



**FACTORS INFLUENCING CLIMATE SMART AGRICULTURAL PRACTICE
ADAPTATION STRATEGIES AMONG FARMING HOUSEHOLDS IN NIGER STATE,
NIGERIA**

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ABSTRACT

The study examined the factors influencing climate-smart agricultural practice adaptation strategies among farming households in Niger State, Nigeria. Specifically, the study aimed to examine the level of utilisation of climate-smart agricultural practices and determine the factors influencing climate-smart agricultural practice adaptation strategies. The study used a three-stage sampling technique to select 247 respondents. Data were collected from primary sources using a structured questionnaire administered via the KoboToolbox mobile app with assistance from ten enumerators. Primary data were analysed using descriptive statistics (mean, percentages and frequency counts) and inferential statistics, such as an ordinary least squares (OLS) regression model. The climate-smart agricultural practices (CSAPs) used by farming households included soil management practices such as cover cropping (WM = 3.94), organic amendments (WM = 3.62), and conservation agriculture (WM = 3.40), which were widely adopted. Water management practices, including irrigation management (WM = 3.87) and drought-tolerant crops (WM = 3.60), were also widely used. Similarly, crop management and

farm management practices such as crop diversification (WM = 3.89) and climate information use (WM = 3.81) recorded high adoption levels. The OLS regression result revealed that age ($\beta = 4.5636$; $p < 0.05$), years of education ($\beta = 1.1340$; $p < 0.05$), household size ($\beta = 3.1681$; $p < 0.05$), farming experience ($\beta = 2.5529$; $p < 0.01$), farm income ($\beta = 0.0000528$; $p < 0.01$) and extension contacts ($\beta = 168.4685$; $p < 0.05$) significantly influenced CSAP adaptation among farming households. In conclusion, farming households in the study area had high utilisation of climate-smart agricultural practices. It was therefore recommended that government and non-governmental organisations (NGOs) strengthen extension delivery through tailored, farmer-specific advisory services, and establish structured certification programmes for climate-smart agriculture (CSA) adopters. In addition, financial institutions should introduce conditional access to credit facilities and targeted subsidy schemes linked to certification status to encourage wider uptake and sustained adoption of CSA practices among farming households.

Keywords: Utilisation, climate smart, adaptation strategies practices

INTRODUCTION

Agriculture is the backbone of African development as it influences the progress of other economic sectors (Saran, 2022). The agricultural sector contributes more than 25% of Africa's gross domestic product and around 70% of its labour force (Munonye *et al.*, 2023). Farmers in rural areas depend on agriculture for their livelihoods; therefore, changes in climatic elements can have both immediate and delayed effects on their sustainable livelihoods (Tadesse and Ahmed, 2023). Alterations in climatic variables such as rainfall, relative humidity, sunshine, temperature and soil moisture will have more negative impacts, such as an increase in pests and diseases, a decrease in soil fertility and farm output, a reduction in the availability of soil water and an increase in leaching and soil erosion in developing countries due to their dependence on agriculture (Njoku *et al.*, 2024).

Climate change has emerged as one of the most critical environmental challenges affecting agricultural production, food security, and livelihoods globally. Developing countries, including Nigeria, are particularly vulnerable to climate change because of their heavy dependence on rain-fed agriculture and limited adaptive capacity (Ogunjimi *et al.*, 2020; World Bank, 2022). Across Sub-Saharan Africa, changing rainfall patterns, rising temperatures, and the increasing occurrence of extreme weather events such as droughts, floods, severe bush fires, and storms continue to threaten agricultural productivity and household food security through declining soil fertility, reduced crop yields, accelerated soil erosion, and biodiversity loss (Saran, 2022; Barasa *et al.*, 2021; Gebre *et al.*, 2023). In addition, rising temperatures and heat stress reduce livestock

productivity by lowering fertility, milk production, and disease resistance (Jones *et al.*, 2021). These growing climatic challenges have intensified the need for effective adaptation strategies to mitigate climate change's adverse effects on agricultural systems and rural livelihoods (Bongole *et al.*, 2020; Gwambene, 2020).

In this context, adaptive strategies refer to deliberate actions, practices and technologies farmers adopt to reduce vulnerability to climate variability and enhance resilience in agricultural production systems (Barasa *et al.*, 2021). These strategies include innovations such as improved soil and water management practices, drought-resistant crop varieties, agroforestry, and early warning systems. Climate-Smart Agricultural Practices (CSAPs) have become a key set of adaptive strategies that aim to improve productivity, enhance resilience, and reduce greenhouse gas emissions in agriculture (Bongole *et al.*, 2020). Farmers' socioeconomic characteristics, institutional support such as extension services, access to credit, education level, and exposure to climate information systems influence CSAP adoption and determine how effectively farmers can respond to climate change challenges.

Despite agriculture's crucial role, Africa's food production system depends mainly on natural precipitation and makes little use of innovative technologies. In Africa, only 5% of cultivated land has irrigation facilities, compared to 14% and 37% in Latin America and Asia, respectively (Munonye *et al.*, 2023).

Climate-smart agricultural practices represent a collection of agricultural production innovations targeted at mitigating the impact of climate change, and their implementation is gaining credence all over the world (Njoku *et al.*, 2024). These practices aim to increase food production and build farmers' resilience to climate change while reducing greenhouse gas emissions. It improves farmers' production and serves as a dependable alternative to the weaknesses of traditional agricultural practices that do not account for climate change threats (Tabe-ojong *et al.*, 2023).

Although some studies have examined the adoption of CSA practices among smallholder farmers in Nigeria (Ogunjimi *et al.*, 2020; Gwambene, 2020; Njoku *et al.*, 2024), empirical evidence on the level of CSA adoption among smallholder farmers in Niger State remains limited. Moreover, the potential factors that influence the utilisation of CSA practices among smallholder farmers in Niger State remain largely unexplored. Thus, this knowledge gap remains unfilled because documented evidence is scarce. Utilisation of CSA practices, particularly in the study area, has

been ignored over the years; hence, it requires investigation to guide policy efforts to identify the factors that influence its utilisation. Based on the foregoing, the study was conducted to achieve the following objectives, which are to:

1. assess the level of utilisation of climate-smart agricultural practices among the farming households in the study area;
2. determine the factors influencing the utilisation of climate-smart agricultural practices among the farming households in the study area

METHODOLOGY

The study was conducted in Niger State, located in the North-Central region of Nigeria between approximately latitude $8^{\circ}20'N$ and $11^{\circ}30'N$ and longitude $3^{\circ}30'E$ and $7^{\circ}20'E$. The State has a land area of about 76,363 km² and a population estimated at over 4 million people (NPC, 2022 projection). Niger State falls within the Guinea Savannah agro-ecological zone, characterised by distinct wet and dry seasons, moderate to high temperatures, and annual rainfall ranging from 1,100 mm to 1,600 mm. The vegetation is predominantly derived savannah with scattered woodland, supporting diverse agricultural activities. Major occupations include farming, fishing, livestock rearing, and petty trading. The dominant ethnic groups are Nupe, Gbagyi, Hausa, Kambari, and Kamuku, with agriculture serving as the primary source of livelihood, particularly smallholder crop production.

The study adopted a multistage sampling technique. In the first stage, Niger State was stratified into its three agricultural zones, and one Local Government Area (LGA) was randomly selected from each zone. In the second stage, the researchers randomly selected villages or farming communities from the selected LGAs. In the final stage, farming households were selected from community household lists obtained from extension and local agricultural records using Taro Yamane. The study reached 247 farming households.

Primary data were collected through a structured questionnaire administered to respondents with the assistance of trained enumerators. The data collected were analysed using descriptive statistics such as frequency counts, percentages, and mean scores, as well as inferential statistics,

particularly the Ordinary Least Squares (OLS) regression model to determine factors influencing climate-smart agricultural practice adoption.

Ordinary least square

The Ordinary Least Squares (OLS) regression model is a statistical technique used to examine the relationship between a dependent variable and one or more independent variables by estimating parameters that minimise the sum of the squared differences between observed and predicted values. It is widely used in empirical studies to determine the magnitude and direction of explanatory variables' influence on an outcome variable. In this study, we used the OLS model to identify the factors influencing climate-smart agricultural practice (CSAP) adoption among farming households.

Implicit form of the model:

$$Y_i = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}) + \varepsilon_i$$

Where:

Y_i = level of adoption of climate smart agricultural practices

$X_1 - X_{11}$ = explanatory variables influencing CSAP adoption

ε_i = stochastic error term

Explicit form of the model:

The model is explicitly expressed as follows:

$$Y_i = Y_i = \alpha_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \varepsilon_i \quad (1)$$

Y = utilization of CSA practices (Likert scale to generate the aggregate scores)

α_0 = Constant (intercept)

X_1 = Age (Years)

X_2 = Education of household head (years)

X_3 = Household size (Number)

X_4 = Gender (Male =1, and if otherwise =0)

X_5 = Farming experience (Years)

X_6 = farm income (Naira)

X_7 = Off-farm income (Naira)

X_8 = Years of practicing CSAPs (Years)

X_9 = Farm size (Ha)

X_{10} = Extension contacts (Numbers of visits)

X_{11} = Credit (Naira)

ε_i = Error term (residuals)

RESULTS AND DISCUSSION

Utilisation of climate-smart agricultural practices by the farming households

Table 1 provides a comprehensive overview of the utilisation of climate-smart agricultural practices (CSAPs) among farming households in the study area. CSAPs fall into four major categories: soil management, water management, crop management and farm management. Within the soil management practices, cover cropping and organic amendments emerged as the most frequently utilised, with weighted means of 3.94 and 3.62, respectively. This high utilisation shows farmers' recognition of the importance of maintaining soil fertility, improving organic matter content and preventing erosion, all of which are fundamental for sustaining crop yields under changing climatic conditions. Cover cropping, in particular, provides multiple benefits, including weed suppression, moisture retention and enhanced soil nutrient availability, which directly influence productivity and, ultimately, household food security.

Underwater management practices, irrigation management (= 3.87) and the planting of drought-tolerant crops (= 3.60) were the most frequently used climate smart agricultural practices. This preference shows farmers' responsiveness to water scarcity and rainfall variability, which characterise Niger State. By implementing effective irrigation systems and adopting drought-tolerant varieties, farmers can buffer their production against extended dry spells, stabilise yields, and reduce vulnerability to climate-induced food insecurity. These practices also improve water use efficiency, supporting sustainability and resilience in farming operations.

In crop management, crop diversification and crop rotation were widely used, with crop diversification recording the highest weighted mean score (3.89). This trend suggests that farmers are actively employing strategies to reduce pest and disease pressures, improve soil

fertility and mitigate risks associated with monocropping under unpredictable climatic conditions. Crop diversification not only enhances ecological balance but also increases the variety of food available for household consumption, thereby supporting food security.

Table 1: Utilization of climate smart agricultural practices by the respondents

Variable	Frequently Used (%)	Freq.	Occasionally Used (%)	Freq.	Rarely Used (%)	Freq.	Not Used (%)	WS	WM	Remark
Soil management CSA										
Cover cropping	235 (95.1)		11 (4.5)		0 (0.0)		1 (0.4)	974	3.94	Frequently
Organic amendments	154 (62.3)		92 (37.2)		1 (0.4)		0 (0.0)	894	3.62	Frequently
Mixed cropping	150 (60.7)		96 (38.9)		0 (0.0)		1 (0.4)	889	3.60	Frequently
Mulching	72 (29.1)		169 (68.4)		6 (2.4)		0 (0.0)	807	3.27	Frequently
Conservation agriculture	101 (40.9)		145 (58.7)		1 (0.4)		0 (0.0)	841	3.40	Frequently
Reduce tillage	81 (32.8)		158 (64.0)		8 (3.2)		0 (0.0)	814	3.30	Frequently
Water management CSA										
Irrigation management	214 (86.6)		33 (13.4)		0 (0.0)		0 (0.0)	955	3.87	Frequently
Drought-tolerant crops	148 (59.9)		99 (40.1)		0 (0.0)		0 (0.0)	889	3.60	Frequently
Water conservation	100 (40.5)		147 (59.5)		0 (0.0)		0 (0.0)	841	3.40	Frequently
Efficient water use	103 (41.7)		144 (58.3)		0 (0.0)		0 (0.0)	844	3.42	Frequently
Crop management CSA										
Crop diversification	219 (88.7)		28 (11.3)		0 (0.0)		0 (0.0)	960	3.89	Frequently
Crop rotation	91 (36.8)		156 (63.2)		0 (0.0)		0 (0.0)	832	3.37	Frequently
Climate-resilient crop varieties	154 (62.3)		93 (37.7)		0 (0.0)		0 (0.0)	895	3.62	Frequently
Integrated pest management	137 (55.5)		110 (44.5)		0 (0.0)		0 (0.0)	878	3.55	Frequently
Agroforestry	90 (36.4)		147 (59.5)		10 (4.0)		0 (0.0)	821	3.32	Frequently
Farm management CSA										
Climate information & early warning	199 (80.6)		48 (19.4)		0 (0.0)		0 (0.0)	940	3.81	Frequently
Farm mechanization & technology	139 (56.3)		108 (43.7)		0 (0.0)		0 (0.0)	880	3.56	Frequently
Climate-smart farm planning	111 (44.9)		135 (54.7)		1 (0.4)		0 (0.0)	851	3.45	Frequently
Insurance & risk management	126 (51.0)		121 (49.0)		0 (0.0)		0 (0.0)	867	3.51	Frequently
Sustainable livestock management	91 (36.8)		147 (59.5)		9 (3.6)		0 (0.0)	823	3.33	Frequently

Source: Field survey, 2025

More so, under farm management practices, climate information and early warning systems (= 3.81), and farm mechanization and technology (= 3.56) were widely utilized. These findings suggest that farmers value timely access to climate data and technological innovations as critical

enablers of informed decision-making, improved efficiency, and risk reduction. Integrating climate information with mechanised farming allows farmers to optimise input use, schedule operations more effectively and respond proactively to adverse weather events.

This finding aligns with the study by Tabe-Ojong *et al.* (2023), who reported that smallholder farmers in Northern Nigeria who frequently employed soil, water and crop management CSAPs experienced improved resilience, increased productivity and enhanced household food security.

Factors influencing utilisation of climate-smart agricultural practices as adaptation strategies

Table 2 presents the regression estimates of factors influencing the utilisation of climate-smart agricultural practices (CSAPs) as adaptation strategies among farming households in the study area. The results show a coefficient of determination (R-squared) of 0.7242, indicating that approximately 72% of the variation in the utilisation of CSAP adaptation strategies is explained by the socioeconomic and institutional variables included in the model. This high explanatory power suggests that the model effectively captures the major determinants influencing utilisation of CSAP adaptation strategies. The remaining 28% may be attributable to unobserved factors or measurement errors. The model's overall significance is further supported by the F-statistic of 16.27, which is significant at the 0.01 probability level, confirming that the model is robust and appropriate for the study. Of the eleven variables included, seven were positive and statistically significant: age, education, household size, farming experience, farm income and extension contact. Each variable has a distinct influence on CSAP utilisation and adaptation strategies, highlighting their critical role in shaping adaptive agricultural behaviour.

The coefficient of age (4.5636, $p < 0.05$) was positive and statistically significant at the 5% level, implying that, holding all other factors constant, an increase in the farmer's age is associated with increased utilisation of CSAP adaptation strategies. This outcome may reflect older farmers' accumulated experience and knowledge, which can strengthen their understanding of the benefits of sustainable practices. Older farmers may also have stronger decision-making and risk-assessment skills, allowing them to adopt practices that support long-term farm sustainability and resilience to climate variability. This finding aligns with Jones *et al.* (2021), who found that age positively influenced the adoption of climate-resilient practices among

smallholder farmers in Nigeria, as older farmers were more likely to integrate knowledge and experience into practical farm management decisions.

Table 2: Regression estimates of factors influencing the climate smart agricultural practice adaptation strategies

Variable	Coefficient	Standard Error	t-value
Age	4.563641**	2.131127	2.14
Number of years of education	1.134039**	0.5401531	2.10
Household size	3.168079**	1.15701	2.74
Gender	0.927530	2.13065	0.44
Farming experience	2.552921***	0.4069188	6.27
Years of practicing CSAPs	0.5752123	0.4171094	1.38
Off farm income	-0.0005816	0.0027852	-0.21
Farm size	0.4537384	0.4483267	1.01
Farm income	0.0000528***	0.00000956	5.52
Extension contacts	168.4685**	68.7343	2.45
Credit	-6.149973	6.662436	-0.92
Constant	313.9791*	169.3397	1.85
F-statistics	16.27		
R-squared	0.7242		
Prob > F	0.0000		

Source: Field survey, 2025

The coefficient of education (1.1340, $p < 0.05$) was positive and statistically significant at the 5% level, indicating that, holding all other factors constant, higher educational attainment is associated with greater utilisation of CSAP adaptation strategies. This outcome can be attributed to the fact that education equips farmers with the cognitive skills necessary to comprehend technical information, evaluate adaptation strategies critically and implement innovative agricultural practices effectively. Educated farmers are more likely to seek information, interpret

climate data and adopt management techniques that improve resilience and productivity. This finding corroborates the study by Tadesse and Ahmed (2023), which reported that higher education significantly enhances awareness and adoption of climate-smart agricultural practices among Nigerian farmers.

The coefficient of household size (3.1680, $p < 0.05$) was positive and statistically significant at the 5% level, implying that, holding all other factors constant, an increase in household size could lead to increased utilisation of CSAP adaptation strategies. Larger households are more likely to utilise CSAP adaptation strategies. This can be explained by the increased availability of family labour in larger households, which facilitates the timely implementation of labour-intensive practices. Adequate labour supply reduces reliance on hired labour and ensures efficient execution of farm operations, enhancing the effectiveness of climate-smart interventions. This finding is consistent with Gwambene (2020) and Barasa *et al.* (2021), who reported that household size positively influences the adoption of agricultural innovations because it increases labour availability in smallholder farming systems.

The coefficient of farm income (0.0000528, $p < 0.01$) was positive and statistically significant at the 1% level, indicating that higher farm income could lead to greater utilisation of CSAP adaptation strategies. Higher farm income enhances the adoption of CSAP adaptation strategies. This is because increased financial resources allow farmers to invest in improved inputs, irrigation and other technologies necessary for climate-smart agriculture. Adequate income reduces the risks associated with trying new practices and encourages innovation. This finding corroborates Gebre *et al.* (2023), who observed that farm income positively influences the adoption of sustainable agricultural practices in Africa.

The coefficient of extension contacts (168.4685, $p < 0.05$) was positive and statistically significant at the 5% level, suggesting that increased extension contacts could increase CSAP adoption in farming households. Frequent interaction with extension agents increases the utilisation of CSAP adaptation strategies. Extension services provide critical technical knowledge, guidance on climate-smart techniques, and updates on innovations, enabling farmers to implement these practices effectively. This finding is consistent with earlier studies by Gwambene (2020), who reported that access to extension services significantly increases farmers' adoption of improved agricultural technologies through knowledge transfer and

technical support. Similarly, Jones *et al.* (2021) found that frequent extension contact enhances farmers' understanding and uptake of climate adaptation practices by improving awareness and reducing information gaps.

CONCLUSION AND RECOMMENDATIONS

This study concluded that farming households generally used climate-smart agricultural practices at high levels, though some practices showed moderate adoption. Farming households in the study area frequently used practices such as cover cropping, organic amendments, mixed cropping, irrigation management, crop diversification, climate-resilient crop varieties, integrated pest management, climate information and early warning systems, farm mechanisation and insurance-based risk management. Meanwhile, factors such as age, education, household size, farming experience, farm income and extension contacts significantly influenced climate-smart agricultural practice adaptation strategies among farming households. Based on the findings of the study, the following recommendations are made:

- i. The widespread use of climate-smart agricultural practices such as cover cropping, organic amendments, irrigation management, and crop diversification should be strengthened through targeted input subsidy programmes implemented by the State Ministry of Agriculture in collaboration with relevant financial institutions. In addition, farmer cooperatives and producer associations should actively facilitate bulk procurement of improved seeds, organic fertilisers, and water-efficient technologies to reduce farmers' cost burden and increase adoption.
- ii. Given that age, education, household size, farming experience, farm income, and extension contact significantly influence adoption of climate-smart agricultural practices, the State Government, in collaboration with agricultural development agencies and non-governmental organisations (NGOs), should intensify personalised extension delivery services and establish structured certification schemes for CSA adopters. Furthermore, commercial banks and agricultural finance institutions should design conditional credit facilities and subsidy-linked financing programmes targeted specifically at certified CSA farmers to encourage sustained and widespread adoption of climate-smart practices

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