



PERCEIVED EFFECTS OF CLIMATE CHANGE ON RICE PRODUCTION IN JAMAARE AND ITAS GADAU LGAs OF BAUCHI STATE, NIGERIA

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ABSTRACT

The study examined the effect of climate change on rice production in Jama'are and Itas/Gadau LGAs of Bauchi State, Nigeria. Multistage sampling techniques was used to select 216 respondents from the study area. Data were collected using structured questionnaire and analyzed using both descriptive and inferential statistics. The result revealed that almost all (97%) of the respondents were male and 62.9% married with a mean age of 35years. The result also showed that the respondents had a mean household size and farm size of 6 persons and 1.6ha. The most severe perceived effects of climate change on rice production were loss of soil water, low yields, increased weed growth and low soil fertility with a mean score ($\bar{X}=3.7$), ($\bar{X}=2.8$), ($\bar{X}=2.7$) and ($\bar{X}=2.7$), respectively. The results of regression analysis revealed that farm size and farming experience were positive and significant ($P<0.01$) influencing rice yield while access to credit was positive and significant ($P<0.05$). The major constraints faced by rice farmers were low capital, low yield of early maturing varieties (100%), frequent floods (100%), and high cost of fertilizer (100%). The study concluded that loss of soil water, low yield, increased weed growth and loss of soil fertility were some of the perceived effects of climate change in the study area. Based on the findings the respondents should promote and strengthen cooperative membership, Adequate and timely information on climate change should be provided by extension agents to enable rice farmers take adequate adaptation and mitigation measures.

Keywords: Climate, Change, Effect, Rice and Production

INTRODUCTION

Agriculture plays a vital role in the economy of most countries, contributing significantly to their Gross Domestic Product (GDP) and economic development, According to the Food and Agriculture Organization (FAO) of the United Nations, the global agriculture sector contributes around 10-12% to GDP, African countries, contributing around 20-30% to GDP, while Nigeria accounts for around 22-25% to GDP. Globally, climate change is a threat to humanity. These have triggered a wide variety of physical and biological changes across the world (Torres, 2024). Vulnerability is exacerbated by the continents with low adaptive capacity and dependence on rain-fed agriculture (Apraku *et al.*, 2021; Azadi *et al.*, 2021). Despite the damaging effects of climate change to Nigeria's agriculture, options aimed at responding (adapting) to climate change are few and therefore makes the poor who depend on farming, fishing and forestry as their main livelihood become more vulnerable to the changes in climatic condition (Bello, *et al.*, 2023). The impact of climate change on rice farmers in Jama'are and Itas Gadau local government areas, Bauchi State, Nigeria is a of great concern. Climate change has been projected to alter temperature and precipitation patterns, leading to increased frequency and severity of droughts, floods, and heatwaves, which can result in reduced crop yields, lower food quality, and increased food waste. Despite the importance of rice as a staple food in Nigeria, the country's rice production is vulnerable to climate change. Therefore, it is essential to investigate and address the impacts of climate change on rice production and the livelihood of rice farmers, and to identify strategies for building resilience and promoting sustainable agriculture practices.

Climate change is a global phenomenon that has significant impacts on agriculture, food security, and livelihoods. Nigeria, like many other countries, is experiencing the effects of climate change, including changes in temperature and precipitation patterns. The study focused on the perceptions of rice farmers from the immediate effect of climate change, resulting to disruption of agricultural activities in the study area. The study is very important because, as observed, there was



limited in-depth study on the effects of climate change on rice production in Jama'are and Itas Gadau LGAs of Bauchi State. The change in rice production due to effect of climate change will remain important research focus as well as measures needed to improve the resilience of the farmers to enable them adapt to climate change. Recent research has shown that rice can be used to offset the major impacts of climate change because of its potentials and unique properties as a food crop for urban and rural rice-growing populations (Manneh *et al.*, 2020). The authors added that rice is a major cereal in Nigeria in terms of its output and land area. The crop is currently grown in more than 70% of the States in Nigeria.

The broad objective of the study is to analyse the effect of climate change on rice production in Jama'are and Itas Gadau Local Government Areas of Bauchi State. While the specific objectives of the study are to:

- i. describe the socio-economic characteristics of rice farmers in the study area;
- ii. examine the perceived effects of climate change on rice production;
- iii. determine the factors influencing climate change effect on rice yield; and
- iv. identify the constraints affecting rice production due to climate change in the study area.

METHODOLOGY

The Study Area

The study was conducted in Jama'are and Itas Gadau local government areas of Bauchi State, Nigeria. Jama'are headquarters is in the town of Jama'are. Its geographical coordinates are 11° 40' 0" longitude to North and 9° 55' 53" latitude to East. It has an area of 493 km² and a population of 176,883 as of 2006 census, and approximately 209,800 as of 2023 projection density of 3.7% annual population changes NPC (2024), in 2025, the population is expected to reach around 250,800 driven largely by high birth rates and a youthful population. It is populated by a Fulani tribe that migrated from Dulare in the Lake Chad basin in the Republic of Chad. It has an average temperature of 31 °C. The popular Jama'are river flows through the LGA with average humidity level of the area put at 41%. The rainy season is hot, oppressive, and mostly cloudy and the dry season is sweltering and partly cloudy. Over the course of the year, the temperature typically varies from 56 °F (13.3 °C) to 104 °F (40.0 °C) and is rarely below 50 °F (10.0 °C) or above 108 °F (42.2 °C). The average wind speed in Jama'are LGA is estimated at 12 km/h.

Itas/Gadau headquarters is in the town of Itas, at Longitude 10° 10' 1.20" E and Latitude 11°50 4.79"N, It consists of two districts, namely Itas district and Gadau district. Gadau District holds Baauchi State University main campus. Itas Gadau has an area of 1,398 km² and had a Population of 229,996 during 2006 census, and approximately 408,100 as of 2024, Projection density of 3.7% Annual Population Change [2006 → 2023], in 2025, the population is expected to reach around 450,800 driven largely by high birth rates. The predominant ethnic group in the area are the Hausa and Fulani. Itas Gadau has two seasons (dry and rainy), the dry season is oppressively hot and partially cloudy, while the wet season is oppressively hot and predominantly cloudy. The average annual temperature ranges from 56 to 104 degrees Fahrenheit, rarely falling below 50 or rising over 108.

Farming is the major economic activity of the people of Jama'are and Itas Gadau LGAs crops such as rice, cotton, cowpea, peanuts (groundnuts), cotton, sorghum, millet, and onions, and vegetables are being cultivated in the area. They also rear domestic animals like sheep and goats, cattle, sheep, donkeys, and horses. Other important economic enterprises undertaken by the people of Jama'are and Itas Gadau LGAs are trades, fishing, hunting, weaving and dyeing of cotton.

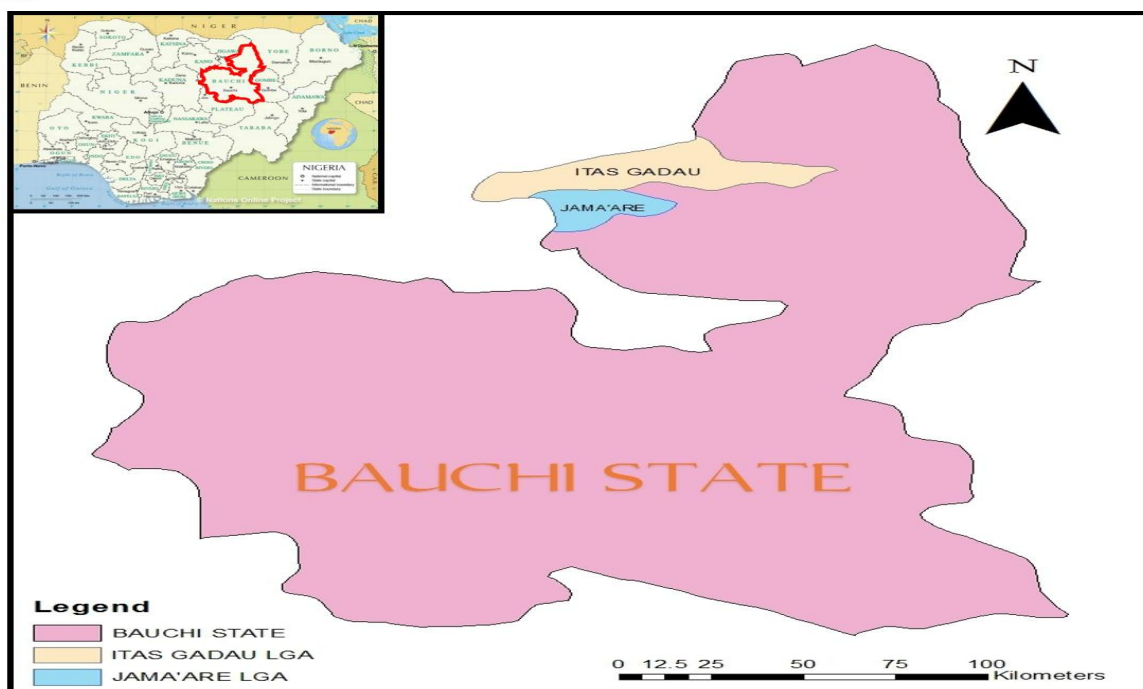


Figure 1: Map of the Study Area.

Sampling Techniques and Sample Size

A multi stage sampling procedure was employed. In the first stage, two Local Government Areas (Jama'are and Itas Gadau LGAs) were selected using purposive sampling techniques based on their high climate change-related hazards which seem to reduce rice availability. In the second stage, two districts were purposively selected from each LGA because they are predominantly known for rice production making a sample of four (4) Districts. In the third stage, three (3) villages that are predominantly known in Rice production were purposively selected from each district making a sample of 12 villages. In the final stage, 10% of rice farmers were selected using proportionate sampling from the sampling frame giving a sample size of 216 rice farmers.

Data Collection

The study employed structured questionnaire to collect information from the selected rice farmers in the study area. The questionnaire was divided into sections; section "A" contained items on socio – economic characteristics of the respondents; section "B" causes of climate change, section "C" consists of questions on factors influencing climate change on rice production in the study area; "D" covered factors influencing the effect of climate change on rice production and livelihood; section "E" covered of question on the rice production constraints in the study areas. The questions in the questionnaire are both open and close ended and was distributed to rice farmers in the study area. It is important to note that out of 216 questionnaires distributed to the respondents, only 197 were retrieved and analysed.

Data Analysis

The study employed both descriptive and inferential statistics in achieving its objectives. The data were analysed using SPSS version 23 in achieving the specific objectives of the study.

Descriptive statistics

Descriptive statistics such as frequency, distribution, percentages and mean were used to achieve objectives (i), (ii) and (iv).

Inferential statistics

Linear regression was used to achieve objective (iii) that is to determine the factors influencing the effect of climate change on rice yield in the study area.

The regression model is specified as:



$$Y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10} + b_{11}x_{11} + b_{12}x_{12} + b_{13}x_{13} + b_{14}x_{14} + b_{15}x_{15} + b_{16}x_{16} + e \quad \dots\dots\dots ii$$

Where;

Y = Rice yield (Kg/ha)

b₀ = Intercept

b₁- b₁₆ = Regression coefficients

X₁ = Age (Years)

X₂ = Sex (Male = 1, Female = 2)

X₃ = Marital status (1= Single, 2= Married, 3= Divorced, 4= Widowed)

X₄ = Household size (Number of persons)

X₅ = Education level (1= Non formal, 2= Primary, 3=Secondary, 4=Adult Education, 5= Tertiary)

X₆ = Farm size (ha)

X₇ = Farming experience (Years)

X₈ = Rice production (sole cropping (Yes = 1, No =2)

X₉ = Livestock production (Yes = 1, No =2)

X₁₀ = Civil servant (Yes = 1, No =2)

X₁₁ = Artisan (Yes = 1, No =2)

X₁₂ = Cooperative membership (Number of Cooperative membership)

X₁₃ = Access to credit (Yes = 1, No =2)

X₁₄ = Amount of credit received (₦)

X₁₅ = Access to inputs (Yes = 1, No =2)

X₁₆ = Annual Income (₦)

e = Error term

RESULTS AND DISCUSSION

Socioeconomic Characteristics of the Respondents

The result in Table 2 depicts the socioeconomic characteristics of the respondents. The finding revealed that 39.1% and 34.5% of the respondents were within the ages bracket of 35 – 42 and 27-34 years with an average age of 35 years. According to Nwalieji and Uzuegbunam (2018) most of the rice farmers were between the age ranges of 40 to 49 years. This finding implies that most of the respondents were within their active ages of production. The finding further showed that almost all (97%) of the respondents were male. This finding implies that most of the respondents were male which could be attributed to the cultural and religious belief of the respondents which limits women participation in on-farm activities. Bello *et al.* (2023) reported that majority (76.4%) of the farmers were male. The finding also showed that majority (62.9%) of the respondents were married and 31.5% of the respondents were single. This finding implies that most of the respondents were married which indicates that respondents will be willing to take responsibilities of their dependents. This result is in agreement with the finding of Enete (2018) in Gombe State, where he observed about 50% of the farmers were married.



Table 1: Distribution of Respondents according to Socio-economic Characteristics (n=197)

Variables	Frequency	Percentage	Mean
Age			
19-26	25	12.7	35
27-34	68	34.5	
35-42	77	39.1	
43-50	25	12.7	
51 and Above	2	1.0	
Sex			
Male	191	97.0	
Female	6	3.0	
Marital status			
Single	62	31.5	
Married	124	62.9	
Divorce	4	2.0	
Widowed	7	3.6	
Household size			
1-5	109	55.3	6
6-10	51	25.9	
11-15	27	13.7	
16-20	8	4.1	
21 and Above	2	1.0	
Educational level			
Non-formal	19	9.6	
Primary	35	17.8	
Secondary	51	25.9	
Adult education	13	6.6	
Tertiary	79	40.1	
Farm size			
0.5-1.5	130	66.0	1.6
1.6-2.5	45	22.8	
2.6-3.5	12	6.2	
3.6-4.5	6	3.0	
4.6 Above	4	2.0	
Farming experience			
1-4	49	24.9	7
5-8	94	47.7	
9-12	34	17.3	
13-16	13	6.5	
17 and Above	7	3.6	

Source: Field Survey, 2024

The result further showed that more than half (55.3%) of the respondents had a household size of 1-5 persons with a mean household size of 6 persons. This finding implies that most of the respondents had relatively moderate household size which indicates that respondents had chances of cheap family labor for rice production activities in the study area. Yakubu *et al.* (2021) reported that majority of the respondents in Kebbi and Sokoto States had a family size of 10 - 14 individuals. The results further showed that 40.1% and 25.9% of the respondents had tertiary and secondary levels of education. This finding implies that most of the respondents had attended one form of education or another which in turn help to increase respondents' level of knowledge and awareness on the effects of climate change in the study area. Yakubu *et al.* (2021) reported that majority had primary, secondary and tertiary education. The result further revealed that majority (66%) of the respondents had a farm size ranging 0.5 - 1.5ha with an average farm size of 1.6hecters. This implies that most of the respondents were relatively small-scale rice farmers in the study area. This is in contrast with Obioha (2018) who reported that 30.8% of the rice farmers had farm sizes of 2-4 hectares. The finding



also revealed that 47.7% and 24.9% of the respondents had 5 - 8 years and 1-4 years of farming experience. The finding also showed that the mean years of farming experience was 7 years in the study area. This finding implies that implies that most of the respondents had relatively good number of years in farming which plays a good role in increasing respondents' knowledge and skills in climate change adaptation techniques in the study area. The result also corroborates with the finding of Lansigan, (2020) who reported that long farming experience is an advantage for increase in farm productivity since it encourages rapid adoption of farm innovations.

The finding further showed that majority (59.9%) of the respondents had a yield of 10 - 82 bags of rice, with a mean yield of 101 bags this implies that most of the respondents had relatively good harvest from rice production and were small scale rice farmers in the study area. The finding also showed that 57.4% had not received any amount as credit While 22.8% and 16.8% received ₦344,000-₦507,000 and ₦180,000-₦343,000 as credit from their respective sources of credit with a mean credit of ₦170,015. This finding implies that most of the respondents who had access to credit and were able to obtain a reasonable amount to improve their rice production in the study area. The finding further showed that majority (65%) of the respondents had an annual income of ₦220,000 - ₦1,175,000, while 16.8% and 12.2% of the respondent had an annual income of ₦1,176,000 - ₦2,132,000 and ₦2,133,000-₦3,088,000. Only 5.1% and 1% of the respondents had an annual income of ₦3,089,000 - ₦4,044,000 and ₦4,045,000 and above in the study area. The result showed that respondents had a mean annual income of ₦1,202,487, which implies that most of the respondents had relatively high annual income from rice production in the study area.

Table 2: Distribution of Respondents according to Yield in Bags, Amount of Credit Received and Annual Income (n=197)

Variables	Frequency	Percentage	Mean
Yield in bags			
10-82	118	59.9	101
83-155	46	23.4	
156-228	24	12.2	
229-301	6	3.0	
302 and Above	3	1.5	
Amount of credit received			
Non	113	57.4	170,015.00
₦180,000- ₦ 343,000	33	16.8	
₦344,000- ₦ 507,000	45	22.8	
₦508,000- ₦ 671,000	2	1.0	
₦672,000 and Above	4	2.0	
Annual income			
₦ 220,000- ₦ 1,175,000	128	65.0	1,202,487.00
₦1,176,000- ₦ 2,132,000	33	16.8	
₦2,133,000- ₦ 3,088,000	24	12.2	
₦3,089,000- ₦ 4,044,000	10	5.0	
₦4,045,000 and Above	2	1.0	

Source: Field Survey, 2024

Effect of Climate Change on Rice Production

The result in Table 4 showed the perceived effects of climate change on rice production in the study area. The finding revealed that loss of water from the soil with a mean score of (\bar{X} =3.7), low yield (\bar{X} =2.8), increase weed growth (\bar{X} =2.7) and low soil fertility (\bar{X} =2.7) were considered severe effects of climate change by the respondents on rice production as indicated by the mean score above the threshold value of 2.5 in the study area.

Table 3: Effect of Climate Change on Rice Production

Variables	VS	S	MS	NS	Mean	Decision
Easy loss of water from the soil	179(90.9)	-	-	18(9.1)	3.7	Severe
Low yield	8(4.1)	149(75.6)	40(20.3)	-	2.8	Severe
Increase in growth of weeds	36(18.3)	69(35.0)	92(46.7)	-	2.7	Severe
Reduction in soil fertility	-	157(79.7)	40(20.3)	-	2.7	Severe
Reduction in farm income	12(6.1)	55(27.9)	130(66.0)	-	2.4	Not severe
Increases hunger/famine	-	18(9.1)	179(90.9)	-	2.4	Not severe
Food insecurity	-	8(4.1)	103(52.3)	86(43.7)	1.6	Not severe
Desertification	-	28(14.2)	118(59.9)	51(25.9)	1.8	Not severe
Increases soil erosion	-	68(34.5)	129(65.5)	-	2.3	Not severe
Pest and disease infestation	18(9.1)	-	177(89.8)	2(1.0)	2.1	Not severe
Unemployment	-	22(11.2)	173(87.8)	2(1.0)	2.1	Not severe
Stunted growth in crops	-	32(16.2)	147(74.6)	18(9.1)	2.0	Not severe
Increase in prices of rice	-	79(40.1)	118(59.9)	-	2.4	Not severe
Loss of farmland	-	10(5.1)	187(94.9)	-	2.0	Not severe
Reduction in supply of raw materials	-	54(27.4)	143(72.6)	-	2.2	Not severe

Source: Field Survey, 2024, Very Severe, Severe, Moderately Severe, Not Severe.

The finding further revealed that reduced farm income ($\bar{X}=2.4$), increase in hunger/famine ($\bar{X}=2.4$), food insecurity ($\bar{X}=1.6$), desertification ($\bar{X}=1.8$) and increase in soil erosion ($\bar{X}=2.3$) were found to be not severe effects of climate change on rice production by the respondents as indicated by the mean score values less than the threshold value of 2.5 in the study area. Other factors includes pest/disease infestation ($\bar{X}=2.1$), unemployment ($\bar{X}=2.1$), stunted growth in crops ($\bar{X}=2.0$), increase price of rice ($\bar{X}=2.4$), loss of farm land ($\bar{X}=2.0$) and reduction in supply of raw materials ($\bar{X}=2.2$) were also not severe effects of climate change on rice production as indicated by the mean score values less than the threshold mean value of 2.5 in the study area. This finding implies that most of the respondents were aware of the various effects of climate change on rice production and were able to measure the effects on rating scale to determine the level of severity of the effects on rice production in the study area. This is in line with Yakubu *et al.* (2021) indicated that farmers' experienced negative effects of climate change on rice production and rice yield.

Factors Influencing Rice Yield among the Respondents

The result in Table 5 shows an R-square value of 0.8832. This indicates that approximately 88.32% of the variation in rice yield explained by the independent variables included in the model, suggesting a strong explanatory power. The finding shows that Farm size has a highly significant and positive ($P<0.01$) effect on rice yield. This implies that a unit increase in farm size leads to a substantial increase in rice yield, holding other factors constant. The finding also showed that farming experience significantly and positive ($P<0.05$) influenced rice yield. A one year increase in farming experience leads to 1.38 increase in rice yield. Experienced farmers tend to have accumulated practical knowledge about local weather patterns, soil conditions, pest management, and optimal timing for farm operations. Also, civil servant as a secondary occupation significantly and positively ($P<0.01$) influences rice yield. This suggests that farmers who also hold civil service jobs achieve higher rice yields. Which indicates that civil servants have access to stable off-farm income, enabled them to invest more in quality inputs (improved seeds, fertilizers, irrigation) or hire labor, thereby overcoming financial constraints faced by full-time farmers. Similar to civil servants, having an artisan secondary occupation significantly and positively ($P<0.01$) influences rice yield. This reinforces the idea that diversified livelihoods with stable income enable farmers to inject capital into

their farming operations, leading to higher yields. Access to credit significantly and positively ($P < 0.05$) influences rice yield. This implies that farmers who have access to credit tend to achieve higher yields. This finding highlights the critical role of financial resources in boosting agricultural productivity. Credit enables farmers to purchase necessary inputs (seeds, fertilizers, pesticides), invest in small-scale irrigation, or adopt modern farming technologies that are often capital-intensive.

Table 4: Factors Influencing Rice Yield among Respondents

Variables	Coef.	Std. Err.	t	P> t
Age(x ₁)	-.1339195	.3995554	-0.34	0.738
Sex(x ₂)	-1.618251	11.27433	-0.14	0.886
Marital status(x ₃)	.785291	3.856674	0.20	0.839
Household size(x ₄)	.4930857	.5872961	0.84	0.402
Educational level(x ₅)	1.531702	1.897429	0.81	0.421
Farm size(x ₆)	55.1525	3.701869	14.90	0.000***
Farming experience(x ₇)	1.389039	.6070122	2.29	0.023**
Rice production(x ₈)	-2.68637	11.89584	-0.23	0.822
Livestock production(x ₉)	10.51668	10.51668	1.79	0.076
Civil servant(x ₁₀)	17.9337	6.511892	2.75	0.006***
Artisan(x ₁₁)	14.10358	5.166943	2.73	0.007***
Membership of cooperatives(x ₁₂)	-8.782454	5.54338	-1.58	0.115
Access to credit(x ₁₃)	16.60879	7.706664	2.16	0.032**
Amount of credit received(x ₁₄)	.0000124	.0000166	0.74	0.458
Access to inputs(x ₁₅)	-8.708007	4.755335	-1.83	0.069
Annual income(x ₁₆)	2.98e-06	3.24e-06	0.92	0.359
_cons	-71.68734	35.68452	-2.01	0.046
R-squared	0.8832			
Adj R-squared	0.8729			

Source: Field Survey, 2024 ***, **Significant at ($P < 0.01$ and 0.05)

Constraints to Rice Production in the Study Area

The result in Table 6 depicts the constraints affecting rice production in the study area. The finding showed that the major constraints to rice production were low capital base, low yield of early maturing varieties, frequent flood, high cost of fertilizer and labour were 100.0% and were ranked 1st respectively. This finding is in accordance with Malabe *et al.* (2019) who identified financial constraints as a major barrier to climate change adaptation among farmers in Nigeria. These were followed by inadequate knowledge on climate change, poor road network 74.1%, 56.9%, and were ranked 6th and 7th. This finding is in conformity with Akeem (2022) who reported that the use of climate change adaptation strategies is constraints by poor knowledge of climate change and its effects.

Table 5: Constraints Affecting Rice Production due to Climate Change

Variables	Frequency	Percentage	Rank
Low capital base	197	100.0	1 st
Low yield of early maturing varieties	197	100.0	1 st
Frequent flood	197	100.0	1 st
High cost of fertilizer	197	100.0	1 st
High cost of labor	197	100.0	1 st
Inadequate knowledge on climate change	146	74.1	6 th
Poor road network	112	56.9	7 th

Source: Field Survey, 2024

CONCLUSION AND RECOMMENDATION

Based on the findings, it was concluded that loss of soil water, low yield, increased weed growth and loss of soil fertility were some of the perceived effects of climate change in the study area.



Also farm size, farming experience and other occupations were found to be the significant factors influencing rice yield.

Based on the findings, the following recommendations were made;

- i. Farmers should promote and strengthen cooperative membership in the study area, Cooperatives should support research and development of climate-resilient rice varieties and improved farming techniques.
- ii. NGO should provide support to small-scale rice farmers, considering their limited resources and vulnerability to climate change.
- iii. Extension agents should intensify climate change education and awareness programs, focusing on practical adaptation strategies and the importance of sustainable farming practices.
- iv. Improving farmers' access to affordable and timely credit is essential for commercializing rice farming and enhancing food security in the study area.

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