DOI: 10.22620/agrisci.2025.44.014

Climate change adaptation practices of rice farmers in Borgu local government area of Niger state, Nigeria

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Abstract

The study assessed climate change adaptation practices among rice farmers in Borgu Local Government Area, Niger State, Nigeria. An interview schedule was used to collect data from eighty respondents who were selected through the multi-stage sampling technique. Descriptive statistics were used to describe the data while the Pearson's Product Moment Correlation (PPMC) was used to determine the relationship between the variables. Results of the findings indicated that mean farm size was 1.4 ha while mean rice output was 5310 kg. Mean annual income from rice farm was ₦636,206 and average years of experience in rice farming was 8 years. Majority (92.5%) of the rice farmers had observed climate change with major indicators being flooding, unstable rainfall, insufficient rainfall and longer rainy season. Making of mounds and digging ridges across slopes, prayer/ritual offering, cultivation of more farm lands and use of organic manure constituted the major adaptation practices used by farmers. The major constraints of utilizing climate change adaptation practices included factors such as limited access to weather forecast technologies, non-availability of improved rice varieties and high cost of improved rice varieties. Pearson's Product Moment Correlation (PPMC) showed that age ($r = -0.25$, $p=0.02$) and years of experience ($r = -0.31$, $p=0.00$) had a significant relationship with the use of climate change adaptation practices. Farmers should be provided with information on climate change adaptation practices and weather forecast as this will enable them to effectively cope with the negative effects of climate change on their farming practices.

Keywords: climate change, adaptation practices, rice farming, Borgu

INTRODUCTION

Agriculture is the art and science of food production which spans soil cultivation, crop growing, and livestock rearing (Bashari, 2023). Over the decades, agriculture has been a means of livelihoods and contributing to the total gross domestic product of the country. In recent years, climate change is considered as a major challenge to agriculture, particularly in developing countries (Yakubu *et al.*, 2020; Ahmed *et al.*, 2020; Mba *et al.*, 2022). Poor and marginalised communities in many developing countries are expected to be the most vulnerable to climate change and its impacts, due to their limited capacity for adaptation and heavy dependence on natural resources (Ho & Shimada, 2018; Amaefule *et al.*, 2023). Similarly, Ali *et al.*, (2017) rightly made known that approximately 2.5 billion people who derived their livelihoods, in partly or in totally, from agricultural production were affected by climate change. Despite the fact, climate change is a threat to agricultural and non-agricultural development, agricultural production activities being more vulnerable to climate change than other sectors.

Climate change is the long term shift in temperatures and weather patterns. This shift may be natural or anthropogenic such as burning of fossil fuels like coal, oil, and gas which produce greenhouse gasses. Climate change, as delineated by the Intergovernmental Panel on Climate Change (IPCC) in 2001, includes shifts in the frequency and magnitude of sporadic weather events, as well as slow continuous increase in global mean surface temperature (IPCC, 2001). Evidence has shown that climate change is already affecting crop yield in many countries (Deressa *et al.,* 2008; Sheu-Usman *et al.,* 2022). Moreover, IPCC predicts that, by 2050, crop productivity in sub-Saharan Africa will decline by 5% for maize, 14% for rice, and 22% for wheat, pushing a large number of already disadvantaged people, who rely on agriculture for their livelihoods, deeper into food insecurity and poverty (IPCC, 2018). IPCC also predicts decreased food availability by 21% in 2050 and a further increase in the number of malnourished children by over 10 million, to a total of 52 million in 2050 in sub-Saharan Africa alone (IPCC, 2018; Ahmed *et al.,* 2020).

Rice is one of the major crops affected by climate change in Nigeria. Rice, as a staple crop, is one of the most farmed in Niger State. Niger state contributes about 16% of the rice produced in the country and is the second largest rice producing state in the country after Kaduna state 19.63% (National Bureau for Statistics NBS, 2013). The position that the state occupies necessitates an investigation into adaptation practices used by the rice farmers since they are vulnerable to climate change effect. In an attempt to cope with the negative effects of climate change the rice farmers need to adopt climate change practices (Ho & Shimada, 2018). Adaptation practices entail taking the right adaptive measures to reduce the negative effects of climate change, or exploit the positive ones, by making suitable adjustments and changes.

Climate change adaptation practices relate to a wide range of approaches including planting drought-tolerant crops, early planting, crop diversification, rainwater harvesting, market responses, such as income diversification and credit schemes, developing meteorological forecasting capability, improving agricultural markets and information provision (Atube *et al.,* 2021; Franklin *et al.,* 2021; Gebre & Rahut, 2021). The effect of climate change on rice production, as with other cereals, is initially evident in a sharp increase in production costs and a reduction in grain yields, which ultimately results in a decrease in farmers' profit margins (Sokoto *et al.,* 2016; Adebayo *et al.,* 2024). Farmers in developing countries are more affected due to their high dependence on rain-fed agriculture, low adaptive capacity and higher dependency on natural resources (Leary & Kulkarni, 2007). Based on this background the current study aimed to assess climate change adaptation practices among rice farmers in Borgu Local Government Area, Niger State, Nigeria.

MATERIALS AND METHODS

The study was conducted in Borgu Local Government Area, Niger State Nigeria. It is located between latitude $9^0\ 50^1$ to $100\ 57^1$N and longitude $40\ 25^1$ to $40\ 45^1$E with an area of 1270 km^2 and is situated at the border of sub-Sudan and Guinea Savanna (Ibanga *et al.,* 2019). The area is one of the twenty-five Local Government Areas (LGAs) in the state, with the headquarters in New Bussa. The major occupations of the people in the area include crop and livestock farming. A multi-stage sampling technique was used to select the sample size. The first stage was the purposive selection of four (4) out of the ten (10) wards in the local government area due to their high involvement in rice production. Twenty (20) farmers were randomly selected from each of the selected wards to give eighty (80) rice farmers as the sample size of the study.

Structured questionnaire was used to collect data from the respondents. A four-point-Likert-type scale was used to measure farmers utilization of climate change adaptation practices marked as: frequently used (4), occasionally used (3), rarely used (2) and never used (1). A three-point Likert-type scale was used to measure the constraints as severe constraint (3), mild constraint (2) and not a constraint (1). The data were analyzed using descriptive and inferential statistics. The descriptive statistics include: frequency, percentages, means and standard deviation, while the Chi-square and Pearson's Product Moment Correlation were used to test the hypotheses. The dependent variable was the adoption of climate change adaptation practices by rice farmers. The independent variables were farmers' personal characteristics, farm characteristics and constraints to adopt climate change adaptation practices.

RESULTS AND DISCUSSION

Socio-Demographic and Farm Characteristics of the Respondents

Table 1 depicts that the mean age was 46 years implying that majority of the rice farmers had family responsibilities that would require more financial commitment which might serve as an impetus for them to adopt recommended rice farming practices as corroborated with other research. Ronald *et al*. (2014) suggested that farming was practiced mostly by married people to provide for their families. Majority (87.5%) of the respondents were male while 12.5% were female. This result was similar to the findings of Tiku and Ugbada (2012) who reported about 86% men dominance in rice production in Cross-Rivers state. Majority (73.3%) of the rice farmers were married. According to Ojo & Jibowo (2008) such personals are responsible individuals whose views and contributions are highly respected within rural communities in Africa. Majority (85%) of the respondents had one form of formal education, an indication that the respondents were literate. The result is in consonance with the findings of Muhammad-Lawal *et al.,* (2009) who also stated that the level of education was expected to influence farmers' adoption of agricultural innovations and decision on various aspects of farming. The mean household size was 8 persons implying a medium family size. This result is higher than the average family size of about 5 persons in Ethiopia (Central Statistical Agency of Ethiopia CSA, 2007).

Table 1 also presents the farm characteristics of respondents. The mean farm size of the respondents was 1.4 ha which is in line with the findings by Tijani (2007) and Shanono *et al.,* (2023). The researchers reported that majority (72.0%) of the farmers in Borno State, Nigeria, were small-scale farmers who had farm size between 3-4 hectares. The mean annual output of rice was 5310 kg. This figure is slightly higher than 4500 kg obtained by Zalkuwi (2019) in Mubi North Local Government Area of Adamawa State, Nigeria. Niger State is known to be one of the major rice producing states in Nigeria. The mean farming experience of 8 years was found out. This result reveals that the respondents were relatively experienced in farming activities hence they were able to adopt quickly various climate change adaptation practices. The mean annual farm income was ₦636,206 indicating that they were medium income earners.

Table 1. Socio-demographic and farm characteristics of respondents **(n=80)**

Variables	Values
Mean Age (years)	46
Sex (male %)	87.5
Marital Status (married %)	73.3
Educational Level (literate %)	85
Mean Household Size (persons)	8
Mean Farm Size (Hectares)	1.74
Mean Farming Experience (years)	8
Mean Annual Rice Output (Kg)	5310
Mean Annual Farm Income **(₦)**	636,206.00

Source: Field survey, 2023

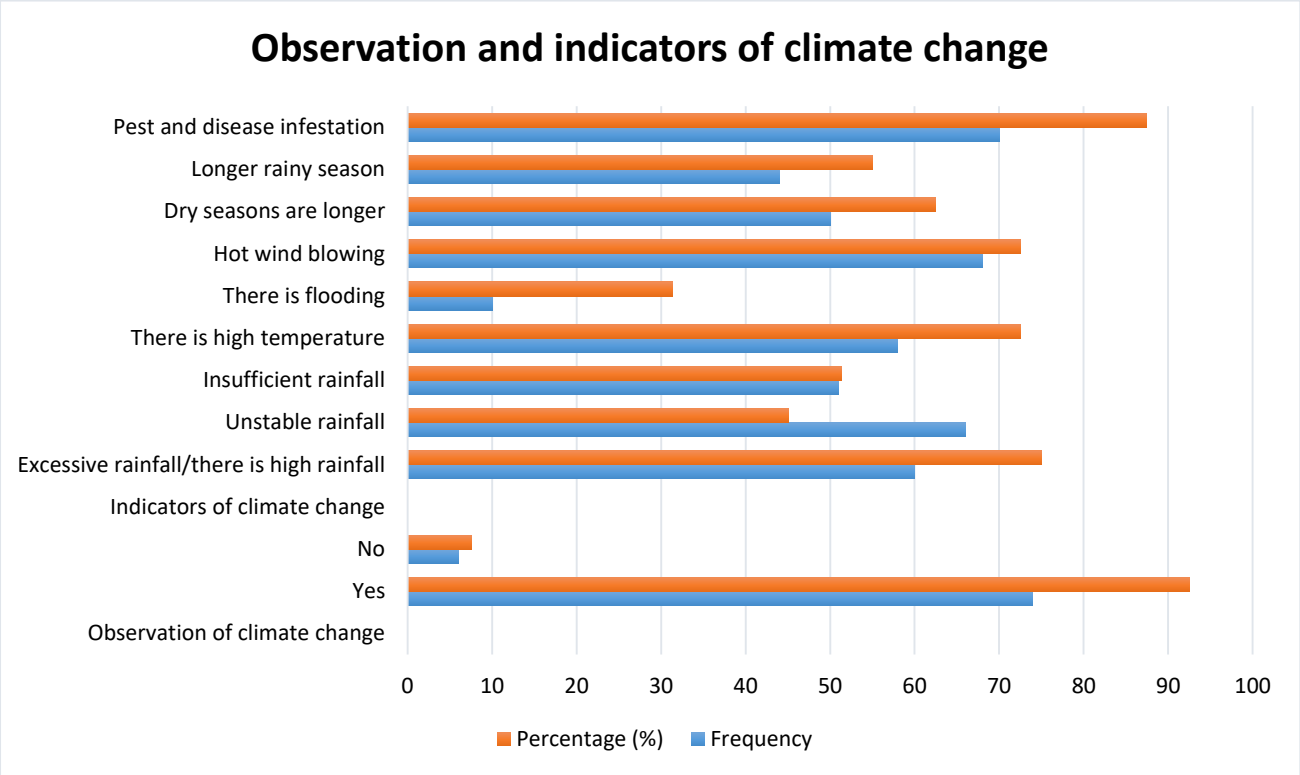

Figure 1. Observation and indicators of climate change

Respondents' observation and indicators of climate change

Figure 1 shows that majority (92.5%) of the rice farmers witness the climate change. The major indicators of climate change as reported by respondents were pest and disease infestation (87.5%), "excessive rainfall/there is high rainfall" (75.0%), hot wind blowing (72.5%), high temperature (72.5%) and "dry seasons are longer" (62.5%). Other indicators were longer rainy season (55.0%) and insufficient rainfall (51.3%). This finding suggests that the respondents had observed fluctuations in climate variables, indicating that the phenomenon is real. These fluctuations are expected to have adverse effects on rice production. For example, pest and disease infestations are anticipated to negatively impact the yield and quality of rice. Similarly, excessive rainfall and increased wind temperatures (heat waves) are likely to pose additional challenges. Most crops, such as rice, typically thrive under relatively stable climatic conditions, which is often not the case during periods of fluctuating conditions. This finding is consistent with that of Shanono *et al*. (2023), and Sheu-Usman *et al*., (2022).

Adaptation measures to climate change in rice farming

The results from table 3 show that making mounds and digging ridges across slopes ($\bar{x}$ =3.40), prayer/ritual offering ($\bar{x}$ =3.36), cultivation of more farm lands ($\bar{x}$ =3.28), use of organic manure ($\bar{x}$ =3.26), moderate use of chemicals ($\bar{x}$ =3.21), use of rivers/streams ($\bar{x}$ =3.16), late harvesting and rain water harvesting ($\bar{x}$ =3.06), and planting of cover crops ($\bar{x}$ =3.05) constituted the major adaptation practices used in the study area. The finding suggests that the adopted measures are low-cost practices, such as making mounds, digging ridges across slopes, and offering prayers or rituals. The use of prayers and rituals also reflects, to a large extent, the farmers' perception of the root

causes of climate change. Umunna (2016) reported that farmers in surrounding communities of Kainji Lake National Park attributed climate change to an act of God. Consequently, prayer and ritual offerings were considered a coping mechanism. Furthermore, Apata *et al.* (2009) reported that main measures for reducing climate risk is to diversify production and livelihood system such as soil and water management measures, and plant protection measures.

The results on Table 3 indicate farm insurance and farmers' cooperatives as the least ranked adaptation practices. This implies that farmers rarely insure their farms against uncertainties, which is common among farmers in developing countries where farm insurance is not widely practiced. Farmers' cooperatives can serve as an effective means of financing farm operations, as members are able to pool their resources for collective use at very minimal interest rates.

Constraints to use of climate change adaptation strategies among respondents

Table 4 highlights the constraints faced by rice farmers in adopting climate change adaptation strategies. The means were used to rank the constraints according to their order of severity as indicated by the respondents. Limited access to weather forecast technologies ($\bar{x}$ =2.44), lack of availability of improved rice varieties ($\bar{x}$ = 2.41), and high cost of improved rice varieties ($\bar{x}$ =2.30) were the most serious constraints as they were ranked 1st, 2nd and 3rd, respectively. This is in line with the finding of Benhin (2006) and Oladimeji *et al*., (2023) who reported that lack of access to credit happened to be one of the major problems encountered by farmers in adapting to climate change.

Table 3. Respondents' use of adaptation practices to climate change

Adaptation practices	Frequently Used	Occasionally Used	Rarely Used	Never Used	Mean	Std. Deviation	Rank
Use of improved rice varieties	39(48.8)	8(10.0)	11(13.8)	22(27.5)	2.80	1.31	11th
Intercropping	18(22.5)	17(21.3)	28(35.0)	17(21.3)	2.45	1.07	13th
Planting of cover crops	43(53.8)	8(10.0)	19(23.8)	10(12.5)	3.05	1.14	8th
Moderate use of chemicals	40(50.0)	21(26.3)	15(18.8)	4(5.0)	3.21	0.92	5th
Use of organic manure	43(53.8)	21(26.3)	10(12.5)	6(7.5)	3.26	0.95	4th
Mulching	21(26.3)	22(27.5)	17(21.3)	20(25.0)	2.55	1.14	12th
Crop rotation across seasons	37(46.3)	12(15.0)	19(23.8)	12(15.0)	2.93	1.15	9th
Early planting	49(61.3)	13(16.3)	8(10.0)	10(12.5)	3.26	1.08	4th
Late planting	19(23.8)	16(20.0)	12(15.0)	33(41.3)	2.26	1.23	15th
Early harvesting	36(45.0)	14(17.5)	12(15.0)	18(22.5)	2.85	1.22	10th
Late harvesting	49(61.3)	3(3.8)	12(15.0)	16(20.0)	3.06	1.26	7th
Zero tillage	29(36.3)	5(6.3)	11(13.8)	35(43.8)	2.35	1.36	14th
Making mounds and ridges	46(57.5)	24(30.0)	6(7.5)	4(5.0)	3.40	0.84	1st
Use of rivers/streams	49(61.3)	7(8.8)	12(15.0)	12(15.0)	3.16	1.16	6th
Digging of well	18(22.5)	13(16.3)	11(13.8)	38(47.5)	2.14	1.24	16th
Rain water harvesting	42(52.5)	14(17.5)	11(13.8)	13(16.3)	3.06	1.15	7th
Farm insurance	11(13.8)	5(6.3)	11(13.8)	53(66.3)	1.68	1.09	18th
Joining cooperative society	22(27.5)	5(6.3)	12(15.0)	41(51.3)	2.10	1.30	17th
Cultivation of more farm lands	46(57.5)	15(18.8)	14(17.5)	5(6.3)	3.28	0.97	3rd
Prayer or ritual offering	58(72.5)	4(5.0)	7(8.8)	11(13.8)	3.36	1.12	2nd

Legend: Percentages in parentheses Source: Field survey, 2023

Table 4. Constraints to use of climate change adaptation practice

Constraints	Serious	Mild	Not a constraint	Mean	Std. Deviation	Rank
Lack of information on climate change adaptation practices	38(47.5)	17(21.3)	25(31.3)	2.16	0.878	4th
Non availability of credit facilities	27(33.8)	36(45.0)	17(21.3)	2.13	0.736	6th
Limited access to weather forecast technologies	43(53.8)	29(36.3)	8(10.0)	2.44	0.672	1st
Limited availability of land	34(42.5)	23(28.8)	23(28.8)	2.14	0.838	5th
High cost of improved rice varieties	43(53.8)	18(22.5)	19(23.8)	2.30	0.833	3rd
Non availability of improved rice varieties	46(57.5)	21(26.3)	13(16.3)	2.41	0.758	2nd

Legend: Percentages in parentheses Source: Field survey, 2023;

Table 5. Result of correlation analysis of relationship between personal characteristics of the respondents and climate change adaptation strategies

Variables	R-value	P-value	Decision
Age	-0.25	0.02	Significant
Family size	-0.18	0.11	Non-significant
Years of experience	-0.31	0.00	Significant
Annual income	-0.15	0.20	Non-significant
Farm size	-0.15	1.36	Non-significant

Legend: Correlation is significant at the 0.05 level Source: Field survey, 2023;

Correlation between personal characteristics and use of climate change adaptation strategies

In table 5, the analysis of Pearson's Product Moment Correlation (PPMC) shows that age (r=0.25, P=0.02) and years of experience (r=-0.31, P=0.00) had a significant relationship with the use of climate change adaptation strategies. Other personal characteristics such as family size (r=-0.18, p=0.11), annual income (r= -0.15, p=0.20) and farm size (r= -0.15, p=1.36) were not significant. This implies that age and farm experience are likely to affect the use of climate change adaptation strategies among the farmers.

CONCLUSIONS

The study revealed that respondents had observed climate change, identifying the major indicators as flooding, unstable rainfall, insufficient rainfall, longer rainy seasons, and longer dry seasons. This indicates that the farmers are aware of fluctuation in the climate variables suggesting their awareness of climate change phenomenon. Thus they can take actions on their own to cope with its negative effects on their production. Furthermore, the respondents identified some major climate change adaptation measures they had adopted. These measures include making of mounds and digging ridges across slopes, prayer/ritual offering and cultivation of more farm lands, early planting, moderate use of chemicals, use of river/stream to irrigate their farm and rain water harvesting. However, as the serious constraints for climate change adaptation measures they indicated limited access to weather forecast technologies, lack of availability of improved rice varieties and high cost of improved rice varieties. An attempt to address the constraints will result in increased adoption of adaptation measures by the respondents, thereby reducing their vulnerability to the effects of climate change. Farmers' age and experience are identified as

the factors that are likely to affect the utilization of climate change adaptation strategies. Since respondents rely solely on their experience, the study recommends regular and up-to-date training about various adaptation measures. In addition, there should be improved access to weather forecast technologies and ensuring the availability of improved varieties of rice at affordable price.

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