INFLUENCE OF CLIMATE CHANGE ON FOOD SECURITY AMONG MEMBERS OF AGRICULTURAL COOPERATIVE HOUSEHOLDS IN KADUNA STATE, NIGERIA

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Abstract

Climate change poses a major threat to food security, particularly among agricultural households whose livelihoods depend on climate-sensitive activities. This study examined the influence of climate change on food security among members of agricultural cooperative households in Kaduna State, Nigeria, focusing on rainfall shortage, flooding, windstorms, and heat waves and their effects on food availability, accessibility, affordability, and stability. The study was anchored on the Social-Ecological Systems (SES) Theory. A descriptive survey design was adopted, and data were collected from 321 respondents selected through a multistage sampling technique across four agricultural zones. A structured questionnaire, validated by experts and achieving a Cronbach's Alpha reliability coefficient of 0.84, was used for data collection. Data were analyzed using descriptive statistics and Ordinary Least Squares (OLS) regression at the 5% significance level with SPSS version 23. Findings revealed that rainfall shortage significantly reduced food availability ($R = .996$, $R^2 = .992$, $p < .001$), while flooding significantly reduced food accessibility ($R = .997$, $R^2 = .995$, $p < .001$). Windstorms significantly affected food affordability ($R = .490$, $R^2 = .240$, $p < .001$), while heat waves significantly reduced food stability ($R = .994$, $R^2 = .988$, $p < .001$). The study concludes that climate change significantly undermines food security and recommends climate-resilient agricultural technologies, irrigation, flood control, crop insurance, and cooperative-based adaptation strategies.

Key words: *Climate change; food security; agricultural cooperatives; climate resilience; Kaduna State; Nigeria.*

Introduction

Food security is a fundamental aspect of sustainable development, especially in agrarian economies where agriculture plays a central role in livelihood and poverty reduction. Ideally, food security is achieved when all individuals have access to sufficient, safe, and nutritious food that meets their dietary needs for a healthy life (FAO, 2020). In rural areas of sub-Saharan Africa, where farming is predominantly rain-fed, it involves a stable climate that supports consistent agricultural productivity,

reliable access to food, and stable food prices. Additionally, membership in agricultural cooperatives can help farmers access resources like credit, training, and better market opportunities, which further enhance food security by boosting productivity and facilitating collective action (Adewale, Okafor, & Hassan, 2021).Between 2018 and 2023, Nigeria experienced significant climate variations, including changing rainfall patterns, increased flooding, and temperature fluctuations (USAID, 2024; Ani, Anyika & Mutambara, 2022).

Agricultural cooperatives are member-owned organizations that enable farmers to pool resources for better access to inputs, markets, and financial services, fostering improved livelihoods and rural development (FAO, 2021). By operating democratically, agricultural cooperatives empower small-scale farmers to achieve better pricing, share risks, and promote sustainable farming practices(ILO, 2019).Agricultural cooperatives, which allow farmers to pool resources and share risks, are particularly important in regions where agricultural systems are vulnerable to external shocks, such as climate variability. Under ideal conditions, agricultural cooperatives provide their members with the necessary tools to adapt to climate change, improve yields, and diversify income sources, all of which contribute to food security (Bouteska, Sharif, Bhuiyan, and Abedin, 2024). However, this situation is increasingly challenged by the growing effect of climate change.

In Kaduna State, Nigeria, the majority of farmers rely on rain-fed agriculture, making them highly susceptible to rainfall variability. Studies have shown that fluctuations in rainfall patterns significantly affect crop yields in the region. For instance, research assessing the effect of rainfall variability on maize productivity in Kaduna State found a direct correlation between rainfall patterns and maize yields, indicating that inconsistent rainfall can lead to reduced crop productivity (Abubakar & Usman, 2023). Excessive rainfall, on the other hand, leads to flooding, which can severely disrupt agricultural activities. Flooding damages crops, erodes soil, and makes farmlands inaccessible, reducing the amount of food produced and increasing food insecurity (Yolchi, Wang, Pede, 2024). For agricultural cooperative members, floods also make it more difficult to transport food to markets, reducing access to food and increasing the cost of purchasing food (Obafemi & Njoroge, 2024). Flooding thus affects both the physical availability of food and its accessibility for local populations (Kamau & Diallo, 2024). These disruptions not only diminish food availability but also drive up food prices, further limiting access to adequate nutrition for vulnerable households. Recent studies emphasize that heat waves exacerbate existing inequalities, disproportionately affecting smallholder farmers who lack access to irrigation, modern farming technologies, and financial safety nets, thereby intensifying the risk of hunger and malnutrition (World Bank, 2023; Adeyemi & Okonkwo, 2024).

Objectives of the Study

The main objective of this study is to assess the Influence of Climate Change on Food Security Among Members of Agricultural Cooperative Households in Kaduna state, Nigeria while the specific objectives are to;

1. Determine the extent to which shortage of rainfalls affects food availability among members of agricultural cooperative households in Kaduna State.
2. Evaluate the relationship between excess flood and food accessibility among members of agricultural cooperative households in the study area.

Research Questions

The following research questions were raised to guide the study.

1. How does shortage of rainfall affect food availability among members of agricultural cooperative households in Kaduna State?
2. To what extent does excessive flooding influence food accessibility among members of agricultural cooperative households in the study area?

Research Hypotheses

The following research hypotheses were further raised to guide the study.

H_{o1}: Shortage of rainfall does not significantly affect food availability among members of agricultural cooperative households in Kaduna State.

H_{o2} There is no significant relationship between excessive flooding and food accessibility among members of agricultural cooperative households in the study area.

Literature Review

Climate Change

The United States Global Climate Change Programme (2013) defined climate change as extreme weather reactions that have a negative impact on agricultural resources, water resources, human health, ozone layer depletion, vegetation, and soil, resulting in a doubling of carbon dioxide concentrations in the ecosystem. Intergovernmental Panel on Climate Change (Intergovernmental Panel on Climate Change (IPCC), 2023) in its Sixth Assessment Report (AR6), opined that climate change is defined as "a change in the state of the climate that can be identified (by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period,

typically decades or longer." Climate change refers to changes in the mean variability of the climate that last for decades or more (Lieberman & Gordon et al. 2018). Climate change is defined as a long-term divergence from the climate's mean or fluctuation. The primary source of current climate change is human-caused greenhouse gas emissions (IPCC, 2014). Operationally, climate change refers to measurable and observable long-term shifts in weather patterns and environmental conditions that directly affect agricultural productivity in Kaduna State.

Food Security

The Food and Agriculture Organization (FAO) (2019) describe food security as a situation where all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Berry et al. (2015), state that food security is achieved when individuals have consistent access to adequate and appropriate food resources necessary for a healthy and active lifestyle.The United States Department of Agriculture (USDA, 2024) defined food security as access by all people at all times to enough food for an active, healthy life. This includes the ready availability of nutritionally adequate and safe foods and the assured ability to acquire acceptable foods in socially acceptable ways.In the context of this study, food security can be operationally defined as the consistent ability of all household members to access and utilize, sufficient, safe, and nutritious food that meets their dietary needs and cultural preferences, ensuring an active and healthy lifestyle.

Members of Agricultural Cooperative Households

Agricultural cooperatives play a crucial role in enhancing food production, improving farmers' livelihoods, and promoting economic stability within rural communities. These cooperatives are formed by farmers who come together to pool resources, share knowledge, and collectively market their produce (FAO, 2020). As noted by Birchall (2018), members of agricultural cooperative households are individuals or families who voluntarily join cooperatives to collectively enhance agricultural productivity, access markets, and improve food security. These members pool resources, share risks, and adopt cooperative principles to achieve mutual economic benefits while sustaining rural livelihoods.Wanyama (2020) define members of agricultural cooperative household as smallholder farmers, rural agribusiness owners, or agricultural workers who form agricultural cooperative to leverage collective bargaining power, receive technical training, and access credit and input supplies. These members rely on cooperative structures to enhance resilience against economic and environmental challenges, including climate change.

Shortage of Rainfall and Food Availability

Rainfall shortage refers to prolonged periods of below-average precipitation that reduce soil moisture and water availability for agricultural production (Oladipo, 2017; FAO, 2020). It may occur through delayed rainfall onset, early cessation, or prolonged dry spells, all of which negatively affect crop productivity and farmers' livelihoods (Musa & Adebayo, 2019). Food availability refers to the physical presence and quantity of food produced and supplied through farms and markets (WFP, 2021). In Kaduna State, where maize, millet, sorghum, and rice are major staples, inadequate rainfall can reduce crop yields and consequently food supplies. Thus, persistent rainfall shortages pose a significant threat to food availability among agricultural households by reducing agricultural productivity and limiting the supply of staple foods.

Excess Flooding and Food Accessibility

Flooding and food accessibility are deeply interconnected. In Nigeria, the Nigeria Hydrological Services Agency (2015) identified ten flood-prone states, with significant impacts on food production and distribution. The 2012 Lagdo Dam release caused widespread agricultural damage in states such as Kogi and Bayelsa (NEMA, 2012). In 2022, over 600 people died and 1.4 million were displaced due to similar flooding, affecting 110,000 hectares of farmland (Wikipedia, 2022). In 2024, flooding in northeastern Nigeria claimed 49 lives, displaced over 41,000 people, and destroyed nearly 700 hectares of farmland (Reuters, 2024). Short-term effects include crop destruction and transport disruption, leading to shortages and price hikes (NEMA, 2024; Okoruwa, 2018). Long-term consequences involve soil fertility loss, labor shortages due to displacement, and declining productivity (Doocy et al., 2023). Environmental mismanagement, such as poor drainage and deforestation, worsens flooding risks, while prolonged floodwaters heighten health crises, further impairing food access (Mitiku, 2019; UNISDR, 2015).

Theoretical Framework

The study is grounded on the social-ecological systems theory, the Social-Ecological Systems (SES) theory, developed by Elinor Ostrom in 2007, offers a robust framework for understanding the complex and interdependent relationships between human societies and the ecosystems they depend on. It emphasizes that social systems comprising human communities, institutions, and economies and ecological systems consisting of natural resources and environmental processes are inherently interconnected. Changes in one system often produce cascading effects in the other. This interconnectedness means that challenges such as climate change cannot be effectively addressed without considering both social and ecological dimensions

together.

In the context of this study, which examines the influence of climate change on food security among members of agricultural cooperative households in Kaduna State, the SES framework provides critical insights. For instance, climatic stressors such as reduced rainfall, excessive flooding, heatwaves, and windstorms directly affect agricultural ecosystems by disrupting crop growth cycles, degrading soil quality, and reducing water availability. These ecological impacts, in turn, influence social outcomes by reducing agricultural productivity, straining cooperative resources, and threatening household food security.

Empirical Review

Adokwe, Ezeanyeji, Obi, Ugwunna, and Oguanobi (2025) conducted a study titled "The Impact of Climate Change on Food Security in Nigeria" using quarterly data from 1986Q1 to 2023Q4. The population comprised all macroeconomic indicators related to food security in Nigeria, while the sample size involved time-series data across decades. The Robust Least Squares (RLS) technique was employed to analyze secondary data collected from the National Bureau of Statistics (NBS), CBN, Transparency International, and the World Development Indicators. Statistically, the coefficient of climate change on food security was -2.8086 with a p-value of 0.0098, confirming a significant negative effect. Population growth and poor governance also had statistically significant negative impacts, while agricultural infrastructure showed a positive impact with a coefficient of 0.0053 and a p-value of 0.0000. This study aligns with the current project by demonstrating how macro-level climate and policy variables jointly affect food security within agricultural communities.

Ezekwe, Humphrey, and Esther (2025) conducted a comprehensive empirical study titled "Climate Change and Food Security in Nigeria: Implications for Staple Crop Production". The research aimed to investigate the influence of carbon dioxide emissions, temperature, rainfall, and methane emissions on food crop production between 1990 and 2023. Time series data were obtained from reputable sources, including the Central Bank of Nigeria (CBN) Statistical Bulletin, World Bank, and FAO statistics. Data analysis employed descriptive statistics and econometric techniques such as the Augmented Dickey-Fuller (ADF) unit root test, bounds cointegration test, and least squares regression. Findings showed a statistically significant positive impact of carbon dioxide emissions and rainfall on crop production at the 5% significance level. Conversely, temperature variations had a negative but statistically insignificant impact in the long run. Methane emissions also positively influenced crop production. This study is relevant to the present research topic as it highlights key climatic variables affecting food security in cooperative households over time.

Marafa (2025) examined the relationship between climate change and food inflation in a study titled "Climate Change and Food Price Inflation: Evidence from Nigeria." The population for this study included national food price trends across Nigerian states. Using the Auto-Regressive Distributed Lag (ARDL) model, the study analyzed the effects of precipitation anomalies on food price inflation. The findings showed that a 1% increase in precipitation anomaly led to a 0.58% increase in food inflation in the short run and a 0.11% increase in the long run. These results are statistically significant and highlight the inflationary pressures induced by climate variations. This empirical work supports the current research topic by demonstrating how climate anomalies directly influence food accessibility through price instability particularly relevant to vulnerable agricultural cooperative households.

Anthony and Dumbiri (2024), along with Ahile, Tyozua, Iorfa, and Uyeh (2024), independently studied the impacts of flooding on food security across Nigeria's coastal and central regions. Anthony and Dumbiri's study titled "Empirical Analysis of Flood Impact on Food Security in Nigeria's Coastal Regions" used a sample of 120 households and employed Multiple Regression Analysis (MRA) and Geographically Weighted Regression (GWR). Their results revealed a strong statistical relationship between flood exposure and food insecurity ($R^2 = 0.68$, $p < 0.01$), with low-income and poorly adaptive households facing the worst outcomes. Meanwhile, Ahile et al. focused on Benue State, using a sample size of 100 farmers and applying descriptive statistics to quantify losses. Their findings indicated that 65% of respondents lost over half of their crop yield due to seasonal flooding. These findings are highly applicable to the ongoing research, as cooperative households often located in similar rural areas require targeted, resilient food security planning in the face of climate volatility.

Biluaminu and Bilikisu (2024) conducted an empirical investigation on the effect of climate change on food security in Adamawa State, focusing on 19 out of the 21 local government areas in the state. The study population consisted of farmer heads and agricultural product wholesalers, with a sample size of 35 respondents selected through a random sampling technique. Data were collected using copies of structured questionnaire, and the analysis was carried out using the Structural Equation Model (SEM). The results indicated that climate change had a significant pass-through effect on the three pillars of food security: availability, accessibility, and utilization. The findings showed that climate change had the strongest effect on food stability, with a path coefficient of 0.78 ($p < 0.05$), leading to decreased nutritional well-being among respondents. The study concluded that government intervention and adaptation measures were critical for mitigating these adverse effects. This study is methodologically robust, and its focus on food stability within agricultural cooperatives aligns with the current research, which seeks to understand the challenges faced by cooperative households in maintaining food security.

Methodology

This study used a descriptive survey design to examine how climate change affects food security among members of agricultural cooperative households in Kaduna State. The study covered four agricultural zones in Kaduna State and focused on 84 registered agricultural cooperatives with a total estimated membership of 1,638. Using Taro Yamane's formula (error limit $e = 0.05$), a sample size of 321 respondents was obtained through a multistage sampling technique involving stratification by zones, random selection of cooperatives, and systematic selection of households. Data were collected with structured questionnaires on a 5-point Likert scale covering demographic information and four objective-based clusters (rainfall shortage, excess flooding, weather change, and migration/food stability). The instrument was validated by expert review and tested through a pilot study, with reliability confirmed using Cronbach's Alpha (0.84). Data analysis involved descriptive statistics and OLS regression in SPSS version 23, testing hypotheses at the 5% significance level ($p \leq 0.05$).

Analysis of Research Questions

Research Question 1: How does a shortage of rainfall affect food availability among members of agricultural cooperative households in Kaduna State?

Descriptive Analysis

Analysis of Objective One

Table 1: Descriptive Statistics

	Mean	Std. Deviation	N
Food Availability	14.8089	5.19908	314
Shortage Rainfall Reduced Quantity Food Harvested	3.7643	1.29950	314
Irregular Rainfall Leads Low Productivity Coop Farms	3.7134	1.30397	314
Livelihoods Negatively Affected by Lack of Rainfall	3.6688	1.30072	314
Increase in Hunger due to Rainfall Shortages	3.7643	1.28962	314
Mean Score	3.73	1.30	

Source: Spss version, 26.

Table 1 presents the descriptive statistics on food availability and the impact of rainfall shortages on food production and livelihoods. The mean score for overall food

availability is 14.81, with a relatively high standard deviation of 5.20, indicating some variation in respondents' experiences of food access. The rainfall-related indicators show mean scores ranging from 3.67 to 3.76, with a combined mean of 3.73 and an average standard deviation of 1.30, suggesting that respondents generally agree that irregular and insufficient rainfall negatively affects food quantity, farm productivity, livelihoods, and increases hunger, while responses exhibit moderate variability. Therefore, the data indicate that rainfall shortages are a significant factor influencing food security and livelihood outcomes among the respondents.

Regression Analyses

Analysis of Objective One

Table 2: Correlations

		FoodAvailability	ShortageRainfallReducedQuantityFoodHarvested	IrregularRainfallLeadsLowProductivityCoopFarms	LivelihoodsNegativelyAffectedbyLackofRainfall	IncreaseinHungerduetoRainfallShortages
Pearson Correlation	FoodAvailability	1.000	-.988	-.991	-.990	-.987
	ShortageRainfallReducedQuantityFoodHarvested	-.988	1.000	.986	.974	.996
	IrregularRainfallLeadsLowProductivityCoopFarms	-.991	.986	1.000	.987	.986
	LivelihoodsNegativelyAffectedbyLackofRainfall	-.990	.974	.987	1.000	.974
	IncreaseinHungerduetoRainfallShortages	-.987	.996	.986	.974	1.000
Sig. (1-tailed)	FoodAvailability	.	.000	.000	.000	.000
	ShortageRainfallReducedQuantityFoodHarvested	.000	.	.000	.000	.000
	IrregularRainfallLeadsLowProductivityCoopFarms	.000	.000	.	.000	.000

	LivelihoodsNegativelyAffectedbyLackofRainfall	.000	.000	.000	.	.000
	IncreaseinHungerduetoRainfallShortages	.000	.000	.000	.000	.
N	FoodAvailability	314	314	314	314	314
	ShortageRainfallReducedQuantityFoodHarvested	314	314	314	314	314
	IrregularRainfallLeadsLowProductivityCoopFarms	314	314	314	314	314
	LivelihoodsNegativelyAffectedbyLackofRainfall	314	314	314	314	314
	IncreaseinHungerduetoRainfallShortages	314	314	314	314	314

Source: Spss version, 26.

Table 2 shows the correlation coefficients between food availability and indicators of rainfall shortage among members of agricultural cooperative households in Kaduna State. The results reveal very strong negative correlations between food availability and all rainfall-related variables: shortage of rainfall reducing food quantity harvested ($r = -.988$, $p < .001$), irregular rainfall leading to low productivity on cooperative farms ($r = -.991$, $p < .001$), livelihoods negatively affected by lack of rainfall ($r = -.990$, $p < .001$), and increase in hunger due to rainfall shortages ($r = -.987$, $p < .001$). All correlations are statistically significant at the 0.01 level, indicating that as rainfall shortages, irregular rainfall, and related challenges increase, food availability significantly decreases among cooperative households. The consistently high correlation values suggest a strong and direct relationship between rainfall scarcity and reduced food production and access in the study area.

Research Question 2: How does excessive flooding influence food accessibility among members of agricultural cooperative households in the study area?

Table 3: Descriptive Statistics

	Mean	Std. Deviation	N
FoodAccessibility	14.9522	5.15705	314
ExcessFloodingAffectsTransportationFoodtomarkets	3.7898	1.29896	314
FloodingLimitsFarmersAccesstoFarms	3.7580	1.28596	314
FoodPricesIncreaseDueDistributionDelaysCausedFlooding	3.7197	1.31268	314
HouseholdsUnabletoSupplyFoodonTimeDuetoFloods	3.7357	1.31962	314
Mean Score	3.77	1.30	

Source: Spss version, 26.

Table 3 presents the descriptive statistics on the effect of excessive flooding on food accessibility among members of agricultural cooperative households in Kaduna State. The overall mean score for food accessibility (M = 14.95, SD = 5.16) suggests a moderate level of access to food among respondents. The specific indicators—flooding affecting food transportation to markets (M = 3.79, SD = 1.30), flooding limiting farmers' access to farms (M = 3.76, SD = 1.29), increased food prices due to distribution delays (M = 3.72, SD = 1.31), and households unable to supply food on time due to floods (M = 3.74, SD = 1.32) all recorded mean values above the midpoint of 3.00 on a 5-point Likert scale. This implies that respondents generally agreed that excessive flooding negatively influences food accessibility through transportation challenges, restricted farm access, delayed distribution, and increased food costs. The relatively close standard deviation values also indicate consistent responses among participants.

Analysis of Objective Two

Regression

Table 4: Correlations

		FoodAccessibility	ExcessFloodingAffectsTransportationFoodtomarkets	FloodingLimitsFarmersAccesstoFarms	FoodPricesIncreaseDueDistributionDelaysCausedFlooding	HouseholdsUnabletoSupplyFoodonTimeDuetoFloods
Pearson Correlation	FoodAccessibility	1.000	-.987	-.995	-.993	-.994
	ExcessFloodingAffectsTransportationFoodtomarkets	-.987	1.000	.987	.981	.985
	FloodingLimitsFarmersAccesstoFarms	-.995	.987	1.000	.989	.990
	FoodPricesIncreaseDueDistributionDelaysCausedFlooding	-.993	.981	.989	1.000	.994
	HouseholdsUnabletoSupplyFoodonTimeDuetoFloods	-.994	.985	.990	.994	1.000
Sig. (1-tailed)	FoodAccessibility	.	.000	.000	.000	.000
	ExcessFloodingAffectsTransportationFoodtomarkets	.000	.	.000	.000	.000
	FloodingLimitsFarmersAccesstoFarms	.000	.000	.	.000	.000
	FoodPricesIncreaseDueDistributionDelaysCausedFlooding	.000	.000	.000	.	.000
	HouseholdsUnabletoSupplyFoodonTimeDuetoFloods	.000	.000	.000	.000	.
N	FoodAccessibility	314	314	314	314	314

	ExcessFloodingAffectsTransportationFoodtomarkets	314	314	314	314	314
	FloodingLimitsFarmersAccesstoFarms	314	314	314	314	314
	FoodPricesIncreaseDueDistributionDelaysCausedFlooding	314	314	314	314	314
	HouseholdsUnabletoSupplyFoodonTimeDuetoFloods	314	314	314	314	314

Source: Spss version, 26.

The correlation matrix in Table 4 reveals a very strong and positive relationship among all the variables examined. Specifically, food accessibility shows high correlations with all flood-related factors excess flooding affects transportation of food to markets (r = -.987), flooding limits farmers' access to farms (r = - .995), food prices increase due to distribution delays caused by flooding (r = -.993), and households unable to supply food on time due to floods (r = -.994). These values, all above 0.98, indicate that as flooding intensifies and disrupts transportation and farming activities, food accessibility declines sharply. The significance values ($p < .001$) across all relationships confirm that these correlations are statistically significant.

Test of Hypotheses

Hypothesis One

H_{o1}: A shortage of rainfall does not significantly affect food availability among members of agricultural cooperative households in Kaduna State.

H_{i1}: A shortage of rainfall significantly affects food availability among members of agricultural cooperative households in Kaduna State.

Table 5: ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	8391.683	4	2097.921	9415.212	.000[b]
	Residual	68.852	309	.223		
	Total	8460.535	313			

a. Dependent Variable: FoodAvailability

b. Predictors: (Constant), IncreaseinHungerduetoRainfallShortages, LivelihoodsNegativelyAffectedbyLackofRainfall, IrregularRainfallLeadsLowProductivityCoopFarms, ShortageRainfallReducedQuantityFoodHarvested

Source: Spss version, 26.

Table 5 presents the ANOVA results assessing the overall significance of the regression model examining the effect of rainfall shortage variables on food availability among agricultural cooperative households in Kaduna State. The table shows a regression sum of squares of 8391.683 and a residual sum of squares of 68.852, indicating that most of the variation in food availability is explained by the predictors. The F-value of 9415.212 with 4 and 309 degrees of freedom is highly significant at p = .000, which is less than the 0.05 level of significance. This demonstrates that the combined predictors shortage of rainfall reducing food quantity harvested, irregular rainfall leading to low productivity, livelihoods negatively affected by lack of rainfall, and increase in hunger due to rainfall shortages jointly have a statistically significant effect on food availability in the study area.

Hypothesis Two

H_{o2} There is no significant relationship between excessive flooding and food accessibility among members of agricultural cooperative households in the study area.

H_{i2}: There is a significant relationship between excessive flooding and food accessibility among members of agricultural cooperative households in the study area.

Table 6: ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	8281.869	4	2070.467	15083.726	.000[b]
	Residual	42.415	309	.137		
	Total	8324.283	313			

a. Dependent Variable: FoodAccessibility

b. Predictors: (Constant), HouseholdsUnabletoSupplyFoodonTimeDuetoFloods, ExcessFloodingAffectsTransportationFoodtomarkets, FloodingLimitsFarmersAccesstoFarms, FoodPricesIncreaseDueDistributionDelaysCausedFlooding

Source: Spss version, 26.

The ANOVA table (Table 6) shows that the regression model is statistically significant in explaining variations in food accessibility. The regression sum of squares (8281.869) is substantially larger than the residual sum of squares (42.415), indicating that most of the variation in food accessibility is accounted for by the independent variables: excess flooding affecting food transportation, flooding limiting farmers' access to farms, food price increases due to distribution delays, and households' inability to supply food on time. The F-value of 15,083.726 with a p-value of .000 (less than 0.05) confirms that the overall model is highly significant. This means that the predictors jointly have a strong influence on food accessibility, and the changes observed in food accessibility are not due to random chance but are meaningfully explained by the flood-related factors.

Discussion of Findings

The findings of objective one, which examined the effect of rainfall shortage on food availability, reveals that inadequate and irregular rainfall significantly reduces food availability among cooperative households. The findings show that rainfall scarcity leads to low agricultural productivity, reduced harvest volumes, and disruptions to farming livelihoods, thereby increasing the risk of hunger and food shortages. Respondents consistently indicated that insufficient rainfall constrains crop growth and weakens the overall food supply, particularly in areas that rely heavily on rain-fed agriculture such as Kaduna State. The rejection of the null hypothesis confirms that rainfall shortages exert a significant influence on food availability. These findings are consistent with the conclusions of Ezekwe, Humphrey and Esther (2025), who found that average rainfall positively influences food production in both the short and long run, implying that rainfall scarcity undermines staple crop output. Similarly, Oyinbo, Rekwot and Duniya (2018) and Oyakhilomen (2014) reported that rainfall patterns are key determinants of agricultural production in Nigeria, and that deviations from normal rainfall cycles negatively affect food security outcomes. Supporting this evidence, Idumah et al. (2016) demonstrated that variations in rainfall significantly influence agricultural output and food production, particularly in the short run.

For Objective Two, which examined the effect of excessive flooding on food accessibility, the findings reveal that flooding significantly disrupts food transportation systems, restricts farmers' access to farmlands, and leads to increased food prices, thereby reducing overall food accessibility. Flood events were found to weaken food supply chains and constrain both physical and economic access to food, particularly in flood-prone communities. The rejection of the null hypothesis confirms that flooding has a strong and significant effect on food accessibility. These findings are consistent with the studies of Anthony and Dumbiri (2024), Week and Wizor (2020), and Jonathan et al. (2020), who reported that flooding in Nigeria's coastal and flood-prone regions

severely disrupts food distribution, reduce market availability, and worsen food insecurity. Similarly, Ahile et al. (2024) and Ogechukwu and Chuks-Ezekwibe (2024) observed that flood disasters destroy farmlands and food crops, resulting in acute food shortages and restricted access, especially among vulnerable rural households. Collectively, these studies support the present findings that climate-induced flooding undermines food accessibility by damaging infrastructure, disrupting supply chains, and limiting access to food.

Conclusion and Recommendations

This study clearly shows that climate change is seriously affecting food security among agricultural cooperative households in Kaduna State, Nigeria, as key climate hazards such as rainfall shortages, flooding, windstorms, and heat waves were found to negatively impact food availability, accessibility, affordability, and stability. The findings reveal that changes in rainfall patterns, extreme flooding, and rising temperatures are major drivers of food insecurity, often overwhelming the coping and adaptation capacity of agricultural cooperatives despite their role in pooling resources and supporting farmers. As climate shocks become more frequent and severe, the ability of cooperative households to produce, access, and afford food continues to decline. The study therefore highlights the urgent need to strengthen agricultural cooperatives with climate-resilient measures, including climate-smart farming practices, early warning systems, and stronger institutional and policy support, to help smallholder farmers adapt to climate variability, protect livelihoods, and ensure sustainable food security in climate-vulnerable regions of sub-Saharan Africa.

Based on the findings of this study, the following recommendations are made:

1. Government and agricultural cooperatives should invest in irrigation systems, water harvesting technologies, and drought-resistant crop varieties to reduce dependence on erratic rainfall and sustain food production throughout the year.
2. Kaduna State Ministry of Agriculture and Rural Development, the State Ministry of Environment, the Kaduna State Emergency Management Agency (KADSEMA), local government councils, and relevant federal agencies including the National Emergency Management Agency (NEMA) should develop and maintain effective drainage systems, improve rural road networks, and implement community-based flood management programs to ensure that farmlands remain accessible and food distribution is not disrupted during flood events.

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