

INFLUENCE OF CLIMATE CHANGE ON FOOD SECURITY IN GUSAU LOCAL GOVERNMENT AREA OF ZAMFARA STATE, NIGERIA

¹MALAMI Y., ²OPASOLA O.A., ³GARBA M., ⁴BALA L.G. & ⁵SHESHI A.A.

^{1&3}Department of Environmental Health Science, Bayero University Kano, Nigeria

²Department of Environmental Health Science, Kwara State University Malete, Nigeria

⁴Department of Environmental Health Science,

College of Health Sciences and Technology Tsafe, Nigeria

⁵Department of Environmental Health Science, College of Health Technology Minna, Nigeria

*Corresponding Author: Malami Yusuf

E-mail: malamiyusuf2@gmail.com

Abstract

Food security is a vital element in ensuring the wellbeing and sustainability of every community, this study guided by three objectives: to assess farmers' knowledge of climate change, to examine the effects of climate change on food security, and to identify adaptation options that enhance farmers' resilience. Three null hypotheses were tested, focusing on the effects of climate change on food security, the relationship between farmers' awareness and agricultural practices, and the relationship between adaptation strategies and food security. A cross-sectional descriptive research design was adopted. The population comprised 253,105 farming households in Gusau Local Government Area, Zamfara State, from which a sample of 384 farmers was selected using stratified sampling, while 384 structured questionnaires were administered. Data were collected using a validated and reliability-tested questionnaire and analyzed using descriptive and inferential statistics with SPSS version 22.0 and Microsoft Excel 2013. The findings revealed that 75.5% respondents understood climate, 73.4% believed that climate change is occurring, the study also found that 50.1% respondents agreed that climate change impacts significantly on food production leading to reduction in crop yields, similarly the findings from the study reveals that 77% respondents reported worsening food security on adaptation strategies to resist the effects of climate change the study found that 57.2% respondents access rainfall forecasts mainly through local government councils, 58.9% respondent had taking measures to reduce exposure to climate risks, 59.9% respondents agreed that early warnings and utilization of at least 22 Acres of land for crop production could mitigate climate change and food security. The study concluded that climate change impacts significantly on food production, leading to reduction in seasonal yield hence resulting to food insecurity. It is recommended that climate education and awareness programmes should be strengthened through local government councils, agricultural extension services, and community-based platforms to improve farmers' understanding of climate change, its impacts, and available adaptation options and policy interventions.

Keywords: Climate change, Food security, Adaptation strategies

Introduction

Climate change remain a serious threat to developing countries where most of their population depends on climate-sensitive livelihoods with poor adaptive capacity (Asfaw et al., 2021). Climate change is increasingly recognized as a substantial public health concern to global health, affecting human populations through multiple and interconnected pathways. The World Health Organization (2024), reports that climate change undermines key determinants of health, including air quality, access to safe water, food security, and adequate shelter, thereby jeopardizing decades of progress in public health. Projections suggest that between 2030 and 2050, climate-related exposures could contribute to approximately 250,000 additional deaths annually from malnutrition, malaria, diarrhoeal diseases, and heat stress. In economic terms, the direct health-related costs of climate change are estimated at US\$ 2–4 billion per year by 2030. These impacts are expected to disproportionately affect developing

countries, where weak health systems and limited adaptive capacity constrain effective preparedness and response (WHO, 2024).

Nigeria faces recurrent climate disasters such as floods, droughts, and heat waves that strike nearly annually and are projected to intensify over coming decades as global temperatures rise unabated for at least the next 20 years (Omokaro, 2025; Ani et al., 2022). These events impose devastating tolls on farmers' livelihoods, particularly in vulnerable agrarian regions like the north, where smallholders endure crop failures and income erosion (Miko, 2024; Action Aid Nigeria, 2024). Geographically, Nigeria's exposure stems from its Sahelian north prone to desertification, coastal south vulnerable to flooding, pervasive poverty affecting 40% of citizens, dense rural populations (70% agrarian), and limited adaptive capacity marked by weak infrastructure and extension services (Aniye et al., 2024; AfriPoli, 2025).

Drought ranks among Nigeria's foremost climate hazards, arising from prolonged precipitation deficits, heightened frequency, extended durations, and groundwater depletion amid erratic monsoons (Omokaro, 2025; Akintoye et al., 2019). Climate change has amplified drought occurrences, rendering it a pressing national crisis, with the Nigeria Meteorological Agency documenting delayed rainy season onsets and early cessations that diminish soil moisture across 40-85% of croplands in northern states (Ani et al., 2022; Food and Agriculture Organization (FAO) Annual Scientific Index (ASI), 2024). In northern Nigeria, Zamfara State included, this manifests acutely due to geo-climatic aridity, where extreme heat and rainfall inconsistency have shifted farming to groundwater-dependent irrigation, accelerating aquifer drawdown from 3-5 meters in the 1980s to 8-12 meters by 2023 (Nigeria Meteorological Agency (NIMET), 2023; Ogbuchi, 2020). Consequently, drought threatens agricultural viability, impacting 33 million Nigerians with acute food insecurity in 2025 and inflicting economic losses exceeding \$5 billion since 2010 through yield shortfalls and pastoral displacements (World Food Programme (WFP), 2025; Action Aid Nigeria, 2022).

Climate Change in Nigeria

Nigeria's climate continues to change markedly, with significant implications for agricultural systems and food security. Over the past decade, average temperatures across the country have continued to rise, contributing to longer dry seasons and more frequent heat stress for crops, particularly in northern regions where rainfall is already limited (Emegha et al., 2025). Rainfall patterns have become increasingly erratic, characterized by delayed onset of rains, unpredictable cessation, and alternating periods of drought and intense downpours, which disrupt farming calendars and heighten crop failure risks (Ani et al., 2022; Emegha et al., 2025). These shifts have been documented in national meteorological data showing that drought conditions affected as much as 40–85% of cropland in some areas by mid-2024, significantly reducing soil moisture and planting opportunities (Ani et al., 2022). At the same time, heavy rainfall events have triggered severe flooding in parts of the country, leading to loss of farmland, destruction of crops, and displacement of rural communities, as seen in the devastating 2025 Mokwa flood in Niger State (Mokwa flood, 2025).

Security Dimensions

Food security is achieved when individuals consistently have adequate physical, social, and economic access to safe, nutritious, and sufficient food required for a healthy and productive life (FAO, 2022). It is a multidimensional concept comprising food availability, access, utilization, and stability, all of which are influenced by environmental, economic, and socio-political conditions. Climate change poses growing risks to these dimensions by disrupting agricultural production and food supply systems (availability), increasing food prices and reducing household purchasing power (access), negatively affecting dietary quality and nutritional status (utilization), and intensifying exposure to climate-

related shocks such as floods and droughts that destabilize food systems over time (Wheeler & von Braun, 2013; FAO, 2024). Recent assessments indicate that over 30 million people are currently experiencing acute food insecurity, a situation that is likely to persist or worsen during lean seasons in the absence of effective interventions. Food insecurity is particularly pronounced in northwestern states such as Zamfara, Sokoto, and Katsina, where an estimated 400,000 residents in Zamfara State alone are projected to face Crisis or more severe food insecurity between June and August 2025 (FAO, 2025).

Climate-Agriculture-Food Security Linkages

Climate change affects agricultural systems primarily through rising temperatures and increasing variability in rainfall patterns. Elevated temperatures accelerate crop phenological development and expose crops to heat stress during critical growth stages, particularly flowering and grain filling, resulting in significant yield reductions in major cereal crops (IPCC, 2022; Zhao et al., 2021). At the same time, altered precipitation regimes characterized by delayed rainfall onset, early cessation, and prolonged dry spells disrupt planting schedules and reduce soil moisture availability, thereby increasing the risk of drought-induced crop failure (Sultan & Gaetani, 2016; IPCC, 2022). These combined biophysical stresses reduce agricultural productivity and farm incomes, with projected losses of up to 30% in the absence of effective adaptation measures (FAO, 2023). Smallholder farmers are disproportionately affected due to limited access to resources, climate-resilient technologies, and adaptive capacity, which heightens vulnerability to food insecurity and livelihood instability (Thornton et al., 2021).

Adaptation Strategies

Farmers in Nigeria have adopted a range of adaptive practices to manage the risks posed by climate variability and change. Empirical research in northwestern Nigeria shows that arable farmers employ multiple coping and adaptation strategies, including the use of crop residues, chemical weed control, fertiliser application, organic amendments (cattle manure), regular weeding, and irrigation, to sustain productivity under changing climatic conditions (Abdullahi et al., 2024). Concurrently, studies in other parts of the country, such as Ogun State, highlight that smallholder farmers combine irrigation, cultivation of resistant crop varieties, and agroforestry practices to counter drought and erratic rainfall patterns, though uptake of certain introduced strategies is mediated by access to extension services, climate information, and household socio-economic characteristics (Ogunnaike et al., 2024). Research across Nigeria further identifies the 112 as widely practiced adaptive options, reflecting farmers' responses to both short-term climate shocks and long-term shifts in climatic norms (Nandi et al., 2024). Despite these efforts, barriers such as limited access to credit, agricultural inputs, and timely climate information continue to inhibit broader adoption of effective adaptation measures among smallholder farming communities (Ogunnaike et al., 2024).

Research Objectives

1. To assess the knowledge of farmers on climate change issues
2. To determine the effects of climate change on food security
3. To identify the adaptation options that could enhance farmers and community resistance to climate change effects with reference to food security.

Research Questions

1. What is the level of awareness of farmers on climate change?
2. What are the effects of climate change on food security?
3. What adaptations strategies are farmers employing to address the effects of climate change on food security?

Hypotheses

Ho: Farmers have no significant knowledge of climate change issues.

Hi: Farmers have significant knowledge of climate change issues.

Ho: Climate change has no significant effect on food security among farming households.

Hi: Climate change has a significant effect on food security among farming households.

Ho: Farmers' adaptation options do not significantly enhance community resistance to the effects of climate change on food security.

Hi: Farmers' adaptation options significantly enhance community resistance to the effects of climate change on food security.

Methodology

The study were conducted in Gusau Local Government Area of Zamfara State Nigeria, the State has 14 Local Government Areas (LGAs) and each LGA is divided into districts which are made up of villages, it has a population of 383, 162 and 3,364 square kilo metres and a farming families of 253,105 with majority living in rural areas. (2006 population census), it was estimated to 682,700 by Nigerian Bureau of Statistics (2022). It is located between latitudes 12o 9' 46.25"N and longitude 6o 40' 28.21"E the climate change is characterized by rainy and dry season, the rainy season begins from June to October and dry season between November to May (2006 population census).

This study employed a cross-sectional descriptive research design to investigate the influence of climate change on food security in Gusau Local Government Area of Zamfara State, Nigeria. The study population comprised all farming households within the Local Government, totaling 253,105 families. The sample was determined using a stratified sampling technique, with agro-ecological zones serving as strata to ensure representation across the different ecological conditions of the area. Within each stratum, representative towns were selected based on historical records of food insecurity incidence, including Mada, Magami, Wanke, Rijjiya, Wonaka and Damba. Villages within these towns were identified in collaboration with district authorities using district maps, and household registers were consulted to obtain the list and number of farmers in each village. From this framework, 384 farmers were selected as the sample size, while a total of 384 structured questionnaires were administered to capture data from the respondents.

The instrument of data collection was a structured questionnaire designed to gather quantitative information on household perceptions of climate change, food security status, and adaptation strategies. To ensure validity, the questionnaire was reviewed by experts in agricultural and environmental studies, while a reliability test was conducted through a pilot study in neighboring communities, and adjustments were made to enhance clarity and consistency. Data collection involved the direct administration of questionnaires to selected farmers within their communities, following proper explanations of the study objectives to ensure informed participation. The collected data were subsequently coded and analyzed using descriptive statistics, including frequencies, and percentages, as well as inferential statistical techniques to examine relationships between climate change indicators and household food security outcomes.

Results

Table 1: Socio-Demographic Data of Respondents

Demographics	Options	Frequency	Percentage (%)
Gender	Male	251	65.4
	Female	133	34.6
	Total	384	100
Age Group	21-30	170	44.3
	31-40	90	23.4
	41-50	72	18.8
	51 and above	52	13.5
	Total	384	100
	Educational Qualification	Primary Education	60
Secondary Education		190	49.3
Tertiary Education		72	18.8
None		62	16.3
Total		384	100
Income Source	Farming	235	61.2
	Civil Service	72	18.8
	Business	77	20.0
	Others	-	-
	Total	384	100

The table above indicated that out of 384 respondents, 65.4% were male, while 34.6 respondents were female. The distribution shows that 44.3% (21-30), 23.4% (31-40), 18.8% (41-50), 13.5% (51+). The level of Education of the respondents revealed that 15.6% primary, 49.3% secondary, 18.8% tertiary, 16.3% none. Occupation of the respondents indicated that 61.2% farmers, 18.8% civil servants, 20% business.

Level of Knowledge of Farmers on Climate Change Issues

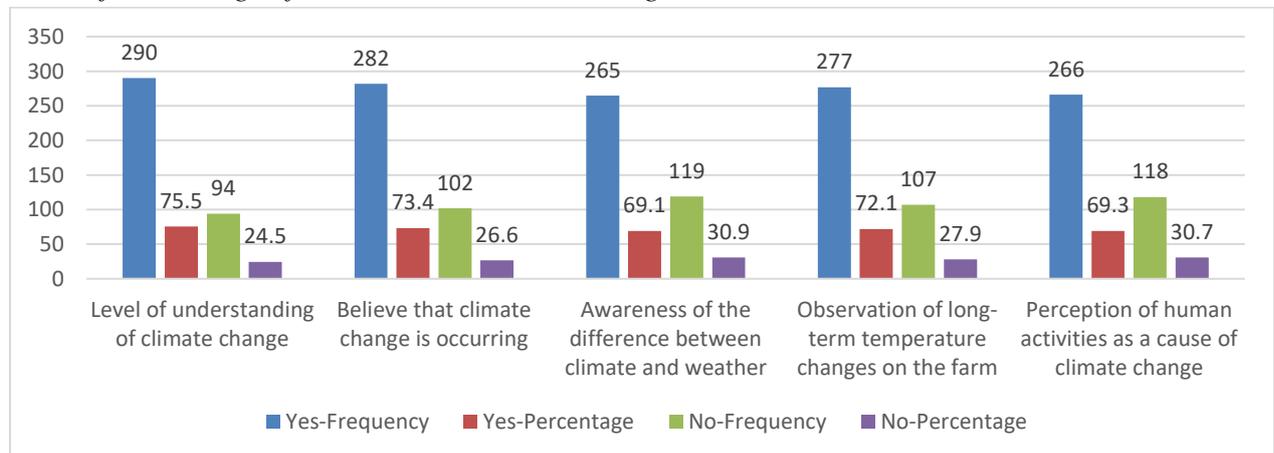


Figure 1: Assessment of the knowledge of farmers on climate change issues

The figure above indicated that majority of the respondents reported understanding climate change (75.5%), while (73.4%) of the respondents believed that climate change is occurring, Similarly, (69.1%) of the respondents recognized the difference between climate and weather, (72.1%) of the respondents had noticed long-term changes in temperature on their farms, Perception of human activities as a cause of climate change was affirmed by (69.3%) of the respondents as against 30.7%.

The Impacts of Climate Change on Food Security

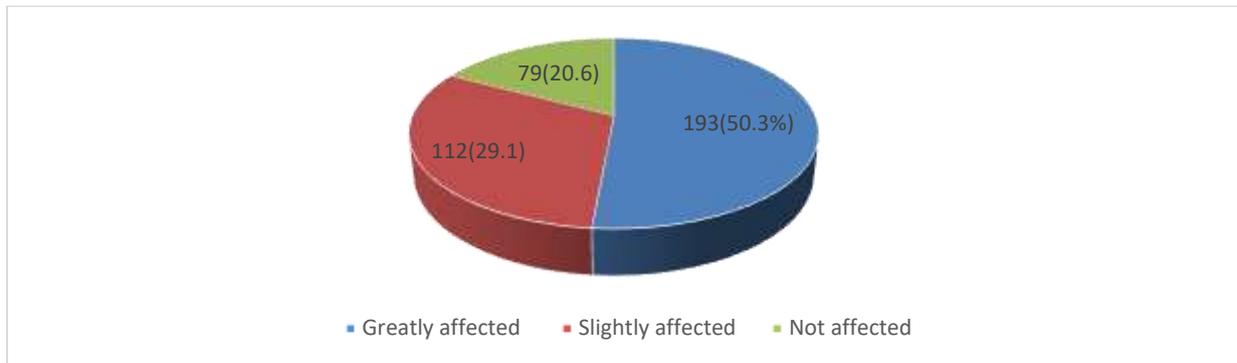


Figure 2: Climate Change and its impact on food production.

The figure above indicated that one hundred and ninety-three (50.3%) respondents were of the opinion that climate change greatly affected the states of food production; one hundred and twelve (29.1%) respondents slightly affected food production; while seventy nine (20.6%) respondents said climate change do not affects food production, this shows that majority of the respondents are on the opinion that climate change greatly affects food production.

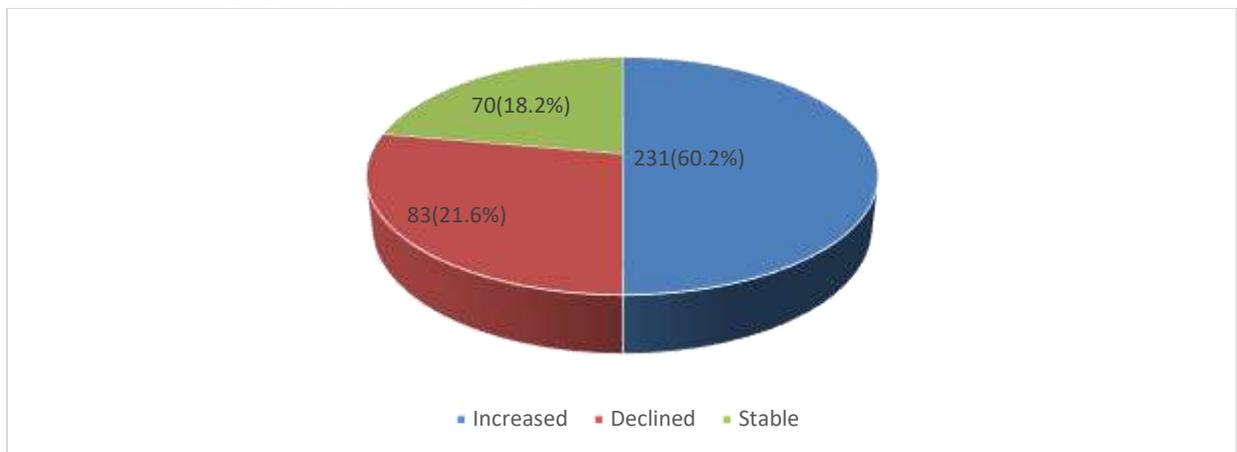


Figure 3: Change crop yield over time since ten years ago

The figure above indicated that two hundred and thirty-one (60.2%) respondents showed increased, eighty-three (21.6%) respondents showed declined, while seventy (18.2%) respondents showed stable. This means that majority of the respondents indicated the change in the crop yield over time due to climate change.

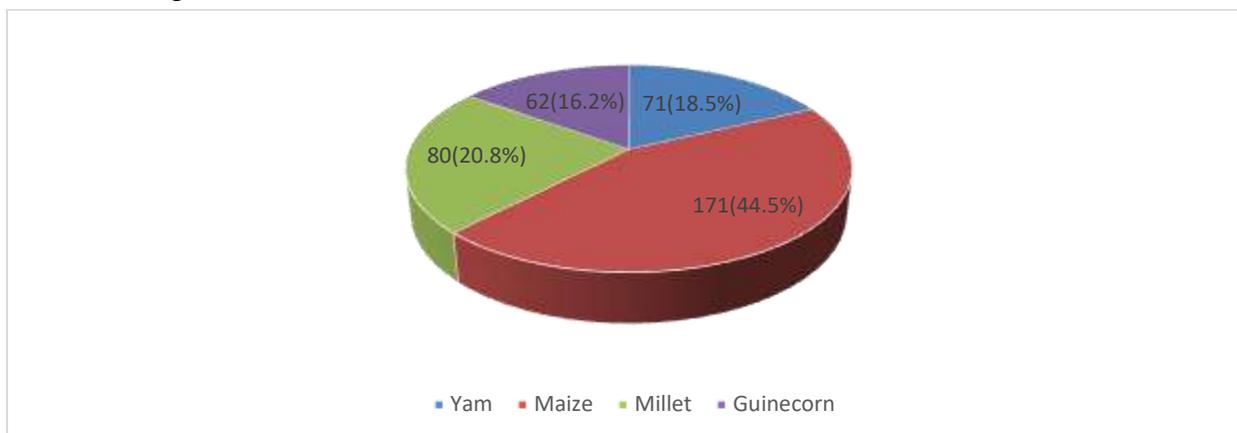


Figure 4: Type of crops usually cultivated in the area in each season

The figure above indicated that seventy-one (18.6%) respondents ticked yam, one hundred and seventy-one (44.5%) respondents ticked maize, eighty (20.8%) respondents ticked millet, while sixty-two (16.2%) respondents ticked guinea corn. This shows that majority of the respondents said maize

is the major crop cultivated in the area within the season.

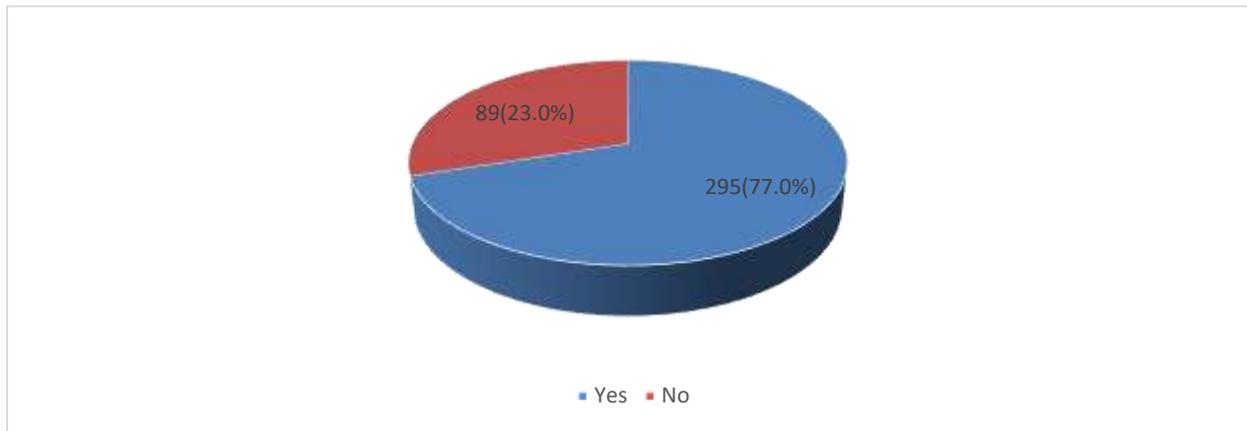


Figure 5: Change of food security from better to worse due climate change.

The figure above indicated that two hundred and ninety-five (77.0%) respondents said yes, while eighty-nine (23.0%) respondents said no. This shows that majority of the respondents believed that food security is changing from better to worse.

Identification of Adaptation options that could enhance farmers and community resistance to climate change effects with reference to food security.

Table 2: How many hectors of land were under crop production this year?

Opinion	Frequency	Percentage
10 acres	40	10.4
15 acres	55	14.3
18 acres	35	9.1
22 acres	205	53.4
25 acres	49	12.7
TOTAL	384	100

The table above indicated forty (10.4%) respondents said ten acres, fifty-five (14.3%) respondents said fifteen acres, thirty-five (9.1%) respondents said eighteen acres, two hundred and five (53.4%) respondents said twenty-two acres, while forty-nine (12.7%) respondents said twenty-five acres. This shows that the highest respondents used 22 acres for crop production these years.

Table 3: Have you ever accessed any forecast information for the past 10 years of rainy season?

Opinion	Frequency	Percentage
Yes	236	61.5
No	148	38.5
Total	384	100

The table above indicated that two hundred and thirty-six (61.5%) respondents said yes, while one hundred and forty-eight (38.5%) respondents said no. This shows that majority of the respondents have accessed forecast information for the past ten years for the rainy seasons.

Table 4: If yes in above, how did you get the information, how much confidence do you have in forecast from the specified?

Source of which the respondents access information	Frequency	Percentage
Local government council	220	57.2
Village heads	61	15.9
Local/religious elders	54	14.1
Government extension agents	49	12.8
Total	384	100

The table above indicated that two hundred and twenty (57.2%) respondents said through local government council, sixty one (15.9%) respondents said through village head, fifty (14.1%) respondents said through local/religious elders, while forty nine (12.8%) respondents said through government extension agents. This shows that the highest number of the respondents got information through local government council.

Table 5: If forecasts about a coming rainy season could be provided reliably, what type of forecast information will be most useful to you?

Opinion	Frequency	Percentage
Forecasts about when rains are expected to fall in your area	88	22.9
Forecast about whether the amount of rainfall will be above average; normal or below average	99	25.8
Forecasts about the distribution of the rainfall during the season	197	51.3
Total	384	100

The table above indicated that eighty-eight (22.9%) respondents said Forecasts about when rains are expected to fall in the area, ninety-nine (25.8%) respondents Forecast about whether the amount of rainfall will be above, normal or below average; one hundred and ninety-seven (51.3%) respondents said Forecasts about the distribution of the rainfall during the season. This shows that the majority of the respondents choose forecasts about the distribution of the rainfall during the season.

Table 6: What is your opinion about the land cover/land use changes in your area in regard to food security?

Opinion	Frequency	Percentage
Very high	198	51.6
High	60	15.6
Moderate	45	11.7
Low	43	11.2
Very low	38	9.9
Total	384	100

The table above indicated that one hundred and ninety-eight (51.6%) respondents said very high, sixty (15.6%) respondents said high, forty-five (11.7%) respondents said moderate, forty-three (11.2%) respondents said low, while thirty-eight (9.9%) respondents said very low. This shows that majority of the respondents said very high.

Table 7: Do you take any measures to reduce your exposure to the impacts of climate change on food security risk?

Opinion	Frequency	Percentage
Yes	226	58.9
No	158	41.1
Total	384	100

The table above indicated that two hundred and twenty-six (58.9%) respondents said yes, while one

hundred and fifty-eight (41.1%) respondents said no. This shows that majority of the respondents took measures reduce their exposure to the effects of climate change.

Table 8: Do you believe that problem related to climate changes and food security will be reduced if early warning measure were communicate on time?

Opinion	Frequency	Percentage
Yes	220	57.3
No	164	42.7
Total	384	100

The table above indicated that two hundred and twenty (57.3%) respondents said yes, while one hundred and sixty-four (42.7%) respondents said no. This shows that majority of the respondents believed that problem related to climate changes and food security will be reduced if measures were taken on time.

Tested Hypothesis

Table 4: Chi-square test result for hypothesis on climate change and food security

Hypothesis Tested	Test Statistic	Degree of Freedom (df)	P-value	Interpretation
H ₀₁ : Farmers have no significant knowledge of climate change issues	Pearson Chi-square	1	0.001	Highly Significant
H ₀₂ : Climate change has no significant effect on food security	Pearson Chi-square	1	0.001	Highly Significant
H ₀₃ : Farmers’ adaptation options do not significantly enhance resistance to climate change effects on food security	Pearson Chi-square	1	0.001	Highly Significant

The Chi-square tests revealed statistically significant results ($p < 0.01$) across all hypotheses. All null hypotheses were rejected. The findings demonstrate that farmers possess significant knowledge of climate change, climate change significantly affects food security, and farmers’ adaptation strategies play a critical role in enhancing resilience to climate change impacts.

Discussion

The study found that 75.5% of respondents understood climate change, 73.4% believed that climate change is occurring, 72.1% of the respondents noticed long term shift in temperature on their farms, 69.3% of the respondents believed that climate change is caused by human activities. These findings align with previous studies conducted by Olayemi et al. (2022) who found that 63% of farmers in Northern Nigeria recognized that climate change is a human-induced phenomenon, which is consistent with the 75.5% reported in this study. Adenegan (2025) found that 75% of farmers were aware of climate change. Madaki (2023) reported that most farmers recognized bush burning and deforestation as drivers of climate change, but fewer linked it to methane from livestock or fertilizers.

The study found that 50% respondents agreed that climate change impacts significantly on food production, 77% reported worsening food security, and 60% noted changes in crop yields over the past decade. These perceptions are strongly supported by recent empirical evidence which documented decline in crop yields and increased food insecurity due to rising temperatures, erratic rainfall, and drought. Studies by Tajudeen et al. (2022), while regional crop simulation studies projected yield declines of 10–20% for millet and 5–15% for sorghum due to anthropogenic warming (Sultan et al., 2019). These projections support the observation by 60.2% of respondents that crop yields have

changed over time. The high proportion of respondents reported worsening food security (77%) is also consistent with national and regional assessments documented increase food insecurity in northern Nigeria driven by climate-induced shocks (FAO, 2023; Cadre Harmonisé, 2024). Furthermore, the IPCC (2022) reports that climate change has reduced agricultural productivity growth in Africa by approximately 34% since 1961, reinforcing respondents' perceptions that climate change is undermining food production systems.

On adaptation strategies to resist the effects of climate change, the study indicates that 57.2% respondents accessed rainfall forecasts; mainly through local government councils, 51.3% respondents predict distribution of rainfall as most useful, 58.9% respondents had taken measures to reduce exposure to climate risks, 59.9% respondents agreed timely early warnings, and utilization of at least 22 acres of land for crop production could mitigate climate change and food security issues. These results are largely consistent with findings by Vaughan et al. (2019) who reported that seasonal forecasts effectively reached 65% of farmers in Zimbabwe, highlighting the importance of localized climate information. Similarly, Nocezo et al. (2024) emphasized that access to climate services in South Africa is strongly influenced by trust in local delivery systems, such as extension officers and local councils, which mirrors the preferences observed among respondents in this study. Furthermore, research by Wekesa et al. (2020) demonstrates that adoption of climate-smart agriculture enhances sustainable agricultural productivity and income by building resilience against climate variability.

The results align with recommendations by Adebisi et al. (2022), who advocate for climate-smart agricultural practices as an effective strategy to reduce vulnerability to climate change, and Abegunde et al. (2022), who reported similar positive outcomes of such adaptation measures among smallholder farmers. These studies indicate that the adaptation strategies reported in this study are in agreement with recent evidence across sub-Saharan Africa, emphasizing the effectiveness of early warning systems, climate information services, and climate-smart agricultural practices in mitigating climate risks.

Conclusion

Based on the findings of this study, it was concluded that farmers had adequate knowledge on climate change issues, and it was noticed that climate change impacts significantly on food production, leading to reduction in seasonal yield hence resulting to food insecurity, it was also observed proper attention to climate forecast/early warning system, acquisition of drought tolerant plants, expansion of land used for agriculture and implementation of climate smart agriculture system can increase sustainable agriculture productivity and incomes as adaptation strategies to resist the effects of climate change.

Recommendations

Based on the findings of this study, it is recommended that climate education and awareness programmes should be strengthened through local government councils, agricultural extension services, and community platforms to improve farmers' understanding of climate change and adaptation options. It also emphasized the need for government and non-governmental organizations to invest in reliable, localized climate information systems and ensure timely dissemination of weather and early warning messages via radio, mobile phones, and farmer groups. Policies supporting sustainable land-use practices, particularly climate-smart agriculture, crop diversification, mixed cropping, and drought-tolerant varieties, should be reinforced to enhance resilience. In addition, community-based early warning systems should be integrated into disaster preparedness frameworks. Improved access to financial support, including microcredit, agricultural insurance, and climate risk financing, is essential to help farmers adopt and sustain effective adaptation strategies.

References

- Abdullahi, T. Y., Abdulazeez, A., Ahmed, M. M., Usman, U. N., Uba, A. A., Shehu, S. A., & Ndakuru, M. A. (2024). Assessment of coping and adaptation strategies to climate change by arable farmers in northWestern Nigeria. *FUDMA Journal of Earth and Environmental Sciences*, 1(2), 1–15. <https://doi.org/10.33003/jees.2024.0102/01>
- Abegunde, V., Adeyemi, T., & Olatunji, S. (2022). Adoption of climate-smart agriculture among smallholder farmers: Evidence from Nigeria. *International Journal of Climate Change Strategies and Management*, 14(4), 507–523. DOI: <https://doi.org/10.1108/IJCCSM-08-2021-0115>.
- Action Aid Nigeria. (2024). Climate change and rural livelihoods: Impacts on smallholder farmers in Nigeria. Retrieved from <https://nigeria.actionaid.org/land-and-climate>.
- Adebisi, O., Oladipo, S., & Balogun, M. (2022). Climate-smart agriculture: Adaptation strategies for mitigating climate change impacts in Nigeria. *Journal of Environmental Management and Sustainability*, 7(2), 33–47. Available at: <https://WWW.ajol.info/index.php/jems>
- Adenegan, K. O. (2025). AWAreness and perception of climate change among smallholder farmers in Nigeria. *Nigerian Journal of Agricultural Economics*, 15(1), 45–58. Available at: <https://njae.org.ng>
- AfriPoli. (2025). Mainstreaming Climate Action into Agriculture and Food Security in Nigeria. AfriPoli Policy Brief. Retrieved from <https://afripoli.org/mainstreaming-climate-action-into-agriculture-and-food-security-in-nigeria>
- Akintoye, S. O., Adeboye, F. O., & Oladipo, H. O. (2019). Rainfall variability, drought incidence, and impacts on farming systems in northern Nigeria. *Journal of Arid Environment and Agricultural Sustainability*, 10(2), 85–98. Available at: <https://jaeas.org/vol10/issue2/akintoyeetal2019>
- Ani, O., Anyika, J., & Mutambara, J. (2022). The effects of climate variability and change on agricultural productivity and food security in Nigeria. *International Journal of Research and Scientific Innovation (IJRSI)*, 12(4), 904–914.
- Aniye, E., Umeh, J., & Bello, O. (2024). Climate exposure, poverty, and adaptive capacity in Nigeria’s agricultural zones. *African Journal of Climate Change and Development*, 12(2), 101–121. Available at: <https://ajccd.org/volume12/issue2/aniyeetal2024>
- Asfaw, S., Scognamillo, A., Di Caprera, G., Sitko, N., & Ignaciuk, A. (2021). Climate change, agriculture, and food security in developing countries. *FAO Agricultural Development Economics Technical Study No. 21*, pp. 1–52.
- Cadre Harmonisé. (2024). Acute food insecurity analysis in northern Nigeria: 2024 report. Government of Nigeria & UN partners, Abuja, Nigeria. Available at: <https://www.fao.org/nigeria/news/detail-events/en/c/1720792>
- Emegha, K. N., Bosah, P. C., Idigo, B. C., & Ofobuike, C. L. (2025). The effects of climate change on food security in Nigeria: A review. *International Journal of Research and Scientific Innovation (IJRSI)*.
- Food and Agriculture Organization of the United Nations (FAO). (2022). The state of food security and nutrition in the World 2022: Repurposing food and agricultural policies to make healthy diets more affordable.
- Food and Agriculture Organization of the United Nations (FAO). (2023). The impact of disasters and crises on agriculture and food security. FAO, Rome, Italy
- Food and Agriculture Organization of the United Nations (FAO). (2024). Climate change and food security. FAO. <https://WWW.fao.org/climate-change>
- Food and Agriculture Organization (FAO). (2025). Latest food insecurity figures reveal persistent threats to the lives of 30.6 million people. FAO Nigeria. Available at: <https://www.fao.org/nigeria/news/detail-events/en/c/1735060>
- Intergovernmental Panel on Climate Change (IPCC). (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the IPCC. Cambridge University Press, Cambridge, pp. 1–3056. DOI: <https://doi.org/10.1017/9781009325844>
- Madaki, Y. S. (2023). Perception of climate change causes and impacts among rural farming

- communities in Nigeria. *Journal of Environmental Studies and Policy*, 6(2), 33–44. Available at: <https://WWW.ajol.info>
- Miko, J. (2024). Climate variability and agrarian livelihoods: Evidence from northern Nigeria. *Journal of Environmental Resilience and Rural Development*, 9(1), 55–73. Available at: <https://jer-rd.org/volume9/issue1/miko2024>
- Mokwa flood. (2025). Wikipedia. Retrieved December 2025 Available at: https://en.Wikipedia.org/Wiki/2025_MokWa_flood
- Nandi, J. A., Usman, A., Hamidu, K., Shirama, L., and Ogenyi, M. O. (2024). Assessment of Climate Change Mitigation Strategies Adopted By Crop Farmers in Niger State, Nigeria. *International Journal of Global Affairs , Research and Development (IJGARD)* Vol.2, No.1, 2024, 172-186 ISSN 2992-2488
- National Bureau of Statistics (NBS). (2022). Population estimates by state and local government area. National Bureau of Statistics, Abuja, Nigeria, pp. 1–45. Available at: <https://nigerianstat.gov.ng>
- National Population Commission (NPC). (2006). Population and housing census of the Federal Republic of Nigeria: National and state population tables. National Population Commission, Abuja, Nigeria, pp. 1–200. Available at: <https://nigerianstat.gov.ng/elibrary/read/474>
- Nigeria Meteorological Agency (NIMET). (2023). Annual Climate Review 2023: Temperature, Rainfall, and Hydrological Trends in Nigeria. NIMET, Abuja, Nigeria, pp. 1–128. Available at: <https://nimet.gov.ng/reports/2023-annual-climate-review>
- Nocezo, K., Moyo, P., & Ncube, R. (2024). Trust and access to climate services: Insights from smallholder farmers in South Africa. *Environmental Science & Policy*, 150, 45–55. DOI: <https://doi.org/10.1016/j.envsci.2024.03.006>
- Ogbuchi (2020) “Quantitative indicators of production of food crops” *journal of tropical Agriculture*, Vol. 32 No. 1, pp 79-88
- Ogunnaike, M. G., Olabode O.J, OsinoWo O.H, Osunmakinde M.A. and Ilori A.R. (2024). Factors Influencing Adoption Of Climate Change Adaptation Strategies Among Smallholder Maize Farmers In Ikenne Agricultural Zone, Ogun State, Nigeria. *International Journal of Organic agricultural Research & Development* Volume 19 (3) (2024)
- Olayemi, A. O., Yusuf, S. A., & Oni, O. A. (2022). Farmers’ perception of climate change and adaptation strategies in Northern Nigeria. *African Journal of Agricultural Research*, 17(4), 512–523. DOI: <https://doi.org/10.5897/AJAR2021.15672>
- Omokaro, G. O. (2025). Multi-impacts of climate change and mitigation strategies in Nigeria: Agricultural production and food security. *International System for Agricultural Science and Technology*. Retrieved from <https://agris.fao.org/search/en/providers/122436/records/68515b4cd76397b49ef68b08>.
- Sultan, B., & Gaetani, M. (2016). Agriculture in West Africa in the twenty-first century: Climate change impacts and adaptation strategies. *Climate Dynamics*, 46(3–4), 995–1008. DOI: <https://doi.org/10.1007/s00382-015-2603-7>
- Sultan, B., Defrance, D., & Janicot, S. (2019). Agricultural impacts of climate variability in West Africa: Crop simulation-based assessment. *Climatic Change*, 155, 139–154. DOI: <https://doi.org/10.1007/s10584-019-02468-4>
- Tajudeen, O., Adeyemi, T., & Balogun, M. (2022). Impact of Weather variability on crop yields in Lagos State, Nigeria: Evidence from maize and cassava production. *Nigerian Journal of Agricultural and Environmental Research*, 18(2), 45–59. Available at: <https://njaer.org.ng>
- Thornton, P. K., Loboguerrero, A. M., Campbell, B. M., Kavikumar, K. S., & Sova, C. (2021). Rural livelihoods, food security and climate change. *Nature Climate Change*, 11, 774–780. <https://doi.org/10.1038/s41558-021-01087-5>
- Vaughan, C., Buja, L., & Pulwarty, R. (2019). Reaching farmers With seasonal forecasts: Evidence from Zimbabwe. *Climate Risk Management*, 25, 100–110. DOI: <https://doi.org/10.1016/j.crm.2019.100110>
- Wekesa, B., Mutua, J., & Kinyua, A. (2020). Climate-smart agriculture for smallholder farmers: Enhancing resilience and productivity in sub-Saharan Africa. *Agricultural Systems*, 182, 102–

116. DOI: <https://doi.org/10.1016/j.agry.2020.102842>
- Wheeler, T., & von Braun, J. (2013). Climate change impacts on global food security. *Science*, 341(6145), 508–513. <https://doi.org/10.1126/science.1239402>
- World Food Programme (WFP). (2025). Nigeria Food Security Outlook 2025. Retrieved from <https://WWW.Wfp.org/neWs/Wfp-calls-urgent-life-saving-support-nigeria-33-million-people-face-food-insecurity-2025>
- World Health Organization (WHO). (2024). Climate change, health and Well-being: Global public health implications. World Health Organization, Geneva, Switzerland, pp. 1–72. <https://WWW.Who.int/neWs-room/fact-sheets/detail/climate-change-and-health>
- Zhao, C., Liu, B., Piao, S., Wang, X., Lobell, D. B., Huang, Y., Asseng, S. (2021). Temperature increase reduces global yields of major crops in four independent estimates. *Nature Food*, 2(4), 263–272. DOI: <https://doi.org/10.1038/s43016-021-00250-8>