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Analysis of Adoption of Climate Smart Practices among Rice Farmers in Oyo State, Nigeria

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Abstract

This study evaluated the characteristics that influence rice farmers in Oyo State to adopt climate-smart agriculture practices. To interview 218 respondents using a structured questionnaire, a multi-stage sampling strategy was employed: sixteen villages were selected from two local government areas, and fourteen farmers were selected at random from each location. The data were analysed using descriptive statistics and Tobit regression. The results show that the adoption of agricultural innovations is favourably associated with the average farmer's age (47 years), primarily male (66%), and with an average of 10 years of formal education. Numerous factors, such as belonging to farmer associations (0.0319, P<0.01), farm size (0.0184, P<0.10) having climate awareness (-0.089, P<0.05), access to climate information (0.06501, P<0.10), and proximity of farms to households (0.0031, P<0.01), all affected the adoption of climate-smart practices. A large number of these farmers hold a neutral position to variations in temperature and precipitation. This suggests that more education and understanding about the effects of climate change on agriculture are obviously needed. These results highlight the necessity of focused government initiatives to promote climate-smart agriculture adoption in the research region. The study therefore recommended creating frameworks to encourage climate-smart agriculture and developing incentives to implement. The study therefore recommended that creating frameworks that encourage climate-smart agriculture, as well as developing incentives for implementing sustainable practices, should be a top priority for policymakers.

Introduction

Global crop production has increased dramatically over the years. Global agricultural output of primary crops increased by 54% between 2000 and 2021, reaching 9.5 billion tonnes in 2021, according to the Food and Agricultural Organization (FAO) of the United Nations. These crops were used as food, animal feed, or as inputs for converting into products ranging from biofuels to cosmetics (FAO 2022). One of the main primary crops produced is cereals of which rice is prominent example; in 2021, the world produced 787 million tonnes of rice, a 30% increase from 2000 (FAO 2022).

Within the genus Oryza, rice is a staple meal for more than half of the world's population, particularly in Asia, where China accounted for more than 212 million tonnes of worldwide output in 2021 (FAOSTAT, 2022). About 80% of freshly produced rice grains are carbohydrates, making them a good source of energy (Deepak and Prem, 2020). It is grown in a variety of climates, from temperate to tropical. Nigeria consumes more rice than any other country in Africa (Getachew *et al.*, 2017), and as the population grows and dietary habits change, so does the demand for rice. However, several factors, particularly the climate, make it difficult for Nigeria to meet its rice demand (Bamiro *et al*., 2020).

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To address this, Nigerian rice producers must employ certain techniques in order to meet the country's rice consumption requirement. Climate-smart strategies are some of the methods required for a rice farm to successfully fulfill Nigeria's high rice consumption demand (Oba *et al.*, 2022). Adopting climate-smart techniques is crucial to addressing the challenges posed by climate variability and change in Nigeria, where agriculture is the primary source of income for millions of people and contributes significantly to the country's economy (Aryal *et al*., 2020). The encouragement of agroforestry is a noteworthy illustration of climate-smart activities (Amadu *et al.*, 2020).

A range of sustainable techniques are included in climate-smart agriculture, which aims to reduce the consequences of climate change while boosting resilience and productivity (Subedi *et al.*, 2019). Using conservation agriculture methods is another crucial climate-smart activity (Pagliacci *et al*., 2020). Through the reduction of soil erosion and the improvement of soil structure, conservation agriculture increases yields, lowers input costs, and increases resilience to extreme weather events. These techniques include crop rotation, permanent soil cover, and minimal soil disturbance (Shrestha *et al*., 2020).

Farmers can reduce production risks and achieve stable yields even in unfavourable weather conditions by breeding and spreading plant varieties that are resistant to heat, drought, pests, and diseases. This is also crucial for ensuring food security and livelihood sustainability in the face of climate change (Nyang'au *et al*., 2021). Farmers may help with global efforts to mitigate climate change and promote sustainable development by implementing these techniques, to enable them adapt to changing climate circumstances (Sadar *et al*., 2021). The adoption of climate-smart methods by Nigerian farmers is hampered by several challenges, despite their potential benefits. Financial limitations, a lack of supportive government policies and incentives, a problem in climate-smart activities (Kapoury, 2023).

The adoption of climate-smart techniques can also be influenced by sociocultural factors, such as aversion to change and reliance on conventional farming methods (Bwema *et al.*, 2021). Developing successful strategies and policies to encourage the adoption of climate-smart practices by Nigerian rice farmers requires an understanding of the determining factors that influence their adoption. The agricultural sector can increase productivity, guarantee food security, strengthen its resilience to climate change, and support sustainable development in Nigeria by recognizing and addressing these factors (Yoselin *et al*., 2023).

According to this perspective, the following research issues will be addressed: How do rice farmers view the effects of climate change?. What climate-smart strategies are rice farmers now implementing?. What are the driving forces behind rice farmers' adoption of climate-smart practices?

Materials and Methods

Description of the Study Area

On February 3, 1976, Oyo State was established from the Western State of Nigeria. As the ancestral home of the Yoruba people, it holds historical significance as the site of the once-dominant Oyo Empire, which flourished from the late 19th century until the 14th century. With the Alaafin of Oyo playing a significant role in government, the empire was renowned for its highly developed political system and military might. With a total area of 28,454 square kilometers, Oyo State is bounded to the north by Kwara State, to the east by Osun State, to the south by Ogun State, and to the west by the Republic of Benin. The terrain is made up of dome-shaped hills and old hard rocks, and the heights range from roughly 500 meters in the south to 1,219 meters in the north. The state has an equatorial climate with separate wet and dry seasons. The rainy season runs from April to October, while the dry season runs from November to March. All year long, the average temperature is between 25 °C (77 °F) and 35 °C (95 °F). With yams, maize, cassava, millet, rice, and cocoa as its main crops, agriculture is the main driver of Oyo State's economy. The state also boasts a wide range of cottage industries, including wood carving, leatherworking, and textiles. Ibadan's notable sectors include publishing, furniture manufacturing, and food processing.

Data source

Data was obtained from primary sources with the aid of a structured questionnaire, which was designed to achieve the aim and objectives of the study. The questionnaires were administered on rice farmers in the study area.

Sampling Technique and Sample Size

A multi-stage sampling procedure was employed in the investigation. Ido and Ibarapa Central Local Government Areas were selected in the first stage. Due to the significant concentration of rice farmers in each local government area, eight communities were purposively selected for the second stage, bringing the total to sixteen. These included Ogunweide, Dada, Odetola, Onidoko, Tade, Oderemi, Apooyin, Erinwugbio, Idofin, Idere, Onigbio, Isale-Oba, Pako, Oke-Odo, Molete, and Iberekodo. In the third stage, 14 rice farmers were selected from each community, yielding 224 respondents from which a total of 218 questionnaires was used for the analysis.

Data Analysis

To characterise the socioeconomic characteristics, the way in which rice farmers perceive climate change, climate-smart farming practices that they have adopted, the gathered data were analysed. The climate-smart agricultural practices that they have adopted, the gathered data were analysed using descriptive statistics, including frequency counts, percentages, means, and standard deviation. The farmers were shown the following climate-smart farming techniques. Agroforestry, climate-resistant rice cultivars, crop rotation, integrated pest control, water management strategies, mulching, minimum tillage, planting cover crops, applying fertilizer precisely, using organic manure, raised beds, land leveling, and alternate wetting and drying irrigation. The factors influencing the adoption of climate-smart behaviours were evaluated using the Tobit regression model.

One of the models having discrete and continuous components, the Tobit model is an extension of the probit and logit model and is mostly used to address the issue of censored data. The dependent variable calculates the ratio of climate smart practices for each of the thirteen (13) climate smart practices that were examined in this study: agroforestry, planting resistant varieties, mulching, minimum tillage, crop rotation, water management techniques, integrated pest management strategies, planting cover crops, precise fertilizer application, use of organic manure, raised beds, and land leveling. Because it utilizes both observations at the limit, typically zero, the Tobit model is best suited to handle this type of data. (those who did not adopt any climate smart practices) and those with positive values. The empirical tobit model is represented by:

$$Y^* = \beta X_i + \mu_i$$

Where:

Y^* = Extent of climate smart practiced

The independent variables includes, X_1= Age (Years); X_2= sex (1 if male, 0 if female); X_3= Years of formal education; X_4= Farming experience (Years); X_5= Marital status (1 if married, 0 otherwise); X_6= Household size (Number of persons); X_7= Farm size (Hectares); X_8= Membership of farmers association (1 if yes, 0 otherwise); X_9= Access to extension services (1 if yes, 0 otherwise); X_{10}= Access to credit (1 if yes, 0 otherwise);X_{11}= Climate change awareness (1 if aware to climate change, 0 otherwise); X_{12}= Climate information (1 if access to information, 0 otherwise); X_{13}= Participation in non-farm activity (1 if yes, 0 otherwise); X_{14}= Farm income (Naira); X_{15}= Distance to farm (Km).

Results and Discussion

Socio-economic characteristics

Agricultural output is influenced by the farmer's age. To put it another way, a farmer's affect farming improves with age. Additionally, new technology is likely to be adopted by younger farmers more quickly than by older ones. The findings in Table 1 indicate that young people, with an average age of 47.5 years, are primarily responsible for rice farming in the region, suggesting that the farmers engaged in this activity were in their economically active age range. According to the respondents' sex breakdown, 33% of them were women and 66% were men. This suggests that men were more involved in rice growing in the research area than women were.

Male dominance in rice production was confirmed by Abdul-Gafar *et a*l. (2017), Orifah *et al*. (2017) and Orifah *et al*. (2021), and the result supports their

conclusions. With an average household size of four people, 66.6% of the respondents reported being married. This implies that labour is available to assist in the implementation of CSA practices. This line of reasoning supports the claims made by Audu *et al*., (2014), Njuguna *et al*., (2015), and Atube *et al.*, (2021) that family size is a significant source of labour to lower production costs. The average is 9 years of formal education. It may be concluded that the respondents had adequate expertise because in rice cultivation, as their average agricultural experience was 11.17 years. Presumably, the rice farmers in the research area had some education that could have raised their understanding of the consequences of climate change. The perspective expressed by Fadairo *et al. (2015) and Orifah and Fadairo (2015) that education as a whole focuses on imparting knowledge that is meant to bring about change in attitude, skills, or knowledge, as the case may be,* is consistent with this line of thinking. The outcome also raises the possibility that rice farmers in the research region may be somewhat aware of the difficulties posed by climate change and have developed adaptation strategies.

This claim is based on the findings of Gasperini (2000), who found that farmers with only an elementary education are 8.7 percent more productive than those without, and that their potential to boost production is nearly doubled (by 13 percent) with complementary inputs. The outcome supports the conclusions of Abdul-Gafar *et al.*, (2017) and Ogunnaike *et al.*, (2024), who demonstrated that over 50% of the rice farmers in their study had formal education.

Table 1: Distribution of Farmers by Socioeconomic Characteristics

Characteristics	Frequency	Percent
Age of Farmers		
25 - 34	23	10.6
35 - 44	62	28.4
45 - 54	64	29.4
55 - 64	55	25.2
>64	14	6.4
Mean ±SD	47.86 ±10.58	
Sex of farmers		
Female	74	33.94
Male	144	66.06
Marital Status		
Single	30	13.76
Married	140	64.22
Divorced	8	3.67
Widow	6	2.75
Widower	21	9.63
Separated	13	5.96
Household size		
1 - 4	113	51.80
5 - 8	102	46.80
9 - 12	1	0.50
>12	2	0.90
Mean ± SD	4.47 ± 2.09	
Years of Farming Experience		
1 - 10	127	58.30
11 - 20	74	33.90

21-30	9	4.10
>30	8	3.70
Mean ±SD	11.17 ± 6.92	
Education Status		
No formal education	37	16.97
Primary education	52	23.85
Secondary education	61	27.98
Tertiary education	68	31.19
Mean ± SD	9.7 ± 5.71	
Access to Extension Contact		
No	134	61.47
yes	84	38.53
Membership of Farmers Association		
No	121	55.50
yes	97	44.50
Access to credit		
No	136	62.39
Yes	82	38.70
Climate change awareness		
No	26	11.93
Yes	192	88.07
Access to Climate Information		
No	112	51.38
Yes	106	48.62
Participation in off-farm activities		
No	61	27.98
Yes	157	72.02
Type of Labour Used		
Family labour	20	9.17
Hired labour	118	54.13
Family and Hired labour	80	36.70

Perception of rice farmers to climate change

Table 2 displays the analysis's findings. The research area's rice-growing was influenced by rainfall patterns. 35.0%, agreed that rainfall should be increased while 29.4%, agreed with the decrease in rainfall. When it came to late-onset rains, 40 people (33.3%) agreed, 57 people (47.5%) were neutral, and 23 people (19.2%) disagreed.

The early end of rains,40.0% of the respondents agreed, 42.5% were neutral, and 17.5%, disagreed while 60.5% agreed to rainfall with poor distribution. This suggests that the majority of people had a neutral opinion about rainfall patterns. However, the majority of respondents acknowledged that the study area's rainfall was poorly distributed. The view of rice growing in relation to climate change was significantly influenced by weather. Regarding flooding, 29.2% of the rice farmers in the research area agreed, 35.8% were neutral, and 35% disagreed. Also, majority (62.5%) were neutral with the temperature drop while (13.3%) agreed with the temperature increase. In contrast, 17.6% disagreed, 52.1% were neutral, and 30.3% agreed with strong wind. This suggests that there was little to no impact of weather threats on rice farmers' perceptions of climate change in the research area. This line of reasoning is consistent with the assertion made

by Orifah *et al*., (2020) that Nigeria's low level of awareness is to blame for the exacerbated consequences of climate change. The results of this study support those of Akinagbe *et al*., (2012), who found that farmers were aware of rising daytime and nighttime temperatures, significant declines in agricultural output, increased rainfall variability, a decrease in the number of forest tree species, and an increase in drought. Nonetheless, the study's findings indicate that much work has to be done to increase farmers' understanding of and ability to respond to the demands of climate change.

Table 2: Distribution of farmers by perception to Climate Smart Agriculture

Climate Pattern	Agree	Neutral	Disagree
Rainfall pattern			
Increased Rainfall	141	48	29
	(64.68)	(22.02)	(13.30)
Decreased rainfall	23	118	77
	(10.55)	(54.13)	(35.32)
Late onset of rains	74	82	62
	(33.94)	(37.61)	(28.44)
Climate Intensity	114	57	47
	(52.29)	(26.15)	(21.56)
Poor distribution of rainfall	159	35	24
	(72.94)	(16.05)	(11.01)
Weather risk			
Flooding	84	64	70
	(38.53)	(29.36)	(32.11)
Decreased temperature	36	138	44
	(16.51)	(63.30)	(20.18)
Increased Temperature	148	55	15
	(67.89)	(25.23)	(6.88)
Strong winds	74	82	62
	(33.94)	(37.61)	(28.44)
Climate Intensity	Very intense	Intense	No change
	72	133	13
	(33.03)	(61.01)	(5.96)

Source: Field survey, 2024. Figures in parenthesis are percentages

Climate smart practices adopted by rice farmers

A range of sustainable techniques are included in climate-smart agriculture, which aims to increase resilience and productivity while reducing the effects of climate change (Subedi *et al.,* 2019). According to the findings (Table 3), 51.83% of planting varieties. 54 stands for alternate wetting and drying (24.77%), 14 for mulching (6.42%), and 132 for minimum tillage (60.55%).

The following percentages are represented: 89 for 40.83% crop rotation, 100 for 45.87% water management techniques, 103 for 47.25% integrated pest management strategies, 23 for 10.55% cover crop planting, 131 for 60.09% precise fertilizer application, 103 for 47.25% use of organic manure, 83 for 38.07% raised beds, and 136 for 62.39% land leveling. Land levelling, little tillage, and accurate fertilizer application are the most climate-smart practices now in use, followed by planting resistant cultivars.

The findings imply that awareness of CSA practices was not uniformly distributed and could have an effect on the degree of CSA practice adoption. Adoption of innovations or practices requires awareness, but awareness alone is insufficient. Idrisa *et al*., (2012) made the claim that awareness could result in the acceptance of innovation, which is consistent with this reasoning. The outcome supports their awareness of the practice because it is consistent with the findings of Abdulmumini *et al.,* (2021), who indicated that the recommended improved variety was a key rice production technology in Jigawa State.

Factors that influence the adoption of climate smart practices

The results of the analysis in Table 4 indicate that the distance to the farm, climate information, and farmer association membership were the actual significant variables. The log likelihood function was 59.217464, the chi square of X^2 was 44.40, the pseudo R-square was -0.5997, and the degrees of freedom were 10%, 5%, and 1%, respectively. In the study area, farmers' experience and marital status had a 10% significant negative impact on the adoption of climate-smart measures. This suggests that when farmers' experiences and married family heads decline, the research area's adoption of climate-smart measures increases.

Table 3: Distribution of respondent by adoption of climate smart practice

Climate-Smart Practices	Freq	Percent
Agroforestry	48	22.02
Planting resistant varieties	113	51.83
Alternate wetting and drying irrigation	54	24.77
Mulching	14	6.42
Minimum Tillage	132	60.55
Crop Rotation	89	40.83
Water Management Techniques	100	45.87
Integrated Pest management strategies	103	47.25
Planting cover crops	23	10.55
Precise Application of fertilizer	131	60.09
Use of organic manure	103	47.25
Raised beds	83	38.07
Land leveling	136	62.39

Source: Field survey, 2024

According to the findings on farm size and farmers' association membership, CSA techniques will be adopted more frequently if farm size and association membership increase by one unit. The outcome is consistent with research by Kassie *et al.,* (2022) and Orifah *et al*., (2024), which discovered that factors influencing the adoption of CSA practices include farm size, farming experience, and educational attainment. The results reveal that climate knowledge does not directly influence the adoption of climate-wise activities in the research area at 5% significant level. This suggests that the adoption of climate-smart practices in the research area is indirectly correlated with climate awareness. farm. The distance from the farm positively impacts the adoption of climate-smart techniques. This suggests that the farmer may easily make a wise adoption if the farm is closer to his home. This might have an impact on the variables affecting the climate intelligence of farmers in the research area, suggesting that they are significant factors affecting rice output in the research region.

Table 4: Factors that influence the adoption of climate-smart practices

Variables	Coefficient	Standard error	T-ratio
Constant	0.3928	0.074	0.33
Age	0.008	0.02	0.45
Sex	0.227	0.028	0.82
Year of formal education	0.010	0.003	0.30
Farm experience	-0.00378*	0.002	-1.89
Marital status	-0.0567*	0.030	-1.89
Household size	-0.009	0.009	1.56
Farm size	.0184*	.0103	1.79
Membership of farmers association	0.0319***	0.011	2.90
Access to extension services	-0.013	0.029	-0.48
Access to credit	0.004	0.031	0.10
Climate awareness	-0.089**	0.036	-2.34
Climate information	0.06501*	0.033	1.97
Participation in non-farm activity	-0.010	0.035	-0.29
Farm income	1.65 e-08	5.78e-08	0.28
Distance from farm	0.0031***	0.001	3.07
R-square	**0.5997**		
Chi-square	**44.40**		
Log likelihood	**59.217464**		

Conclusion and Recommendations

Rice is the main cereal consumed in most of part of Nigeria, and while many factors influence farmers' adoption of rice farming, the climate is considered the most critical factor affecting rice farming practices in the study area. Interestingly, a large number of these farmers hold a neutral position regarding climate change, especially as it relates to variations in temperature and precipitation. This suggests that more education and understanding about the effects of climate change on agriculture are obviously needed. The following recommendations were made in light of the findings:

1. Farmers' knowledge of climate change and its effects needs to be improved. Targeted training initiatives and the distribution of climatic data will help farmers to access climate education and information and this will enhance awareness of Climate-smart activities.

2. Farmers should be encouraged to adopt new technologies and methods. Financial institution can create access to lower the cost of climate-smart technologies, this may entail expanding access to credit facilities, subsidies, and other financial support.

3. Farmers will benefit from farmers' association through access to better seeds, training support and technologies as this will assist them to be more productive and resilient to climate-related issues. Results also shows that farmer associations positively influence the adoption of climate-smart practices. More farmers joining these groups might increase their access to knowledge, resources, and collective bargaining power, increase their adoption rates.

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