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ANALYZING THE EFFECT OF CLIMATE SHOCKS ON FOOD INSECURITY IN ADAMAWA STATE, NIGERIA

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Abstract

Food insecurity remains a persistent development challenge in Nigeria, particularly in Adamawa State where agriculture forms the backbone of rural livelihoods and climate shocks increasingly threaten household food security. This study empirically examined the effect of climate shocks on food insecurity in Adamawa State, Nigeria, with particular attention to drought, flooding, rising temperature and altered rainfall patterns. The study adopted a quantitative research design using cross-sectional data collected through structured questionnaires administered to 520 respondents across eight Local Government Areas selected from the four Agricultural Development Programme (ADP) zones of Adamawa State. Data were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM) to examine the relationships among climate shock variables and the four dimensions of food security: food availability, food accessibility, food stability and food utilization. The measurement model demonstrated satisfactory internal consistency and convergent validity, with Cronbach's alpha and composite reliability values exceeding the recommended threshold of 0.70. The structural model revealed that climate shock variables explained 26.8% of the variation in food availability, 23.8% in food accessibility, 51.4% in food stability and 41.5% in food utilization. The hypothesis testing results showed that drought had a significant positive relationship with all four dimensions of food insecurity ($\beta = 0.200, 0.240, 0.460$, and 0.291; $p < 0.01$), while rising temperature also significantly affected food availability, accessibility, stability and utilization ($\beta = 0.275, 0.266, 0.209$, and 0.285; $p < 0.01$). Flooding significantly affected only food utilization ($\beta = 0.123$, $p < 0.05$), while altered rainfall patterns showed no significant effect on any dimension of food insecurity. The study concludes that climate shocks, particularly drought and rising temperature, constitute significant threats to household food security in Adamawa State. The study recommends that government at both federal and state levels prioritize the development of climate-resilient agricultural systems through investment in irrigation infrastructure, water harvesting technologies, and drought-resistant crop varieties to reduce dependence on rain-fed agriculture and enhance household capacity to withstand climate shocks.

Keywords: *Climate shocks, food insecurity, drought, flooding, rising temperature, Adamawa State, PLS-SEM*

1.0 Introduction

Food insecurity remains one of the most persistent development challenges confronting the world, particularly in developing countries where large sections of the population depend directly or indirectly on agriculture for food, income and livelihoods. The problem is becoming more complex as climate change increasingly manifests through climate shocks such as drought, flooding, irregular rainfall and unusually high temperatures. These shocks affect food security not only by reducing agricultural production but also by disrupting markets, damaging productive assets, increasing food prices and weakening household purchasing power. The consequences are particularly severe for rural and poor households whose livelihoods depend heavily on rain-fed agriculture and whose capacity to absorb shocks is limited. Evidence from Nigeria shows that climate-related hazards are already contributing to

the deterioration of food and nutrition security alongside economic hardship and insecurity (FAO, 2024; FAO, 2025).

The relationship between climate shocks and food insecurity operates through several interconnected channels. Drought reduces soil moisture and water availability, shortens growing seasons and lowers crop yields, while excessive rainfall and flooding can destroy crops, farmland, livestock, storage facilities and rural infrastructure. Changes in the timing and distribution of rainfall can also make agricultural planning increasingly difficult for farmers who depend on seasonal rainfall. High temperatures further increase evapotranspiration and crop water requirements and can reduce agricultural productivity. A systematic review of Nigerian evidence found that droughts and floods are increasingly threatening food security, while also identifying a significant underrepresentation of semi-arid northern areas in the existing literature and a shortage of longitudinal evidence (Adewuyi et al., 2024). Thus, climate shocks should not be viewed merely as environmental events; they are economic shocks that can simultaneously affect food availability, food access and household welfare.

The Nigerian situation provides compelling evidence of the seriousness of this problem. The Food and Agriculture Organization (FAO) reported that about 25.1 million Nigerians experienced acute food insecurity between October and December 2024, while the number was projected to rise to 30.6 million during the June August 2025 lean season. Climate hazards, particularly floods, were identified among the major drivers of the worsening food-security situation. The scale of the problem became even more evident following the 2024 floods, which affected more than 9.2 million people and submerged approximately 4.5 million hectares of land, including about 1.6 million hectares of farmland. FAO estimated that potential losses of maize, sorghum and rice in affected areas could reach about 1.1 million tonnes an amount sufficient to feed approximately 13 million people for one year. More recently, FAO reported that northeastern Nigeria, including Adamawa State, continues to face a protracted humanitarian crisis associated with climate shocks, conflict, displacement and economic hardship.

These challenges are particularly important in Adamawa State, where agriculture constitutes a major source of livelihood and where many farming households depend substantially on rainfall. The state's ecological and socioeconomic conditions make households vulnerable to fluctuations in rainfall, drought, flooding and rising temperatures. Evidence from northern Nigeria has long shown that agricultural production is highly exposed to drought and flooding because of dependence on rain-fed farming and widespread rural poverty (Dahiru & Tanko, 2018). Recent evidence from Adamawa provides stronger empirical support for this concern. For example, Audu, Hong and Adamu (2026), using data from 399 households in Hong Local Government Area, found that temperature change, drought frequency, soil degradation and tree-cover loss significantly reduced the probability of household food security. Specifically, temperature change and drought frequency reduced the probability of food security by 15.2 and 11.2 percentage points, respectively. Similarly, Abdussalam and Mbaya (2026), using evidence from farming households in Mubi North, Ganye and Fufore, found that erratic rainfall, more frequent droughts, delayed rainfall onset and rising temperatures substantially affected food-crop production and rural livelihoods. These findings suggest that climate shocks are not abstract future risks in Adamawa State; they are already influencing agricultural production and household welfare.

Despite the growing evidence, food insecurity remains a serious and persistent problem in Adamawa State, and the specific contribution of individual climate shocks to household food insecurity is still inadequately understood. Existing studies have established that climate change negatively affects agricultural production and food security in Adamawa, but much of the available evidence focuses broadly on “climate change” rather than distinguishing the effects of specific shocks such as drought and flooding. For instance, Bilyaminu et al. (2024) investigated climate change and food security across 19 of Adamawa State's 21 Local Government Areas, providing useful state-level evidence, but the study treated climate change largely as a broad phenomenon rather than offering a sufficiently focused assessment of the separate food-security consequences of major shocks. Likewise, the recent study in Hong Local Government Area provides important evidence of the effects of temperature changes and drought, but its geographical concentration limits the extent to which the findings can be generalized to households across Adamawa State. The 2026 study by Abdussalam and Mbaya also examines climate impacts across three LGAs, but its emphasis is on crop production, rural livelihoods and adaptation

rather than directly estimating how climate shocks translate into household food insecurity. Furthermore, a recent review of Nigerian research identifies a broader gap in longitudinal and geographically balanced evidence, particularly for semi-arid northern regions.

Consequently, an important empirical gap remains concerning how drought and flooding, as distinct climate shocks, affect household food insecurity in Adamawa State. Understanding this relationship is important because different shocks may operate through different economic mechanisms and may require different policy responses. A drought-induced crop failure, for example, may primarily reduce production and household income, whereas flooding can simultaneously destroy crops, farmland, roads, houses, storage facilities and market infrastructure. A study that examines these shocks directly can therefore provide more useful evidence for designing targeted agricultural, social-protection and climate-adaptation policies. This study addresses this gap by empirically examining the effect of climate shocks on food insecurity in Adamawa State, Nigeria, with particular attention to the mechanisms through which drought and flooding undermine households' ability to obtain sufficient, stable and nutritious food. The study is therefore positioned to contribute evidence that is both locally relevant and useful for strengthening climate-resilient food-security policy in Adamawa State.

2.0 Literature Review

2.1 Empirical Literature

This section review previous literatures on climate change and food security

Edewor and Ogbe (2026) investigated the relationship between climate change, natural-resource conflicts, insecurity and food security in Nigeria. The study provides particularly recent national evidence relevant to the present research. Unlike the survey-based studies above, it relied primarily on secondary quantitative data, combining the 2018/2019 General Household Survey (LSMS-ISA) with the 2022 National Agricultural Sample Census (NASC). These datasets provided household- and community-level information on climate shocks, disasters, conflict and food-security outcomes. The study used descriptive statistics, Ordinary Least Squares (OLS), Ordered Logit and Ordered Probit models to investigate the determinants of food security. The explanatory variables included climate-related shocks, natural-resource conflicts, insecurity and household characteristics, while food security was the principal dependent variable. The results demonstrated that climate-related shocks and insecurity significantly increased resource conflicts and had strong negative consequences for food security. Importantly, flooding emerged as the most damaging disaster, whereas asset ownership strengthened household resilience. The study provides strong evidence that flooding can undermine food security in Nigeria, but it does not answer whether environmental policies can reduce the adverse effects of flooding and drought at the sub-national level. The present research therefore provides a more geographically focused analysis of Adamawa State, where both drought and flood risks are important, while explicitly incorporating environmental policy as a central explanatory factor.

Bilyaminu *et al.,* (2024) investigate the effect of climate change on food security in Adamawa state, Nigeria. The instrument used for collecting data were questionnaire and interview in 19 local government of Adamawa state were sampled. Structural equation model (SEM) was used to analysis the data. The result shows that the evidence of pass-through effect of climate charge on food security in Adamawa state as food stability, food accessibility and food animation significantly reduce as a result or decrease in arability cause by change in climate. However the study proxy food security by four variables i.e food stability, food accessibility, food availability and food utilization but failed to provide four different model. However the findings is in line with the and study conducted by Adeyimi *et al* (2021), Odjugo (2022) but contrary to the findings of Abu (2024), Abdulrahaman *et al*., (2022).

Chima etal (2023) study consequences of land degradation on hire hood and food security of rural farmers in south-east, Nigeria a comparative analysis. The study adopted purposive and straits sampling techniques in the selection of location and 900 resonating the study used (450) farmers farming on water degraded farm land and 450 farmers farming on non-water degraded farm land both primary and secondary data. Primary data were collected from the selected sample following a field survey which secondary data were collected from textbook, Newsletters from new map ministry of environmental articles and journals from agriculture. The employed descriptive statist or mean frequencies percentages

and paired Z-test was used to achieved the shows the mean annual food expenditure or rural farmers in degraded and non-degraded farm lands were N 273664122 and 290,592.67 respectively. The perceived socio-economic cons equal of water erosion degradation on farm lands were decreased farm income

Jonathan and Emmanuel (2023) examined the impact of climate change on the Nigerian economy using secondary data from 1981 to 2014. The study used OLS and Johansen co- integration and the result indicate that both in the long-run and short-run, carbon emission affect growth adversely in Nigeria. However, the period between 2014 and 2023 is huge which so many economic activities may have occurred within the period which the study did not take into consideration. Also, the study uses a single variable that influence climate change which is not enough to give conclusion. Odjugo (2022) investigated the regional evidences of climate change using Nigeria as a case study. Mean annual air temperature from 30 synoptic stations between 1901 and 2005 were collected from the Nigerian Meteorological Agency, Lagos and, Meteorological Departments in some airports. The data were divided into three climatic periods, namely, 1901-1935, 1936-1970 and 1971-2005 for the purpose of comparison. Time series, correlation, least square range test, ANOVA and isotherm maps were the statistical tools used to analyze the data. Results showed that air temperature is steadily increasing especially from the 1970s. Between 1901-1935 and 1936-1970 climate periods, temperature anomalies were below the 1970-2005 normal, but 22 years out of the 35 years were above the normal between 1971and 2005. The temperature anomalies showed that climate change signal is stronger as from the 1970s; the rate of temperature increase is higher in the semi-arid region than the coastal areas of Nigeria. The current available pieces of evidence show that Nigeria, like most parts of the world, is experiencing the basic features of climate change.

Abdulrahman and Suleiman (2022) examined climate change impacts on crop yields in Adamawa State using panel data from selected LGAs. Secondary panel data were obtained from the Nigeria meteorological Agency (NiMet) for climate variables (temperature and rainfall) and from the Adamawa State Agricultural Development Programme (ADADP) and National Bureau of Statistics (NBS) for crop yield data across selected Local Government Areas. The data were analyzed using panel econometric techniques, specifically Fixed Effects and Random Effects models, while the Hausman test was employed to determine the most appropriate estimator. The result shows that rising temperatures and erratic rainfall patterns negatively affect maize and sorghum output. Although the study focused on Adamawa, but failed to analyze food insecurity outcomes, limiting its practical policy relevance

2.2 Gap in the Literature

Previous studies have largely concentrated on the direct effects of climate variability on agricultural production, crop yields and household food security. For example, studies on Nigeria have demonstrated that climate change negatively affects food and human security, while evidence from Adamawa State indicates that temperature changes, drought and other environmental pressures reduce household food-security outcomes (Ani et al., 2022; Audu et al., 2026). Similarly, the IPCC (2022) observes that climate change affects African food systems not only through agricultural production but also through food processing, storage, distribution and consumption. However, much of the empirical literature remains heavily focused on the he production dimension of food security rather than examining the four interrelated dimensions of food availability, accessibility, utilization and stability. Second gap concerns the limited attention to environmental policies as an intervening mechanism between climate change and food insecurity. Existing studies have examined climate adaptation strategies and agricultural policies, with evidence suggesting that adaptation can improve household food security (Ogunpaimo et al., 2021). A third gap is methodological**.** Existing Nigerian studies have employed case-study approaches, regression models, time-series techniques and adaptation-impact models to investigate climate change and food security (Ani et al., 2022; Ogunpaimo et al., 2021). However, relatively little attention has been given to modelling the simultaneous relationships among multiple climate-risk indicators, environmental policies and the different dimensions of food insecurity using Structural Equation Modelling (SEM). This is important because climate change is multidimensional, while food insecurity is also multidimensional. The use of SEM can therefore provide a more integrated assessment of the relationships among drought, flooding, rising temperature, altered rainfall, environmental policies and food availability, accessibility, utilization and stability

2.3 Theoretical Framework

This study is anchored on externality theory

The Externality Theory, rooted in welfare economics and advanced by Arthur CecilPigou, explains how economic activities can impose costs or benefits on third parties that are not reflected in market prices (Pigou, 1920). Environmental degradation such as deforestation, pollution, and greenhouse gas emissions is a classic example of a negative externality. Farmers or industries may exploit natural resources without bearing the full social cost, leading to overuse and environmental harm. Climate change itself can be viewed as a global externality, where emissions from one region affect weather patterns and agricultural productivity elsewhere. In the absence of intervention, markets fail to allocate resources efficiently due to these externalities. This justifies the need for government policies, such as environmental regulations, carbon taxes, and conservation programs, to internalize these external costs. In Nigeria, environmental policies aimed at land management, afforestation, and climate mitigation are essential to reduce degradation and protect agricultural productivity. Relating this to food insecurity, environmental degradation reduces soil fertility and crop yields, thereby limiting food availability and increasing vulnerability among farming households. Therefore, Externality Theory provides a strong theoretical basis for examining why environmental policies are necessary to address climate induced food insecurity.

3.0 Methodology

3.1 Research Design

This study adopts quantitative research design, using cross-sectional data quantitative approaches to explore the intricate relationships between climate shocks and food insecurity in Adamawa State, Nigeria. The design is chosen to ensure a well-rounded understanding of the problem, as it allows the research to capture measurable data deeper, more personal insights. This approach allows the study to provide concrete evidence about the scale and scope of the issue, which is essential for informing policy and practical interventions (Neuman, 2023).

3.2 Sources of Data

This study sources data from field survey, the primary data is source through the use of structured questionnaire administered to the responders (farmers*/* households) in selected LGAs of Adamawa State which covers food insecurity proxy by four dimensions (food availability, food accessibility, food utilization and food stability), climate change proxy by temperature, altered rainfall, drought, flood and construct of environmental policies.

3.3 Methods of Data Collection

Surveys: Structured questionnaires is collected to analyses quantitative the data on climate change, environmental policies and food insecurity. The questionnaire include Likert scale questions, multiple-choice questions, and demographic information distributed to 8 local government of Adamawa State.

3.4 Population of the study

The population of the study comprises the entire population in the 21 local government areas of Adamawa state. The population of Adamawa State is 3,737,223 based on census 2006, this aims to capture a comprehensive picture of the challenges faced by the people of Adamawa State, especially in terms of how climate change, food security and environmental policies.

3.5 Sampling Technique

Adamawa State has been divided into four zones known as Agricultural Development Programs (ADP) Zones, namely; Zones I, II, III and IV (Table 3.1). They have agricultural activities practiced that are both common and specific.

Table 3.1 Adamawa State Agricultural Development Program (ADP) Zones

Zones	Local Government Area
Zone 1	Mubi North, Mubi South, Maiha, Madagali and Micika
Zone 2	Gombi, Hong, Song, and Girei

Zones	Local Government Area
Zone 3	Fufore, Yola North, Yola South, Mayo Belwa, Jada, Ganye and Toungo
Zone 4	Guyuk, Shelleng, Lamurde, Numan and Demsa

Source: Adamawa State Agricultural Development Program (ADP)

This study use multistage sampling technique in the selection of the local government. The first stage involved purposive sampling in selection of local government that is affected by temperature and altered rainfall from the zones, see page 90 while the second stage involve using random sampling to select two local government from each zones which is 8 local government that is selected from 21 local government of Adamawa State. This would help the study in terms of measuring the relationship among climate change, environmental policies and food insecurity in Adamawa state.

3.6 Sample Size

To determine the sample size of this study Taro Yamane (1967) method was adopted.
This formula used for the calculation of the sample size for this study.
95% confidence level and ×level of maximum variability (P= 0.5) are assumed.
The formula is given by;
$n=N/1 + (Ne^2)$

$$n= \frac{N}{1 + (Ne\,2)}$$

Where
n= is the sample size,
N = the population size, and
e = the level of precision (allowable error) that is 5% or 0.05. Thus, using the total population of the study; N = 3,737,223 e = 5% = 0.05.

$$n= \frac{3{,}737{,}223}{1 + (3{,}737{,}223 \times 0.0025)}$$

n=400
In order to have large sample size 30 percent is added to have more responses and improve the efficiency of the technic.
Therefore, the sample size was determined to be 520 by purposive sampling and 8 out of 21 local government is selected in terms of temperature and rainfall see page 91.

3.7 Model Specification

The Structural Equation Model (SEM)

This study adopt Structural Equation Model (SEM) is a multivariate statistical technique that use to analyze the magnitude of the structural relationship, SEM constitute of two components; confirmatory factor analysis; this is to evaluate the latent psychological traits, like attitude and satisfaction (Galton 1888; Pearson and Lee 1903; Spearman 1904). While Path analysis evaluate biometrics which aimed to discover the causal relationship among multiple variables using Adanco or Amos diagram (Wright 1918, 1920, 1921). SEM was adopted by Biliyaminu (2024) to investing in Adamawa state, Nigeria. The model is adopted to achieve objective one (1- 4) as:

$Y_i^* = \beta 1 X_i + \varepsilon y_i^*$ …… (3.1)

The Structural Equation Model (SEM) can therefore be expressed further as:

$X_i = \beta_1 Y_i + \beta_2 X_{i2} + \varepsilon x_i$ ..... …. (3.2)

Therefore, Y is food insecurity and is proxy by (food availability, food accessibility, food utilization and food stability) while X is drought, rising temperature, flooding, altered rainfall pattern and environmental policies.
Where:
Y* = output (Endogenous/dependent variables Y at thesamae time is exogenous variable), which include, FA, FACC, FU, FS
X* = (inputs: Exogenous/independent variables X_1 is al Endogenous variable as you see above.) which is CCh

$\beta^* = \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$, (parameter estimates)
$\varepsilon^* = \varepsilon$, …… (Error Terms)
Where;
FA = food availability
FACC = food accessibility
FU= food utilization
FS= food stability
X* = (i.e. inputs: Exogenous/independent variables X_1) which in DR, RT, FL, ARP and EPL
Where;
DR = drought
RT= rising temperature
FL= flooding
ARP= altered rainfall pattern

Table 3.2 Measurement of Variable

Variable	Definition	Measurement
Temperature	Hotness or coldness of a given region	Average annual temperature in degrees celcius
Rainfall	Amount of rain realized over a given period of time	Average annual rainfall received in millilitres
Drought	Prolonged period of abnormal dry weather	Precipitation index
Flood	Over flow of water that submerges land and dry area	Depth(height in feed or meter) flow volume per second
Environmental Policies	Law adopted by government minimize humanity ecological foot print	Policy stringency indixes, knowledge or level of education

Source: Developed by the author

3.8 Techniques of Analysis

The Structural Equation Model (SEM)

This study adopt Structural Equation Model (SEM) is a multivariate statistical technique that used to analyze the magnitude of the structural relationship, SEM constitute of two components; confirmatory factor analysis; this is to evaluate the latent psychological traits, like attitude and satisfaction (Galton 1888; Pearson and Lee 1903; Spearman 1904). While Path analysis evaluate biometrics which aimed to discover the causal relationship among multiple variables using Smart-PLS, Adanco or Amos diagram (Wright 1918, 1920, 1921).

Correlation matrix

Correlation matrix was used to determine the relationship between climate change and environmental on food insecurity in Adamawa State. Were food insecurity is proxy by (food availability, food accessibility, food utilization and food stability while climate change is proxy by (Drought, temperature, flood, and altered rainfall pattern

Structural Model Assessment for Climate Change and Food Insecurity

4.1 Correlation Analysis

Table 4.1: Mean, Standard Deviation and Correlation Matrix

Construct									Mean	SD
1 ARP	1.000								0.000	1.000
2 DR	0.644	1.000							-0.000	1.000
3 FA	0.424	0.449	1.000						-0.000	1.000
4 FACC	0.391	0.435	0.700	1.000					-0.000	1.000
5 FL	0.701	0.679	0.424	0.377	1.000				0.000	1.000
6 FS	0.570	0.681	0.583	0.637	0.567	1.000			0.000	1.000
7 FU	0.518	0.577	0.645	0.683	0.541	0.700	1.000		0.000	1.000
8 RT	0.754	0.644	0.481	0.449	0.700	0.602	0.581	1.000	-0.000	1.000

The correlation results are presented in Table 7. The outcome revealed a moderate positive inter-relationship among the constructs, signifying significant correlations between the dependent and independent variables. This result indicates that drought is an important predictor of food availability, accessibility, utilization and stability in Adamawa State. Thus, there is no problem of serial correlation between and among the construct for drought and food security since all the correlation values are less than 0.8. In addition, the constructs exhibited a positive and negative mean values with a perfect standard deviation of 1.000, indicating that the data have been standardized

4.2 Assessment of Structural (Inner) Model

Subsequent to full evaluation of the measurement model (outer model), the study examined collinearity within the structural model. The collinearity procedure comprises investigation of crucial model parameters like the coefficient of determination (R^2squared and Adjusted R-squared), effect size (f-squared), collinearity diagnostic variance inflation factor (VIF), and model fit criteria. From table 10 The R-squared values show the model's explanatory power for the dependent variable constructs. Food availability, accessibility, stability and utilization achieved R-square values of 0.268, 0.238, 0.514, and 0.415, repetitively. These values suggest substantial explanatory power except for food accessibility is moderate in line with the Cohen (1989) benchmark. The findings revealed that the exogenous construct (climate change measures) account for a considerable proportion of variation in FA, FACC, FS and FU. Precisely, the high R-square value for FA, FS and FU indicates that climate change constructs jointly explain a substantial variation in food insecurity.

In addition, the effective size (f-square) statistics was also conducted to ascertain the relative contribution of each explanatory constructs within the structural model. Inline with the benchmark provided by Cohen (1989) procedures (0.02 = small, 0.15 = medium, 0.35 = large), climate change constructs exert a weak and medium effect on food insecurity constructs. Moreso, the collinearity test further reenforced structural model stability because the Inner VIF values ranges between 2.147 and 2.785 and for the most part remain below the Hair Jr et al. (2021) benchmark. This outcome suggests that there is no multicollinearity in the structural relationships and that parameter coefficients are statistically stable. Lastly, model fit was conducted using the standardized root mean square residual (SRMR), Chi-square and the Normed Fit Index (NFI). The values of these tests suggest that the structural model exhibits satisfactory fit within a variance-based framework.

Table 4.2: Construct Validity and Reliability

Constructs	Items	F.L.	CA	CR	AVE
Food Availability (DV1)	**FA1:** Climate change has reduced the amount of food produced in my community	0.682	0.804	0.849	0.488
	FA2: Weather changes affect the availability of major staple crops	0.706			
	FA3: Farmers cannot produce enough food to meet local needs	0.677			
	FA4: Seasonal changes make food supply unpredictable	0.666			
	FA5: Erratic rainfall reduces crop yield	0.769			
	FA6: Food availability has become less reliable over time	0.688			
Food Accessibility (DV2)	**FACC1:** Climate change has contributed to rising food prices	0.632	0.828	0.827	0.538
	FACC2: Extreme weather limits access to food markets	0.766			
	FACC3: Flooding disrupts the movement of food to markets	0.760			
	FACC4: Road conditions worsen food access during bad weather	0.746			
	FACC5: Climate events make food less affordable	0.757			
	FACC6: Farmers face difficulty transporting produce due to climate impacts	0.734			
Food Utilization (DV3)	**FU1:** Climate affects the nutritional quality of food	0.617	0.766	0.775	0.455
	FU2: Irregular supply disrupts household meal planning	0.599			

Constructs	Items	F.L.	CA	CR	AVE
	FU3: High temperatures increase food spoilage	0.709			
	FU4: Weather conditions affect safe food storage	0.734			
	FU5: Climate impacts force households to change diets	0.712			
	FU6: Dry seasons reduce access to fresh and nutritious foods	0.617			
Food Stability (DV4)	**FS1:** Climate change causes instability in food supply	0.705	0.837	0.838	0.551
	FS2: My community experiences food shortages due to weather changes	0.751			
	FS3: Droughts, floods, and heat waves reduce food stability	0.704			
	FS4: Seasonal food production has become unpredictable	0.757			
	FS5: Long dry spells cause unstable household food supply	0.764			
	FS6: Climate-related shocks increase long-term food insecurity	0.770			

Table 8: Continued

Constructs	Items	F.L.	CA	CR	AVE
Drought (IV1)	**DR1:** Drought reduces crop production	0.649	0.825	0.829	0.534
	DR2: Water scarcity affects farming practices	0.756			
	DR3: Drought occurs more frequently now	0.773			
	DR4: Food supply reduces during drought	0.733			
	DR5: Drought increases food prices	0.753			
	DR6: Farmers struggle to irrigate crops during drought	0.715			
Flooding (IV2)	**FL1:** Flooding destroys crops and farmlands	0.687	0.823	0.823	0.531
	FL2: Floods have become more frequent	0.733			
	FL3: Flooding disrupts access to markets	0.705			
	FL4: Stored food is damaged during flooding	0.762			
	FL5: Flooding causes food scarcity	0.748			
	FL6: Floods disrupt planting and harvest cycles	0.731			
Rising Temperature (IV3)	**RT1:** High temperatures reduce crop yields	0.726	0.838	0.841	0.553
	RT2: Heat affects livestock health	0.735			
	RT3: Farming has become more difficult due to heat	0.748			
	RT4: Increased heat reduces soil moisture	0.727			
	RT5: Some crops fail due to excessive heat	0.799			
	RT6: Rising temperature increases evaporation from soil	0.726			
Altered Rainfall Patterns (IV4)	**ARP1:** Rainfall is now highly unpredictable	0.671	0.812	0.814	0.516
	ARP2: Irregular rainfall disrupts planting schedules	0.716			
	ARP3: Heavy rainfall damages crops	0.733			
	ARP4: Early/late rainfall disrupts farming decisions	0.704			
	ARP5: Changed rainfall patterns reduce productivity	0.757			
	ARP6: Farmers are unsure when to plant due to rainfall variations	0.728			

Note(s): F.L =factor loadings; CA = Cronbach's alpha; CR = Composite reliability; AVE = Average variance extracted

The measurement model was done to ensure the reliability and validity of all reflective construct as proposed by Hair et al. (2021). Internal consistency reliability was estimated using the Cronbach Alpha (CA) and composite reliability (CR). As shown in Fig. 6 and Table 8 all CA and CR values surpassed the recommended threshold of 0.70, signifying strong internal consistency and stable measurement of the construct. Convergence validity was examined using the indicator loadings and Average Variance Extracted (AVE). Consistent with the criteria of Hulland (1999) and Hair Jr et al. (2021), indicator loadings should greater than or equal to 0.40 (preferably greater than 0.70) and AVE values greater than 0.50. The result presented in Figure 1 revealed that all items loaded significantly on their corresponding constructs, with outer loadings above 0.40, indicating a good indicator reliability. Also, all the AVE values surpassed the 0.50 threshold, affirming that each construct explains more than half of the variance in its indicator. Jointly, the outcome confirms that the measurement model exhibits robust internal consistent reliability and moderate convergent validity, meeting the suggested standard for a reflective measurement evaluation in PLS-SEM. This outcome is in line with result obtain from Akintunde et al (2020), Abdulrahman & Suleiman (2022) but contrary to the findings of Ikelegbe et al (2021).

Table 4.3: Structural Model Assessment (R2, F2, Inner VIF, and Model Fit)

R-Square	Variables	R-square			R-square Adjusted	Benchmark
	FA	0.268			0.262	0.26: Substantial
	FACC	0.238			0.233	0.13: Moderate
	FS	0.514			0.510	0.02 Weak (Cohen, 1989)
	FU	0.415			0.411	
Effect Size (f-Square)	**Variables**	**FA**	**FACC**	**FS**	**FU**	**Benchmark**
	ARP	0.001	0.000	0.005	0.001	0.35: Substantial
	DR	0.025	0.035	0.202	0.068	0.15: Medium Effect
	FA					0.02: Weak Effect (Cohen, 1988)
	FACC					
	FL	0.002	0.000	0.002	0.010	
	FS					
	FU					
	RT	0.037	0.034	0.032	0.050	
Inner VIF Values	**Variables**	**FA**	**FACC**	**FS**	**FU**	**Benchmark**
	ARP	2.785	2.785	2.785	2.785	VIF ≤ 5.0 (Hair et al., 2017)
	DR	2.147	2.147	2.147	2.147	
	FA					
	FACC					
	FL	2.574	2.574	2.574	2.574	
	FS					
	FU					
	RT	2.777	2.777	2.777	2.777	
Model Fit	**Criteria**	**Saturated model**			**Estimated model**	**Benchmark**
	SRMR	0.062			0.075	SRMR < 0.08
	Chi-square	2989.140			3528.957	
	NFI	0.762			0.719	NFI > 0.9

4.4 Hypotheses Testing Results for Climate Change and Food Insecurity

The results presented in Table 11 and Figure 7 revealed the outcomes of examining sixteen (16) hypotheses obtained from using the bootstrapping with 5000 resampling iterations. The individual hypothesis observes the relationships between various model's variables. The Beta (β) values show the direction and strength of these relationships, while the t-statistics, p-values and confidence interval measures statistical significance and degree of certainty. In this study, interpretation is restricted to only significant variables. H5 to H8, which investigates the relationship between drought (DR) and food availability (FA), food accessibility (FACC), food sustainability (FS) and food utilization (FU) is supported with a positive beta value of 0.200, 0.240, 0.460 and 0.291, t-statistics of 3.425, 3.726, 7.883, and 4.814 (above the threshold of 1.96), and p-values of 0.001, 0.000, 0.000, 0.000, respectively. The result revealed a positive relationship between drought and food insecurity in Adamawa State at the 1 per cent significance level. In addition, H12 which examines the relationship between flooding (FL) and food utilization (FU) is also supported with a beta value of 0.123, t-statistic of 2.258, and a p-value 0.024, indicating moderate positive effect at the 5 per cent significance level. Similarly, H13 to H16, which measures the relationship between rising temperature (RT) and food availability (FA), food accessibility (FACC), food sustainability (FS) and food utilization (FU) is significant, indicating beta values of 0.275, 0.266, 0.209, 0.285, t-statistics of 4.307, 3.012, 3.702, and 4.281, demonstrating a robust positive impact at the 1 per cent significance level. Thus, altered rainfall pattern and flooding do not have significant effect on food insecurity in Adamawa State since their p-values are not supported. This result is in line with the findings of Nnadi et al (2019), and Ebele and Emoli (2016).

Table 4.4: Path Coefficient (Direct Effect) Results

			97.5% Confidence Interval Bias Corrected				
Hypotheses	Beta Value (β)	SD	LL (2.5%)	UL (97.5%)	T statistic	P value	Decision
H1: ARP -> FA	0.043	0.066	-0.094	0.167	0.639	0.523	Not Supported
H2: ARP -> FACC	0.032	0.080	-0.123	0.192	0.396	0.692	Not Supported
H3: ARP -> FS	0.078	0.055	-0.029	0.189	1.408	0.159	Not Supported
H4: ARP -> FU	0.029	0.059	-0.084	0.145	0.490	0.624	Not Supported
H5: DR -> FA	0.200	0.058	0.084	0.310	3.425	0.001**	Supported
H6: DR -> FACC	0.240	0.064	0.112	0.370	3.726	0.000**	Supported
H7: DR -> FS	0.460	0.058	0.343	0.569	7.883	0.000**	Supported
H8: DR -> FU	0.291	0.061	0.173	0.410	4.814	0.000**	Supported
H9: FL -> FA	0.066	0.063	-0.064	0.186	1.036	0.300	Not Supported
H10: FL -> FACC	0.006	0.057	-0.109	0.115	0.099	0.922	Not Supported
H11: FL -> FS	0.054	0.056	-0.047	0.175	0.957	0.339	Not Supported
H12: FL -> FU	0.123	0.055	0.002	0.216	2.258	0.024*	Supported
H13: RT -> FA	0.275	0.064	0.137	0.388	4.307	0.000**	Supported
H14: RT -> FACC	0.266	0.088	0.092	0.438	3.012	0.003**	Supported
H15: RT -> FS	0.209	0.056	0.100	0.319	3.702	0.000**	Supported
H16: RT -> FU	0.285	0.067	0.154	0.417	4.281	0.000**	Supported

*Note: ** and * = significant at 0.01 and 0.05 percent; LL = Lower limit; UL = Upper limit*

5.0 Conclusion and Recommendations

5.1 Conclusion

The study examined the effect of climate shocks on food insecurity in Adamawa State, Nigeria, with particular emphasis on drought, flooding, rising temperature and altered rainfall patterns. The findings provide empirical evidence that climate shocks constitute an important threat to household food security in the state, although the magnitude and significance of their effects differ across the dimensions of food availability, food accessibility, food stability and food utilization. The measurement model established satisfactory internal consistency and convergent validity, as the Cronbach's alpha and composite reliability values exceeded the recommended threshold of 0.70, while the indicator loadings and Average Variance Extracted generally satisfied the required criteria. The structural model further showed that climate-shock variables explained 26.8% of the variation in food availability, 23.8% in food

accessibility, 51.4% in food stability and 41.5% in food utilization, indicating that climate-related factors have considerable explanatory power, particularly for food stability and utilization.

5.2 Recommendations

Based on the empirical findings of this study, it is recommended that government at both federal and state levels prioritize the development and implementation of climate-resilient agricultural systems in Adamawa State. Given the strong and statistically significant effect of climate change on food insecurity, there is an urgent need to reduce the heavy dependence on rain-fed agriculture. This can be achieved through large-scale investment in irrigation infrastructure, water harvesting technologies, and drought-resistant crop varieties. Expanding access to climate-smart agricultural practices will not only stabilize food production but also enhance farmers' capacity to withstand climate change.

References

Abdulrahman, S., & Suleiman, A. (2022). Climate change and crop yield performance in Adamawa State, Nigeria. Journal of Agricultural and Environmental Studies, 11(3), 45–62.

Adebiyi, O. A., Ogunleye, K. Y., & Adebayo, A. A. (2017). Economic development and environmental degradation in Nigeria: Challenges and policy implications. Journal of Environmental Economics and Policy, 6(3), 234–249.

Adejuwon, J. O. (2012). Climate change and crop agriculture in Nigeria: Prospects, problems, and policy implications. In Climate Change and the Nigerian Environment (pp. 45–55). Nigerian Environmental Study Action Team (NEST).

Adeniyi, O. R. (2020). Climate change and agricultural productivity in Nigeria: Impacts and adaptation strategies. African Journal of Sustainable Development, 10(1), 55–70.

Adeyemi, A. O., Yusuf, S. A., & Omonona, B. T. (2020). Environmental degradation and its effect on food security in Nigeria. Journal of Sustainable Development in Africa, 22(2), 66–80.

Adjognon, G. S., Liverpool-Tasie, L. S. O., & Reardon, T. (2017). Agricultural input use and food security in sub-Saharan Africa: Evidence from Ghana. World Development, 97, 43–61. https://doi.org/10.1016/j.worlddev.2017.03.005

Ani, K. J., Anyika, V. O., & Mutambara, E. (2022). The impact of climate change on food and human security in Nigeria. International Journal of Climate Change Strategies and Management, 14(2), 148–167. https://doi.org/10.1108/IJCCSM-05-2021-0046

Anyanwu, C. N., Ijere, M. O., & Okorie, A. (1997). Agricultural policy in Nigeria: Scope, achievements and problems. Fulladu Publishing Company.

Audu, S. D. (2022). Climate change and environmental degradation in northern Nigeria: Implications for food security. Journal of Environmental Issues and Agriculture in Developing Countries, 14(1), 33–45.

Ayinde, O. E., Ojehomon, V. E. T., Daramola, F. S., & Falaki, A. A. (2020). Climate change and agricultural productivity in Nigeria: A review of empirical studies. Journal of Agricultural Science and Environment, 20(1), 12–28.

Bilyaminu, M., & Kawu, B. M. (2024). Investigating the effect of climate change on food security in Adamawa State, Nigeria. Sapientia Global Journal of Arts, Humanities and Development Studies, 7(1), 45–62.

Chima, P., Eze, E. U., & Okorie, M. (2023). Land degradation and its effect on food security among rural farmers in Southeastern Nigeria. African Journal of Agriculture and Food Security, 9(1), 22–37.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Lawrence Erlbaum Associates.

Department for International Development (DFID). (1999). Sustainable livelihoods guidance

Food and Agriculture Organization (FAO). (2016). The state of food and agriculture: Climate change, agriculture, and food security. Food and Agriculture Organization of the United Nations.

Food and Agriculture Organization (FAO). (2021). The state of food security and nutrition in the world 2021. Food and Agriculture Organization of the United Nations.

Food and Agriculture Organization & International Food Policy Research Institute (FAO & IFPRI). (2020). Assessing climate shocks and food insecurity in West Africa. Food and Agriculture Organization of the United Nations.

Galton, F. (1888). Co-relations and their measurement, chiefly from anthropometric data. Proceedings of the Royal Society of London, 45, 135–145.

Global Environment Facility (GEF). (2007). Investing in our planet. Global Environment Facility. https://www.thegef.org

Global Hunger Index. (2023). Nigeria | Global Hunger Index (GHI) – peer-reviewed annual publication. https://www.globalhungerindex.org/nigeria.html

Goldberg, E. D. (1994). The greenhouse effect and global climate change. Environmental Science & Technology, 28(3), 120–132.

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2021). A primer on partial least squares structural equation modeling (PLS-SEM) (3rd ed.). SAGE Publications.

Hulland, J. (1999). Use of partial least squares (PLS) in strategic management research: A review of four recent studies. Strategic Management Journal, 20(2), 195–204.

Idowu, A. O., Eboh, E. C., & Olayemi, S. O. (2011). Poverty and environmental degradation in Nigeria: A quantitative analysis. Nigerian Economic Society.

Intergovernmental Panel on Climate Change (IPCC). (2021). Climate change 2021: The physical science basis. Cambridge University Press. https://www.ipcc.ch/report/ar6/wg1/

Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES). (2024). Assessment report on climate change and biodiversity. IPBES Secretariat.

National Bureau of Statistics (NBS). (2024). Nigeria poverty assessment: A multidimensional perspective. National Bureau of Statistics.
Neuman, W. L. (2023). Social research methods: Qualitative and quantitative approaches (8th ed.). Pearson Education.
Odjugo, P. A. O. (2010). General overview of climate change impacts in Nigeria. Journal of Human Ecology, 29(1), 47–55.
Sen, A. (1981). Poverty and famines: An essay on entitlement and deprivation. Oxford University Press.
Spearman, C. (1904). "General intelligence" objectively determined and measured. The American Journal of Psychology, 15(2), 201–292.
.United Nations Development Programme (UNDP). (2024). Human Development Report 2023/24: Breaking the gridlock. United Nations Development Programme. https://hdr.undp.org
United Nations Environment Programme (UNEP). (2010). Climate change science compendium 2009. United Nations Environment Programme. https://wedocs.unep.org
United Nations Framework Convention on Climate Change (UNFCCC). (2007). United Nations Framework Convention on Climate Change: Essential background. https://unfccc.int
United Nations Framework Convention on Climate Change (UNFCCC). (2015). The Paris Agreement. https://unfccc.int/paris-agreement
Usman, A., Jayeoba, O. J., & Kundiri, A. M. (2024). Climate change impacts on food and water security in Nigeria. Journal of Environmental Science and Policy, 15(3), 78–94.
World Bank. (2021). Agriculture and food security. World Bank Group.
World Commission on Environment and Development. (1987). Our common future. Oxford University Press.
World Food Programme (WFP). (2025). Nigeria emergency report. World Food Programme.
World Food Summit. (1996). Rome Declaration on World Food Security and World Food Summit Plan of Action. Food and Agriculture Organization of the United Nations. https://www.fao.org/3/w3613e/w3613e00.htm
World Health Organization (WHO). (2023). Climate change and health: Fact sheet. World Health Organization.
World Health Organization (WHO). (2024). Climate change and human health: Impacts and risks. World Health Organization.
Yamane, T. (1967). Statistics: An introductory analysis (2nd ed.). Harper and Row