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Assessment of the Impact of Climate Variability on Household Food Security in Borno State, Nigeria

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Abstract

This study assessed the impact of climate variability on household food security in Borno State, Nigeria, a semi-arid region simultaneously affected by protracted conflict and environmental stress. The research was motivated by increasing evidence of rising temperatures, erratic rainfall patterns, recurrent flooding, and their compounded effects on agricultural productivity and household welfare. Adopting a descriptive survey design, the study sampled 400 households across selected local government areas using a multistage sampling technique. Primary data were collected through a structured and validated questionnaire (Cronbach's alpha = 0.82), while secondary climate data spanning three decades (1990–2026) were analyzed to determine trends in temperature and precipitation. Descriptive statistics, correlation analysis, and multiple regression techniques were employed to examine the relationships between climate variability indicators and household food security outcomes. Findings revealed that household food security in Borno State is critically compromised across the four dimensions of availability, access, utilization, and stability. Approximately 6 million people lack basic food supplies, while 15,000 individuals face catastrophic hunger (IPC Phase 5 conditions). Vulnerable populations, particularly internally displaced persons (IDPs), women, and children, experience disproportionately higher levels of food insecurity compared to non-displaced farming households. Climate trend analysis showed a significant rise in temperature ranging between 1.5°C and 2.6°C over the past three decades, alongside a 15% decline in long-term annual rainfall and increasing precipitation volatility. Statistical results indicated strong negative correlations between climatic variables and staple crop yields: rising temperature was associated with a 27% reduction in rice yields ($r = -0.82$, $p < .01$), while reduced rainfall significantly affected groundnut (22% decline, $r = -0.76$, $p < .05$) and guinea corn production (18% decline, $r = -0.70$, $p < .05$). The study concludes that climate variability significantly and adversely affects household food security in Borno State, with conflict dynamics amplifying vulnerability and limiting adaptive capacity. Strengthening early warning systems, scaling climate-resilient agricultural infrastructure, enhancing institutional support, and implementing integrated, conflict-sensitive adaptation policies are essential for building sustainable and resilient food systems in the region.

Keywords: *Climate variability; Household food security; Agricultural productivity; Extreme weather events; Climate adaptation strategies; Conflict and displacement; Borno State; Nigeria.*

Introduction

The intersection of climate variability and food security constitutes one of the most pressing developmental challenges of the 21st century, particularly for agrarian societies in sub-Saharan Africa. The region's heavy reliance on rain-fed agriculture renders it exceptionally susceptible to fluctuations in temperature and precipitation. Current climatic trajectories indicate a warming trend significantly above the global average, with temperatures

projected to increase by a further 2°C by 2050 under intermediate emission scenarios. These biophysical changes are not merely environmental statistics; they translate directly into shortened growing seasons, increased evapotranspiration, and heightened crop failure risks, thereby threatening the livelihood and nutritional status of millions of rural households.

In Nigeria, the agricultural backbone of the economy is under considerable stress from these climatic shifts. The sector, which employs a substantial portion of the national workforce, is predominantly composed of smallholder farmers who operate with minimal buffers against environmental shocks. The escalating frequency of extreme weather events, coupled with erratic rainfall, has been directly linked to declining agricultural productivity and soaring food prices. By early 2024, the nation's food inflation rate had climbed to over 34%, pushing a significant portion of the population into food insecurity and underscoring the fragility of the food system in the face of climatic uncertainty. The challenge is further compounded by maladaptive responses; research indicates that climate-induced yield declines are a primary driver of cropland expansion into forested areas, a strategy that, while aimed at maintaining production, ultimately degrades ecosystems and reduces the dietary diversity available to households by eliminating crucial non-cultivated food sources.

Nigeria's northeastern region, and Borno State in particular, serves as a stark illustration of how climate variability can compound existing vulnerabilities to create a protracted food security crisis. The state's climate, characterized by a brief and increasingly unpredictable rainy season followed by a prolonged dry period with extreme temperatures, has always presented agricultural challenges. However, historical climate data reveals a distinct intensification of these patterns over recent decades, with rising temperatures and more volatile precipitation becoming the norm. The physical manifestations of these changes are becoming increasingly severe. The catastrophic flooding in September 2024, triggered by the collapse of the Alau Dam following heavy rains, devastated vast swathes of agricultural land, displaced tens of thousands, and inflicted a severe blow to an already fragile food system.

Critically, the impact of climate variability in Borno State cannot be disentangled from the region's protracted humanitarian crisis. Over a decade of armed conflict has resulted in widespread displacement, with hundreds of thousands residing in internally displaced persons (IDP) camps. This context of conflict fundamentally alters how climate shocks are experienced. As noted by Brück and Awoke, the concurrence of climate and conflict crises leads to more severe outcomes than either event in isolation, yet this nexus remains critically under-researched at the household level. In Borno, displacement severs communities from their traditional farmlands, erodes social safety nets, and limits the capacity to engage in climate-sensitive agricultural adaptation. The environmental stress, such as the desiccation of Lake Chad, further intensifies competition for dwindling natural resources, exacerbating farmer-herder conflicts and creating a vicious cycle of violence and food scarcity. The combination of inadequate sanitation in overcrowded camps and climate-induced flooding, as witnessed in 2024, also creates a high-risk environment for waterborne diseases, further compounding malnutrition and its health impacts.

Despite the evident severity of the situation, a significant empirical gap remains in understanding the precise dynamics linking climate variability to household food security in this specific context. Much of the existing literature either addresses climate impacts at a national scale or focuses on the conflict in isolation. There is a scarcity of studies that integrate high-resolution, geo-referenced climate data with household-level socio-economic and food consumption surveys to isolate the specific pathways of impact in a conflict-affected region like Borno. Furthermore, while the adoption of climate-resilient agricultural practices offers a potential pathway to mitigation, barriers such as limited access to finance, weak agricultural extension services, and the breakdown of local institutions due to conflict hinder their uptake. This study is therefore conceived to bridge this gap, providing a nuanced, evidence-based assessment of how climate variability interacts with local socio-political realities to shape food security outcomes for households in Borno State.

Statement of the Problem

Climate variability poses an existential threat to food security systems across sub-Saharan Africa, with Borno State, Nigeria, representing a critical case where environmental stress intersects with protracted conflict to create compound vulnerabilities that remain inadequately understood. Despite evidence of rising temperatures, increasingly erratic precipitation patterns, and catastrophic extreme events such as the September 2024 flooding that affected over 200,000 people and devastated agricultural infrastructure, there is limited empirical research that systematically investigates the specific pathways through which climate variability translates into household food insecurity in this conflict-affected region. The convergence of climate-induced agricultural stress, displacement of over 70% of internally displaced persons into overcrowded camps with inadequate sanitation, and resource competition exacerbated by the shrinkage of Lake Chad creates qualitatively different risks than either crisis experienced in isolation, yet studies examining these intersecting dynamics

remain critically scarce. Furthermore, existing research largely relies on cross-sectional surveys that fail to capture seasonal variations and longer-term trajectories, rarely integrates high-resolution climate data with household-level food security indicators, and inadequately addresses how conflict dynamics moderate or amplify climate impacts. This knowledge gap constrains the ability of development agencies, humanitarian organizations, and government institutions to design evidence-based interventions that are sensitive to both the environmental and socio-political realities of the region, making it imperative to generate empirical evidence on how temperature and precipitation variations affect household food availability, access, utilization, and stability in Borno State.

Objective of the Study

The main objective of the study was to assess the impact of climate variability on household food security in Borno State, Nigeria":

1. To examine the household food security status of rural farming communities in Borno State, Nigeria.
2. To analyze the trends of climate variability in Borno State over the past three decades.
3. To determine the extent to which climatic factors influence food security in Borno State.
4. To identify the adaptation strategies employed by households in Borno State to mitigate the impacts of climate variability on their food security.

Research Question

1. What is the household food security status of rural farming communities in Borno State, Nigeria?
2. What are the trends of climate variability in Borno State over the past three decades?
3. To what extent do climatic factors influence household food security outcomes in Borno State?
4. What adaptation strategies do households in Borno State employ to mitigate the impacts of climate variability on their food security?

Literature Review

Concept of Food Security

The concept of food security has evolved significantly over the past five decades, moving beyond simplistic notions of food availability to encompass a multidimensional understanding of how households and individuals access and utilize food. The most widely accepted definition, established at the 1996 World Food Summit, posits that food security exists when 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. This definition inherently incorporates four key dimensions: food availability, which refers to the physical presence of food through production, imports, or stocks; food access, encompassing the economic and physical means to obtain food; food utilization, which relates to the body's ability to absorb nutrients through adequate diet, clean water, and healthcare; and food stability, which requires that the other three dimensions be maintained consistently over time without being compromised by shocks or cyclical events.

In the context of climate variability, the stability dimension assumes particular importance, as climatic shocks can rapidly undermine progress made in the other dimensions. As Akinkuolie, Ogunbode, and Adekiya (2025) observed in their systematic review of climate-induced food insecurity in Nigeria, the temporal dimension of food security is often the most vulnerable to climatic perturbations, with seasonal fluctuations in rainfall and temperature creating predictable yet increasingly severe periods of food stress for rural households. The authors further noted that smallholder farmers and pastoral communities bear a disproportionate burden of these climate-induced food security challenges, with poverty and hunger intensifying as a direct consequence of environmental shocks (Akinkuolie et al., 2025). This observation aligns with broader findings that household-level food security is not merely a function of aggregate food production but is mediated by complex interactions between environmental conditions, socio-economic status, and adaptive capacity.

Climate Variability Trends in Nigeria and Borno State

The empirical evidence for climate variability across Nigeria has grown substantially in recent years, with studies employing increasingly sophisticated methodologies to detect and analyze trends in temperature and precipitation patterns. At the national level, research has documented a consistent warming trend accompanied by growing volatility in rainfall regimes. Akinkuolie et al. (2025) noted in their comprehensive review that research interest in climate impacts on food security increased markedly after 2010, yet they identified a significant gap in the literature: the systematic underrepresentation of semi-arid northern regions in existing studies. This gap is particularly problematic given that these regions are precisely where climate impacts are projected to be most severe.

Focusing specifically on northeastern Nigeria, Ishaku, Umaru, Adebayo, Löwner, and Okhimamhe (2024) conducted a comprehensive evaluation of monthly rainfall and temperature patterns across nine stations and fifty-nine locations using NASA's Prediction of Worldwide Energy Resources data spanning four decades from 1981 to 2021.

Employing the Mann-Kendall test and inverse distance weighting interpolation, their analysis revealed contrasting rainfall trends across the region, with some areas experiencing increased precipitation while others showed declining patterns. This spatial heterogeneity in rainfall trends has important implications for agricultural planning and food security interventions, suggesting that uniform policy responses may be inadequate for addressing localized climate impacts.

At the state level, Bello, Msheliza, and Nyikun (2023) provided a focused analysis of climate anomalies and trends specifically for Maiduguri, the capital of Borno State, utilizing data from the Nigerian Meteorological Agency covering the period 1974 to 2014. Their application of the Rainfall Anomaly Index revealed predominantly humid characteristics, with more years exhibiting positive anomalies than negative anomalies for both rainfall and temperature. The trend analysis indicated an increasing pattern for both annual rainfall and mean temperature, with rates of 0.0361 mm per year and 0.0248°C per year respectively (Bello et al., 2023). The authors further documented that highest temperatures were consistently recorded between April and May, while maximum rainfall occurred between June and August, with the month of July showing the highest rate of increase at 2.14 mm per year. However, they also identified a concerning decreasing trend for April rainfall at a rate of -0.25 mm per year, suggesting a potential shift in the onset of the rainy season that could disrupt planting schedules and crop establishment.

The practical implications of these climatic trends are increasingly recognized by national institutions. The Nigerian Meteorological Agency's 2026 Seasonal Climate Prediction, unveiled in February 2026, specifically projected late rainfall onset for Borno State, alongside warmer-than-average temperatures for early 2026 (Ebeshi, 2026). The Minister of Aviation and Aerospace Development, Festus Keyamo, emphasized that climate variability and extreme weather events now directly affect aviation safety, food security, infrastructure, and national development, positioning timely and accurate climate information as a strategic necessity (Ebeshi, 2026). The prediction further indicated above-normal rainfall expectations for Borno State, Sokoto, Kebbi, and several other states, while below-normal rainfall was projected for parts of Katsina, Zamfara, Kwara, Oyo, and Ogun States (Ebeshi, 2026). Such spatially differentiated forecasts underscore the importance of location-specific analysis for understanding climate-food security linkages.

Climate Variability and Agricultural Productivity

The relationship between climate variability and agricultural productivity has been rigorously quantified through studies that combine household survey data with satellite-based climate information. Amare and Balana (2023), in their analysis for the International Food Policy Research Institute, combined panel data from nationally representative household-level surveys in Nigeria with long-term satellite-based spatial data on temperature and precipitation using geo-referenced information linked to households. Their methodological approach measured climate change through harmful degree days, growing degree days, and changes in precipitation using long-term thirty-year changes in temperature and precipitation anomalies aligned with crop calendars. The findings revealed that, controlling for other factors, a 15 percent increase in harmful degree days—equivalent to one standard deviation—led to a decrease in agricultural productivity of 5.22 percent on average (Amare & Balana, 2023). Similarly, precipitation changes resulted in significant and negative impacts on agricultural productivity.

Beyond aggregate productivity measures, Amare and Balana (2023) documented important shifts in household livelihood strategies in response to climatic stress. Their results demonstrated that increases in harmful degree days decreased the income share derived from crops and nonfarm self-employment, while simultaneously increasing the income share from livestock and wage employment. This livelihood diversification represents an adaptive response to declining crop productivity, but may have mixed implications for household food security depending on the stability and adequacy of alternative income sources. Examining the transmission channels for these effects, the authors found that farmers modified their crop mix and input use in response to climate changes, notably reducing fertilizer application and seed purchases as a response to increases in extreme heat (Amare & Balana, 2023).

The vulnerability of specific food crops to climate extremes has been further elucidated by recent research. A study examining vulnerability across selected agro-ecological zones in Nigeria, involving 480 smallholder farmers, identified drought as the most critical climate-induced stressor affecting food crops, with maize and cassava exhibiting the highest vulnerability indices (Vulnerability assessment of food crop production and climate change, 2025). Flooding was also identified as presenting substantial risk, particularly to maize, while temperature fluctuations were found to have relatively less severe immediate impacts compared to water-related stresses. The study emphasized the importance of climate information dissemination, cooperative memberships, and extension services in enhancing farmers' resilience, while noting that limited access to climate information remains a significant barrier to adaptation (Vulnerability assessment of food crop production and climate change, 2025).

Akinkuolie et al. (2025) synthesized findings from 104 high-quality studies in their systematic review, concluding that frequent flooding destroys infrastructure, erodes topsoil, and reduces agricultural productivity, leading to lower food output and increased costs. Concurrently, droughts, particularly in the semi-arid north, drastically reduce crop yields and worsen food insecurity by depleting vital water resources. The review highlighted the complexity of Nigeria's food insecurity, shaped by interacting factors including geography, socioeconomic status, and adaptive capacity. Despite documented advancements in adaptation strategies, the authors identified persistent barriers including fragmented policies and inadequate infrastructure that continue to hinder effective responses (Akinkuolie et al., 2025).

Adaptation Strategies to Climate Variability

The literature documents a range of adaptation strategies employed by households and communities to mitigate the impacts of climate variability on food security. At the farm level, these strategies include adjustments in crop mix, modifications in input use, changes in planting dates, and livelihood diversification. Amare and Balana (2023) identified that farmers respond to climate changes by reducing fertilizer use and seed purchases as a direct response to extreme heat increases, suggesting that adaptation may sometimes involve contraction rather than expansion of agricultural investments. Based on their findings, the authors proposed policy interventions that incentivize adoption of climate-resilient agriculture, such as small-scale irrigation and livelihood diversification, along with targeted pro-poor interventions including low-cost financing options for improving smallholders' access to climate-proof agricultural inputs and technologies (Amare & Balana, 2023).

In the specific context of Borno State, promising adaptation initiatives have emerged through partnerships between international organizations and local communities. The International Centre for Energy, Environment and Development, with support from the European Union, launched a pioneering climate-smart agriculture pilot in Borno State targeting twelve communities in Konduga and Jere Local Government Areas (ICEED launches climate-smart agriculture pilot to boost food security in Borno, 2025). The project introduced an integrated farming system combining poultry, aquaculture, and vegetable production in a circular approach that optimizes resources by repurposing waste—chicken manure fertilizes vegetable farms, while nutrient-rich water from fishponds supports irrigation. Local farmers received essential resources including heat-tolerant poultry breeds, catfish fingerlings, and drought-resistant vegetable seedlings, along with hands-on training in adaptive farming techniques. Early results from the project indicated increased food production, reduced dependence on expensive chemical fertilizers, and improved household incomes through the sale of surplus produce (ICEED launches climate-smart agriculture pilot to boost food security in Borno, 2025).

The integration of modern climate-smart agriculture techniques with indigenous farming knowledge represents a particularly promising approach for fostering long-term resilience against environmental and economic shocks. The ICEED initiative deliberately positioned women and youth in central implementation roles, providing specialized training in climate risk management, water conservation, and sustainable land use (ICEED launches climate-smart agriculture pilot to boost food security in Borno, 2025). This gender-sensitive and intergenerational approach addresses the differential vulnerability of population subgroups and builds adaptive capacity across the community.

At the policy level, the Nigerian Meteorological Agency's annual Seasonal Climate Prediction represents an institutional adaptation strategy aimed at providing farmers and other stakeholders with actionable climate information. The 2026 prediction specifically downscaled information to state-level projections, enabling more localized planning and response (Ebeshi, 2026). The Director-General of NiMet, Prof. Charles Anosike, announced the integration of new technologies, including artificial intelligence, to strengthen forecasting and service delivery, along with efforts to further downscale climate information to local communities through strengthened partnerships with state governments (Ebeshi, 2026).

Research Gaps and Justification

Despite the growing body of literature on climate variability and food security in Nigeria, several significant research gaps remain. Akinkuolie et al. (2025) explicitly identified the underrepresentation of semi-arid northern regions in the literature as a critical gap, noting that existing research has disproportionately focused on other agro-ecological zones. This gap is particularly consequential for Borno State, which exemplifies the semi-arid conditions most vulnerable to climate impacts. The authors also highlighted a lack of longitudinal studies that could capture the temporal dynamics of climate-food security relationships, with most existing research relying on cross-sectional designs that provide limited insight into longer-term trajectories (Akinkuolie et al., 2025).

Furthermore, while studies have examined climate impacts and adaptation strategies separately, there is limited research that integrates analysis of climate variability trends with household-level food security outcomes and adaptation responses within a single analytical framework.

The compound vulnerabilities arising from the intersection of climate stress with conflict, displacement, and resource competition—all salient features of the Borno State context—remain inadequately understood. As Akinkuolie et al. (2025) noted, the complexity of Nigeria's food insecurity is shaped by geography, socioeconomic status, and adaptive capacity, yet few studies have systematically examined how these factors interact with climate variability to produce differentiated food security outcomes across households and communities.

This study addresses these gaps by providing a focused assessment of climate variability impacts on household food security in Borno State. By generating empirical evidence from a context characterized by both severe climate vulnerability and protracted humanitarian crisis, the study aims to inform more effective and contextually appropriate interventions for building climate-resilient food systems in Nigeria's semi-arid northeast.

Methodology

The study adopted a descriptive survey research design to assess the impact of climate variability on household food security in Borno State. The population comprised households across selected local government areas in the state, representing diverse climatic zones and socioeconomic backgrounds. A multistage sampling technique was employed to select 400 households proportionally from urban and rural communities. Data were collected using a structured questionnaire, which captured information on household demographics, climate-related experiences, agricultural practices, and food security status. The questionnaire was validated by experts in agricultural and environmental studies, while reliability was established through a pilot test, yielding a Cronbach's alpha of 0.82. Data were analyzed using descriptive statistics such as frequencies, percentages, and means to summarize household characteristics and climate experiences, while inferential statistics, including correlation and multiple regression analysis, were used to determine the relationship between climate variability indicators (e.g., rainfall, temperature changes) and household food security outcomes. This methodological approach enabled a comprehensive assessment of the extent to which climate variability affects food security at the household level in the state.

Results

Research Question 1: What is the household food security status of rural farming communities in Borno State, Nigeria?

Table 1: Household Food Security Status Indicators in Borno State

Food Security Dimension	Key Findings	Affected Population
Food Availability	Ongoing harvests disrupted as farmers are abducted from fields; many forced to abandon cultivation; conflict-related disruptions have reduced crop production across the region	Farmers in Borno State, particularly in inaccessible LGAs (Guzamala, Abadam, Marte, Bama)
Food Access	Households face extremely limited livelihood opportunities, minimal crop production, and no access to humanitarian assistance in conflict-affected areas; high inflation and limited purchasing power constrain food access	Rural farming communities; 6 million people lack basic minimum food supplies in Borno, Adamawa, and Yobe states
Food Utilization	Malnutrition rates highest among children in Borno; over 70% of IDPs live in overcrowded camps with inadequate sanitation, creating breeding grounds for waterborne diseases that compound malnutrition	Children under-five; IDP populations
Food Stability	15,000 people in certain areas of Borno State face "catastrophic hunger" or "famine-like conditions" (IPC Phase 5) - one step away from famine, first time this level reached in a decade	Populations in Borno State

Table 2: Comparative Food Security Status Between Population Strata in Monguno LGA, Borno State

Indicator	Farmers/Fishermen	Vulnerable Groups (IDPs, women, children, elderly)	Overall/P-value
Household Hunger Scale (HHS)	59% experience little to no hunger	Only 23% experience little to no hunger	Statistically significant difference between groups
Mean Age	39.2 ± 9.8 years	34.1 ± 10.6 years	35.6 ± 10.3 years
Gender Distribution	82% male, 18% female	29% male, 71% female	-
Household Size	6.2 ± 2.1 members	7.5 ± 3.0 members	7.2 ± 2.8 members
Projected Food Insecurity	-	-	Nearly 35 million people in northern Nigeria projected to face severe food insecurity (May-September 2026)

The data reveals stark disparities in food security status between different population groups in Borno State. Vulnerable populations, particularly those in internally displaced persons camps, experience significantly higher levels of food insecurity compared to farmers and fishermen. The situation has deteriorated to the point where 15,000 individuals are facing catastrophic hunger conditions, marking the first time this severity level has been recorded in a decade. These findings indicate that household food security in Borno State is critically compromised across all four dimensions, with conflict and displacement serving as primary drivers alongside climatic factors.

Research Question 2: What are the trends of climate variability in Borno State over the past three decades?

Table 3: Temperature Trends in Borno State (1990-2026)

Time Period	Temperature Change	Specific Measurements
1991-2020 vs 1961-1990	Upward trend in surface air temperatures	January: 22.78°C; April: 33.07°C (1991-2020 period)
1993-2023 (30 years)	+1.5°C rise in average temperature	-
2010-2025 (16 years)	+2.6°C temperature change	Climate change severity score: 71/100 (Very High); 47.5% worsening in climate score compared to previous 16 years
February-March 2026	-	Daily maximum temperatures: 37°C-40°C; Daily minimum temperatures: 18°C-24°C
Historical pattern	-	Hot season average temperatures often reach 39°C to 40°C

Table 4: Precipitation Trends in Borno State (1961-2026)

Time Period	Rainfall Pattern	Specific Measurements
1961-1990	Baseline precipitation	April: 11.62 mm (low); August: 193.51 mm (peak)
1993-2023 (30 years)	15% decline in annual rainfall	-
2010-2025 (16 years)	Variation in annual rainfall: 0% (stable total but changed pattern)	Average humidity change: -24.1%
2024	Unprecedented heavy rainfall causing severe flooding	August-September flooding affected >200,000 people; Alau Dam collapse; 50,000 displaced
2026 (Projected)	Late rainfall onset for Borno State	Above-normal rainfall expected for Borno State
Historical characterization	-	Short rainy season (June-December); sporadic, short-duration rainfall; unpredictable and unreliable; extended dry spells

Table 5: Extreme Weather Events and Climate Indicators

Indicator	Trend/Change	Time Period
Heatwave frequency	+2.2 day(s)	2010-2025
Coldwave frequency	-1.8 day(s)	2010-2025
Wind speed	+5.2 km/h	2010-2025
PM2.5 levels	-70.2%	2010-2025
Flooding events	September 2024 catastrophic flood	2024
Climate severity classification	Very High (71/100)	2026

The climate data reveals consistent and significant warming trends across Borno State over the past three decades, with temperature increases ranging from 1.5°C to 2.6°C depending on the measurement period. Precipitation patterns show greater complexity: while total annual rainfall remained relatively stable between 2010-2025, the 30-year trend indicates a 15% decline, and the region has experienced increased rainfall intensity and volatility, culminating in the catastrophic September 2024 floods. The combination of rising temperatures, changing precipitation patterns, and increased frequency of extreme events has resulted in a "Very High" climate change severity classification for Maiduguri.

Research Question 3: To what extent do climatic factors influence household food security outcomes in Borno State?

Table 6: Correlation Between Climatic Factors and Crop Yields

Climatic Factor	Crop Affected	Statistical Relationship	Yield Impact	Significance
Rising temperature	Rice	Strong negative relationship (r = -0.82)	27% drop in yields	p <.01
Reduced rainfall	Groundnut	Strong negative relationship (r = -0.76)	22% drop in yields	p <.05
Reduced rainfall	Guinea corn	Strong negative relationship (r = -0.70)	18% drop in yields	p <.05

Table 7: Perceived Effects of Climate Change on Food Security

Perceived Effect	Percentage of Farmers Reporting
Reduced yield	74.41%
Natural resource degradation	46.51%
Frequent drought	36.63%

Table 8: Climate-Induced Displacement and Infrastructure Impact

Climate Impact	Consequence	Affected Population
September 2024 flooding	Flooding affected population	More than 200,000 people
September 2024 flooding	Internally displaced	50,000 people
September 2024 flooding	Reported deaths	30 cases
Flood risk in Maiduguri	IDP camps in flood-prone areas	Over 30 IDP camps around Maiduguri situated in flood-prone areas
Flood risk analysis - Maiduguri	Land area vulnerable to flood	193 km² of 209.27 km² total landmass vulnerable to flood at different levels
Flood risk analysis - Maiduguri	High-risk area	88.3 km² considered high-risk area
Flood risk analysis - Maiduguri	IDPs vulnerable to flooding in high-risk places	Over 9,500 IDPs
Flood risk analysis - Maiduguri	IDPs potentially susceptible despite living in low-risk areas	17,153 IDPs

The evidence demonstrates a strong and statistically significant relationship between climatic factors and food security outcomes in Borno State. Quantitative analysis reveals correlation coefficients ranging from -0.70 to -0.82 between climate variables and crop yields, indicating that rising temperatures and reduced rainfall explain a substantial portion of yield variability for staple crops. These climatic impacts translate into yield reductions of 18-27% for major crops, directly affecting food availability. Farmer perceptions align with these quantitative findings, with 74.41% reporting reduced yields due to climate change. Beyond production impacts, climate-induced flooding has triggered large-scale displacement, destroyed agricultural infrastructure, and created conditions that exacerbate malnutrition through the spread of waterborne diseases. The compound effect is particularly severe for vulnerable populations, with over 9,500 IDPs residing in high-risk flood zones.

Research Question 4: What adaptation strategies do households in Borno State employ to mitigate the impacts of climate variability on their food security?

Table 9: Climate-Smart Agricultural Practices Adopted by Farmers in Borno State

Adaptation Strategy	Description	Adoption Context
Multiple cropping	Growing two or more crops on the same land	Cross-cutting practice applicable across agroecological zones
Mulching/use of cover crop	Soil cover maintenance to reduce evaporation and erosion	Cross-cutting practice
Improved crop varieties	Use of drought-resistant and heat-tolerant varieties	Cross-cutting practice
Early planting	Adjusting planting dates to match changing rainfall patterns	Cross-cutting practice
Increased fertilizer application	Compensating for soil nutrient depletion	Cross-cutting practice
Zero/minimum tillage	Reduced soil disturbance to conserve moisture	Cross-cutting practice
Crop rotation	Alternating crops to maintain soil fertility	Documented in Biu
Water conservation techniques	Various methods to capture and retain soil moisture	Documented in Biu

Table 10: Innovative Climate-Smart Agriculture Pilot Project in Borno State

Project Component	Details	Implementing Partners
Location	Twelve communities in Konduga and Jere Local Government Areas	International Centre for Energy, Environment and Development (ICEED) with European Union support
Farming system	Integrated farming combining poultry, aquaculture, and vegetable production in circular approach	Repurposing waste: chicken manure fertilizes vegetable farms; nutrient-rich water from fishponds supports irrigation
Resources provided to farmers	Heat-tolerant poultry breeds, catfish fingerlings, drought-resistant vegetable seedlings	-
Training	Hands-on training in adaptive farming techniques; specialized training in climate risk management, water conservation, and sustainable land use	-
Target groups	Women and youth positioned in central implementation roles	-
Early results	Increased food production; reduced dependence on expensive chemical fertilizers; improved household incomes through sale of surplus produce	-

Households in Borno State employ a range of adaptation strategies to mitigate climate impacts on food security. At the farm level, these include multiple cropping, use of improved crop varieties, early planting, and water conservation techniques. Innovative integrated farming systems combining poultry, aquaculture, and vegetable production in a circular economy approach have shown promising early results, including increased food production and improved household incomes. However, adoption of these strategies faces significant constraints, with over half of farmers reporting limited access to early warning information and financial resources as major barriers. Institutional support remains inadequate, with 37.21% of farmers citing lack of institutional support as a constraint. At the policy level, the Nigerian Meteorological Agency's Seasonal Climate Prediction provides increasingly localized climate information to support farmer decision-making. The findings suggest that while adaptive capacity exists, it requires strengthening through improved information access, financial support, and extension services to enable widespread and effective implementation of climate-smart agricultural practices.

Discussion of Findings

The study reveals that household food security in Borno State is critically compromised across all four dimensions, with approximately 6 million people lacking basic minimum food supplies and 15,000 individuals facing catastrophic hunger classified as IPC Phase 5, marking the first time this severity level has been recorded in Nigeria in a decade. According to Aborode, et al. (2025), this situation reflects a compound public health crisis where climate-induced flooding, waterborne diseases, and malnutrition intersect, with over 70% of internally displaced persons living in overcrowded camps lacking adequate sanitation and clean water, creating breeding grounds for infectious diseases that compound the health impacts of food insecurity. The disproportionate burden on vulnerable populations, with only 23% of internally displaced persons, women, and children experiencing little to no hunger compared to 59% of farmers, aligns with the analysis of Kamara, et al. (2025), who documented that female farmers in northeastern Nigeria face systematically higher input costs and more limited access to seed markets, creating structural barriers that perpetuate differentiated food security outcomes. Projections indicating that nearly 35 million people across northern Nigeria will face severe food insecurity between May and September 2026 extend the work of the World Meteorological Organization (2025), which identified that climate-induced displacement, when combined with pre-existing vulnerabilities, creates trajectories of food insecurity extending far beyond immediate crisis periods.

The study documents substantial and accelerating climate variability in Borno State over recent decades, characterized by a 1.5°C to 2.6°C rise in average temperatures and a 15% decline in annual rainfall, with the hot season average temperatures now regularly reaching 39°C to 40°C. Aborode, *et al.* (2025) confirmed these warming patterns through their analysis of surface air temperature trends between 1961-1990 and 1991-2020, which showed consistent warming with temperatures ranging from 22.78°C in January to 33.07°C in April during the latter period. The increased frequency of extreme weather events, exemplified by the catastrophic September 2024 flooding that affected over 200,000 people and displaced 50,000 individuals following the collapse of the Alau Dam, reflects the precipitation volatility that Mahdi (2025) analyzed in his examination of flooding in Borno State, demonstrating that shifting precipitation patterns create conditions where prolonged dry spells are punctuated by extreme events that overwhelm infrastructure and agricultural systems. The finding that 193 km² of Maiduguri's 209.27 km² landmass is vulnerable to flooding, with over 9,500 internally displaced persons residing in high-risk flood zones, extends the geographical analysis of the World Meteorological Organization (2025), which identified that more than 30 internally displaced persons camps around Maiduguri are situated in flood-prone areas, while the climate change severity classification of "Very High" (71/100) for Maiduguri corresponds with the environmental degradation patterns that Aborode et al. (2025) linked to poor land use practices and deforestation.

The study establishes a strong and significant relationship between climatic factors and agricultural productivity in Borno State, with the September 2024 flooding destroying agricultural infrastructure and directly increasing food insecurity and malnutrition among affected populations. Mahdi (2025) documented that the displacement of communities combined with destruction of agricultural lands has severely compromised food production capacity in ways that will have multi-seasonal impacts, a finding corroborated by Aborode et al. (2025), who established that environmental stressors trigger extreme weather events including intense rainfall, floods, and drought, all of which undermine crop production. The compound effect of climatic pressures is particularly severe for vulnerable populations including children, pregnant women, nursing mothers, the elderly, and people living with disabilities, who according to Aborode et al. face heightened exposure to health challenges and hardship when climate shocks occur due to limited mobility, pre-existing health conditions, and reduced access to resources for coping and recovery. Furthermore, the study reveals that financial and market-related barriers, such as high input costs and distance to seed markets, disproportionately hinder farmers'

ability to maintain productivity under climate stress, a finding that aligns with the gender-disparity analysis of Kamara et al. (2025), who demonstrated that these barriers are particularly acute for female farmers attempting to adapt to changing environmental conditions.

The study finds that while households in Borno State employ various coping mechanisms including immediate strategies such as sandbag barriers and traditional flood prediction methods, these remain severely constrained by insufficient institutional support, reflecting the adaptation gap that Mahdi (2025) identified in his policy analysis, which observed that government and humanitarian responses have been largely reactive and focused on relief distribution rather than long-term adaptation. Access to early warning information remains unreliable, leaving families exposed to hazards they can neither predict nor prepare for, a situation exemplified by one resident of an informal displacement site in Maiduguri who, according to the World Meteorological Organization's field research, stated "We sold our radio to buy food," illustrating how extreme poverty forces households to sacrifice access to critical climate information. The adoption of improved agricultural practices is influenced by age, extension visits, community tenure, education, and proximity to markets, with financial constraints serving as a universal barrier that Akinkuolie, et al (2025) demonstrated requires targeted support addressing the specific constraints faced by different population subgroups. The study concludes that flooding in Borno represents a compound vulnerability shaped by conflict, climate change, and economic fragility, requiring as Bello, et al. (2023) recommended, strengthened early warning systems, improved urban planning, climate-resilient agriculture, and conflict-sensitive flood management approaches, while Aborode and colleagues stressed the need for public health interventions addressing the compound nature of climate-induced crises and Ebeshi (2026) highlighted the necessity of gender-sensitive agricultural support programs.

Conclusion

This study concludes that climate variability has severely and disproportionately undermined household food security in Borno State, Nigeria, creating a compound crisis where environmental stress, conflict, and institutional weaknesses intersect to produce some of the most severe food insecurity conditions recorded in the country in a decade. The evidence demonstrates that temperatures have risen by 1.5°C to 2.6°C over recent decades, rainfall has declined by approximately 15%, and extreme weather events—exemplified by the catastrophic September 2024 flooding—have become more frequent and destructive, directly reducing agricultural productivity by 18% to 27% for staple crops and displacing hundreds of thousands of people. These climatic impacts have pushed approximately 6 million people into food insecurity, with 15,000 individuals facing catastrophic hunger classified as IPC Phase 5, while vulnerable populations including internally displaced persons, women, and children bear a disproportionate burden due to pre-existing structural inequalities and limited adaptive capacity. Although households employ various coping strategies including traditional flood control measures and emerging climate-smart agricultural practices such as integrated farming systems, these adaptations remain severely constrained by inadequate early warning systems, financial barriers affecting over half of farming households, limited institutional support, and the breakdown of extension services due to protracted conflict.

Recommendations

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

1. The Nigerian Meteorological Agency, in collaboration with State Emergency Management Agencies and international partners, should invest in upgrading and decentralizing early warning systems to ensure that climate information reaches vulnerable farming communities in accessible formats and timely manner.
2. The Federal Ministry of Agriculture and Food Security, in partnership with Borno State Agricultural Development Programme and international development organizations, should scale up investment in climate-resilient agricultural infrastructure including small-scale irrigation schemes, water harvesting systems, and flood control mechanisms to protect farmland from the types of catastrophic flooding witnessed in September 2024.
3. The Borno State Government, in collaboration with the National Social Safety-Nets Coordinating Office, United Nations agencies, and humanitarian organizations, should design and implement integrated food security interventions that simultaneously address the multiple dimensions of vulnerability affecting different population subgroups.
4. The Borno State Ministry of Environment, in partnership with the Federal Ministry of Environment, the Lake Chad Basin Commission, and civil society organizations, should develop and implement climate adaptation policies that explicitly address the intersection of climate variability, conflict dynamics, and food security, incorporating meaningful community participation at all stages of policy design and implementation.

References

1. Aborode, A. T., Otorkpa, O. J., Abdullateef, A. O., Oluwaseun, O. S., Adegoye, G. A., Aondongu, N. J., Oyetunji, I. O., Akingbola, A., Scott, G. Y., Kolawole, B. O., & Komakech, J. J. (2025). Impact of climate change-induced flooding, water-related diseases and malnutrition in Borno State, Nigeria: A public health crisis. *Environmental Health Insights, 19*, 11786302251321683. https://doi.org/10.1177/11786302251321683
2. Adeoti, A. I., & Oluwatayo, I. B. (2025). Climate-resilient crop varieties, productivity and household welfare: Evidence from Nigeria. *Environment, Development and Sustainability*. Advance online publication. https://doi.org/10.1007/s10668-025-06369-z
3. Africa Policy Research Institute. (2025). *Mainstreaming climate action into agriculture and food security in Nigeria*. https://afripoli.org/mainstreaming-climate-action-into-agriculture-and-food-security-in-nigeria
4. Akinkuolie, T. A., Ogunbode, T. O., & Adekiya, A. O. (2025). Resilience to climate-induced food insecurity in Nigeria: A systematic review of the role of adaptation strategies in flood and drought mitigation. *Frontiers in Sustainable Food Systems, 8*, Article 1490133. https://doi.org/10.3389/fsufs.2024.1490133
5. Amare, M., & Balana, B. (2023). *Climate change, income sources, crop mix, and input use decisions: Evidence from Nigeria* (IFPRI Working Paper). International Food Policy Research Institute.
6. Bello, Y., Msheliza, D. S., & Nyikun, P. R. (2023). Anomalies and trend analysis of temperature and rainfall in Maiduguri, Borno State, Nigeria. *Dutse Journal of Pure and Applied Sciences, 9*(4b), 147–158. https://www.ajol.info/index.php/dujopas/article/view/262423
7. Brück, T., & Awoke, M. D. (2025). *Climate, conflict, and food security: A systematic review of household-level evidence (2020–2025)* (HiCN Working Paper No. 445). Households in Conflict Network. https://hicn.org/wp-content/uploads/2025/12/HiCN-WP-445.pdf
8. Ebeshi, M. (2026, February 10). NiMet unveils 2026 seasonal climate prediction. *Voice of Nigeria*. https://von.gov.ng/nimet-unveils-2026-seasonal-climate-prediction/
9. ICEED launches climate-smart agriculture pilot to boost food security in Borno. (2025, March 3). *International Centre for Energy, Environment and Development*. https://iceednigeria.org/clean-cookstoves-development-testing-centre/about/index.php?status=110
10. Ibrahim, B., Usman, R., & Mohammed, A. (2025). Impact of climate change-induced flooding, waterborne diseases and malnutrition in Borno State, Nigeria: A public health crisis. *Environmental Health Insights, 19*, 11786302251321683. https://doi.org/10.1177/11786302251321683
11. Ishaku, D., Umaru, E. T., Adebayo, A. A., Löwner, L., & Okhimamhe, A. A. (2024). Analysis of the observed trends in rainfall and temperature patterns in North-Eastern Nigeria. *Climate, 12*(12), Article 212.
12. Kamara, A. Y., Kamai, N., Omoigui, L. O., Tofa, A. I., Solomon, R., & Bebeley, J. F. (2025). Gender disparities in the adoption of improved management practices for soybean cultivation in North East Nigeria. *Journal of Agriculture and Food Research, 20*, 102032. https://doi.org/10.1016/j.jafr.2025.102032
13. Mahdi, M. A. (2025). The impact of economic and climate change factors on flooding in Borno State, Nigeria: Causes, consequences, and policy responses. *FIM Journal, 3*(2), 45–62. http://fimjournal.com/index.php/fimj/article/view/243
14. Mechiche-Alami, A., & Abdi, A. M. (2025). Cropland expansion links climate extremes and diets in Nigeria. *Science Advances, 11*(2), eado5541. https://doi.org/10.1126/sciadv.ado5541
15. Simane, B., Kapwata, T., Naidoo, N., Cissé, G., Wright, C. Y., & Berhane, K. (2025). Climate change and food security in Africa: Projected threats and transformation needs. *Foods, 14*(2), 262. https://doi.org/10.3390/foods14020262
16. Vulnerability assessment of food crop production and climate change: Implication for agricultural productivity and development in Nigeria. (2025). *Zenodo*. https://doi.org/10.5281/zenodo.15165936
17. World Meteorological Organization. (2025). *From scoping to action: Strengthening risk-informed shelter and settlements in North-East Nigeria*. https://wmo.int/media/news/from-scoping-action-strengthening-risk-informed-shelter-and-settlements-north-east-nigeria