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Adoption of Climate-Smart Practices among Arable Crop Farmers in Kogi State, Nigeria

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Abstract
This study examined the adoption of climate-smart practices among arable crop farmers in Kogi State, Nigeria. A three-stage sampling procedure was used to select two hundred and thirteen (213) arable crop farmers in the study area. A structured questionnaire was used for data collection. Data collected were analysed using frequency, percentage, mean, and Tobit regression. Findings showed that mixed cropping system (88.3%), planting of trees (77.3%), and changing planting date (79.8%) were the most adopted climate-smart practices in the study area. Also, 45.1% and 34.7% had high adoption and very high adoption of climate-smart practices, respectively. The most severe constraints faced by arable crop farmers were the high cost of input ($\bar{X}$ =2.78), inadequate training on climate-smart practices ($\bar{X}$ =2.74) ,and lack of finance ($\bar{X}$ =2.69). The coefficient of age (β=-0.01), farming experience (β=0.07), and

access to extension (β=-0.07) influenced the adoption of climate-smart practices. It is recommended that training should be organized for arable crop farmers that will update their knowledge on climate-friendly practices in order to control the negative effects of climate change.

Introduction

Agriculture is the major sustenance of livelihood for a greater portion of inhabitants in Nigeria (Udemezie, 2019). Arable crop farmers are agriculturalists who cultivate and manage land for the production of crops such as fruits, vegetables, grains, and legumes. The number of arable crop farmers in full or part-time farming in Nigeria has increased drastically due to the increase in youth unemployment and the negative attitude of the government to entrepreneurship development (Pelemo et al., 2019). The Nigerian government's inability to invest in entrepreneurship and skills acquisition for stranded youths has increased the number of farmers in the country, thereby making farming a competitive enterprise. Farming in Nigeria is mostly concentrated in rural areas due to the vast and fertile land that differentiates it from urban centres, where urbanization and industrial development have prevented farmers from accessing enough farmland for farming. However, despite the number of workers in farming, food unavailability and poverty persist in Nigeria (Elum and Okorodudu, 2021).

Farmers' outputs over the years have been subdued by the unprecedented effects of climate change, such as changes in temperature, flooding, outbreaks of pests and diseases, and drought (Musafiri et al., 2022). Also, the erratic nature of rain and high temperatures have negatively impacted arable crop farmers over time, resulting in a reduction in output. Climate as an environmental factor had severe and unprecedented consequences on agricultural productivity by hampering the crops grown and the duration of the planting season (Adebayo and Ojogu, 2019). Climate change poses a serious threat to both arable and livestock farmers' productivity in Nigeria. High temperatures arising from inadequate rainfall could result in crop failure and a reduction in the performance of poultry, micro-land animals, and ruminant animals. Moussa et al. (2019) reported that arable crop farmers are one of the most terribly affected by severe consequences of climate change. Climate change is a serious challenge in Sub-Saharan Africa due to the high poverty rate, subsistence level of production, land degradation, desertification, and improper adoption of control measures for tackling the menace associated with climate change (Jacob, 2021).

One of the major solutions to climate change is the application of climate-smart agriculture. Climate-smart agricultural practices imply the application of smart practices to reduce the effect of climate change (Zheng et al., 2024). Climate-smart practices are aimed at building a resilient farming system that will reduce climate change effects and increase the productivity and well-being of farmers. Recently, a few states in Nigeria, Kogi included, suffered from floods that severely affected arable crops and livestock farmers (Izuagbe et al., 2023). A larger percentage of rice farms and few other crops were washed away as a result of the flood (Kilani et al., 2023). The effect of the flood on wellbeing and livelihood status can never be underestimated, as many jobs were lost while a few individuals ended up becoming homeless.

Apart from influencing rural farmers negatively, the livelihood status of the urban populace was also affected, and the prices of food items skyrocketed (Izuagbe et al., 2023). Climate-smart agricultural practices include the application of cover crops, planting of trees, erosion control, avoidance of grazing, mixed cropping systems, adoption of irrigation farming systems, water preservation, crop diversification, changing planting dates, timely planting, and harvesting (Ekpa et al., 2021).

The adoption of climate-smart practices is expected to address the negative effects of climate change on arable crop farmers. Numerous studies have been carried out on climate-smart practices. Omer (2020) worked on the adoption of climate-smart agricultural practices among small-scale farmers, and Ekpa (2021), on the other hand, analysed the challenges of climate-smart agricultural practices among crop farmers in the northwest of Nigeria. Overcoming the challenges associated with climate-smart practices will reduce the negative impact of climate change. Ekpa (2024) focused on climate-smart indicators on sorghum enterprises in Katsina and Sokoto States, while Zhen et al. (2024) determined climate-smart agricultural practices for enhanced farm productivity, income, resilience, and greenhouse gas mitigation. However, there is a knowledge gap on the adoption of climate-smart practices among arable crop farmers in Kogi State. Therefore, this research is very important due to recurrent climate-related issues like floods in Kogi State. However, addressing climate-related challenges is vital for sustainable food security among arable crop farmers.

Specifically, the study identified the climate-smart practices among arable crop farmers, determined the level of adoption of climate-smart practices, examined constraints to the adoption of climate-smart practices, and determined the factors influencing the adoption of climate-smart practices.

Methodology

The research was carried out in Kogi State which is in North Central Zone. The State has latitudes 6^0 33' and 8^0 44'N and longitudes 5^0 22' and 7^0 49' E. The State has a population of approximately 5,053,734 people as of 2023 and about 2 million hectares of land (National Bureau of Statistics, 2023). The availability of vast land in the State eases the cultivation of arable crops such as yam, cassava, maize, sorghum, rice, cowpea, and groundnut. A three-stage sampling procedure was employed for this study. The first stage involved a random selection of one local government area (LGAs) from the four agricultural zones in the State. In the second stage, three villages were selected randomly from the selected LGAs making a total of 12 villages. The third stage involved the use of proportionate sampling to select 10% of arable crop farmers from the sample population of 2134 in the chosen villages, which gave a total of 213 arable farmers selected for this study.

Table 1: Sample of arable crop farmers in Kogi State

Agricultural Zones	LGA	Villages	Sample population	Sample size
A	Yagba West	Ejiba	160	16
		Odo-ere	204	20
		Igbaruku	103	10
B	Dekina	Abocho	191	19
		Egume	110	11
		Ojodu	152	15
C	Kogi	Kotonkarfe	232	23
		Ozi	150	15
		Gegu	184	18
D	Idah	Ichala	291	29
		Icheke	174	17
		Nwajaba	183	18
Total			2134	213

Primary data was collected with the assistance of highly trained enumerators using a questionnaire. Objectives one and three were achieved using frequency, percentage, and mean. Objective two was achieved using the adoption index. The index is expressed below;

$$CSAI = \frac{\text{Number of climate-smart practices adopted by ith respondent}}{\text{Total number of climate-smart practices}} \times 100$$

Y=Climate Smart Adoption Index (CSAI)

The categorization is stated below:

$\leq$ 0.25 = very low adoption, 0.26-0.49 = low adoption, 0.50-0.75 = high adoption, $\geq$ 0.76 = very high adoption (Mohammed *et al.,* 2021). The climate smart practices considered were (crop rotation, mixed cropping system, changing of planting date, planting of trees, application of organic fertilizer, mulching, early harvesting, erosion control, planting of early maturing crops, use of compost mature, and water harvesting. Constraints to the adoption of climate-smart practices were measured using a 3-point Likert type scale of very severe 3, severe 2 and not severe 1. The overall constraint was classified into severe for mean score value of $\geq$2, while those with mean score value <2 indicated not severe. Objective four was achieved using Tobit regression model. The implicit and explicit forms are specified as follows:

$Y = \alpha + X_i \beta + \varepsilon_i$ …………………………………… (1)

$Y = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 \ldots \beta_n X_n$…………….. (2)

Where:

Y= Climate Smart Adoption Index(CSAI)

The independent variables are:

X_1=Age (Years)

X_2=Education level (years)
X_3=House-hold size (number)
X_4=Access to credit (naira)
X_5 = farming experience (years)
X_6=Extension visit (number)
X_7 = farm size (hectare)
X_8=Flood times (numbers in the last cropping season)
X_9 =drought times (numbers in the last cropping season)
X_{10}=Rainfall (numbers in the last cropping season)

Results and Discussion

Climate-Smart Practices Adopted by Arable Crops Farmers

Table 2 reveals that the most adopted climate-smart practices by arable crop farmers were mixed cropping system (88.3%), changing planting date (79.8%), planting of trees (77.3%), application of organic fertilizer (73.7%), use of mulching (67.6%), early harvesting (64.8%), planting of cover crops (61.9%), and erosion control (57.8%). These findings agree with those of Adebayo and Ojogu (2019), that mixed cropping, changing planting dates, and applying organic manure were the most climate-smart practices adopted in Ogun State, Nigeria. Similar findings by Eta et al. (2023) reported that early harvesting, planting of cover crops, and use of mulching and cover crops were the most climate-smart practices among crop farmers in Cross River State of Nigeria. Also, Okonta et al. (2023) reported that the application of crop rotation and organic fertilizer can enhance soil fertility among farmers. This implies that climate change is well-pronounced in the study area.

The least climate-smart practices practiced by arable crop farmers were the use of compost mature (22.5%), and water harvesting practices (8.0%). These practices are not common in the study area.

Table 2: Climate-smart practices adopted by arable crop farmers

Climate-smart practices	Percentage
Crop rotation	98.6
Mixed cropping system	88.3
Changing in planting date	79.8
Planting of trees	77.9
Application of organic fertilizer	73.7
Use of mulching	67.6
Early harvesting	64.8
Planting of cover crop	61.9
Erosion control	57.8
Planting of early maturing crops	44.6
Use of compost mature	22.5
Water harvesting	8.0

Sources: Field survey, 2023

Categorization of Adoption of Climate-Smart Practices

Table 3 reveals that 45.1 percent of the respondents had a high adoption of climate-smart practices, while 34.7% had a very high adoption of climate-smart practices. It can be seen that a greater percentage of arable crop farmers adopted climate-smart practices, which might be attributed to the menace of past experiences recorded from uncontrollable climate change such as floods that affected rural farming households around Lokoja and other affected areas in the State (Kilani et al., 2023). A high level of adoption by arable crop farmers is expected to build more reliable resilience for climate change mitigation. This finding concurs with that of Omer and Hassen (2020), who reported high adoption of climate-smart agriculture among arable crop farmers in Sub-Saharan Africa. Eta et al. (2023) also reported high adoption of climate change mitigation measures among arable crop farmers in Cross River State.

Table 3: Categorisation of adoption of climate-smart practices

Variables	**Adoption range**	**Percentage**
Very high adoption	>0.76	34.7
High adoption	0.50-0.75	45.1
Low adoption	0.26-0.49	14.6
Very low adoption	$\leq$25	5.6

Sources: Field survey, 2023

Constraints to Adoption of Climate Smart Practices

Table 4 indicates that the high cost of input ($\bar{x}$ =2.78) was the most severe constraint on the adoption of climate-smart practices. This suggests that the exorbitant prices of improved seeds of arable crops and other agricultural incentives needed to control the menace of climate change are high in Nigeria due to high inflation. Also, the prices of inputs such as organic and inorganic fertilizers in Nigeria are high, and this has affected arable crop farmers' ability to seamlessly mitigate climate effects. Ekpa et al. (2021) stated that the high cost of inputs is a serious problem facing the adoption of climate-smart practices in Nigeria. Inadequate training on climate-smart practices ($\bar{x}$=2.74) is another severe constraint facing the adoption of climate-smart practices. The lack of adequate training on capacity building for the resilient adoption of climate-smart practices is lacking, which could be attributed to poor extension service delivery that arises from the problem of inadequate personnel and a lack of government intervention programs in the study area. Lack of finance ($\bar{x}$=2.69) is another severe constraint. Adoption of climate-smart practices is capital-intensive and could not be properly adopted by poor farmers. Lack of government support ($\bar{x}$=2.68) is another important constraint. The governments at all levels have not been supportive despite the unprecedented impact of climate change on crops and animals, which has increased the prices of agricultural produce in Nigeria (Nigeria Climate Scorecard, 2021). However, the land tenure system ($\bar{X}$ =1.46) was not a severe constraint facing the adoption of climate-smart practices.

Table 4: Constraints facing the adoption of climate-smart practices

Constraints	Mean
High cost of inputs	2.78
Inadequate training on CSAP	2.74
Lack of finance	2.69
Lack of government support	2.68
Climate-smart practices are cost expensive	2.59
Inadequate knowledge	2.51
Lack of technical know how	2.30
Lack of access high quality breed	2.13
High labour cost	2.08
Land tenure system	1.46

Sources: Field survey, 2023

Factors Influencing Adoption of Climate-Smart Practices

Table 5 shows the results of factors influencing the adoption of climate-smart practices using the Tobit Regression Model. The result indicated a Pseudo R^2 of 0.557. This signifies that 55.7% of the variation in the adoption of climate-smart practices was explained by the independent variables included in the model. Age (-0.01) negatively influenced the adoption of climate-smart practices. This indicates that as arable farmers increase in age, the adoption of climate-smart reduces. This finding is in tandem with that of Ndun'u et al. (2023) who stated that older farmers may not likely adopt climate-smart agricultural practices. Farming experience (0.01) positively influenced the adoption of climate-smart practices. This signifies that an increase in farming experience will increase the adoption of climate-smart practices. Many years in farming are expected to serve as practical experience acquired over a long period of time that will increase climate-smart practices. The finding concurs with that of Diallo et al. (2019), who reported that an increase in farming experience influences the adoption of climate-smart practices. Onu et al. (2023) reported that an increase in farming experience will enhance youths' involvement in sweet potato farming in Abia State. Extension access (-0.07) negatively influenced the adoption of climate-smart practices. This indicates that access to extension services will not necessarily increase the adoption of climate-smart practices. This might be due to resistance to change among farmers, limited resources, and a lack of awareness of the benefits embedded in the adoption of climate-smart practices.

Table 5: Factors influencing adoption of climate-smart practices

Variables	Coefficient	t-value
Age	-0.0079824	-2.14**
Educational level	0.008415	1.66*
Household size	-.0065861	-1.01
Credit access	1.27e-07	0.91
Farming experience	0.0071814	2.09**
Extension access	-0.0718049	-2.89***
Farm size	0.027179	0.92
Flood time	0.0199604	0.49
Drought time	0.0856094	0.99
Rainfall	0.0014032	0.55
Constant	-0.4817857	-3.03***
Chi2	30.92***	
Pseudo R2	0.5573	
Log likelihood	-82.80253	

Sources: Field survey, 2023
***P≤0.01, **P≤0.05

Conclusion and Recommendations

It can be concluded that mixed cropping systems, planting of trees and changing planting date were the most used climate-smart practices. Also, there is high adoption of climate-smart practices among arable crop farmers. The severe constraints to climate-smart practices were the high cost of inputs, inadequate training on CSAP and lack of finance. Age and farming experience influenced the adoption of climate-smart practices. It is recommended that inputs be subsidized at affordable prices by the government in order to mitigate the effects of climate change on arable crops. Also, training should be organized for arable crop farmers that will equip them with knowledge of climate-friendly practices to control the negative effects of climate change. Older farmers should be sensitized to the need to practice climate-smart agriculture in Kogi State. Lastly, the adoption of water harvesting practices should be prioritized among arable farmers.

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