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Research Article

Assessment of the Effects of Climate-related Shocks on Farming Households' Food Security in Niger State, Nigeria

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Abstract: This research uses data from a recent survey in Niger State, Nigeria to look at how risk management techniques and climatic shocks affect the welfare of farming households. A logistic regression model was used to investigate the effects of various strategies on household food security, while an OLS model was used to investigate the effects of climate shocks on farming households' food availability. Drought-tolerant crops (62.8%), dry-season agricultural production (41.3%), buffer stock (54.6%), and diversification of agricultural activities (60.8%) are the most commonly used mitigation methods. According to the findings, approximately 52% of households were food secure. Floods were a significant factor affecting farming households' food security. Food security was also negatively linked to marital status and household size. Education, gender, farm size, agricultural structure, revenue, and food security were found to have positive and substantial relationships. According to the logit regression results, dry season rice farming has a significant positive relationship with household food security. The research shows that most farmers engage in dry season rice production and cultivate drought-tolerant crops. Governments should allocate more funds to restore irrigation facilities and conduct research on and develop drought-tolerant crops to enhance food security, while ensuring household resilience.

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1. Introduction

A population, household or individual must not risk losing access to food as a consequence of sudden shocks, e.g., seasonal food insecurity to be food secures (World Bank, 2014). Food availability at the international, national, regional, and state levels has received less attention in recent years than the needs of households and people. Food security at one level, such as the national or family level, does not guarantee food security at other levels (Abu and Soom, 2016). When everyone always has physical and financial access to enough food that is safe, nutritious and meets their dietary requirements and food preferences for an active and healthy existence, national food security is achieved. At the household level, food security means having sufficient access to food in terms of quantity, quality, safety, and cultural accessibility to satisfy each individual's needs (Ingawa, 2002).

Nigeria confronts numerous natural constraints to agricultural output, including desertification, the silting of water resources, and erosion. In addition to these difficulties, Nigeria faces demographic pressures, with a population growth rate of 2.43% per year and an average fertility index of 5.07 children per woman (CIA, 2018). Nigeria's high rate of food insecurity is demonstrated by its 2012 Global Hunger Index (GHI) ranking of 40 out of 79 nations, rising food costs, malnutrition, and fatalities from extreme poverty. It also signifies immense misery for millions of impoverished individuals (Global Hunger Index Report, 2012).

A risk management system is made up of all government actions that have an impact on risk in agriculture, various risk management tools and strategies that farmers use, and a wide variety of risk sources that have an impact on farming. Each risk may be managed using a particular management instrument or approach. Government initiatives greatly influence the availability, development, and application of each plan. Some government initiatives are specifically created to address certain risks faced by farmers, and many initiatives have a significant effect on farming risk even when they are not intended to do so (Antón, 2008). The effects of drought may be lessened by irrigation, using crops that can tolerate drought, and planting crop varieties that mature early (Abubakar and Yamusa, 2013).

Some of the practices used by farming families in Nigeria to mitigate the effects of flood disasters include the planting of flood-resistant trees and plant varieties, the building of manual embankments, and the use of indigenous knowledge. Farmers frequently use land management methods, particularly the use of mounds, to mitigate the effects of flooding. Farmers have expanded their revenue sources in order to cope with environmental risks. Fishing communities in the states of Akwa Ibom, Ondo, and Rivers prepare for flooding and sea level rise by fishing farther from the shore than before and carrying deep freezers to store their catch for the extended time they will be at sea (Erekpokeme, 2015).

Nigerian farmers are using strategies for adaptation that are environmentally robust. These strategies include improved land and soil management, creative methods tailored to certain crops, water management, financing accessibility, education about climate change, and diversification outside of agriculture. Improved management techniques, breeding plans, environmentally friendly health practices, suitable feed composition, and the use of early maturing and heat-resistant bird breeds are all being used by livestock producers. Furthermore, fish farms are putting superior breeding plans and management methods into place (Onyeneke et al., 2019).

Climate change will have a significant impact on Nigeria, as it will in many other nations, particularly in the medium to long term. Nigeria can improve its capacity to plan and implement climate-resilient growth by taking a number of steps. These can be categorized into the following three areas: institutions, knowledge, and investments (World Bank, 2013).

However, Nigerian farmers are faced with low agricultural yields as a result of several factors, including floods, droughts, and storms. All these factors are impacting their welfare, especially food consumption and household income. While agricultural households are working to mitigate the risks associated with climate change and unpredictability, many people still experience food insecurity. Therefore, efforts to reduce poverty and food insecurity have not entirely addressed these challenges. Because of this, the majority of people in rural Nigeria depend on agriculture as their primary source of income, and they work hard to maintain and increase their standard of living. Most of the time, natural occurrences like floods, droughts, wars, storms, and economic failures undermine the outcomes of farmers' efforts in producing livestock and crop goods. Even after using all the mitigation techniques, a large number of farm families continue to live in poverty. This might be due to the farmers' improper or uneconomic use of the mitigation tactics.

Moreover, as a matter of policy, it is important to know the mitigation strategies the farming households apply that can improve the household welfare, especially the food security impact of these strategies. In order to harness institutional support while providing the appropriate and sufficient resources to improve the well-being of farming households and their resilience to climate-related shocks, it is crucial to understand the welfare effects of climate shocks and mitigation mechanisms in agriculture.

To adapt to anticipated and unforeseen impacts of climate change, households, communities, and planners will need to take action.

Many studies have assessed the effects of climate change and variability on farming households and have shown the welfare impacts of climate shocks. However, very few of the studies focused on the welfare impacts of risk management strategies applied to households. Such studies include Deressa et al. (2009), who examined the determining factors of the farmer's choice of ways to adapt to changing climates in the Nile Valley of Ethiopia. Völker et al. (2011) assessed the determinants of climate risk perception and its influence on households' behavior regarding the choice of ex-ante mitigation strategies of rural households in Central Vietnam and Northeastern Thailand. In the north and south of Ghana, in the Zabzugu and South Tongu districts, Azumah et al. (2020) evaluated the perceived economic profitability of farmers employing different on-farm climate change adaptation strategies. Arfanuzzaman et al. (2020) assessed the promising adaptation practices, their economic return, and social welfare in the lower Teesta basin (LTB). Ayinla et al. (2024) used cross-sectional data from 389 randomly selected arable crop farmers in South-west Nigeria to investigate the perceived effects of climate change on farm income. Adjei and Oyebamiji (2024) used a mixed-methods approach to investigate the relationship between climate migration and food security in Africa.

Understanding how the adaptation techniques help farm families and which one works best for the family is crucial, especially in light of the economic ramifications of climate-related shocks. It's also critical to comprehend the welfare advantages of these tactics. This would impact the creation of policies and the financing of adaptation measures, as well as assist policymakers, development partners, and farming households in correctly identifying and utilizing the most successful techniques. Studies on the effects of risk management techniques and climatic shocks on well-being are often quite infrequent.

There is a need for this study since there aren't many studies like this in Nigeria. It will assist farm households in understanding the advantages of major adaptation measures for food security. While there is empirical research on Nigerian farmers' tactics for adapting to climate change, few have examined how these strategies affect household well-being in the wake of climatic shocks, and none have examined the welfare implications of these risk management techniques in Nigeria.

The primary goal of this study is to evaluate the effects of climatic shocks and *ex-ante* strategies to manage risk on the well-being of farming households in Niger State, Nigeria. The specific objectives are to; (i) examine the effects of climate shocks on farming households' food security; and (ii) examine the impact of adopted strategies on households' food security. We used 2020 survey data from 30 communities in Niger State to investigate the welfare effect of climatic shocks and mitigation options. This study addresses a gap in earlier research by concentrating on climate-related shocks and the welfare implications of risk management measures on families in Nigeria. The findings of this research are applicable to policy formulation at all levels of government. It will also function as a resource for both researchers and students.

2. Material and Methods

2.1. Study area

Niger State is situated between latitudes 08° and 11° 30' north and 03° and 07° 40' east. The state is bordered by Zamfara State to the north, Kebbi State to the west, Kogi State to the south, Kwara State to the southwest, Kaduna State to the northeast, and the Federal Capital Territory (FCT) to the southeast. In the northwest, the state borders the Republic of Benin along the Borgu and Agwara Local Government Areas. Niger has a land area of 76,469.90km^2, about 10% of all of Nigeria's territory, 85% of which is arable. 3,950,249people were counted in the State in the 2006 Population and Housing Census (Niger State Bureau of Statistic [NSBS], 2012).

Niger State is engaged in all the dams that make up the Niger Dams Initiative, namely Shiroro Gorge, along the Kaduna River as well as one in Jebba, Kwara state, with a portion of the reservoir being in Niger State. During the rainy season, nearby villages and farms are often flooded when extra water is discharged from dams and reservoirs (Adekunle et al., 2022). The state contains a large stretch of navigable waters and extensive fertile land; most people work in agriculture. The state has three primary soil types. Niger State has distinct dry and rainy periods, with annual rainfall varying around 1,100 mm in the south to 1,600 mm in the north. The highest temperature, which seldom exceeds 34°C, is recorded during March and June, whereas the coldest temperature is frequently recorded during December and January (NSBS, 2012). The rainy season lasts around 120 days in the far north and approximately 150 days across the southern regions of the state. Generally, the fertile soil and hydrology of the state enable the cultivation of most of Nigeria's staple crops and also provide ample opportunities for grazing, freshwater fishing, and forestry development (NSBS, 2012).

2.2. Data

To obtain the study sample of households, a three-stage sampling technique was utilized. Firstly, all of Niger State's agricultural zones were purposefully selected. The state was then divided into two strata based on climate shock experiences, specifically areas affected by droughts and floods. In Stage 2, 15 communities were selected at random from the drought-affected highland areas (first stratum) and the flood-affected lowland areas (second stratum). This was done because farmers in the state do not experience climate-related events equally. The lowland areas are prone to floods more than the upland areas, but both areas are vulnerable to drought. Although upland areas also experience floods, they are less severe. The final step involved choosing 10 farming households at random from each village. A total of 300 respondents were chosen for the research, but only 293 provided sufficient data to be analyzed. For the research, we utilized both primary and secondary data. The primary data was obtained through a questionnaire and scheduled interviews. We collected information on the socioeconomic characteristics of farmers in the study area, including the sources of income for households, the total amount of household spending, the amount of food consumed by households, and information on food prices. Specifically, for shocks, information was gathered on the duration of the shock (in months), expected severity, cost of treatment, asset loss, income loss, and mitigation techniques.

2.3. Analytical technique

The households' use of mitigation measures was analyzed using descriptive statistics, which also included frequency tables, graphs, and percentages. The influence of climatic shocks on the food supply for agricultural families was investigated using ordinary least squares (OLS). To build a mathematical model to relate dependent variables to independent variables, a regression tool was used. The determinants of the effect of adopted strategies on households' food security were examined using a logistic regression model. One type of GLM that can be applied in various situations is the logistic regression model. It can be applied to dichotomous dependent variables (e.g., pass/fail, stay/leave) and can also be extended to consider a dependent variable with several categories (Heck, 2012).

2.3.1. Ordinary least square (OLS)

To analyze the influence of climate shocks on farming households' food security, OLS was employed. This method was chosen because the study intended to analyze the effect of the major variables of interest- drought, flood and storm events- while the outcome variable, which is the general food supply to households, is a discrete variable, making this tool suitable for the objective. The model is explicitly expressed as follows:

$$Y_i = \alpha_o + \alpha_1 S_1 + \alpha_2 S_2 + \alpha_3 S_3 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \varepsilon_i \quad (1)$$

Y_i = Food consumption (kcal/day/AE)
α_o = Constant (intercept)
S_1= Drought index
S_2= Flood index
S_3= Storm index
X_1 = Gender of household head (male =1; 0 otherwise)
X_2= Education of household head (years)
X_3= Family size (number of members)
X_4= Age of the household head (years)
X_5= Farm size of the family (ha)
X_6= Number of extension contacts

X_7= Number of years of farming experience
X_8= Household head marital status (married =1; 0 otherwise)
X_9 = Agricultural organization membership (1 = Yes; 0 = No)
X_{10} = Income
X_{11} = Livestock asset (Tropical Livestock Units - TLU)
ε_i = Error term (residuals)

2.3.2. Climate shocks index

The respondents were asked about their climatic shock experience in the past 12 months to estimate S_i which is drought, flood and storm events. The frequency of these events was asked, and the severity of each of the events was subjective and used a likert-type scale measure according to the experience of the farmers. Following Busby and Smith (2014), the severity was scaled as 0=no-impact, 1=low-impact, 2=medium-impact and 3=high-impact on household food consumption and income. However, the frequencies of the shocks were then used to multiply the severity of the climatic shock events; I used the Min-Max method of standardization to normalize the climatic shock scores.

$$Shock\ scores_i = \frac{actual\ value\ of\ X - minimum\ value\ of\ X}{maximum\ value\ of\ X - minimum\ value\ of\ X} \tag{2}$$

2.3.3. Logistic regression model

Identification of the influence of adaptation strategies on households' food security status utilized logistic regression. This is because the study used a dichotomous variable, which is the food security status of households in the study area. Two major variables of interest in the model are the usage of drought-tolerant crops and dry season farming, which are also dummy variables. These two variables were selected based on their relevance to climate-related shocks and the frequency of their usage in the study area. The use of drought-tolerant crops was the most applied coping strategy. The model is expressed explicitly as:

$$Z_i = C_1X_1 + C_2X_2 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \varepsilon_i \tag{3}$$

Z_i = Food security status (1 = food secure; 0 otherwise)
C_1 = Drought-tolerant crop (1 = applied)
C_2 = Dry season farming (1 = applied)
X_1 = Gender of household head (male =1; 0 otherwise)
X_2= Education of household head (years)
X_3= Family size (number of members)
X_4= Age of the household head (years)
X_5= Farm size of the family (ha)
X_6= Number of extension contacts
X_7= Number of years of farming experience
X_8= Household head marital status (married =1; 0 = non-married)
X_9 = Agricultural organization
X_{10} = Income
X_{11} = Livestock asset (in Tropical Livestock Units - TLU)
ε_i = Error term.

2.3.4. Measuring food security

The food security index was developed to assess household food security, including two stages: recognition and aggregation. The process of identifying the minimal amount of nutrition necessary to support healthy living, known as the "food security threshold" for the demographic group under study, below which families are classified as food insecure, is referred to as recognition. Aggregation, on the other hand, produces household food security data (Olayemi, 1998). Following Adekunle (2022), the daily per capita intake of calories is computed by dividing the expected daily calorie intake of the household by the household size, which is adjusted for adult equivalency using comparable male adult scale weights. Conversely, family calorie accessibility is computed based on dietary nutritional composition.

The study's food security line was set at 2,500 kcal per person per day as the daily recommended amount (FAO, 2008). Accordingly, a household will be considered food secure if the per-calorie consumption is shown to meet or exceed their needs, while a household experiencing a deficit will be considered to be food insecure.

3. Results and Discussion

3.1. Socioeconomic characteristics of the respondents

The result shows that the mean age of respondents was 41.41 years, with a minimum of 19 years and a maximum of 70 years. This suggests that the sample includes both young and older individuals, with a likely concentration in the working-age population. The mean education level was 7.42 years, with a range from 0 (no formal education) to 16 years (tertiary education). This indicates moderate educational attainment, though some respondents had no formal education. The result of the mean sex (1 = male) of 0.92 suggests that most respondents were male (92%), indicating a male-dominated sample. Marital status (married = 1) with a mean of 0.83, indicates that about 83% of the respondents were married, which suggests a high prevalence of married individuals.

The mean household size was 7.12, ranging from 1 to 25. Large household sizes could imply extended family living arrangements, which may influence economic and food security factors. The average farming experience was 21.88 years, with a range of 2 to 46 years. This indicates that most respondents have substantial farming experience, which could impact their resilience to climate shocks. The mean farm size was 3.44 hectares, ranging from 0.4 to 13 hectares. The variation suggests a mix of smallholder and relatively larger farms.

Drought Index- the mean of 0.35 (range 0–1) indicates that about 35% of respondents experience drought conditions. Flood index- with a mean of 0.24, about 24% of respondents reported being affected by floods. Storm Index- the mean of 0.02 suggests that storms are a relatively minor risk in the study area.

Access to Extension Services (1 = Yes) had a mean of 0.65, indicating that about 65% of respondents had access to extension services, which can enhance knowledge transfer and adaptation strategies. The result shows that agricultural organization membership (1 = Yes) was 55%, meaning 55% of respondents belonged to an agricultural organization, which could facilitate collective action and resource sharing.

The average daily caloric intake was 2,589.03 kcal, with a range from 1,539.14 to 4,953.12kcal. This suggests varying levels of food security, with some households potentially facing under nutrition. The mean livestock holding was 0.79 TLU (Tropical Livestock Unit) ranging from 0 to 5 TLU. This suggests that while some households rely on livestock, others may not own any.

Table 1. Socioeconomic characteristics of the respondents

Variable	Description	Mean	Minimum	Maximum
Age (year)	The household head's age	41.41	19	70
Education (year)	The total years of education completed by the heads of the households.	7.42	0	16
Sex (1 = male)	This is the sex of the household heads, male is represented by 1.	0.92	0	1
Marital status (Married=1)	This is the marital status of the household head, they are divided into married and single.	0.83	0	1
Household size	The following indicates the number of members in the household.	7.12	1	25

Table 1. Socioeconomic characteristics of the respondents (continued)

Variable	Description	Mean	Minimum	Maximum
Farming experience	This indicates the number of years the farms have been in operation.	21.88	2	46
Access to extension	This determines the farmers' access to extension services.	0.65	0	1
Food intake (Kcal/capita)	This metric measures the amount of food a household member can obtain in 24 hours.	2589.03	1539.14	4953.12
Livestock asset (TLU)	This is the standard scale in which livestock assets are measured, this measures the units of all farm animals owns by farmers.	0.79	0	5
Drought index	This measures the level of drought experienced by different farming households. İt is measured by the frequency of occurence and the severity of drought events.	0.35	0	1
Flood index	This measures the level of flood experienced by different farming households. İt is measured by the frequency of occurence and the severity of flood events.	0.24	0	1
Storm index	This measures the level of storm experienced by different farming households. İt is measured by the frequency of occurence and the severity of storm events.	0.02	0	1
Agricultural organization	This indicates the groups to which the members of the farming household belong.	0.55	0	1
Farm size (ha)	Total size of all the plots of land operated by farming households.	3.44	0.4	13

3.2. Sources of shocks and stresses experienced by farming households

Table 2 presents data on various sources of risks, shocks, and stresses experienced by farming households in the study area. It categorizes different adverse events and their impact in terms of the number of affected individuals and the corresponding percentage of the surveyed population.

Drought affects the highest proportion of households (91.1%). This implies that drought is the most critical challenge, with over 90% of households experiencing its effects. Floods impact 54.6% of the population, and strong wind/storms are less frequent but still affect 10.6%. This underscores the vulnerability of agricultural livelihoods to climate variability, with drought being experienced by farmers in both lowland and upland areas, while floods were more common in lowland areas. This is line with Ferreira et al. (2022).

Crop pests/diseases affect 52.9% of farming households; animal diseases are less prevalent (6.5%), and crop damage in storage is reported by 3.1%. This shows that pests and diseases (both crop and livestock) remain substantial threats, possibly leading to yield losses and financial instability. This could be linked to climate variability, which favors the breeding of pests and pathogens. This is supported by Demeke et al. (2016). Price deflation of produce is experienced by 59.7% of respondents, making it the second most significant stressor. Inflation of input prices (20.1%) and inflation of food prices (13.7%) also significantly impact households. Inability to pay loans and loss of land are reported at lower levels (both under 3%). Economic shocks (price fluctuations, inflation, and debt issues) are widespread, likely affecting farmers' purchasing power and food security. This is also established by Komarek et al. (2020).

Table 2. Types of shocks and stresses experienced by farming households

Event	Population affected	Percentage
Drought	267	91.1
Floods	160	54.6
Strong wind/storm	31	10.6
Crop pest/disease	155	52.9
Animal disease	19	6.5
Crop damage in store	9	3.1
Price deflation of produce	175	59.7
Inflation of input price	59	20.1
Inflation of food price	40	13.7
Fishing failure	8	2.7
Inability to pay loan/credit	8	2.7
Loss of land	5	1.7

3.3. Employed risk management strategies

The primary techniques of mitigating risks used by farmers are depicted in Table 3; it was noted that many of the households used multiple strategies. More than 62% of farmers used crops resistant to drought, which corroborates the outcome of a study by Demeke et al. (2016). Additionally, 61% of farmers reported using crop, plot, and animal diversification. Aasoglenang and Bonye (2013), as well as Aminu et al. (2019), also discovered that diversification of livelihoods is a major coping mechanism against farm risks. To lessen the effects of climate and other shocks, around 40% of the farming households switched to dry-season irrigation farming. Pili and Ncube (2022) supported this by stating that farmers normally grow main crops under rain fed conditions, while also using supplementary irrigation for cash crops such as vegetables. In the research area, about 23% of respondents claimed to be doing nothing to lessen the effects of climate shocks. It was shown that the resources available to the farming households in the research region influenced the implementation of some of the ex-ante coping techniques.

Table 3. Risk management strategy employed by farming households

Management strategies	Frequency	Percentage
Dry season farming	121	41.3
Switch to more secure income sources	41	13.99
Contract insurances	65	22.18
Use of drought-tolerant crops	184	62.80
Buffer stock	160	54.61
Savings	92	31.4
İncome sources diversification	116	39.59
Crop/plot/livestock diversification	178	60.75
Doing nothing	68	23.21
Other (specify)	40	13.65

3.4. Impact of climate shocks on households' food security

The impact of climate shocks on household food security is presented in this section. OLS regression results, with food consumption in Kcal/day/AE as the outcome factor, are presented; it reflects the food available to the households. This study defines a food-secure household as one with a daily calorie intake equal to or greater than the minimum requirement of 2,500kcal for adult men, as set by FAO/WHO/UNU (1985), as cited in Babatunde et al. (2010) and Adekunle (2022).

Table 4 below presents the OLS result of climate shocks' impact on food security. Among the three functional forms- linear, semi log, and double log forms- the linear regression function was selected as the main equation. This choice was based on the t-values, which indicated the relative importance of the various variables. The value of the coefficients of determinations, the significance of the general functions as determined by the f-value, and the suitability of the slope of the regression coefficients according to the prior expectation were all considered. The independent factors were all jointly significant, according to the F-value and R^2, and the model demonstrated a satisfactory goodness of fit. Endogeneity, heteroscedasticity, and multicollinearity issues between the explanatory variables were evaluated in the model, but no such issues were found.

The results from Table 4 indicate that all three climate shock variables- drought, flood, and storm- were negatively related to food security. However, only flood was statistically significant. Several household-specific characteristics, including the education level of the household head, marital status, gender of the household head, household size, farm size, membership in an agricultural organization, and household per capita income, were found to significantly affect food consumption. Floods were found to have a negative and significant relationship with food security at the 1% level of significance. This suggests that as flood occurrences increase, the quantity of food available to households decreases. These findings align with those of Week and Wizor (2020), who reported over 75% of households in the Niger Delta, Nigeria, experienced food scarcity following flood incidents. This can be attributed to the destruction of farm produce, leading to reduced food availability and household income. Although drought and storm events were also negatively correlated with household food availability, their effects were not statistically significant. This implies that increased occurrences of drought and storms may reduce food consumption, but the impact was not strong enough to reach statistical significance. Similar findings were reported by Badolo and Kinda (2015), who concluded that climatic variability negatively affects food security, regardless of the food security indicator used.

Table 4. Result of the regression of the effect of climate shocks on food security

Food consumption (kcal/day/AE)	Coefficient	Standard error
Drought index	-62.29672	99.14142
Flood index	-309.2131***	110.4562
Storm index	-90.84915	139.7608
Household head age (year)	-3.604627	6.673919
Household head education (year)	9.902912**	4.300808
Marital status (married = 1)	-237.3835*	129.4679
Household head sex (male = 1)	336.6552**	138.4505
Household size	-28.58556**	11.62061
Farming experience (year)	1.583291	6.716844
Extension contact	0.1808498	4.598439
Farm size (ha)	64.63208***	22.19598
Agricultural organization	5.462718*	3.277701
Livestock asset (TLU)	-20.12801	24.5107
Income/annum (₦)	0.0007629***	0.0002633
constant	2429.422***	157.4706
F-value = 14.73		
R-squared = 0.46		
Root MSE = 339.06		
Number of observation = 293		

Robust standard errors *** p<0.01, ** p<0.05, * p<0.1.

Education was positively and significantly associated with food security at the 5% level of significance; indicating highereducation levels among household heads contribute to improved food security in farming households. Marital status was negatively significant at the 10% level, suggesting that unmarried household heads tend to have greater food availability. This finding aligns with Seivwright et al. (2020), who reported that marital status influences food insecurity in Australia. The potential explanation is that unmarried household heads may experience less financial strain, resulting in more resources being allocated to food consumption. Additionally, the gender of the household head was positively and significantly related to food security at the 5% level. This suggests that households led by male heads are more likely to be food secure.

The results indicate that household size was negatively and significantly associated with food consumption at the 5% level, suggesting that as the family size increases, per capita food consumption would reduce. This may be connected to the fact that as the family size increases the pressure on family resources decreases. This may be due to greater pressure on household resources, leading to increased competition for food within the family. Farm size was positively significant at the 1% level, indicating that larger farm sizes contribute to improved food availability for households. Similarly, membership in agricultural organizations was positively and significantly associated with food security. This suggests that participating in agricultural organization activities enhances household food consumption, likely due to improved access to information, training, and credit facilities, which can boost productivity and overall household welfare. Additionally, household per capita income was positively significant, reinforcing the notion that higher income levels lead to increased food consumption and improved food security in the study area.

3.5. Effect of adaptation strategies on food security status

Table 5 presents the logistic regression results on the effects of adaptation strategies in managing climate-related shocks among households. The F-test and R^2 values indicated that the response variables are jointly significant and that the model has a reasonable goodness of fit. The average per capita calorie intake in the study area was 2,589 kcal/day/AE, which slightly exceeded the recommended daily intake. However, for this study, the threshold was set at 2,500 kcal/day/AE. Households falling below this threshold were classified as food insecure, while those meeting or exceeding it were considered food secure. Based on this classification, 52% of respondents were food secure.

The results indicate that certain variables—household head age, marital status, household size, and extension contacts—negatively affected food security status. Seven variables were statistically significant: dry-season irrigated farming, marital status, household head gender, family size, farm size, agricultural organization membership, and per capita income. Dry-season irrigated farming had a positive and significant impact on food-security at the 1% level. This suggests that households engaged in dry-season irrigation farming, particularly rice cultivation, have a higher probability of being food secure. These findings align with Tesfaye et al. (2008), who reported that most irrigation users in Ethiopia are food secure. The positive effect of dry-season farming on food security may be due to its ability to mitigate weather risks through a stable water supply, as well as improved market access and profitability, which enhance household income and food availability. Conversely, the marital status of the household head was negatively and significantly correlated with food security at the 1% level. This implies that households with married heads are more likely to experience food insecurity. A possible explanation is the increased in pressure on household food resources due to larger family sizes.

Gender was positively and significantly associated with food security status at the 1% level, indicating that households with male heads were more likely to be food secure than those with female heads. This disparity could be attributed to gender-based discrimination in access to productive assets, which often hinders women's agricultural productivity and, consequently, the welfare of their households. Household size was negatively significant at the 10% level, suggesting that an increase in household size reduces the likelihood of food security. This finding aligns with Bashir et al. (2012), who reported a negative relationship between family size and household food security. The probable explanation is that larger families exert greater pressure on available food resources, thereby reducing per capita food consumption. Farm size was positively and significantly correlated with food security status at the 10% level, implying that larger farm holdings increase the probability of household food security. This finding supports Nkomoki et al. (2019), who argued that increasing farm size enhances household food and nutrition security. A possible reason is that larger farms lead to higher productivity, thereby improving food availability and household income.

Membership in an agricultural organization was positively significant for food security at the 5% level, indicating that increased participation in such organizations enhances the likelihood of household food security. This finding aligns with Ezekiel et al. (2019), who reported that social network positively influence the welfare of farming households, particularly in terms of food security. Participation in agricultural organization facilitates access to crucial information, training on improved agricultural technologies, and credit facilities, all of which contribute to increased productivity and food security. Similarly, household income was positively and significantly associated with food security at the 10% level. This suggests that an increase in per capita income improves the likelihood of household food security. Higher income enhances purchasing power, enabling farming households to access sufficient food and meet their dietary needs.

Table 5. The effect of mitigation strategies on food security status

Food security status	Coefficient	Standard error
Drought tolerant crop	0.2918451	0.345811
Dry season irrigated farming	0.9763373***	0.358751
Household head age (year)	-0.0056105	0.0369394
Household head education (year)	0.0489105	0.0340565
Marital status (married = 1)	-14.20399***	0.8755635
Household head sex (male = 1)	14.77798***	1.021266
Household size	-0.2239512*	0.1255179
Farming experience (year)	0.0113899	0.036242
Extension contacts	-0.0479805	0.0356716
Farm size (ha)	0.2997469*	0.1765003
Agricultural organization	0.0542512**	0.0262552
Livestock asset (TLU)	0.0979555	0.191225
Income/annum (₦)	8.53*	4.81
constant	-2.225718	1.510876
Prob > Chi square = 0.000		
Log pseudolikelihood = -131.0026		
Wald chi2(13) = 1771.20		
Pseudo R2 = 0.3543		
Number of observation = 293		

***Significant at 1%; **Significant at 5%; *Significant at 10%.

4. Conclusion

This study examines the effects of climatic shocks and *ex-ante* risk management strategies on the welfare of farming households in Niger State, Nigeria. An OLS regression model was employed to assess the impact of climate shocks on households' food security, while a logit regression model was used to analyze the influence of adopted risk management strategies on food security outcomes.

The study identifies the adoption of drought-tolerant crops and dry-season rice cultivation as key strategies for mitigating climate shocks in the region. The findings highlight that over 41% of farmers adopted dry-season farming, while more than 62% cultivated drought-resistant crops. An analysis of food security revealed that 48% of households were food insecure, whereas 52% were food secure. Household food security decreases with increasing climate related shocks; household food security decreases with increasing household size. Household food security increases with increasing household head education, farm size, agricultural organization participation and per capita income. Households that used dry season farming, male-headed households, tend to be more food secure than those who used drought tolerant crops in the study area; while unmarried household heads and reduced family size have the likelihood of being food insecure.

Based on the results of this research, the under-mentioned suggestions are made to enhance the resilience of farm families in Nigeria. As agriculture serves as the primary source of rural livelihood, any increase in income and food supply results in a corresponding rise in agricultural output. Therefore, the primary objective should be to enhance productivity. A developmental strategy aimed at improving agricultural productivity will enhance the resilience of rural households. Promoting agricultural policies with appropriate input price, agricultural credit and supply of inputs should be improved so as to make farmers take the opportunity of these to enhance food production and preservation. It is crucial to support agricultural methods appropriate for arid environments and to motivate farming communities to cultivate crops resistant to drought throughout the dry season. More funding should be provided by governments to upgrade and restore irrigation infrastructure. These actions are necessary to guarantee year-round food production, strengthen household resilience, and lessen food insecurity.

Ethical Statement

Ethical approval for this study was obtained from the Ethical Review Committee (UERC). Review Board (UERC), on behalf of Ismaila Isah.

Conflict of Interest

The authors declare that there are no conflicts of interest with regards to this research.

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