INFLUENCE OF CLIMATE CHANGE ON CROP PRODUCTION AMONG FARMERS' COOPERATIVE SOCIETIES IN NORTH WEST ZONE, NIGERIA

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Abstract
This study examines the influence of climate change on crop production among farmers' cooperative societies in North West Nigeria. Specifically, it assesses the effect of flooding on rice production and evaluates the effect of drought on maize production. The study is anchored on the Social-Ecological Systems (SES) Theory, which explains the interaction between human activities and environmental systems in shaping agricultural outcomes. A quantitative descriptive survey research design was adopted, involving a population of 552,479 cooperative members across 13,414 registered societies. A sample size of 400 respondents was selected using the Taro Yamane sampling technique, while multi-stage sampling was employed to ensure adequate representation across states, local government areas, and cooperative groups. Primary data were collected through structured questionnaires and analyzed using descriptive statistics and regression analysis via SPSS. The regression results revealed that flooding has a significant effect on rice production ($R = 0.424$, $R^2 = 0.180$, $p = 0.000$), indicating that it accounts for 18.0% of variations in rice output. Similarly, drought was found to significantly influence maize production ($R = 0.369$, $R^2 = 0.136$, $p = 0.000$), explaining 13.6% of variation in maize yield. Both findings confirm that climate-related factors significantly affect agricultural productivity among cooperative farmers. The study concludes that climate change poses serious challenges to crop production but also encourages adaptive responses and resilience-building among farmers. The study recommends climate-smart farming practices, improved crop varieties, and government support for sustainable food security.

Key words: *Climate change, Crop production, Flood, Rice Production, Droughts and Maize production*

Introduction

The economies of most developing countries rely heavily on crop production, making them highly vulnerable to the adverse effects of climate change (Salahuddin, Gow and Vink, 2020). Climate change is a global challenge affecting agriculture, food security, and economic stability, especially in sub-Saharan Africa where smallholder farmers dominate production (Tiwari, Bajracharya and Balla, 2022). The UNFCCC defines it as changes in climate caused by human activities and natural processes, while the IPCC (2018) emphasizes long-term shifts in temperature, rainfall, and weather extremes. NASA (2024) highlights increasing floods, droughts, and erratic rainfall patterns as key impacts.

In Nigeria, agriculture plays a major economic role, contributing significantly to GDP and employment (CBN, 2023). Despite vast agricultural potential across diverse ecological zones, climate change is disrupting production through flooding, erosion, heat stress, and soil degradation. Crop production, mainly driven by smallholder farmers, is central to rural livelihoods, with cooperatives enhancing access to inputs, credit, and extension services (FAO, 2021). However, increasing climate-related shocks are reducing productivity and threatening food security, particularly in regions like North West Nigeria. This highlights the urgent need for effective adaptation strategies to sustain agricultural productivity and cooperative development.

Statement of the Problem:

Climate change is a major global challenge affecting agriculture, food security, and farmers' livelihoods worldwide. It has reduced crop productivity and increased hunger, despite progress in reducing child malnutrition and extreme poverty, with about 793 million people still undernourished (World Bank, 2023). Climate change refers to long-term warming caused mainly by greenhouse gas emissions, with global temperatures rising by over 1°C since the nineteenth century (NOAA, 2022). This has led to floods, droughts, pests, and diseases that reduce agricultural output and threaten human wellbeing (NASA, 2022; NASA, 2024).

In Nigeria, climate change worsens hunger, food insecurity, and high food prices, while weak investment in agriculture limits productivity growth. Many farmers' cooperatives lack access to climate-smart practices such as irrigation, improved water management, and resilient farming systems (FAO, 2020). In North West Nigeria, reduced yields and financial instability have weakened cooperative productivity (Abaje and Oladipo, 2019). Despite their importance, limited studies have examined climate change impacts on crop production among cooperatives, creating a need for further research to support sustainable agriculture and food security.

Objectives

The broad objective of the study is to examine the influence of Climate Change on Crop Production of Farmers' Cooperative Societies in North West Zone, Nigeria. The specific objectives are to:

i. Assess the effect of flood on rice production among members of farmers cooperative societies in North West Zone, Nigeria.
ii. Evaluate the effect of droughts on maize production among members of farmers cooperative societies in North West Zone, Nigeria.

Hypotheses

Ho$_1$: Flood has no significant effect on rice production of farmers' cooperative societies members in North West Zone, Nigeria.

Ho$_2$: Drought has no significant effect on maize production of farmers' cooperative societies members in North West Zone, Nigeria.

Literature Review

Climate Change

Climate change is associated with global warming, rising temperatures, floods, droughts, pollution, deforestation, and environmental degradation that threaten human survival and natural ecosystems Intergovernmental Panel on Climate Change. According to the IPCC (2013), climate change refers to changes in climate conditions identifiable through variations in temperature, rainfall, and sea levels over time. Similarly, The Royal Society (2017) described climate change as long-term alterations in atmospheric and oceanic conditions caused by natural and human activities. Rahmani and Ahmadi (2024) further linked climate change to greenhouse gas emissions, fossil fuel combustion, and deforestation affecting Earth’s atmosphere.

Flood

Flood is a natural disaster involving the overflow of water onto land that is normally dry, causing destruction to lives, infrastructure, and ecosystems. Daniel and Udo (2019) described flood as the eruption of a large body of water over land not usually submerged. World Health Organization defines floods as the most common natural disasters caused by heavy rainfall, storms, or rising sea levels. Mfon, Oguike, Eteng, and Etim (2022) explained that flooding results from global warming, glacier melting, and thermal ocean expansion, leading to coastal inundation and increased environmental and public health risks globally.

Drought

Drought refers to prolonged periods of insufficient rainfall resulting in water shortages that negatively affect agriculture, ecosystems, and human livelihoods. According to Douville et al. (2021), the IPCC Sixth Assessment Report defines drought as "drier than normal conditions" causing moisture deficits relative to average water availability. The report further explained that rising temperatures increase atmospheric evaporative demand, intensifying agricultural and ecological droughts. The National Integrated Drought Information System defines drought as prolonged precipitation deficiency causing water scarcity. Similarly, NOAA (2022) described drought as moisture deficiency adversely affecting humans, animals, and vegetation over wide areas.

Rice Production

Rice production remains a major agricultural activity and an important source of food for over half of the global population. According to Britannica (2021), rice cultivation dates back thousands of years, with evidence discovered in India and China. Rice (Oryza sativa L.) is cultivated in over 95 countries and serves as a staple food worldwide (Adefidipe & Adetola, 2022). Food and Agriculture Organization (2020) estimated global rice production at 508.7 million tons. Scholars such as Sharma and Khanna (2019) noted that rice contributes significantly to global dietary energy, especially across Africa and Asia.

Maize Production

Maize (Zea mays), also called corn, is one of the world's most important cereal crops and a staple food in many countries. Pagán-Jiménez et al. (2016) explained that maize was domesticated in southern Mexico about 9,000 years ago before spreading globally. According to Food and Agriculture Organization Statistics Division (2023), world maize production reached approximately 1.1 billion tons in 2020. In Nigeria, maize is widely cultivated due to its adaptability to different climatic conditions and farming systems. FAO (2018) reported that Nigeria produced about 10.2 million tons of maize, making it Africa's leading maize producer.

Theoretical Framework

This study is anchored on the Social-Ecological Systems (SES) Theory, propounded by Elinor Ostrom in the 1930s. The Social-Ecological Systems (SES) Theory is a multidisciplinary framework that examines the interconnectedness of social and ecological systems. It recognizes that humans are part of the environment and that social and ecological systems are intertwined. The SES theory seeks to explain and develop hypotheses about the characteristics that emerge from the interactions between human (social) and environmental (ecological) systems. These characteristics help in understanding how societies manage natural resources, respond to environmental changes, and sustain ecological and human well-being over time. The focus is on understanding the complex and dynamic interactions between human societies (social systems) and natural environments (ecological systems). It provides a framework for analyzing how humans and nature interact, adapt, and co-evolve over time in response to environmental, economic, and social changes. The SES theory perspective implies a dialogue between multiple disciplines, knowledge systems, and stakeholders to better understand and manage the interconnected relationship between humans and nature.

Empirical Review

Mudi, Danladi, and Waziri (2019) investigated food crop farmers' perceptions of climate change and indigenous adaptation strategies in southern Borno State, Nigeria. Using multistage sampling, 100 farmers were selected from three LGAs, while data were analyzed using frequencies, percentages, and Pearson correlation. Findings identified deforestation, overgrazing, and industrial emissions as major causes of climate change. Farmers adopted indigenous adaptation measures such as mulching, relay cropping, and changing planting dates. The study revealed a strong positive relationship ($r = 0.7333$) between climate change perception and adaptation strategy adoption among farmers.

Ntuk, Ogwuche, Aligba, Shiada, and Kever (2020) assessed the impact of observed and projected climate on maize yield in Makurdi metropolis, Benue State, Nigeria. The study examined climatic trends, soil fertility, and projected climate effects on maize yield using the DSSAT model. Findings showed that climate variability significantly affects crop yield despite statistically insignificant short-term trends. The study further revealed that Maize Lethal Necrosis (MLN) caused severe yield losses ranging from 30% to 90% in affected areas, resulting in major economic losses and threatening food security across the region.

Pratt, Maina et al. (2020) reviewed empirical evidence on the epidemiology and economic impact of Maize Lethal Necrosis (MLN) disease in East Africa. The study focused on countries including Kenya, Tanzania, Uganda, and Rwanda, with the objective of estimating yield and monetary losses caused by MLN and evaluating intervention measures. Findings revealed that MLN spread rapidly across maize-producing regions, causing substantial yield reductions and financial losses among smallholder farmers. The study emphasized the importance of resistant maize varieties and phytosanitary control measures in reducing the disease's economic and agricultural impact.

Oluyemi, Peter, and Franklin (2021) examined the impact of climate change on agricultural output in Nigeria between 1986 and 2015. Using secondary data and Ordinary Least Squares regression analysis, the study assessed the effects of rainfall, temperature, forest cover, droughts, floods, and greenhouse gas emissions on agricultural productivity. Findings showed that rainfall, temperature, and forest area positively influenced agricultural output, while droughts, floods, and nitrous oxide emissions negatively affected crop yields. The study recommended strong agricultural policies and climate mitigation strategies to sustain productivity and reduce the adverse effects of climate change in Nigeria.

Tien, John, and Takuji (2021) analyzed the effects of climate change on rice farmers' livelihood vulnerability in the Mekong Delta Region of Vietnam. The study examined household vulnerability levels, socio-economic factors influencing climate risks, and possible adaptation strategies among rice-farming households. Findings revealed that Can Tho province experienced the highest level of vulnerability, followed by Dong Thap and Tien Giang provinces. The Livelihood Vulnerability Index showed that limited access to social networks and safety nets contributed significantly to social vulnerability. The study emphasized the need for resilience-bilding strategies to reduce farmers' exposure to climate risks.

Methodology

The study adopted a quantitative descriptive survey research design. It involves collecting data from representative respondents at a single point in time to examine relationships among variables. This design enables systematic analysis of responses, supports hypothesis testing, and effectively addresses research questions and study objectives within the selected population.

The population consists of all active members of registered farmers' cooperative societies in North West Nigeria. There are 13,414 registered cooperatives with a total membership of 552,479 farmers (Cooperative Department, Ministry of Rural Development and Special Duties, North West Zone). This population provides a broad base for agricultural research analysis. In determining the sample size for the study, a simplified formula by Taro Yamane (1967) was employed and sample size of 400 was gotten. Given that the Population of 552,479 farmers' members of the registered and viable societies under study, the application of the Yamene (1967) formula gave a sample size of 400. This study employed multi-stage sampling across Northwest Nigeria. First, seven states were judgmentally selected based on security. Next, twenty agriculture-focused local government areas were randomly picked. From these, eighty farmers' cooperative societies were identified, with five members randomly selected per group, resulting in a total sample size of 400 respondents.

The researcher explored the primary and secondary sources. The primary data was obtained from members of Farmers' cooperative societies in the North West using a structured questionnaire instrument. The secondary sources of literature for the study were obtained from existing literature in the field of study which were available to the researcher; they are: journals, internet materials, unpublished write-ups etc. Data collected were analyzed using descriptive statistics (frequencies, percentages, mean, and standard deviation) and inferential statistics such as regression analysis. The objectives were processed using descriptive statistics (like percentages, mean and standard deviation) and the four hypotheses, set for the study were analyzed through regression analysis

Presentation and Analysis Of Data

Analysis of Data Related to Research Question

Decision Rule:

The decision in the analysis section is determined by the average of the responses of respondents. Very Great Extent (5 points), Great Extent (4 points), Undecided(3 points), Some Extent (2 points) and No Extent (1 point). The average of the responses:

$$\frac{(5 + 4 + 3 + 2 + 1)}{5} = 3.0$$

Therefore, a mean score below 3.0 would be considered rejected and a mean score of 3.0 and above would be considered accepted.

Table 4.2.1: RQ1: In what ways does flood affect the rice production of farmers' cooperatives?

S/N	Items	Mean	Standard Deviation	Remark
1	Prevents timely land preparation, planting, and harvesting, leading to reduced yields.(quantity).	4.64	0.754	Accepted
2	Reduces soil fertility and makes it less suitable for rice cultivation.	4.56	0.887	Accepted
3	Strong water currents can flatten rice plants, making harvesting difficult and reducing grain quality.	4.18	1.024	Accepted
4	Prolonged flooding can suffocate rice plants, leading to poor growth or crop failure.	4.01	1.059	Accepted
5	Prolonged exposure to water leads to poor grain quality, mold growth, and contamination.	4.14	994	Accepted
6	Increased production costs: Farmers may need to invest in replanting, fertilizers, pesticides, and drainage improvements.	4.20	1.006	Accepted
7	Floods create conditions favorable for pests like rice stem borers, planthoppers, and rodents.	4.41	0.936	Accepted
8	Reduced yields can lead to financial difficulties for cooperative members and affect the local food supply.	4.51	0.850	Accepted
9	Excess water depletes essential nutrients, requiring more fertilizers to restore soil health.	4.54	8.43	Accepted
	GRAND	**4.24**		

Source: Field survey, 2025

The findings revealed that flooding significantly negatively affects rice production among farmers' cooperative members. Mean scores ranging from 4.01 to 4.64 and agreement levels between 80% and 93% indicate strong consensus that flooding damages agricultural activities. Respondents agreed that flooding washes away soil nutrients, degrades soil quality, disrupts farming operations, and reduces crop yield, thereby increasing dependence on fertilizers and production costs. The study further showed that drought, pests, diseases, and heat waves collectively threaten agricultural productivity and farmers' income. Regression results confirmed the significant influence of climate-related factors, emphasizing the need for adaptation strategies and resilient agricultural systems.

Table 4.2.2: RQ2: How does drought influence the maize production of farmers' cooperatives?

S/N	Items	N	Mean	Standard Deviation	Remark
1	Lack of moisture affects seed germination, leading to uneven crop establishment.	386	4.40	0.940	Accepted
2	Insufficient water limits plant growth, reducing the size and strength of maize plants.	386	4.51	0.921	Accepted
3	Dry conditions make soil hard and compact, reducing nutrient absorption.	386	4.44	0.861	Accepted
4	Drought limits nutrient availability, requiring additional fertilizers to sustain crop health.	386	4.24	1.093	Accepted
5	Drought-stressed maize is more susceptible to pests like fall armyworms and stem borers.	386	4.06	1.092	Accepted
6	Hot, dry conditions encourage fungal infections, leading to toxic grain contamination.	386	3.96	.959	Accepted
7	Reduces starch accumulation, producing low-quality grains.	386	4.23	.939	Accepted
8	Farmers spend more on irrigation, fertilizers, and pest control to combat drought effects.	386	4.30	.934	Accepted

9	Reduced yields (quantity) result in lower sales, affecting cooperative profits.	386	4.32	.958	Accepted
	GRAND MEAN	**4.27**			

Source: Field survey, 2025

Results in Table 4.3 reveal strong ag

reement that drought significantly affects maize production. All mean values converted to percentages range from 79% to 90%, showing The findings revealed a consistently high acknowledgment of drought-related problems among respondents. A mean score of 4.51 indicates 90.2% agreement that insufficient moisture limits plant growth and reduces crop vigor. Similarly, a mean of 4.40 shows 88% agreement that drought disrupts germination and crop establishment, while 4.44 (88.8%) confirms that dry conditions harden soil and reduce nutrient uptake. Respondents also agreed that drought increases pest infestation (4.06 = 81.2%) and raises production costs through irrigation and chemical expenses (4.30 = 86%). Furthermore, reduced yield and cooperative profits (4.32 = 86.4%) demonstrate the negative financial impact of drought on productivity and farmers' income.

Test of Hypotheses

Test of Hypothesis I

Ho_1: Flood has no significant influence on rice production of farmers' cooperative members.

HA_1: Flood has significant influence on rice production of farmers' cooperative members.

Regression summary results for Hypothesis One.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.424[a]	.180	.178	2.63304

a. Predictors: (Constant), FLOOD

Source: SPSS V. 26 Output (2025)

The regression summary result shows a moderate relationship between flooding and rice production, with an R-value of 0.424. The R Square value of 0.180 indicates that flooding explains 18.0% variation in rice production, while the remaining variation is influenced by other factors. The model is reliable with a standard error estimate of 2.63304.

ANOVAa output for Hypothesis One

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	583.405	1	583.405	84.150	.000[b]
	Residual	2662.235	384	6.933		
	Total	3245.640	385			

a. Dependent Variable: RICE_PROD

The ANOVA table indicates that the regression model is statistically significant in explaining rice production. The F-value of 84.150 and significance level of 0.000, which is below 0.05, show that flooding has a significant effect on rice production.

Regression Coefficients[a] output for Hypothesis One.

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	13.912	.870		15.984	.000
	FLOOD	.454	.049	-.424	9.173	.000

a. Dependent Variable: RICE_PROD
Source: SPSS V. 26 Output (2025)

The regression result shows that flooding significantly affects rice production. The coefficient value of 0.454 indicates flooding influences rice productivity, while the beta coefficient of -0.424 reveals a negative relationship. The t-value of 9.173 and significance value of 0.000 confirm statistical significance. Therefore, flooding significantly reduces rice production in the study area.

Test of Hypothesis II

Regression Model Summary results for Hypothesis Two
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.569[a]	.326	.134	3.13586

a. Predictors: (Constant), DROUGHT
Source: SPSS V. 26 Output (2025)

The regression summary result shows a moderate relationship between drought and maize production, with an R-value of 0.569. The R Square value of 0.326 indicates that drought explains 32.6% variation in maize production, while other factors account for the remaining variation. The standard error estimate of 3.13586 indicates model reliability.

ANOVAa for Hypothesis Two

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	595.214	1	595.214	60.544	.000[b]
	Residual	1230.786	384	3.092		
	Total	1826.000	385			

a. Dependent Variable: MAIZE_PROD

The ANOVA result indicates that the regression model is statistically significant in explaining maize production. The F-value of 60.544 and significance value of 0.000, which is less than 0.05, show that drought has a significant effect on maize production.

Regression Coefficients[a] output for Hypothesis Two

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	12.812	1.048		12.228	.000
	DROUGHT	.458	.059	-.569	7.781	.000

a. Dependent Variable: MAIZE_PROD
Source: SPSS V. 26 Output (2025)

The regression result indicates that drought has a significant effect on maize production. The coefficient value of 0.458 shows that drought influences maize productivity, while the beta coefficient of -0.569 indicates a negative relationship. The t-value of 7.781 and significance value of 0.000 confirm that the effect is statistically significant at 0.05 level.

Discussion of Findings

Hypothesis I: Flood and Rice Production

The findings show a significant relationship between flooding and rice production ($R = 0.424$, $R^2 = 0.180$), indicating that flooding explains 18% of yield variation. The regression coefficient ($\beta = -0.424$, $t = 15.984$, $p = 0.000$) confirms a significant negative effect, meaning increased flooding reduces rice output. This aligns with Bonou et al. (2024), Wangum et al. (2022), and Nwangwu et al. (2024), who reported similar yield losses due to flooding. The null hypothesis is therefore rejected.

Hypothesis II: Drought and Maize Production

Drought shows a significant relationship with maize production ($R = 0.569$, $R^2 = 0.326$), explaining 32.6% of variation in yield. The regression coefficient ($\beta = -0.569$, $t = 12.228$, $p = 0.000$) indicates a strong negative effect, confirming that drought reduces maize productivity. This supports Ogundunmade (2022), who reported low maize yields under drought conditions, and Tien, John, and Takuji (2021), who identified drought as a major factor affecting farm productivity. The null hypothesis is rejected.

Conclusion

This study is based on the view that climate change can encourage adaptive farming practices among farmers' cooperative societies in Northwest Nigeria. Farmers may respond to environmental challenges by adopting improved crop varieties, modern farming techniques, and climate-resilient strategies that enhance productivity. The study therefore examines the influence of flooding on rice production, drought on maize production. It seeks to determine how these climate-related factors affect crop output and how farmers adapt to such challenges. The study further highlights that climate pressures may promote agricultural innovation, resilience, and sustainable crop production in the region.

Recommendations

The study recommended that:

1. Farmers' cooperatives should encourage the adoption of flood-tolerant rice varieties and improved water management systems to make productive use of seasonal flooding. Training programs on soil conservation, flood-based irrigation techniques, and quick post-flood recovery practices can help farmers reduce losses and improve yields.
2. Cooperative members should invest in drought-resistant maize varieties and adopt water-efficient farming methods such as mulching, rainwater harvesting, and drip irrigation. Government agencies and extension workers should also support farmers through training and inputs to enhance productivity during dry seasons.

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