



## ANALYSIS OF RICE FARMERS' PERCEPTION AND ADAPTATION STRATEGIES TO CLIMATE CHANGE IN BAUCHI AND JIGAWA STATES, NIGERIA

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### ABSTRACT

The study analyzed rice farmers' perception and adaptation strategies to climate change in Bauchi and Jigawa States, Nigeria. A multi-stage sampling procedure was used to select 400 rice farmers from the study area. Data were collected using structured questionnaires and analyzed using descriptive and inferential statistics. The results showed that, the mean age of the respondents was 44 years in Bauchi and Jigawa States, the result also revealed that most (92.5%) and majority (88.5%) of respondents were male in Bauchi and Jigawa States respectively. Similarly, the results further revealed that most (90.5%) and majority (78.0%) of respondents were married in both States with a mean household of 7 persons. The results also showed that 36.5% and 34.5% of respondents had secondary education in both States with the mean farming experience of 26 years in Bauchi State and 25 years in Jigawa State respectively. Majority of farmers in Bauchi and Jigawa State perceived that climate change has led to increase in temperature with a mean of ( $\bar{x}=2.4$ ) and ( $\bar{x}=2.7$ ) respectively. The results also revealed that farmers in Jigawa State perceived that climate change has led increase in rainfall in Jigawa State with a mean of ( $\bar{x}=2.3$ ) while farmers in Bauchi State perceived decreased in rainfall with a mean of ( $\bar{x}=1.7$ ). Principal component analysis (PCA) revealed that the three principal components explained approximately (32%) crop management factor, while sustainable resource management and livelihood diversification factor account for (26%) of the variation, soil conservation and management practice factor account for (28%) variation in the sample. It can be concluded that rice farmers in the study area perceived increased in temperature, precipitation, pest and diseases, dry season as the consequences of climate change. The study recommends that government at all levels, non-governmental organizations and other stakeholders should join hands and extend their climate change awareness campaign deep into the rural communities where no attention or less care is given to environmental sustainability.

**Keywords:** Rice; Farmers; Perception; Adaptation; Climate; Change.

### INTRODUCTION

Climate refers to the long-term pattern and averages of temperature, precipitation, humidity, wind and other atmospheric conditions in a particular region over a decades or centuries. It is distinct from weather, which describes short-term variations in atmospheric conditions. Climate is influenced by factors such as the earth's tilt, solar radiation, atmospheric composition (green-house gases), ocean currents and land surface features. Human activities, particularly the burning of fossil fuels and deforestation have significantly altered the earth's climate system, leading to global warming and climate change. Climate change refers to long-term shifts in temperature, precipitation patterns, wind patterns, and other aspects of the Earth's climate system. These changes can occur naturally, but are predominantly caused by human activities such as burning fossil fuels, deforestation, and industrial processes (Adekunmi, 2022). Climate change is the observed and projected changes in the Earth's



climate system over a long period of time, typically spanning decades or longer. It includes changes in temperature, precipitation, atmospheric composition, and other factors that can have significant environmental, economic, and social impacts (Yeleele et al., 2023). Climate change refers to the alteration of global or regional climate patterns, including temperature, precipitation, and wind patterns, as well as other climatic variables. These changes are primarily attributed to the increased greenhouse gas emissions caused by human activities, leading to global warming and related impacts on ecosystems, communities, and the overall planet (Ismail, 2023). Climate change entails the variations in statistical distribution of weather patterns over a prolonged period, typically spanning decades or more. It is driven by natural processes as well as human activities, which result in alterations to the Earth's atmospheric and oceanic conditions, leading to shifts in weather patterns, sea level rise, and other environmental consequences. Climate change refers to the alteration in the Earth's climate system, caused by both natural factors and human activities. It encompasses changes in temperature, precipitation, extreme weather events, and other climatic variables that can occur on global, regional, or local scales, and is recognized as a significant global challenge due to its potential to affect ecosystems, economies, and human well-being (Igberi et al., 2022).

Rice production in African nations, especially Nigeria, relies largely on the natural weather conditions of the locality. Unexpected changes in the climatic condition of Nigeria are evident in increased desert encroachment and extreme droughts in the Northern region (Akomolafe, et al., 2023). Nigeria rice farming is one of the most profitable types of agribusiness, staple food for the larger population and as such is that it is evaluated that almost 7 million tons of rice are consumed per year (Malabe and Ango 2023). From 1980 to date, Nigeria has become the highest producer of rice in West Africa and third in Africa, after Egypt and Madagascar. The trend has made Nigeria to attain 2.103 and 3.46 million metric tons (MMT) of milled rice production in 2005 and 2008 respectively (NRDS, 2022). Despite numerous studies on analysis of rice farmers' perception and adaptation strategies to climate change in Bauchi and Jigawa States, past studies have shown none or little empirical studies that simultaneously analyzed rice farmers' perception and adaptation strategies to climate change in both States. Thus, the need for this study to analyzed rice farmer' perception and adaptation strategies to climate change in Bauchi and Jigawa States, Nigeria. This study was aimed at:

- (i) describe the socio-economic characteristics of rice farmers
- (ii) describe the perception of rice farmers to climate change;
- (iii) examine the adaptation strategies used by rice farmers to combat the effect of climate change in the study area.

## **METHODOLOGY**

### **The Study Area**

The study was carried out in two States namely; Bauchi and Jigawa States, Nigeria. Bauchi state Comprises of three Agricultural Zones such as Northern Zone (9 LGAs) Central Zone (4 LGAs) and Western Zone (7 LGAs). The study Areas has a population of 4,653,066 million people (NPC 2006). The population growth of the State stand at 3.7% with a projection of 8,308,800 million people. It lies approximately between 9°3 and 12°3 North and longitude 8°50–11°50 East. The area has a total land mass of 49,259 sq kilometres. Bauchi State is bordered in a clockwise direction by Yobe, Gombe, Taraba, Plateau, Kano and Jigawa states., The major occupations of the people include farming, livestock rearing and trading. The major tribes of the area are Hausa, Fulani, Jarawa, Sayawa and minor tribes such as Yoruba and Igbo other Nigeria tribes are found. Agricultural production accounts for a greater percentage of the total employment in the study area and as result, over eighty percent (80%) of the inhabitants of the State practiced one form of agriculture or the other in which different crops and livestock are produced. The climate of the study area is characterized by long dry season (October-May) with a short rainy season (May-October), National Bureau of Statistics (2016).

The study was conducted in Jigawa State, Nigeria. The State is situated in the north-western part of the country which lies between latitudes 11.00°N to 13.00°N and longitudes 8.00°E to 10.15°E. The state has a total land area of approximately 23,154 square kilometers with twenty-seven (27) Local Government Areas (LGAs) (National Population Commission, NPC, 2006). The state had a



population of 4,348,649 persons (NPC, 2006), with a projected population of 7,599,100 in 2024 using 3.5% annual growth rate with about 48 % of the population falling under the age of fifteen. Rainfall variability is pronounced in this area and rainfall distribution skewed, with its annual average ranging from 635mm to 899mm, or less than 1000 mm (NIMET, 2016). The State experiences a mean annual temperature of about 30°C. The topography is characterized by high land areas which is almost 750 meters. Soil is fertile ranging from sandy-loamy with many compartments of fadama and alluvial plains suitable for the cultivation of rice, sugar-cane, millet, vegetables and sorghum (Ahmed, 2010). Jigawa state is predominantly an agrarian state with over 80% of the population involved in Agriculture. The major rain fed crops grown in the state includes rice, millet, sorghum, cowpea, groundnut, cocoyam, soya beans. Dry crops include sugarcane, Hot pepper, okra, tomatoes, onions and spinach. The major livestock kept in the state includes, sheep and goat, poultry, cattle. The major rivers in the state that provide water for irrigation activities are the Hadejia and Katagum rivers. The Hadejia-Nguru River has the largest fadama area in Nigeria. Jigawa state is divided into four ADP Zones namely Gumel zone, Birnin-Kudu zone, Hadejia zone and Kazaure zone.

#### **Sampling Procedure and Sample Size**

A multi-stage random sampling procedure was used for selecting respondents. The first stage was selection of three Local Government Areas from each State. In this regard, Jama'are, Dass and Ningi in Bauchi State were selected while in Jigawa State, Birnin-Kudu, Hadejia and Kazaure was chosen. The sample frame for Rice farmers associations is constituted by two thousand and seven (2,007) registered members based on figures for the selected LGAs provided by Bauchi State Agricultural Development Programme and Jigawa Agricultural and Rural Development Authority. In the second stage of sampling, three villages noted for rice cultivation was selected from each of the 6 LGAs.

In Jama'are LGA in Bauchi State, Dako-Dako, Bodinga and Yola was selected while in Dass LGA had Bagel, Dass Kantaga and Lushi was selected and Ningi LGA, Kujera, Kafin Zaki and Gadan maiwa was selected, similarly, the locations were selected for Birnin-Kudu LGA in Jigawa State were Kafin gana, Zuma and Kantoga. In Hadejia LGA, Yamidi, Ganuwa Kuka and Shawara. In Kazaure LGA were Furji, Gada and Dambo dam were selected for the study because of widespread rice cultivation in the areas. The total number of registered farm families in the eighteen (18) selected villages was 2,007. This figure therefore represents the sample frame. The sample size for each village was determined by a mathematical formula given by Chaokromthong and Sintao (2021) as;

$$n = \frac{N}{1 + N(\alpha)^2}$$

where:

N is the sample frame for the eighteen villages

n is the sample size and

$\alpha$  is the margin of error (fixed at 5%)

$$\frac{2,007}{1 + 2,007(0.05)^2} = 400 \text{ farm families}$$



**Table 1: Sampling Procedure and Sample Size**

States	Zones	L.G.A	Village	Sampling Frame	SampleSize20%
Bauchi	Northern	Jama'are	Dako-Dako	200	40
			Bodinga	85	17
			Yola	72	14
	Western	Dass	Bagel	80	16
			Dass Katanga	106	21
			Lushi	94	19
	Central	Ningi	Kujera	54	11
			Kafin Zaki	102	20
			Gadan Maiwa	212	42
	<b>Sub-total</b>	<b>3</b>	<b>9</b>	<b>1,005</b>	<b>200</b>
	B/Kudu Zone	B/Kudu	Kafin Gana	97	19
			Zuma	188	38
			Kantoga	150	30
Jigawa	Hadejia Zone	Hadejia	Yamidi	85	17
			Ganuwar Kuka	90	18
			Shawara	107	21
	Kazaure Zone	Kazaure	Furji	75	15
			Gada	68	14
			Dambo dam	142	28
	<b>Sub-total</b>	<b>3</b>	<b>9</b>	<b>1,002</b>	<b>200</b>
<b>Total</b>		<b>6</b>	<b>18</b>	<b>2,007</b>	<b>400</b>

Source: BSADP (2020) and JARDA (2021)

### Method of Data Collection

Data for this study were collected through the use of structured questionnaire and administered with the help of trained enumerators.

### Method of Data Analysis

The data collected were analyzed using descriptive and inferential statistics, the inferential statistics was principal component analysis (PCA)

### Descriptive statistics

Frequency, percentage and mean were used in achieving objective i, ii, and iii of the study.

### Inferential statistics

#### Factor Model with 'm' Common Factors

Principal Component Analysis was used to achieve objective iv because of its relative ease in identifying relationships between variables and the components or factors to be retained.

Let  $X = (X_1, X_2, \dots, X_p)$  is a random vector with mean vector  $\mu$  and covariance matrix  $\Sigma$ . The factor analysis model assumes that  $X = \mu + \lambda F + \varepsilon$ , where,  $\lambda = \{ \lambda_{jk} \}_{p \times m}$  denotes the matrix of factor loadings;  $\lambda_{jk}$  is the loading of the  $j^{\text{th}}$  variable on the  $k^{\text{th}}$  common factor,  $F = (F_1, F_2, \dots, F_m)$  denotes the vector of latent factor scores;  $F_k$  is the score on the  $k^{\text{th}}$  common factor and  $\varepsilon = (\varepsilon_1, \varepsilon_2, \dots, \varepsilon_p)$  denotes the vector of latent error terms;  $\varepsilon_j$  is the  $j^{\text{th}}$  specific factor.

## RESULTS AND DISCUSSION

### Socio-economic Characteristics of the Respondents

The socio-economic variables in the study included age, sex, marital status, household size and years of farming experience. The results in Table 2 showed that majority (52.0%) of rice farmers were between the ages of 41 - 50 years in Bauchi State with a mean of 43 years, while 32.0% of rice farmers in Jigawa State were between ages of 41-50 years with a mean of 45 years. Pooled results show that 42.0% of the rice farmers were between the ages of 41-50 with a mean of 44 years. This implies that the rice farmers were still in their active age bracket and they will be more willing to take risk in adopting new practices than older farmers. This agreed with (Bello *et al*, 2023) who said younger farmers have been found to be more knowledgeable about better practices and adapt to better farming techniques because of their longer planning horizons and quest for innovation.



The result also shows that most (92.5%) and majority (88.5%) of rice farmers in Bauchi and Jigawa States were male, while 7.5% and 11.5% were female in Bauchi and Jigawa States with a pooled of (90.5%). Both States have a significant male majority, with Bauchi having a slightly higher percentage. This gender imbalance suggests that men are more likely to participate in rice farming activities, which may reflect cultural norms or barriers that limit female participating in farming activities especially in northern part of the country. This indicates that most of the rice farming activities and adaptation strategies to climate change were widely practiced by male farmers in the study area. It also indicates that there were more male-headed households engaged in farming than female-headed households in the study area. This is in agreement with Shaba (2021) who states that more males were found to be engaged in farming activities than their female counterpart because of its labour intensive nature. It also showed that men are easily contacted by disseminators because their movements are not restricted thereby having the chance of being aware of improved farm practices faster than the women.

The result in Table 2 shows that most (90.5%) and majority (78.0%) of the rice farmers in Bauchi and Jigawa States were married with a pooled of 84.3% of rice farmers in both States are married, with Bauchi showing a notably higher percentage. The implication is that high number of married rice farmers could increase the release of family labour, thus making more hands available for productive activities on respondents' rice farms. This agreed with Bello *et al* (2023) who said that most of the rice farmers in his study area were married and it is assumed that marriage creates some stability and also improves access to more family labour for agricultural activities as it is necessary to feed their family. This also agrees with findings of Adisa, *et al.* (2021) who found out that majority (97.0%) of the respondents were married. It shows that they have the necessary experience to relate well with farming households, especially when handling delicate issues such as settling of family disputes.

Table 2 revealed that 43.0% of rice farmers had 7-9 members in their respective households in Bauchi State with a mean of 8 persons, while 46.5% had a family size of between 4-6 members with average of 6 persons in Jigawa State with a pooled household size of 7-9 persons. This implies that large household size in many village settings is believed to be one of the sources of labour. The findings suggest availability of labour force for farming in the study area. This may imply that households have labour source which is needed in farming activity. Household size is an important source of labour especially during the peak of farming, for example, during weeding and harvesting where an evenly available farming labour is required (Njuguna *et al.*, 2022). Household size determines the available human labor force leaving together and eating from the same pot that can be employed in carrying out agricultural activities (Garba *et al*, 2021)





**Table 2:** Distribution of Respondents based on Socio-economic Characteristics in Bauchi and Jigawa States

Socio-economic characteristics	Bauchi State Frequency	Jigawa State Frequency	Pooled Frequency
<b>Age</b>			
21-30	19(9.5)	31(15.5)	25(12.5)
31-40	58(29.0)	44(22.0)	51(25.5)
41-50	104(52.0)	64(32.0)	84(42.0)
51-60	10(5.0)	39(19.5)	25(12.3)
61-70	9(4.5)	22(11.0)	16(7.8)
<b>Mean</b>	<b>43</b>	<b>45</b>	<b>44</b>
<b>Sex</b>			
Male	185(92.5)	177(88.5)	181(90.5)
Female	15(7.5)	23(11.5)	19(9.5)
<b>Marital Status</b>			
Single	11(5.5)	27(13.5)	19(9.5)
Married	181(90.5)	156(78.0)	169(84.3)
Divorced	5(2.5)	8(4.0)	7(3.3)
Widowed	3(1.5)	9(4.5)	6(3.0)
<b>Household size</b>			
1-3	9(4.5)	31(15.5)	20(10.0)
4-6	38(19.0)	93(46.5)	66(32.8)
7-9	86(43.0)	48(24.0)	67(33.5)
10-12	67(33.5)	28(14.0)	48(23.8)
<b>Mean</b>	<b>8</b>	<b>6</b>	<b>7</b>
<b>Total</b>	<b>200(100)</b>	<b>200(100)</b>	<b>200(100)</b>

**Source:** Field Survey (2024)

Figures in parenthesis are percentage

The result in Table 3 revealed that a reasonable proportion (36.5%) and (34.5%) of rice farmers had secondary education in Bauchi and Jigawa States respectively. Similarly, 23% had primary education in Bauchi and 11.0% in Jigawa State while 16.0% of rice farmers had tertiary education in Bauchi and 20.0% in Jigawa State. The percentages for secondary education are relatively similar, with Bauchi at 36.5% and Jigawa at 34.5%. The Pooled 35.5% indicated that large number of rice farmers had secondary education in both States. The finding implies that a good number of farmers have formal education which can help them in their agricultural activity. Education has an important role in farming especially when farmers are trained on a particular aspect and put it into practice. Educated farmers can easily seek information and disseminate it to other farmers who are not knowledgeable enough. The high level of literacy among the respondents may facilitate better adoption of climate change adaptation Strategies and better ability of impacting knowledge and skills for adoption of an innovation. Farmers level of education is reflected in the ability to access understand and utilise information for making decisions at the appropriate time. Shaba *et al* (2021) posited that household who had obtained education and have it to the highest stage is of great advantage to be able to interpreted information as well as pen it down where necessary.

The result shows that majority (53.5%) and (58.5%) of rice farmers were found to have between 26-35 years of farming experience in Bauchi and Jigawa States respectively, while good number 36.0% and 24.0% of rice farmers had between 11-25 years of farming experience with a mean of 26 years in Bauchi State and 25 years in Jigawa State. It implies that the long farming experience will enable the rice farmers to make sound decisions as regards to resource allocation, adaptation to climate change strategies and general management of their farms. (Shaba *et al*. 2021) posited that farming experience is one of the indicators in decision making on what to produce, how to produce and from where to produce it. It also guides farmers on adaptation of new technologies as well the application of different techniques or strategies. Farming Experience refers to the length of time taken in years that the respondent had been engaged in farming as an occupation.

The results in Table 2 showed that 31.5% and 37.0% of the farmers have farm size ranging from 2.1-3.0 hectares in Bauchi and Jigawa States respectively, while a significant number 24.5% and



25.0% had farm size of between 1.1-2.0 hectares in both States. The pooled shows significant number 34.3% of rice farmers had farm size ranging from 2.1-3.0 hectares. This shows that majority of the farmers had small farms, which prevents them from enjoying economy of large-scale in production. The small farm size might be as a result of the fact that most of the farmers got their land through inheritance, which is assisted with fragmenting and sharing land of deceased persons to their heirs. Land in agriculture is sought to be one of the productive resources for people to engage in agriculture. This agreed with Bello *et al* (2023) who said majority of the farmers (50.7%) are subsistence farmers with average of 1.5 hectares. Majority of the respondents had farm size of less than hectare, meaning that most of the farmers operated on small scale basis. This implies that the majority of the respondents were small scale farmers. Small scale farmers lack the capital to invest in large scale agricultural production, they make use of mainly family labour.

The result shows that a small number 7.5% and 2.5% of rice farmer in both States earn between ₦100,000 and ₦300,000. Bauchi has a higher representation in this income bracket, about 4.0% and 1.5% of rice farmers earn between ₦301,000 and ₦600,000 indicating that very few farmers fall into this income range in both States, similarly, a reasonable number 22.5% and 20.0% of rice farmers earn between ₦1,601,000 and ₦1, 900,000 respectively, while a significant number 28.0% and 39.0% of rice farmers earn between ₦2,901,000 and ₦2, 300,000 in Bauchi and Jigawa States respectively. Jigawa has a notably higher percentage of respondents in this income bracket, indicating that a significant number of farmers are achieving high income levels. This could be attributed to factors such as better land quality, access to irrigation, or more favorable market conditions, allowing farmers to maximize their yields and profits

**Table 3:** Distribution of Respondents based on Socio-economic Characteristics in Bauchi and Jigawa States

Socio-economic characteristics	Bauchi State Frequency	Jigawa State Percentage	Pooled Frequency
<b>Level of Education</b>			
Quranic education	38(19.0)	52(26.0)	36(22.5)
Adult education	11(5.5)	17(8.5)	14(7.0)
Primary education	46(23.0)	22(11.0)	34(11.0)
Secondary education	73(36.5)	69(34.5)	71(35.5)
Tertiary education	32(16.0)	40(20.0)	36(18.0)
<b>Farming experience</b>			
5-10	17(8.5)	26(13.0)	22(10.8)
11-25	72(36.0)	48(24.0)	60(30.0)
26-35	107(53.5)	117(58.5)	112(56.0)
36-40	4(2.0)	9(4.5)	7(3.3)
<b>Mean</b>	<b>26 Yrs</b>	<b>25 Yrs</b>	<b>26 Yrs</b>
<b>Farm size</b>			
<1	29(14.5)	12(6.0)	21(10.3)
1.1 – 2	49(24.5)	50(25.0)	50(24.8)
2.1 – 3	63(31.5)	74(37.0)	68(34.3)
3.1 – 4	36(18.0)	43(21.5)	39(19.8)
4>	23(11.5)	21(10.5)	22(11.0)
<b>Mean</b>	<b>2.8 ha</b>	<b>3.0 ha</b>	<b>2.9 ha</b>
<b>Farm income</b>			
₦100,000 - ₦300,000	15(7.5)	5(2.5)	10(5.0)
₦301,000 – ₦600,000	8(4.0)	3(1.5)	6(2.8)
₦601,000 – ₦900,000	5(2.5)	13(6.5)	9(4.5)
₦901,000 – ₦1,300,000	29(14.5)	30(15.0)	30(14.8)
₦1,301,000 – ₦1,600,000	42(21.0)	31(15.5)	37(18.3)
₦1,601,000 – ₦1,900,000	45(22.5)	40(20.0)	43(21.3)
₦2,901,000 – ₦2,300,000	56(28.0)	78(39.0)	67(33.5)
<b>Mean</b>	<b>₦890,110</b>	<b>₦ 964,322</b>	<b>₦927,216</b>
<b>Total</b>	<b>200(100)</b>	<b>200(100)</b>	<b>200(100)</b>

**Source:** Field Survey (2024)

Figures in parenthesis are percentage



### PERCEPTION OF RICE FARMERS ON CLIMATE CHANGE

In this section the respondents were asked to indicate their level of perception to climate change. The perception level on climate change among rice farmers in Bauchi and Jigawa State is presented in Table 4 below. The perception of the respondents was measured on 3 point likert scale; any mean score of perception equals/above 2.0 was considered as “increased” and below 2.0 was “decreased”.

The result in Table 4 revealed that the mean score ( $\bar{x}=2.4$ ) and ( $\bar{x}=2.7$ ) of rice farmers in Bauchi and Jigawa State perceived increased in Temperature. This is in line the findings of Banjade *et al* (2024) who said most respondents (96.8%) reported experiencing an increase in temperature over the past 10 years and 93.6% observed an increase in the number of hotter days. Rainfall was perceived decreased ( $\bar{x}=1.7$ ) in Bauchi State and increased ( $\bar{x}=2.3$ ) in Jigawa State. This is in line with findings of Ismail (2023) who said majority (86.4%) of respondents perceived high level of temperature as a result of excess sun shine and high rainfall distribution in the area which in most cases result to unaware flash floods as major indicators of climate change in the region, it also agreed with Banjade *et al* (2024) who said majority (90.4%) noted a decline in rainfall frequency, while 88.3% observed shorter rainfall durations. The result further shows that precipitation was perceived at an increased rate ( $\bar{x}=2.2$ ) and ( $\bar{x}=2.1$ ) in Bauchi and Jigawa States, the findings disagreed with Banjade *et al* (2024) who said farmers in the study area also perceived a decrease in precipitation compared to the past 10 years. Drought was perceived decreased ( $\bar{x}=1.9$ ) in Bauchi State and increased ( $\bar{x}=2.2$ ) in Jigawa State. The both States perceived floods to be at decreased ( $\bar{x}=1.8$ ) and ( $\bar{x}=1.9$ ) with Jigawa slightly higher than Bauchi State. This is also in line with Banjade *et al* (2024) who said majority (72.3%) and (70.3%) of respondents reported declines in flooding frequency and intensity, respectively, over the past 10 years. Both States perceived pest and diseases to be at an increased rate ( $\bar{x}=2.0$ ) and ( $\bar{x}=2.0$ ), similarly, Dry season was perceived increased ( $\bar{x}=2.1$ ) and ( $\bar{x}=2.0$ ) in Bauchi and Jigawa States. The perception of an increased dry season in Bauchi and Jigawa State may indicate longer periods of drought, which can affect planting schedules and crop choices, Bauchi and Jigawa States rice farmers had decreased perception on Hurricanes ( $\bar{x}=1.7$ ) and ( $\bar{x}=1.9$ ). Rice farmers in both States perceive a decrease in hurricanes, which may reflect regional climate patterns and the relative rarity of such events in these areas, Hail and frost was perceived at an increased rate ( $\bar{x}=2.0$ ) and ( $\bar{x}=2.0$ ) in both States. Heavy winds was perceived decreased ( $\bar{x}=1.9$ ) and ( $\bar{x}=1.8$ ) by rice farmers from both States. Both States perceive a decrease in heavy winds, which can be beneficial for crop stability and growth. Drying up Streams was perceived decreased ( $\bar{x}=1.9$ ) in Bauchi State and increased ( $\bar{x}=2.0$ ) in Jigawa State. The perception of stable stream conditions in Jigawa may indicate better water management practices, while the perception of decreased drying in Bauchi suggests some improvement in water availability. Thunder storms was perceived decreased ( $\bar{x}=1.9$ ) and ( $\bar{x}=1.9$ ) by rice farmers in both States. Harmattan had an increased ( $\bar{x}=2.0$ ) and ( $\bar{x}=2.1$ ) perception by rice farmers in both States indicating changes in seasonal weather patterns, which can affect crop growth and soil moisture levels.



**Table 4:** Distribution of Respondents based on Perception of Climate Change in Bauchi and Jigawa States

Variables	Bauchi State Mean score	Remark	Jigawa State Mean score	Remark
Temperature	2.4	Increased	2.7	Increased
Rainfall	1.7	Decreased	2.3	Increased
Precipitation	2.2	Increased	2.1	Increased
Drought	1.9	Decreased	2.2	Increased
Floods	1.8	Decreased	1.9	Decreased
Pest and Diseases	2.0	Increased	2.0	Increased
Dry season	2.1	Increased	2.0	Increased
Hurricanes	1.7	Decreased	1.9	Decreased
Hail and frost	2.0	Increased	2.0	Increased
Heavy winds	1.9	Decreased	1.8	Decreased
Drying up streams	1.9	Decreased	2.0	Increased
Thunder storms	1.9	Decreased	1.9	Decreased
Harmattan	2.2	Increased	2.1	Increased

**Source:** Field Survey (2024)

### Adaptation Strategies Practiced to Mitigate the Effects of Climate Change

The result in Table 5 presents the summary of the factor analysis (FA) of the major adaptation Strategies to climate change in the study area. The sampling adequacy is measured by the Kaiser-Meyer-Olkin (KMO) statistic which is 0.801. The Bartlett's Test of Sphericity is significant at 1% for the samples. All these indicators underlying the consistency of factor analysis models. A total of three underlying factors with eigenvalues higher than one were identified in each group, and these three factors account for about 86% of variation of the sample. All the variables have communalities greater than 0.5, which implies that the factors explained more 50% of the variation in the variable.

**Factor 1:** This factor has a high positive loading for planting drought tolerant varieties. This factor account for about 32% of the variation in the sample and was named "crop management factor" The study found that Strategies such as planting high yielding (0.5988), planting drought tolerant varieties (0.7929), vegetation cover (0.5479) and timely of farm operation (0.5935) were highly loaded on crop management factor. The parameter that loaded most heavily on this factor was planting drought tolerant varieties (FA = 0.7929). This implies that planting drought tolerant varieties was the key strategy recognized by respondents as essential for adapting to climate change in Bauchi and Jigawa States. This agreed with Malabe and Ango (2023) who said majority of rice farmers (67.0%) adopted drought resistant rice variety in his study area.

**Factor 2:** This factor is highly loaded with parameters such as use of manure (organic or inorganic) (0.5579), shifting cultivation (0.6299) and Diversifying to non-farm activities (0.6055). This factor accounts for about 26% of the variation in the sample and is associated with sustainable resource management and livelihood diversification factor. The result further revealed that shifting cultivation (0.6299) and Diversifying to non-farm activities (0.6055) were the major adaptation strategies adopted in Bauchi and Jigawa State. This implies that the factor focuses on sustainable resource management and livelihood diversification.

**Factor 3:** This factor is highly loaded with parameters such as use of manure (organic or inorganic) (0.5101), crop rotation (0.5329) and mulching (0.7067). This factor account for about 28% of the variation in the sample and was named "soil conservation and management practice factor". The result in Table 10 revealed that mulching (FA=0.7067) has the highest factor loading, representing the highest adaptation strategy under soil conservation and management factor in Bauchi and Jigawa States.



**Table 5:** Adaptation Strategies Practiced to Mitigate the Effects of Climate Change in Bauchi and Jigawa States

Adaptation Strategies	Factors			
	1	2	3	Communality
Planting early maturing varieties	0.1415	0.1469	0.4110	0.7895
Planting of high yielding varieties	<b>0.5988</b>	0.2515	0.3606	0.6482
Mixed cropping	0.0459	0.1654	0.0808	0.9640
Use of minimum tillage system	0.3169	0.0116	0.0885	0.8916
Agroforestry practice	0.2667	0.2357	0.1889	0.8376
Use of agro-chemical	0.3081	<b>0.6289</b>	0.2640	0.4399
Use of manure (organic or inorganic)	0.1814	<b>0.5579</b>	<b>0.5101</b>	0.8957
Planting drought tolerant varieties	<b>0.7929</b>	0.0703	0.1195	0.3521
Crop rotation	0.1538	0.2698	<b>0.5329</b>	0.6195
Use of irrigation scheme	0.3780	0.0066	0.4630	0.6426
Shifting cultivation	0.2073	<b>0.6299</b>	0.1292	0.8875
Vegetation cover	<b>0.5479</b>	0.4007	0.3141	0.6405
Timely of farm operation	<b>0.5935</b>	0.2715	0.0559	0.5709
Diversifying to non-farm activities	0.3676	<b>0.6055</b>	0.1793	0.6660
Rural- urban migration	0.0809	0.4656	0.1392	0.7573
Mulching	0.1589	0.2150	<b>0.7067</b>	0.5292
<b>Model validation statistics</b>				
Eigen values	2.59804	2.86919	1.60053	
% of variance	32	26	28	
Bartlett's Test of Sphericity	991.134***			
Overall Kaiser-Meyer-Olkin	0.801			

**Source:** Field Survey (2024)

## CONCLUSION AND RECOMMENDATIONS

The study concluded that rice farmers in the study area perceived increased in temperature, precipitation, pest and diseases, dry season and harmattan as consequences of climate change. Also adaptation strategies adopted were planting high yielding varieties of rice, use of agro-chemical, use of manure (organic or inorganic), planting drought tolerant varieties and shifting cultivation among others. The study therefore, recommended:

- Government at all levels, Non-governmental organizations and other stakeholders should join hands and extend their climate change awareness campaign deep into the rural communities where no attention or less care is given to environmental sustainability.
- There is need for development of human capacity to adapt to climate change, the policy makers, planners and development agencies should develop area focused research and development strategies to cope with impacts of climate change
- All relevant stakeholders should be involved in educating rural farmers on effects of climate change, appropriate adaptation methods and creating opportunity for off farm employment and conducting research on the use of new crop varieties that are better suited to farmers' new climatic conditions.

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