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ANALYSIS OF FACTORS INFLUENCING MILLET FARMERS ADAPTATION STRATEGIES TO CLIMATE CHANGE IN YOBE STATE, NIGERIA

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ABSTRACT

The study analyzed factors influencing millet farmers adaptation strategies to climate change in Yobe State, Nigeria. A multistage sampling technique was used to select 305 millet farmers for the study. Data were collected primarily, through the administration of structured questionnaire and FGD. Data collected were analyzed using mean, frequency, percentage, and multiple regression. The results on socioeconomic characteristics of the respondents showed that 29.8% fell within the economically active age bracket of 41-50 years, 65.9% were male, 74.8% were married, 37.4% had no formal education while 53.4% had a household size of 6-10 persons. The result also revealed that 50.8% had 8-12 years of farming experience, 48.9% had access to 2-4 hectares, 44.9% had access to climate change information, and 60% were members of association. The result revealed that extension visit account for 58% while 39.7% had an annual farm income of between ₦251,000-₦350,000 respectively. Educational background, farming experience, access to climate change information, annual farm income, extension visit, and membership of association were significant determinants of millet farmers adaptation strategies to climate change at different probability levels ($P<0.001$ and $P<0.05$). Variables such as desertification, temperature, rainfall, and drought had both positive and negative influence on millet production. The study recommends extension organizations to exposed millet farmers to more effective adaptation strategies to avert climate-related risk; government and other stakeholders should provide or link millet farmers to available sources of fund or credit that will promote the use of climate-resilient infrastructures; extension organizations should enhance farmers use of diverse sources of climate change information in the study area.

Keywords: Adaptation, Climate Change, Millet Farmers, Socioeconomic

1 INTRODUCTION

Millet production has been widely increasing globally over the last few years in order to address the dietary requirements of the world increasing population density [1]. Millet is an important source of essential nutrients including carbohydrates, fat, protein, minerals, vitamins, and also possess bio-active compounds such as antioxidant, anti-cholesterol, anti-hypertensive, anti-hypoglycemic, as well as anthropometric impact and regulation of gut micro-biota composition in humans. These bio-active compounds, nutrients composition, and functions of most cereal grains including millet can be hindered through poor processing methods such as decortication, milling, fermentation, soaking, and malting [1]. Millet is grown as the most resilient cereal crop that produce enough quantity yield under severe climatic conditions that lower production which is attributed to unusual rainfall pattern, reduction in soil fertility, drought, high salinity, low soil pH, and excessive temperature [2,3]. The Sahel is known to be inclined to climate change challenges, threats and risk which greatly impacts agriculture [4]. The demands on maize by multiple industries have necessitated for an alternative cereal grains, as an option to limit the pressure. Therefore, replacing maize with pearl (*Pennisetum glaucum*) and finger millet (*Eleusine coracana*) in the diets has significantly impacted performances. These is attributed to several micro and macro nutrients composition of the grains as well as the presence of phytochemicals which impacts human health by lowering the cholesterol and phytates [5]. The pearl millet is the most widely cultivated millet in the Sahelian and Sudano-Sahelian zones, because of its tolerant to insufficient rainfall, drought, poor soil conditions and high temperature [6].

Agriculture as a sector contributes immensely to economic growth and development of most farming communities in sub-Saharan Africa. In developing countries like Nigeria, the sector make significant contribution to gross domestic product (GDP) which plays a crucial role in improving livelihoods. It was reported that Nigerian agricultural sector contribute 14% of Africa's GDP, making it among the three most highest African countries with top ranked GDP contributions derived from the agricultural sector [7]. From January-March 2021, the sector contributed 22.35% GDP, indicating the dependent of over 140 million Nigerians in the sector; while 28.9 million of labor force in the country was subjected to agriculture, with over 80% being subsistence farmers [8,9,10]. Agricultural sector is influenced by various climatic conditions and changes, through increased temperatures, erratic precipitation, and increase in the rate of extreme weather patterns [11]. The change in climate exposed agriculture to danger, especially rain-fed agriculture because of its reliance on favourable weather conditions to remain productive [12]. The relative dependent of millet farmers on rain-fed agriculture exposed them to become more vulnerable to climate change variability resulting in a significant decreased in crop yield, food insecurity, land degradation, high temperature, high market prices, flooding, displacements, soil erosion, desertification, deepening poverty, and poor livelihoods [13,14,15,16,17]. By 2050, it was estimated that crop yield, will decline by 5-17% especially in the sub-Saharan Africa due to increase in temperature and rainfall volatility and changes in other climatic conditions and institutions among others [18].

In Yobe State, agriculture continue to remain the most vital and viable economic sector of majority of the population. However, in spite of its numerous contribution to the economy, the sector faces a lot of challenges due to climate change and climate-induced socioeconomic stress. This challenges affect millet farmers productivity. This shows that there still remains a gap on how climate change affect farmers socioeconomic activities and millet production in the state. Climate-related risk has caused many seasonal changes in Nigeria and the influence of these challenges on our socioeconomic activities cannot be overemphasized. [19], observed that farmers economic stability is significantly affected by increased cost of production and low yields which negatively impacts farmers income and livelihood activities. The implication of climate variability to farmers food security status and economic stability is highly crucial on millet production. Several studies were carried out to assessed the impact of climate change on agricultural productivity, but there is no literature or empirical evidences on the influence of socioeconomic factors on millet farmers adaptation strategies to climate change in the study area. It is against this backdrop that the study aimed to analyze the factors influencing millet farmers adaptation strategies to climate change in Yobe State, Nigeria. Specifically, the study aimed to:

- describe the socioeconomic characteristic of millet farmers in the study area;
- determine the factors influencing millet farmers adaptation strategies to climate change in the study area.

2 MATERIALS AND METHODS

2.1 The Study Area

The study was conducted in Yobe State, Nigeria. The state is located in the Northeastern Nigeria and fall within latitudes 12^0 00' N and 11^0 30' E of the equator and longitudes 12.000^0 N and 11.500^0 E of the Greenwich Meridian [20]. The State has a total land area of 45,502 km^2 with a population of 2,321,339 and 2026 projected population estimate of 4,358,454 based on 3.2% population growth rate [21]. The climate is dry Savannah belt with hot and dry seasons for most of the year, except in the southern part of the State which has a mild climate. The area experiences 300mm-9000mm of annual rainfall with an annual temperature of 28^{0}C - 42^{0}C and relative humidity of 82% [22]. The period of rainy season in the state varies from place to place, but generally lasts for about 120 days (i.e. June to September) in the North and more than 140 days (May to October) in the South [22]. Greater proportions of the population in the state are farmers followed by civil servants and some inhabitants who are engaged in tailoring, trading, fishing, craft, etc. The major crops cultivated in the area include millet, sorghum, rice, cowpea, groundnut and sesame. Livestock such as sheep, goat and cattle are kept for domestic purposes including poultry and fisheries [20].

2.2 Sampling Technique and Sample Size

Multi-stage sampling technique was employed in selecting the respondents for the study. The first stage involved the selection of all the three (3) senatorial zones in the State. The second stage involved purposive selection of three local government areas (LGAs) with high production of millet from each of the senatorial zone, making a total of nine (9) LGAs. In the third stage, two communities were purposively selected from each of the selected LGAs due to their prominence in millet production, which gave a total of 18 communities. The fourth stage involved proportionate selection of 24% of millet farmers from the sampling frame of each of the selected communities using Taro Yamane (1967) proportionate formula [23]. This gave a total of 305 millet farmers that were randomly selected for the study. The Yamane formula for determining sample size is expressed as;

$$n = \frac{N}{1 + N(e)^2} \quad \ldots\ldots(i)$$

- Where,
- n = Sample size
- N = Population size
- e = Error term (0.05)

Table 1: Distribution of the Sampling Techniques and Sample Size

Senatorial Zone	L.G.A	Community	Sampling frame	Sample size (24%)
Southern zone:	Nangere	Dawasa	93	22
		Sabon garin nangere	81	19
	Potiskum	Danchuwa	68	16
		Badejo	72	17
	Fune	Garin idi barde	60	14
		Alagarno	75	18
Central zone:	Tarmuwa	Biriri	86	21
		Chirokusko	71	17
	Yunusari	Kanamma	97	23
		Kapia	60	14
	Geidam	Kelluri	57	13
		Garin Gada	48	12
Northern zone:	Jakusko	Jakusko	107	26
		Buduwa	75	18
	Yusufari	Yusufari	45	11
		Guya	33	8
	Karasuwa	Karasuwa galo	52	12
		Jajimaji	100	24
TOTAL	9	18	1280	305

Author compilation, 2026

2.3 Method of Data Collection

The study used primary data. The data were collected through the administration of structured questionnaire. The questionnaires were pre- tested, reliable and validated. The qualitative techniques, namely focus group discussion (FGD) was also applied as the survey instrument with the help of trained enumerators.

2.4 Method of Data Analysis

A combinations of different statistical tools were used in analyzing the data for the study. The tools include both descriptive and inferential statistics. The descriptive statistics used include; frequency, percentages, and means. The inferential statistical tools used was multiple regression analysis.

2.4.1 Multiple Regression

The multiple regression models were used to determine the factors influencing millet farmers adaptation strategies to climate change in the study area.

The regression model is expressed as:

$$Y_i = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + e \quad \ldots\ldots (ii)$$

- Where,
- Yi = Adaptation strategies used (number),
- X_1= Age of respondents (years),
- X_2= Sex (male = 1, female = 0),
- X_3 = Educational background (no education = 1, primary = 2, secondary = 3, tertiary = 4),
- X_4 = Household size (number of persons),
- X_5= Farming experience (years),
- X_6 = Access to climate change information (often = 1, rarely = 2, never = 3)
- X_7 = Extension visits (number of visit/month)
- X_8 = Membership of association (yes = 1, no = 2),
- X_9 = Annual farm income (naira),
- a = Constant,
- e = Error term
- β_1 - β_7 = Coefficient of estimated parameters
- X_1 - X_7 = Estimated parameters

3 RESULTS AND DISCUSSION

3.1 Socio-economic Characteristic of the Respondents

The results presented in Table 2 showed the socioeconomic characteristics of the respondents in the study area. The results revealed that 29.8% of the respondents fell within the age bracket of 41-50 years. The mean age of the respondent was 45.4 years indicating that they are within their economically active age. This correspond with the findings of [24] who reported the age of the respondents to be relatively young and active. This implies that the respondents were vibrant and economically active with higher commitment to satisfy their family demands. A greater majority of male (65.9%) were engaged in millet production compared to female (34.1%). Additionally, the results of the respondents' marital status surveyed indicated that majority (74.8%) were married while 4.6% had been widowed. This agree with [25] who revealed that a significant majority (89.5%) of the respondents were married, which could contribute essentially to the use of family labor. Marriage in most rural farming communities was perceived to significantly increase household size and family units that can provide the needed farm labor [26]. Married farmers tends to have more responsibilities and financial demands than others, which can highly increase their urge and motives to obtain high yields and adopt climate adaptation strategies. This was validate by [27] who equally reported that 90% of the respondents were married. This indicates that farmers have numerous responsibilities and commitments that can influence their adaptation to climate change, which can help in addressing food insecurity. Similarly, [28] shows that 62.5% were married. Implying that a greater percentage of the farmers are responsible and highly committed in the study area.

The result also revealed that 37.4% of the respondents had no formal education signifying that the respondents had some level of illiteracy in the study area. This implies that awareness creation and sensitization campaign should be carried out at the farming communities to promote the adoption of the adaptation strategies to climate change. The result are in tandem with the findings of [29] who equally reported that the respondents had no formal education, which could hinder their ability to access information and innovations that could significantly improve their resilience to climate change [30]. [25] also revealed that 22.7% of the respondents had no formal education, while 77.3% had at least primary education. This implies that education level of farmers is perceived to greatly influence the use of improved technologies or innovations like climate change adaptation strategies that can positively enhance their productivity. Hence, farmers with limited or no formal education face a lot of problems in assimilating the complexity of scientific innovations and application of climate change towards sustainable agriculture [31]. Contrarily, [28] who demonstrated that majority (81.2%) of the farmers had formal education and by implication, they can access climate change information since they can read and write. A higher proportion (53.4%) of the respondents had a household size between 6-10 persons with a mean average of 6 person. The average household sizes of 6.9 was perceived as a valuable source of labor in sub-Saharan Africa compared to other regions of the world like North America and Europe [32,33]. In agriculture, a substantial household size is seen as an asset that contribute to farming operations, hence, it can also be seen as a huge responsibility to address the demands of the family, which might result in a lot of pressure, particularly with the current implications of climate change like low yields and erratic weather conditions [34]. Similarly, [35] opined that farmers with high household sizes are likely to mitigate the effect of climate-related risk by leveraging family labor.

Consequently, the result also showed that 50.8% of millet farmers had farming experience of 8-12 years with a mean farming experience of 11 years. This implies that majority of the respondents in the study area were actively engaged in millet production for many years. It is evident that farmers with more farming experience are more likely to have high resilience and practice some adaptation strategies than those with low experience [36]. This was validated by [37] who demonstrated that farmers with higher farming experience are in better position to implement adaptation strategies, such as a shift in planting dates or the use of drought resistant varieties, in comparison with the younger farmers, with less experience. Additionally, about 48.9% of the respondents had access to cultivate 2-4 hectares of farmland, though their source of acquisition of land were unknown, while 23.3% had access to more than 5 hectare with a mean average of 3.2 hectares respectively. Access to climate change information revealed that 44.9% of the respondents often had access to climate change information while 32.1% rarely had access to the information. This was supported by [38] who revealed that 48% have access to climate change information which can significantly increase farmers' ability to avert climate change impact. This implies that millet farmers in the study area have access to climate change information which could enhance the use of climate change adaptation strategies in the study area. Membership of association showed 60% of the respondents were members of their respective community association of millet producers while 40% were not members of any association/cooperative. This align firmly with the findings of [39] who revealed that more than 24% of the farmers were members of cooperative societies, and this enable them to access relevant adaptation strategies to climate change.

The result on extension visit revealed that 58% of the respondents received extension visit on monthly basis. This suggest that farmers with frequent extension contact may gain a lot of insight on climate change through extension services delivery that can help them integrate climate-resilient practices into their farming system [40]. This correspond with the findings of [39] who indicates that farmers access to extension contacts accounted for more than 40%. This implies that extension visit make farmers to have diverse adaptation strategies and techniques that could significantly mitigate climate change effect. Therefore, the objective of extension services in providing farmers with current information, and training on climate-smart agriculture is highly significant in enhancing productivity and building resilience to climate-related risk [40]. Lack of extension visits among farmers might not give them the needed support to adapt to climate change, therefore, it become necessary to provide regular services for timely transmission of up-to-date agricultural technologies/practice [34]. The results on annual farm income of millet farmers revealed that a larger percentage of the respondents (39.7%) earned between ₦251,000-₦350,000. The mean annual income of the respondents was ₦259,000. The variation in the annual income may be due to difference in the number of farm input used, system of farming, family labor and farm size. This is because most of the respondents were small scale farmers with low income level to practice some of the adaptation strategies to climate change. This corroborate with [39] who reported the mean values of farm income and non-farm income to be within ₦207,000 and ₦263,000 respectively. This implies that there is little marginal variation in annual income which might influence farmers adaptation strategies. The decline in yield is a key factor that contribute to lower productivity and income of the farmers. This findings was validated by several researchers who showed that farmers have relatively low income, which makes them rely on income generated from their agribusinesses [41,42,43,44].

Table 2: Distribution of the Respondents According to their Socio-economic Characteristics

Variables	Frequency (f)	Percentages (%)	Mean ($\bar{x}$)
Age (Years)			
≤ 30	36	11.8	

31-40	85	27.9	
41-50	91	29.8	45.4 years
51-60	50	16.4	
≥ 61	43	14.1	
Sex			
Male	201	65.9	
Female	104	34.1	
Marital Status			
Single	40	13.1	
Married	228	74.8	
Divorced	23	7.5	
Widow	14	4.6	
Educational Level			
No Formal Education	114	37.4	
Primary Education	62	20.3	
Secondary Education	85	27.9	
Tertiary Education	44	14.4	
Household Size (Number)			
1-5	130	42.6	
6-10	163	53.4	6 persons
≥11	12	4	
Farming Experience (Years)			
≤ 2	2	0.6	
3-7	42	13.8	
8-12	155	50.8	11 years
≥ 12	106	34.8	
Farm Size (ha)			
≤ 1	85	27.9	
2-4	149	48.9	3 ha
≥ 5	71	23.3	
Access to Climate Information			
Often	137	44.9	
Rarely	98	32.1	
Never	70	23	
Membership of Association			
Member	183	60	
Not a member	122	40	
Extension Visit			
Once in a week	23	7.5	
Twice in a week	11	3.6	

Fortnightly	94	30.8	
Monthly	177	58	
Annual Farm Income (₦)			
≤ 150,000	50	16.4	
151,000 - 250,000	73	23.9	259,000
251,000 - 350,000	121	39.7	
≥ 351,000	61	20	
Total	305	100	

Source: Field survey, 2026

3.2 Factors Influencing Millet Farmers Adaptation Strategies to Climate Change

The result of multiple regression analysis in Table 3 revealed that the coefficient of determination (R^2) was 0.661. This implies that 66.1% of the total variations in climate change adaptation strategies (Y) was explained by the socioeconomic variables (X) included in the model. The regression results indicates that socio-economic variables such as educational background, farming experience, access to climate change, extension visit, membership of association and annual farm income of the farmers were significant at different probability levels. The coefficient of educational background (0.174), farming experience (0.147), access to climate change information (0.161), and annual farm income (0.191) were both positive and significant at 1% level of probability. This implies that a unit increase in educational status of the millet farmers will result to a corresponding unit increase in probability of climate change adaptation strategy. Therefore, it can be inferred that the more educated the farmers become, the more likely they will adopt the adaptation strategies. Farming experience (0.147) was positive and statistically significant at 1% level of significance. This implies that farmers whose farming experience is high tends to use adaptation strategies to climate change more than those with low farming experience. Access to climate change information (0.161) exhibited a positive coefficient and was highly significant at $P<0.01$, suggesting that farmers with frequent access to climate change information are more likely to practice adaptation strategies to climate change. Annual farm income (0.191) was positively signed and highly significant at 1% level of probability. This signifies that higher annual income was linked to increase in the use of climate change adaptation strategies in the study area.

Table 3: Multiple Regression Analysis of Factors Influencing Millet Farmers Adaptation Strategies to Climate Change

Variables	Coefficient	S.E	T-value	Sig.
(Constant)	1.882	0.089	19.530	0.001
Age	-0.063	0.028	-2.142	0.111NS
Sex	0.571	0.403	1.321	0.247NS
Educational background	0.174	0.014	12.746	0.000***
Household size	0.175	0.153	1.061	0.233NS
Farming experiences	0.147	0.012	6.162	0.000***
Access to climate change information	0.161	0.017	8.999	0.000***
Extension visit	0.095	0.011	2.227	0.049**
Membership of association	0.148	0.017	6.424	0.004**
Annual farm income	0.191	0.018	10.631	0.001***
R^2 = 0.661 Adjusted R^2 = 0.539				

Source: Field survey, 2026; *** = Significant at 1%, ** = Significant at 5%, NS = Not statistically significant

This findings was supported by [45] who reported the determinants of cassava farmers' adaptation strategies to climate change in Ebonyi State, Nigeria. The result showed that about 82% of the of the total variations in the dependent variable was explained by the independent variables. This implies that the dependent variables is significantly influenced by the independent variables. Age was negative and significant, implying negative relationship between farmers ability to adapt to climate change and age. The coefficient of household size, education, farming experience, and extension contact was positive and statistically significant. This implies that a unit increases in these variables will result to a unit increase in farmers adaptation strategies to climate change. Farm size was positive and significant, implying that a unit increase in cassava farmers' output will correlate to 929.4% increase in their likelihood to adapt to climate change [24]. This align firmly with [46] who used binary logistic regression model to determine factors influencing farmers adaptation strategies. The result also showed that age, sex, education, household size, access to extension services and training on climate change significantly influence farmers adaptation. Several studies have reported a positive and significant relationship between farmers socioeconomic characteristics and adaptation strategies to climate change [28,47,48].

4 CONCLUSION

Climate change affect food security and livelihood of millet farmers in the study area. This call for the adoption of adaptation strategies to avert the consequences of climate related risk. The data on socioeconomic characteristic of the respondents confirmed that, millet farmers are more likely to adapt climate change adaptation strategies. The coefficients of education, farming experience, access to climate change information, annual farm income, extension visit, and membership of association were significant determinants of millet farmers adaptation strategies to climate change at different probability levels. Consequently, the coefficients of variables such as desertification, temperature, rainfall, and drought had both positive and negative impacts on millet production.

Recommendations

Based on the research findings, the following recommendations were made:

- Extension organizations should exposed millet farmers to more effective adaptation strategies to avert climate-related risk and challenges.
- Government and other stakeholders should provide or link millet farmers to available sources of fund or credit that will promote the use of climate-resilient infrastructures.
- Extension organizations should enhance farmers use of diverse sources of climate change information including farmer to farmer.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare that there is no conflict of interest.

Statement of ethical approval

The study was carried out in conformity with the recommended ethical guidelines for human participation in survey such as confidentiality, informed consent, anonymity, and voluntary participation.

Statement of informed consent

Both written and oral informed consents was obtained from all the participants.

Authors contribution

The authors carried out the introduction, conceptualization, methodology, writing, editing, analysis, interpretation and discussion of data.

Data availability

Data collected for the study were embedded in the paper.

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