



CLIMATE CHANGE AWARENESS AND ADOPTION OF ADAPTATION STRATEGIES AMONG GINGER FARMERS IN SOUTHERN KADUNA, KADUNA STATE, NIGERIA

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ABSTRACT

This study assessed climate change awareness and adoption of adaptation strategies among ginger farmers in Southern Kaduna, Kaduna State, Nigeria. A multistage sampling procedure was used to select three Local Government Areas and six ginger-producing communities. A total of 150 questionnaires were administered, of which 131 valid responses were retrieved. Data were analysed using descriptive statistics and binary logistic regression. The results showed that 80.9% of the respondents were aware of climate change. The major perceived climate-change patterns were erratic rainfall, drought, increased temperature, and flooding. The major adaptation strategies adopted were planting drought-resistant varieties, irrigation, crop diversification, early planting, planting early-maturing varieties and mulching. Binary logistic regression showed that climate-change awareness ($B = 1.656$; $p = 0.007$; $OR = 5.236$), access to extension services ($B = 2.129$; $p < 0.001$; $OR = 8.410$) and educational level ($B = 2.486$; $p = 0.001$; $OR = 12.009$) significantly increased the likelihood of adopting climate-change adaptation strategies. The study concludes that climate-change awareness, educational level and access to extension services were significant factors associated with the adoption of climate-change adaptation strategies among ginger farmers in Southern Kaduna, and recommends improved extension services and farmer education to enhance climate-change adaptation.

Keywords: Adaptation, Climate, Farmers, Ginger, Kaduna

INTRODUCTION

Climate change poses a major challenge to agricultural production and rural livelihoods, particularly in developing countries where farming depends largely on natural resources and rainfall. Changes in rainfall patterns, temperature, drought and flooding can reduce agricultural productivity and increase the vulnerability of farming households. Farmers' knowledge and perception of climate change are important in shaping their responses to these risks (Madaki *et al.*, 2023; Alhassan&Haruna, 2024). Ginger is an important cash crop in Nigeria and contributes to the livelihoods of many farming households. Kaduna State is one of the major ginger-producing areas of the country, with production concentrated in Southern Kaduna. However, ginger farmers in the area largely depend on rain-fed production and are therefore exposed to climate-related risks, including erratic rainfall, drought, increasing temperature and flooding. Rainfall variability and drought have been documented in Kaduna State (Abubakar *et al.*, 2024), while climate variables such as rainfall and temperature have been associated with ginger yield across Nigeria (Okoye *et al.*, 2023). Recent evidence from Southern Kaduna also highlights the effects of climate change on ginger production and farmers' adaptation responses (Alkali, 2025).

Farmers' awareness of climate change is important for their ability to recognize climate-related risks and respond through appropriate adaptation measures. Adaptation strategies such as the use of drought-resistant and early-maturing varieties, irrigation, crop diversification, early planting and mulching can help farmers reduce the effects of climate variability (Alhassan&Haruna, 2024; Olatinwo *et al.*, 2024). Adoption of climate-smart practices may also depend on farmers' socioeconomic characteristics, access to information, extension services, education, farm resources and institutional



support (Abanigbe *et al.*, 2024; Apehet *et al.*, 2024; Ajibade *et al.*, 2025). Agricultural extension services play an important role in providing farmers with information and technical knowledge needed to understand climate risks and adopt appropriate responses. Extension services can strengthen farmers' capacity to cope with climate change by improving access to technical information, training and appropriate technologies (Mustapha *et al.*, 2024; Ifeanyi-obi & Tolumoyi, 2025). Education can similarly improve farmers' ability to access, interpret and apply agricultural and climate information (Apeh *et al.*, 2024). Studies among Nigerian farmers have reported the adoption of various climate-smart practices and the importance of extension and other socioeconomic factors in this process (Pelemo *et al.*, 2024; Oparaojiaku *et al.*, 2025). Despite the growing literature on climate-change adaptation among Nigerian farmers, limited empirical information is available on climate-change awareness and the factors influencing adoption of adaptation strategies among ginger farmers in Southern Kaduna. This study therefore assessed climate-change awareness and adaptation practices among ginger farmers in Southern Kaduna, Kaduna State, Nigeria.

This study therefore assessed climate-change awareness and adoption of adaptation strategies among ginger farmers in Southern Kaduna, Kaduna State, Nigeria. Specifically, the study sought to:

- I. assess climate change awareness among ginger farmers in the study area;
- II. identify the perceived climate-change patterns among ginger farmers in the study area;
- III. identify climate-change adaptation strategies adopted by ginger farmers in the study area;
- IV. determine the factors influencing the adoption of climate change adaptation strategies among ginger farmers in the study area.

METHODOLOGY

Study Area

The study was carried out in Southern Kaduna, Kaduna State, Nigeria. Southern Kaduna lies between latitude 9°02'N and 10°4'N and longitude 7°15'E and 7°50'E. The area falls within the Guinea Savanna ecological zone and experiences a distinct wet and dry season. The wet season generally occurs from April to October, while the dry season extends from November to March. Annual rainfall ranges from 1,400 to 1700 mm; while mean temperature ranges 23°C to 28°C ((Abaje *et al.*, 2010; Abaje & Oladipo, 2019). Agriculture, particularly crop farming and livestock production constitutes an important livelihood activity among the rural population. Crops such as maize, sorghum, cassava, groundnut, yam and ginger are widely cultivated in the area.

Sampling Procedure

A multistage sampling procedure was used to select respondents for the study. Three Local Government Areas (LGAs)—Jaba, Kachia and Kagarko—were purposively selected because of their importance in ginger production. Two ginger-producing communities were subsequently selected from each LGA: MarabanWalijo and GidanMana from Kachia; Kwoi and Nok from Jaba; and Kubacha and Aribi from Kagarko.

There was no reliable sampling frame of ginger farmers in the selected communities. Therefore, information from Kaduna Agricultural Development Programme (KADP) personnel and community informants was used to estimate the relative distribution of ginger farmers across the selected communities. Respondents were then selected using a simple random lottery method. Papers marked “1” and “0” were used, and farmers who selected “1” were included in the sample.

The sample size was determined using Cochran's formula for an unknown population

$$n_0 = \frac{Z^2 pq}{e^2}$$

The study adopted 90% confidence level and a 6.72% margin of error. Assuming maximum variability in the population ($p = 0.5$ and $q = 0.5$), the required sample size was estimated as follow

$$n_0 = \frac{(1.645)^2 (0.5)(0.5)}{(0.0672)^2}$$

$$n_0 = 150$$



Data Collection

Data were collected from 15 June to 16 August 2025 using structured questionnaire administered by trained enumerators. The instrument was pre-tested among farmers outside the sample communities and revised accordingly. A total of 150 questionnaires were administered, of 131 valid questionnaires were successfully retrieved used for analysis, representing a response rate of 87.3%.

Operationalisation of Variables

The dependent variable was adoption of climate-change adaptation strategies, coded 1 for farmers who adopted at least one strategy and 0 for those who adopted none. The explanatory variables included sex, marital status, education, occupation, access to extension services, access to credit, climate-change awareness, association membership, household size, farming experience, farm size and annual income. Categorical variables were coded as binary variables where applicable, while household size, farming experience, farm size and annual income were retained as continuous variables. Education was recorded into low education (Qur'anic/religious and primary) and high education (secondary, certificate and tertiary), while marital status was coded as single = 0 and married/widowed = 1. Other binary variables were coded 0 for the absence of the characteristic and 1 for its presence.

Data Analysis

Data were analysed using the Statistical Package for the Social Sciences (SPSS), version 22. Descriptive statistics, including frequencies, percentages, means and standard deviations, were used to summarise the data. Multiple-response analysis was used for climate-change information sources, perceived climate-change patterns and adaptation strategies. Binary logistic regression was used to determine the factors influencing farmers' adoption of climate-change adaptation strategies.

The binary logistic regression model was specified as:

$$\text{Logit}(P_i) = \ln\left(\frac{P_i}{1 - P_i}\right) = \beta_0 + \sum_{j=1}^{12} \beta_j X_{ji} + E_i$$

P_i = probability that the farmer adopts a climate-change adaptation strategy

$1 - P_i$ = probability that the farmer does not adopt

β_0 = Intercept

β_j = regression coefficient

X_{ji} = explanatory variables

E_i = error term

X_{ji} = (sex, marital status, educational level, main occupation, household size, farm size, farming experience, membership of association, access to credit, access to extension, climate change awareness, annual income)

The estimated coefficients were interpreted using their corresponding odds ratios, $\text{Exp}(B)$, to indicate the direction and magnitude of the association between the explanatory variables. Statistical significance was assessed at the 5% probability level.

RESULTS AND DISCUSSION

Socio-Demographic Characteristics of Ginger Farmers

The socio-demographic characteristics of the respondents are presented in Table 1. Most respondents were male (78.6%), while females constituted 21.4%. The mean age was 37.9 ± 9.2 years, indicating a predominantly economically active farming population. About 45.0% were civil servants, 29.8% were full-time farmers, 13.0% were traders and 12.2% were students. Most respondents were married (76.3%). Regarding education, 47.3% had tertiary education, while 28.2% had secondary education. The mean household size was 8.57 ± 6



Table 1: Socio-Demographic Characteristics of Ginger Farmers (N=131)

Variable	Frequency	Percentage	Mean $\pm$ SD
Gender			
Male	103	78.6	
Female	28	21.4	
Age			37.9 $\pm$ 9.2
21-38	73	55.7	
39-56	52	39.7	
57 and above	6	4.6	
Main Occupation			
Civil servant	59	45.0	
Student	16	12.2	
Full-time farmers	39	29.8	
Trader	17	13.0	
MaritalStatus			
Single	25	19.1	
Married	100	76.3	
Widowed	6	4.6	
HouseholdSize			8.5 7 $\pm$ 6
1-12	97	74	
13-24	26	19.9	
25 and Above	8	6.1	
Educational Qualification			
Religious	7	5.3	
Primary	4	3.1	
Secondary	37	28.2	
Certificate	21	16.0	
Tertiary	62	47.3	

Source: Field Survey, 2025, SD Standard Deviation

The relatively high proportion of respondents with secondary and tertiary education may facilitate access to and understanding of climate-related information. Education has been identified as an important factor associated with farmers' adoption of climate-smart agricultural practices (Apeh *et al.*, 2024; Ajibade *et al.*, 2025).

Farm and Institutional Characteristics of Ginger Farmers

Table 2 shows the farm and institutional characteristics of the respondents. The mean farm size was 2.7 ± 1.4 ha, while mean farming experience was 10.8 ± 8.2 years. Most respondents (76.4%) had 2–13 years of farming experience. Only 36.6% belonged to cooperative associations, while 51.1% had access to extension services. The mean annual income was ₦394,015 $\pm$ 239696.



Table 2: Farm and Institutional Characteristics of Ginger Farmers (N=131)

Variables	Frequency	Percentage	Mean± SD
FarmSize			2.7 ± 1.4
0.5-2.4	69	52.6	
2.5-4.4	47	35.9	
4.5 and Above	15	11.5	
FarmingExperience			10.8± 8.2
2-13	100	76.4	
14-25	19	14.5	
26 and Above	12	9.2	
Cooperativemembership			
Yes	48	36.6	
No	83	63.4	
Access to Extension Service			
Yes	64	51. 1	
No	67	48.9	
Annual Income in Naira			394015± 239696
130,000-409,999	81	61.8	
410,000-689,999	18	13.8	
690,000 and Above	32	24.4	

Source: Field Survey, 2025, SD= Standard Deviation

The limited access to cooperative and extension services may constrain farmers' access to information, training and institutional support needed for climate adaptation. Previous studies have similarly highlighted the importance of extension services and institutional support in strengthening farmers' capacity to respond to climate change (Mustapha *et al.*, 2024; Ifeanyi-obi &Tolumoyi, 2025).

Climate Change Awareness and Sources of Information

Table 3 shows that 80.9% of the respondents were aware of climate change, indicating a high level of awareness among ginger farmers. Fellow farmers (97.7%), extension agents (96.2%) and the internet (90.8%) were the major sources of climate-change information.

Table 3: Climate Change Awareness and Sources of Information Among Ginger Farmers (n=131)

Variables	Frequency	Percentage
Climate Change Awareness		
Aware	106	80.9
Not aware	25	19. 1
Source of information		
Fellow farmers	128*	97.7
Extension agents	126*	96.2
Internet	119*	90.8
Radio	61*	46.6
Television	32*	24.4
Friends and family	24*	18.3

Source: Field Survey 2025, *Multiple responses

The high contribution of fellow farmers suggests the importance of informal farmer-to-farmer information exchange, while the high proportion reporting extension agents highlights the continuing role of agricultural extension in climate-change information dissemination. Similar importance of climate knowledge, perception and information access has been reported among farming households in Nigeria (Madaki *et al.*, 2023; Mustapha *et al.*, 2024).

Perceived Climate-Change Patterns and Adaptation Strategies Adopted

The major climate-change patterns perceived by respondents were erratic rainfall (91.6%), drought (67.2%), increased temperature (56.5%) and flooding (53.4%) as shown in Table 4. These observations are consistent with reported rainfall variability and drought conditions in Kaduna State



(Abubakar *et al.*, 2024) and with evidence of climate-related effects on ginger production in Southern Kaduna (Alkali, 2025).

Table 4: Perceived Climate Change Pattern and Adaptation Strategy Adopted by Ginger Farmers (n=131)

Variable	Frequency*	Percentage
Pattern of climate change		
Erratic rainfall	120	91.6
Drought	88	67.2
Increased temperature	74	56.5
Flooding	70	53.4
Strategy adopted		
Planting-drought resistance varieties	78	59.5
Irrigation	75	57.3
Crop diversification	75	57.3
Early planting	67	51.1
Planting early maturing variety	64	48.9
Mulching	50	38.2

Source: Field Survey, 2025, *Multiple responses

The major adaptation strategies adopted were planting drought-resistant varieties (59.5%), irrigation (57.3%), crop diversification (57.3%), early planting (51.1%), planting early-maturing varieties (48.9%) and mulching (38.2%). The adoption of these strategies indicates that farmers were responding to perceived climate risks through both crop and water-management practices. Similar climate-smart practices, including changing planting dates, mixed cropping and other farm-management measures, have been reported among Nigerian crop farmers (Pelemo *et al.*, 2024; Olatinwo *et al.*, 2024; Oparaojiaku *et al.*, 2025).

Adaptation responses may also differ according to farmers' resources, gender, socioeconomic conditions and access to institutional support. Findings from Nigerian studies have shown that socioeconomic characteristics can influence the adoption and economic outcomes of multiple climate-smart agricultural practices (Abanigbe *et al.*, 2024; Apeh *et al.*, 2024).

Factors Influencing Adoption of Climate-Change Adaptation Strategies

The results of the binary logistic regression are presented in Table 5. The model was statistically significant ($\chi^2 = 53.654$, $df = 12$, $p < 0.001$), with a Nagelkerke R^2 of 0.472. The Hosmer–Lemeshow test was not significant ($\chi^2 = 10.347$, $df = 8$, $p = 0.242$), indicating an acceptable model fit. The model correctly classified 78.6% of the cases.

Table 5: Factors Influencing Adoption of Climate-Change Adaptation Strategies (N=131)

Variables	Coefficient	Standard Error	Wald	P-Value	Exp(B)
Sex	0.117	0.868	0.018	0.893	1.124
Marital Status	0.834	0.916	0.828	0.363	2.301
Household size	-0.046	0.071	0.431	0.511	0.955
Education	2.486	0.628	15.683	0.001*	12.009
Occupation	-1.128	0.884	1.629	0.202	0.324
Farm size	0.608	0.336	3.276	0.070	1.836
Farming experience	-0.058	0.072	0.643	0.423	0.944
Annual income	-0.001	0.001	0.992	0.319	0.999
Membership of association	0.593	0.599	0.980	0.322	1.809
Access to credit	-1.034	0.669	2.388	0.122	0.356
Access to extension	2.129	0.602	12.532	0.000*	8.410
Climate-change awareness	1.656	0.609	7.402	0.007*	5.236
Constant	-2.357	1.362	2.996	.083	.095

Source: Field Survey, 2025; Exp (B)= odds ratio; * $p < 0.05$. Nagelkerke $R^2=0.472$



Education, access to extension services and climate-change awareness significantly influenced adoption. Education had the largest odds ratio among the significant predictors ($OR = 12.009$, $p = 0.001$), indicating that farmers in the higher-education category had about 12 times higher odds of adopting at least one adaptation strategy than those in the lower-education category, holding other variables constant. This finding agrees with studies that identify education and other socioeconomic characteristics as important factors in the adoption of climate-smart practices among Nigerian farmers (Apeh *et al.*, 2024; Ajibade *et al.*, 2025).

Access to extension services also significantly increased the likelihood of adoption ($OR = 8.410$, $p < 0.001$). Farmers with access to extension services had about 8.4 times higher odds of adopting adaptation strategies than those without access. This finding highlights the importance of extension agents in providing technical information and guidance on climate adaptation. Similar evidence on the role of extension services in climate adaptation has been reported among Nigerian farmers (Mustapha *et al.*, 2024; Ifeanyi-obi & Tolumoyi, 2025; Pelemo *et al.*, 2024).

Climate-change awareness was also significant ($OR = 5.236$, $p = 0.007$). Aware farmers had approximately 5.2 times higher odds of adopting adaptation strategies than farmers who were not aware of climate change. This suggests that awareness can encourage farmers to recognize climate-related risks and respond through appropriate adaptation measures. The importance of climate-change knowledge and perception in farmers' responses to climate risks has also been documented in Nigeria (Madaki *et al.*, 2023; Alhassan & Haruna, 2024).

Farm size showed a positive but statistically non-significant relationship with adoption ($OR = 1.836$, $p = 0.070$). The remaining variables: sex, marital status, occupation, household size, farming experience, annual income, association membership and access to credit were not statistically significant at the 5% level. These variables therefore did not provide sufficient evidence of an independent effect on adoption within the fitted model.

CONCLUSION AND RECOMMENDATIONS

The study found that most ginger farmers in Southern Kaduna were aware of climate change and perceived erratic rainfall, drought, increased temperature and flooding as major climate-related changes. Farmers adopted various adaptation strategies, particularly drought-resistant varieties, irrigation, crop diversification and early planting. Education, access to extension services and climate-change awareness significantly increased the likelihood of adopting adaptation strategies.

The study recommends strengthening agricultural extension programmes to improve farmers' access to climate information and technical guidance. Extension agencies and other stakeholders should also promote farmer education and practical training on appropriate climate-adaptation technologies, particularly among farmers with lower levels of formal education.

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