting to climate change impacts on food production.	