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Adoption of Climate Smart Agricultural Practices among Maize Farmers in Agricultural Zone B, Kogi State, Nigeria

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Abstract
This study analysed the adoption of climate-smart agricultural practices (CSAPs) among maize farmers in Agricultural Zone B, Kogi State, Nigeria. The study employed multi-stage sampling procedure to select 120 respondents, eliciting primary information through a well-structured questionnaire. Data collected were analysed using frequency, percentage, mean and Tobit regression analysis. Results reveal that early planting (84.8%), planting of cover crops to maintain soil moisture (84.8%) farmers' reliance on personal experience to predict weather (79.7%), organic manuring (77.1%), mixed cropping (77.1%) and crop rotation (71.2%) were the major CSAPs used. Clashes with herdsmen ($\bar{x} = 2.61$), inadequate credit facilities ($\bar{x} = 2.32$,) high cost of improved crop varieties ($\bar{x} = 2.31$), high cost of irrigation facilities ($\bar{x} = 2.24$), inadequate access to extension services ($\bar{x} = 2.18$) were the limitations to CSAPs adoption by maize farmers in the area. Age (β= 0.03), level of education (β=0.81), access to extension services (β=0.02), awareness of climate change (β=2.13) and access to information on climate smart agriculture (β=0.02) influenced maize farmers' CSAPs adoption. The study concludes that maize farmers in the area adopted CSAPs. Therefore, pulling resources together to acquire climate smart inputs among maize farmers in the face of climate change is indispensable to provide resilience against negative consequences.

Keywords: Climate Smart Agricultural Practices, Adoption, Income, Maize farmers

Introduction

Maize (Zea mays) is regarded as the most significant cereal crop with diverse global applications, and its cultivation spans all over the world (Erenstein, 2022). Its production is typically affected by climate change and other global factors. Extreme

rainfall and other climatic elements of weather could lead to crop failure, reduced crop yield, with great consequences on agricultural productivity, food security and economic stability (Alotaibi, 2023). For instance, the maize crop has a high water requirement, because it is a “water-loving” crop that detests inadequate rainfall and evapotranspiration. Maize farmers could reduce the climate change impact on the maize crop by adopting climate-smart agricultural practices (CSA), which could provide resilience and sustenance of the crop amid adverse weather conditions.

Climate-smart agriculture encompasses agricultural practices designed for environmental conservation in response to climate change, to meet the food demands of a burgeoning global population (Food and Agriculture Organisation (FAO), 2021). Food and Agriculture initiated the concept of climate change in 2010 after the Hague conference targeting agriculture held in 2009 (World Bank, 2020). CSA could be seen as the means of repackaging agriculture amid climate change which aims at enhancing adaptation, mitigation and development of agriculture despite the consequences of the current global challenges confronting agriculture (Grigorieva et al., 2023).

According to Shea (2021), CSA is a focus-based concept that includes the creation of new technologies that facilitate farmers' shift to more climate-aware practices and provide for the cessation or reduction of operations that raise greenhouse gas emissions. In order to improve agricultural performance, climate-smart agriculture uses techniques that can manage land sustainably, such as applying organic manure, planting trees, and managing water (Mbanasor et al., 2024). It makes it possible to use skills and knowledge effectively, access and disseminate information about climate change, and improve the efficiency of pro-environmental technologies, which may strengthen relationships and help farmers bargain for higher market prices (Grigorieva et al., 2023).

Through 2050, global agricultural output may decline by 2% every ten years, while food consumption is expected to rise by 14% every ten years due to urbanisation, population expansion, and rising incomes (Kumar et al., 2024). In the majority of poor nations that are very vulnerable to the effects of climate change, small and medium-sized farmers practice rain-fed agriculture (Omotosho et al., 2023). Some farmers' inadequate adaptation strategies are a result of their failure to comprehend the effects of climate change (Abbass et al., 2022). Adoption of climate-smart agricultural methods that can offer resilience is essential to lessen the detrimental effects of climate.

Climate-smart agricultural practices offer the conceptual underpinnings that improve climate change adaptation and mitigation while promoting food security (Anuga et al., 2019). Sustainable development is the foundation for the farm-level implementation of Agricultural Practices with Climate Smart Agriculture Potentials (AP-CSAPs) (Ma and Rahut, 2024). The CSA promotes resilience, agricultural capacity and food systems, while eradicating or reducing greenhouse gases, therefore boosting national food security (Oyawole et al., 2020). Despite CSA's conceptual potential and success across Africa's different agro-ecologies and socio-economic settings, its appeal and positive effects are limited and most likely nonexistent (Saadu et al., 2024). The impact of CSA on food security, farming households, and other crops was the focus of earlier studies on climate-smart agriculture (Pelemo et al., 2024; Opeyemi et al., 2021; Saadu et al., 2024). However, there are few empirical studies on the adoption of climate-smart agricultural

practices, even though the study area's maize production is a staple crop and that climate change is a real concern. Therefore, this study specifically sought to:

i. ascertain the common climate smart agricultural practices adopted by maize farmers in the study area,
ii. identify the limitations facing maize farmers in climate smart agricultural practices adoption in the study area,
iii. determine the factors influencing climate smart agricultural practices adoption among maize farmers in the study area.

Methodology

The study was conducted in Agricultural Zone B, Kogi State, Nigeria. The state has 21 Local Government Areas (LGAs) and a total area of 29,833 square kilometers. The state experiences rainfall between April and October with peak between June and October which sometimes leads to flooding. The study population comprises of maize farmers in agricultural Zone B of Kogi State, Nigeria. The study employed multi-stage sampling procedure in selecting respondents in the study area. In stage one, two LGAs (Dekina and Omala) out of four LGAs in the zone were selected. In stage two, three farming communities were randomly selected from each LGA, from Dekina LGA - Agala-Ate,Iyale and Ogojeju communities were selected, while Ofejiji, Agbenema and Ajejima communities were selected from Omala LGA. In stage three, 10% of the registered maize farmers were randomly selected from the six farming communities to give a total sample size of 120 respondents from - Agala-Ate (15), Iyale (25), Ogojeju (20), Ofejiji (20), Agbenema (14) and Ajejima (26). Primary data for the study was collected with the aid of a well-structured questionnaire. Frequency, percentage, mean score and Tobit regression were used for data analysis. Common climate smart agricultural practices adopted by the maize farmers was ascertained using frequency and percentage. Climate smart agricultural practices - Adoption index (CSAPs-AI) adapted from Mohammed et al. (2019) and Pelemo et al. (2024) was used to measure CSAPs adoption by maize farmers respectively.

$$\text{CSAPs} - \text{AI} = \frac{\text{Number of CSAPs adopted by maize farmer}}{\text{Total number of CSAPs}} \text{ x } 100 \qquad (1)$$

Where:

CSAPs-AI = Climate smart agricultural practices- Adoption Index

Hence, CSAPs adoption among maize farmers were measured as high adoption, if the value is greater than or equals 0.76, moderate adoption ranges from 0.5 – 0.75, low adoption ranges from 0.26 - 0.49, while very low adoption equals or less than 0.25.

3-point Likert scale

Mean score from 3-point Likert scale was employed to identify the limitations facing maize farmers in effectively adopting climate-smart agricultural practices following other empirical studies by Ajibade et al. (2021) and Dossa et al. (2023). Rating very serious (3),serious (2) and not serious (1) with real limits of 2.50-3.49; 1.50-2.29; 0.50-1.49 respectively. Any mean score from 2.0 upward indicates a very serious limitation, while less than 2.0 mean score was regarded as not serious limitation.

$$\bar{X} = \frac{\sum FX}{N} \quad (2)$$

Where:

$\bar{X}$ = mean score

∑= summation,

F= number of respondents choosing a particular scale point,

X = numerical value of the scale point and

N = total number of respondents to the item

Tobit Regression

Tobit regression analysis was used to determine the factors influencing climate - smart agricultural practices adoption among maize farmers. The dependent variable (Y*) was the CSAPs- AI among maize farmers, while the independent variables (X_1,X_2, X_3,…..X_n) captured in model were age, Farming experience, education, income, household size, access to extension services, awareness on climate change, information on CSA) the analytical tool following other past empirical studies by Pelemo et al. (2024). The implicit and explicit forms of the model are specified below respectively;

$$Y^* = \alpha + \beta'X + \varepsilon_i \quad (3)$$

$$Y^* = \alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \varepsilon \quad (4)$$

Where:

Y* = Adoption

X1 = Age

X2 = Household size

X3 = Education

X4 =Farming experience

X5 = Access to extension service

X6 = Cooperatives

X7 = Awareness of climate change

X8 = Access to information on CSA

Results and Discussion

Common CSA practices adopted by maize farmers

The results in Table 1 reveal that early planting (84.6%), planting of cover crops (84.8%), personal experience to predict weather (79.7%), mixed cropping (77.1%), organic cropping (77.1%), mulching (61.9%), afforestation (60.7%) and crop rotation (71.2%) were the commonest CSA adopted by the respondents as resilience to climate change impact on maize production. Planting maize early offers resilience to sudden rain break, by ensuring the crop is well-established before potential drought or sudden cessation of rainfall. Maize has high water requirement, especially from sowing to tasseling and early planting allows the crop to develop a strong root system before water stress of rain break. This serves to lower the danger of withering, total crop failure and farmer losses (Jung et al*.,* 2023).

In addition to improving soil fertility and reducing soil erosion, planting cover crops can protect maize crops from the effects of climate change (Scavo et al*.,* 2022). In order to protect their crop from the detrimental effects of climate change, local maize farmers occasionally forecast the weather based on their years of expertise. However, because of periodic changes in the climatic factors, their projections might

not always be accurate (Ogunjinmi et al*.,* 2023). In order to combat climate change, maize farmers in the region have also embraced CSAPs including mixed planting and organic cropping.The mixture of other crops with maize could be a resilience against total crop failure or losses that could emanate as a result of changes in the elements of climate which may lead to pests and diseases outbreak, withering and poor yield (Adekola et al*.,* 2024). Application of organic manure has significant benefits on soil structure by binding the particles into aggregate which increases water infiltration capacity, reduces soil erosion and increase soil nutrient contents(Ramasamy et al*.,* 2024).Mulching, crop rotation and afforestation enhance conservation of soil moisture, improve soil fertility, reduces pests, diseases outbreak and balance nutrients removal from the soil respectively .Okonta et al. (2023) and Saadu et al*.* (2024) also found that organic manure and rotational cropping are the CSAPs improve soil fertility on farmland. These results agree with Bagula et al*.* (2023) and Kudumo et al*.* (2023) findings, in which they asserted that mulching and crop rotation conserve soil moisture content and enhance increase maize yield through soil fertility improvement. Osuji et al*.* (2025) also confirmed that crop rotation is a practice commonly adapted by smallholder farmers against climate change in Ebonyi State, Nigeria.

Table 1: Common CSA practices adopted by maize farmers (n= 120)

Climate smart agricultural practices	Percentage
Engage in mulching	61.9
Control of irrigation water	67.0
Early planting to meet with rain	84.8
Cover cropping	84.8
Rain water storage	67.0
Minimum tillage	65.3
Take crop insurance to predict weather events	46.6
Organic cropping	77.1
Afforestation	60.7
Mixed cropping	77.1
Crop rotation	71.2
Weather prediction by personal experience	79.7
Weather information from Radio/Television	55.9
Training on weather information by relevant organization	47.5
Sourcing for weather information through community center/agents	44.9

Source: Field survey, 2024.

Limitations Facing Maize Farmers in Adopting CSA Practices

The results in Table 2 reveal that clashes with herdsmen, inadequate labour supply*,* inadequate credit facilities, high cost of improved seed varieties*,* inadequate access to agricultural input, high cost of irrigation facilities, lack of technical know-how*,* limited access to micro-finance and insurance and inadequate access to extension services were rated as very serious limitations facing maize farmers in effectively practicing CSA in the study area. The issue of clashes between farmers and herdsmen is worrisome in the area. While farmers are battling with the impact of climate change ravaging globally, cattle are being released by herdsmen to graze on

the growing and surviving maize crops on the farm. This implies that the effort and resources of maize farmers in the study area were probably yielding less returns, thus, frustrating the desire for food security in the midst of climate change. This sometimes lead to fruitless efforts due to total crop loss and inability to break-even in agribusiness. These results agree with the findings of Shaibu et al*.* (2023), Dabo et al*.* (2024) and Ogunleye et al. (2024) where they discovered that destruction of crops by the cattle during grazing is quite alarming among crop farmers in Nigeria. Also, inadequate labour supply is a very serious limitation to CSAPs adoption in the area, especially when they are needed for land cultivation to meet up with timely planting, application of agro-chemicals, organic manure application, hoe weeding, harvesting of maize cobs to prevent loss of produce to flooding and other menace caused by adverse effect of climate change at maturity. Although, most maize farmers in the area operate on a small-scale, yet hired labour are not readily available for major farming operations that could serve as resilience to climate change.

Even when maize farmers are aware of how climate change may impact their crop production and perhaps the CSAPs they could implement, their access to credit is severely limited. Due to their inability to obtain loans or credit from financial institutions due to the lack of collateral security that may guarantee their ability to repay, many farmers may not have the funds necessary to put them into practice. As a result, they are unable to afford more expensive climate-smart inputs, such as enhanced seed types and irrigation facilities (Obianefo et al*.,* 2024).

Accessing extension services also limit maize farmers' ability to adopt climate smart agricultural practices. This implies that most farmers do not have up-to-date information on technologies that are most relevant to maize production in the face of climate change which may be due to the inability of the extension workers to reach out to the farmers in the study area. This result agrees with the findings of Ogundeji (2022), who discovered a serious gap in information knowledge between extension agents and farmers, which hinders dissemination and implementation of feasible climate smart agricultural practices by maize farmers in the study area (Izioguet al*.,* 2021)

Table 2: Limitations facing maize farmers in adopting CSA practices

LIMITATIONS	VS(%)	S(%)	NS(%)	TSS	MS
Lack of access to up to-date information	57.0	24.8	18.2	242	2.02
Inadequate credit facilities.	56.1	38.9	5.0	278	2.32
Lack of understanding of CSA practices	43.3	36.3	10.4	259	2.16
High cost of improved crop varieties	62.8	29.6	7.6	277	2.31
High cost of irrigation facilities	54.7	37.9	7.4	269	2.24
Lack of collateral security	50.0	35.8	14.2	246	2.05
Inadequate access to extension services	56.3	33.0	10.7	261	2.18
Limited access to micro-finance and insurance	55.9	34.2	9.9	263	2.19
Inadequate access to agricultural input	58.7	34.8	6.5	276	2.30
Lack of technical know-how	56.6	34.0	9.4	265	2.21
Inadequate labour supply	60.6	34.0	5.3	282	2.35
Clashes with herdsmen	84.4	10.9	4.8	313	2.61

Source: Field Survey, 2024

VS = Very Serious (%), S = Serious(%), NS = Not Serious(%), TSS = Total Sum of score, MS = Mean score

Factors Influencing Maize Farmers CSAPs Adoption among Maize Farmers

The results in Table 3 reveal the determinants of adoption of CSAPs among maize farmers in the study area. The results reveal a Pseudo R^2 value of 0.573, which implies that .57.3% variations in CSAPs adoption by maize farmers in the area was influenced by the explanatory variables (age, level of education, access to extension services, awareness of climate change and access to information on climate smart agriculture), while the remaining 42.7% could be embedded in the error term as a result of other variables of interest not captured in the model.. The coefficient of age (β=0.333) was negative and significant at 1% - indicating that the older the age of maize farmers the less they could be persuaded or willingly adopt CSAPs - which may be due to their primitive knowledge retention that can be difficult to change by the prevailing situation of climate change impact on their crop or by anyone. This result is in-line with the findings of Pelemo et al. (2024) and Ndung'uet al (2023) - affirming that older arable and smallholder farmers respectively do not adopt climate smart agricultural practices with ultimate eagerness like younger farmers.

The level of maize farmers education has a positive coefficient (β= 0.814) and was significant at 1%. This implies that the more educated the respondents are, the more knowledgeable they could be, to determine and adopt suitable CSAPs that would provide resilience to the challenges of climate change in maize production. The result is in tandem with the findings of Bengeza et al. (2023) who stated that educated farmer have ability to read, access information and make rational decision that will aid their agricultural production by extension adopting CSAPs would not be

difficult for them.

Also, coefficient of access to extension services (β=0.230) was positive and significant at 5%.The result implies that having contact with the extension workers would be an advantage to maize farmers, so that they can have up-to-date information on the new technologies and innovation on CSAPs that would aid their maize production in the midst of climate change. This collaborate with the findings of Abdulmumini et al. (2024) which affirmed that access to extension services enhance first- hand –information on CSAPs among maize farmers in Jigawa and Katsina States. Oyetunde-Usman and Shee (2023) also agree that access to extension services is one of the drivers of climate smart agriculture adoption among farmers. Inaddition, awareness of climate change had positive coefficient (β=2.165) which was significant at 1%. It means that if the maize farmers are fully aware of the impact of climate change on their crop and farmland, they will prepare adequately and adopt activities or practices that would reduce or prevent such on their crop and farmland. Furthermore, the coefficient (β=0.278) of access to information on climate smart agriculture was positive and significant at 5%. The implication is that the more access maize farmers have to information on various agricultural practices that could provide resilience to climate change, the more eager they will be willing to adopt them, because their main reason of been in the agribusiness is to make profit and not to accrue lost due to climate change negative impact. The result concur with the findings of Bengeza et al. (2023) who found out that 89% maize farmers in their study prefer to adopt climate smart agricultural practices instead of getting low yield with low profit or outright loss..

Table 3: Factors Influencing CSAPs Adoption among Maize Farmers

Variables	**Coef.**	**t-value**
Age	-0.033	0.001***
Household size	0.0521	0.865
Level of education	0.814	0.005***
Farming experience	0.892	0.981
Access to extension services	0.0230	0.012**
Cooperative	-3.330	0.281
Awareness of climate change	2.165	0.000***
Access to information on CSA	0.278	0.018**
Income	0.417	0.274
Farm size	-1.267	0.137
Constant	2.435	0.060*
Chi^2	92.75***	
Pseudo R^2	0.573	
Log likelihood	-34.58493	

Source: Field Survey, 2024

***, ** and * were significant at 1%, 5%, and 10% respectively.

Conclusion and Recommendation

The study concludes that early planting, cover cropping, rainwater harvesting and storage, and organic cropping are among the climate-smart agricultural methods used by maize farmers to increase their resistance to climate change. Adoption of CSAPs was limited due to clashes with herdsmen, high cost of improved seed and

inadequate labour supply. Respondents' age, level of education, access to extension services, awareness of climate change and access to information on climate smart agricultural practices influenced adoption of CSAPs among maize farmers. Therefore, maize farmers are to pull their resources together to purchase farm inputs that are needed for resilience against climate change. Also, government should increase the number of extension workers to educate maize farmers on regular basis on climate change impacts, new technologies, technical-know-how on CSAPs utilisation, while the community leaders should find lasting solution to farmers-herdsmen clashes in the area.

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