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Factors Influencing Level of Adaptation to Climate Change among Vegetable Farmers in Bauchi Local Government Area, Bauchi State, Nigeria

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Abstract

Climate change poses significant threats to vegetable farming through erratic weather events, pests and resource scarcity prompting smallholder farmers to adopt adaptation strategies like crop diversification, adjusting planting dates and improved irrigation for resilience. This study assessed the factors influencing vegetable farmers level of adaptation to climate change in Bauchi metropolis, Bauchi State, Nigeria. A multi-stage sampling technique was used in selecting 50 vegetable farmers. Data were collected using structured questionnaire and analysed using descriptive and inferential statistics. The findings revealed that most (96.0%) of the respondents reported noticing changes in the climate change and specifically, observed drought prevalence (66%), increased temperature (60%) and erratic rainfall (50%). Farmers reported that reduced income (80%), reduced yield (78.0%) and pest/disease infestations (72.0%) were the key effects of climate change on vegetable production. The level of adaptation among vegetable farmers was high (58.0%) with minimum tillage (72.0%), irrigation (70.0%) mulching (70.0%) and soil management practices (68.0%) as the adaptation strategies practiced. Effective adaptation strategies noted by the farmers include livestock manure management ($\bar{x}$ =3.26), soil management practice (($\bar{x}$ =3.24), use of early maturing varieties ($\bar{x}$ =3.20), and use of drought-resistant varieties ($\bar{x}$ =3.12) were the effective adaptation strategies. Age (P<0.1), farm size (P<0.1), sex (P<0.1) and household size (P<0.05) were the significant factors influencing level of adaptation to climate change. Inadequate knowledge (82.0%), inadequate resources (72.0%) and cultural sentiments (66.0%) were the major constraints to climate change adaptation. The study concluded that age, household size, farm size and sex significantly influenced farmer's level of climate change adaptation to climate change. To improve vegetable farmers' adaptation to climate change, efforts should focus on strengthening farmers' knowledge through targeted training, addressing cultural and normative barriers with community-based awareness, and enhancing financial inclusion to access to productive resources.

KeyWords: *Climate Change, Level of Adaptation, Vegetable Farmers and Bauchi State*

1.0 Introduction

1.1 Background of the Study

Climate change remains one of the most critical global challenges affecting agricultural systems, particularly in developing countries where farming is largely climate-dependent. Changes in temperature, rainfall variability, and the increased frequency of extreme weather events have been widely reported to reduce crop productivity and threaten rural livelihoods in sub-Saharan Africa (IPCC, 2023). Smallholder farmers, who constitute the bulk of Nigeria's agricultural workforce, are especially vulnerable due to limited resources, weak institutional support, and heavy dependence on rain-fed agriculture (Abid *et al*., 2022). Vegetable farming is highly sensitive to climate variability because vegetables require adequate moisture, stable temperatures, and careful management throughout their short growth cycles. Recent studies show that rising temperatures and erratic rainfall significantly reduce vegetable yield and quality while increasing pest and disease pressure (Gbegbelegbe *et al*., 2021 and Tiwari *et al*., 2024). Consequently, vegetable farmers are compelled to adopt adaptation strategies such as changing

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planting dates, using improved varieties, irrigation, mulching, and crop diversification to sustain production (Nyasimi *et al*., 2022).

In Nigeria, empirical evidence indicates that farmers' adaptation to climate change is influenced by a range of socio-economic, institutional, and environmental factors. For instance, studies by Ojo and Baiyegunhi (2023) and Afolayan *et al*. (2022) reported that education level, access to extension services, farming experience, access to credit, and climate information significantly affect farmers' adoption of climate adaptation measures. Similarly, Sadiq *et al*. (2024) found that institutional support and farmers' awareness levels strongly determine adaptation choices in northern Nigeria. Bauchi State lies within Nigeria's Sudan Savanna ecological zone, which is characterized by increasing temperature, declining rainfall reliability, and recurrent droughts. Evidence from recent studies in Bauchi and neighboring states suggests that climate variability has negatively affected crop yields and farm income, prompting farmers to adjust their production practices (Usman *et al*., 2022 and Lawal *et al*., 2023).

Vegetable farmers in Bauchi Local Government Area are increasingly confronted with climate-related challenges such as erratic rainfall patterns, prolonged dry spells, rising temperatures, declining soil moisture, and increased pest and disease infestation. These challenges have resulted in reduced vegetable yields, unstable income, and heightened food insecurity among farming households (Usman *et al*., 2022; IPCC, 2023). Although various climate change adaptation strategies exist, the level of adoption and effectiveness of these strategies among vegetable farmers varies considerably. Some farmers adopt multiple adaptation measures, while others adopt few or none, despite facing similar climatic conditions. Studies suggest that this variation is often linked to differences in socio-economic characteristics, access to resources, institutional support, and information (Afolayan *et al*., 2022; Ojo and Baiyegunhi, 2023).

In Bauchi Local Government Area, there is limited empirical evidence identifying the specific factors influencing the level of adaptation to climate change among vegetable farmers. This knowledge gap hinders the formulation of effective policies and extension programs tailored to the needs of vegetable farmers. Without such evidence, interventions aimed at improving climate resilience may remain poorly targeted and ineffective. Hence, this study seeks to analyze the factors influencing the level of adaptation to climate change among vegetable farmers in the study area. The findings from this study will be valuable to policymakers, agricultural extension agents, NGOs, and development partners by identifying key socio-economic and institutional constraints to adaptation. Such evidence will support the design of targeted interventions.

The broad objective of the study is determining the factors influencing vegetable farmers' level of adaptation to climate change in Bauchi L.G.A, Bauchi State, Nigeria. The specific objectives were to;

i. examine the effects and adaptation strategies on climate change in vegetable production;
ii. determine the factors influencing farmers level of adaptation to climate change; and
iii. identify the constraints limiting the adaptation to climate change mitigation strategies.

METHODOLOGY

The Study Area

The study was carried out in Western Agricultural Zone of Bauchi State, Nigeria. Western Agricultural Zone of Bauchi State consists of seven (7) Local Government Areas (LGAs) which include Alkaleri, Bauchi, Bogoro, Dass, Kirfi, Tafawa Balewa and Toro. It is located in the northeastern region of the Federal Republic of Nigeria and occupies a total land area of 549,260 km^2 (BAGIS 2024). The State is geographically located between Latitudes $9^0.3^{'}$ and $12^0.3^{'}$ North of the Equator and Longitude $9^0.5^{'}$ and 11^0 East of the Greenwich meridian (Chiroma *et al.,* 2021). The State has a population of a projected figure of 1,856,858 people at 3.8% growth rate per annum (NPC, 2025). The Zone is characterized by two distinct vegetation zones which include Northern Guinea Savannah and Sudan Savannah (Chiroma *et al.,* 2021). The zone experiences both wet and dry season with temperatures ranging between 15-29.7 ^{0}C in January to 23-32.4 ^{0}C in June with an average relative humidity of 40.1 percent. It is also characterized with an average annual rainfall of 85.6mm Chiroma *et al.,* (2021). Agriculture and livestock farming are the major economic activities. Crops cultivated include, maize, rice, sesame, groundnuts, millet, sugarcane etc.

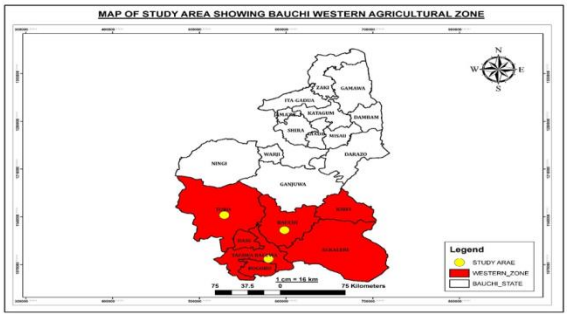

Figure 1: *Map of Bauchi State showing the Study Area*

The vegetation consists of grassland interposed with trees (up to 6m high) and shrubs. The trees normally occur singly or in cluster with shrubs underneath. The effect of cultivation however, reduced the vegetation in most part of the area, most important trees and shrubs found in the study area include; *Cassia stabericina, Isoberlinaspp, Albida, Khayasenegalensis, Tamarindusindica, Phoenicdactylifera* (BSADP, 2013).

Sampling Technique and Sample Size

The study used a three-stage sampling technique to select the respondents. In the first stage two (2) wards were purposively selected to be able to capture those areas with higher concentration of vegetable production. In the second stage three (3) communities were also purposively selected from each ward to give a total of six (6) vegetable production locations. Finally, 11 vegetable farmers were randomly

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selected from each location to give a total sample size of 66 respondents.

Method of Data Collection

The study used primary data only and questionnaire was employed as a data collection instrument. Data were obtained by administering the questionnaire to the respondents and supplemented with interviews.

Method of Data Analysis

Data was analyzed using both descriptive and inferential statistics to achieve the stated objectives of the study.

Model Specification of Logistic Regression Analysis

$P(Y=1)=\frac{1}{(1+e(-2))}$

where;

P(y=1) is the probability of the outcome variable being 1

e=is the base of the natural logarithm

-2= is the linear combination of the predictor variable

RESULTS AND DISCUSSION

Effects of climate change and type of vegetables affected

The findings from Table 1 presents the effects of climate change on vegetable production and identifies the types of vegetables mostly affected by these changes. The most common effects reported by respondents included reduced income (80.0%), reduced yield (78.0%), and prevalence of pest/disease pressure (72.0%) ranking 1st, 2nd, and 3rd, respectively. Other observed effects include changes in the growing season (66.0%) and reduced water supplies for agriculture (62.0%) which were also ranked as 4th and 5th, respectively. The major (74.0% each) types of vegetables mostly affected were tomatoes and cucumbers ranking 1st with both reported by the respondents, followed by onions and peppers at 70.0% each ranking 2nd. Amaranthus and carrots were less affected as reported by 48.0% and 46.0% of the respondents and were ranked 3rd and 4th. The high prevalence of reduced income and reduced yield points to the significant economic consequences of climate change on vegetable farming. These findings are consistent with that of Adedeji *et al.* (2018), who observed that climate change results in lower agricultural output and income. In terms of vegetable types, tomatoes and cucumbers, being high-value crops, are particularly vulnerable to climate-related challenges, which could affect food security and farmers' livelihoods.

Table 1: Distribution of the Respondents According to Effects of Climate Change and Type of Vegetables Affected

Variable	Frequency	Percentage	Ranking
Effects on vegetable production			
Reduced income	40	80.0	1st
Reduced yield	39	78.0	2nd
Prevalence of pest/disease pressure	36	72.0	3rd
Changes in growing season	33	66.0	4th
Reduced water supplies for use in agriculture	31	62.0	5th
Vegetables mostly affected			
Tomatoes	37	74.0	1st
Cucumber	37	74.0	1st
Onion	35	70.0	2nd
Pepper	35	70.0	2nd
Amaranthus	24	48.0	3rd
Carrot	23	46.0	4th

Source: Field Survey, 2024

Climate Change Adaptation Strategies

Level and types of climate change adaptation strategies use by the respondents

Table 2 presents the level of adaptation and the types of strategies adopted by respondents to mitigate the effects of climate change on vegetable production. The level of adaptation among respondents was found to be high for more than half (58.0%) of the respondents, followed by medium adaptation (32.0%), and low adaptation (10.0%). The high level of adaptation observed among the respondents implies a proactive approach to climate change, which could be attributed to the perceived urgency of climate-related challenges on vegetable production. This is consistent with findings from Omidiora and Ayinde (2021), who observed that farmers in regions with better access to agricultural extension services and climate information systems were more likely to adopt higher levels of adaptation.

Table 2: Distribution of the Respondents According to Level and Type of Climate Change Adaptation Strategies Adopted

Variable	Frequency	Percentage	Ranking
Level of adaptation			
Low	5	10.0	
Medium	16	32.0	
High	29	58.0	
Types of strategies adopted			
Minimum tillage	36	72.0	1st
Irrigation	35	70.0	2nd
Mulching	35	70.0	2nd
Soil management	34	68.0	3rd

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practice			
Crop rotation	32	64.0	4th
Livestock manure management	31	62.0	5th
Avoidance of bush burning	31	62.0	5th
Enterprise diversification	31	62.0	5th
Use of early maturing varieties	31	62.0	5th
Integrated pest management (IPM)	28	56.0	6th
Use of drought resistant varieties	27	54.0	7th

Source: Field Survey, 2024

Factors Influencing Farmers'' Level of adoption of Climate Change Adaptation Strategies

The model has a Pseudo R-squared value of 0.270, indicating that approximately 27% of the variation in the level of adoption of climate change adaptation strategies is explained by the socio-economic characteristics of the farmers in the study. The Chi-square statistic of 14.906 with a p-value of 0.094 suggests that the model is marginally significant at the 10% significance level. This implies that the model's predictors are able to explain the variation in adaptation adoption to some extent, though there may be other factors not included in the model that influence this behavior indicating a better model fit. The coefficient for age is 0.143, with a p-value of 0.063, which is statistically significant at 10%. This positive coefficient suggests that as farmers' age increases, their likelihood of adopting climate change adaptation strategies also increases. Older farmers may have more experience and a better understanding of climate-related challenges, making them more inclined to adopt these strategies.

The coefficient for household size is -0.395, and the p-value of 0.028 indicates statistical significance at the 5% level. This negative relationship suggests that larger households tend to have lower levels of adoption of climate change adaptation strategies. This could be due to the higher demand on household resources, which could constrain the ability of these families to implement or invest in adaptation measures. The coefficient for farm size is -1.106, with a p-value of 0.092, which is statistically significant at the 10% level. This negative coefficient suggests that farmers with larger farms are less likely to adopt climate change adaptation strategies. This could be because larger farms involve more complexity and higher costs for implementing adaptation measures, or larger farms might be more resistant to changes due to established practices and economies of scale. The coefficient for sex is 2.553, and the p-value of 0.08 indicates a statistically significant effect at the 10% level. This positive relationship suggests that male farmers are more likely to adopt climate change adaptation strategies compared to their female counterparts. This could be due to gender-based differences in access to resources, decision-making power, or exposure to information.

Table 3: Factors Influencing Farmers'' Level of adoption of Climate Change Adaptation Strategies

Variable	Coef.	Std. Err.	p-value
Age	0.143	0.077	0.063*
Educational level	-0.064	0.348	0.854
Household size	-0.395	0.179	0.028**
Farm size	-1.106	0.657	0.092*
Experience	0.064	0.152	0.674
Income	0	0	0.372
Extension	-0.703	0.983	0.474
Major occupation	-0.184	0.369	0.618
Sex	2.553	1.457	0.080*
Constant	-1.828	3.577	0.609
Mean dependent var	0.760	SD dependent var	0.431
Pseudo r-squared	0.270	Number of obs	50
Chi-square	14.906	Prob > chi2	0.094
Akaike crit. (AIC)	60.202	Bayesian crit. (BIC)	79.322

*** *p<.01*, ** *p<.05*, * *p<.1* Source: Field Survey, 2024

Constraints Limiting the Climate Change Adaptation Strategies

The findings revealed Table 4 describe the constraints limiting farmers' adoption of climate change adaptation strategies. The findings reveal that inadequate knowledge was the most reported constraint, affecting 82% of the respondent's ranked 1st. This aligns with findings from Agbamu (2020) that farmers' awareness and understanding of climate change strategies are critical for successful adoption. This was followed by limited resources (finance, labour, etc.), reported by 72.0% of the respondents and ranked 2nd. This agreed with Adeola *et al.* (2021) that limited access to credit and labour were significant barriers to adopting innovative farming practices. Cultural and religious sentiments affected majority (66.0%) of the respondents, ranking as the 3rd constraint. This finding is consistent with Adetayo *et al.* (2018) that cultural resistance often hinders the adoption of modern agricultural practices. While inadequate infrastructure (irrigation, storage, etc.) was ranked 4th as reported by 64.0% of the respondents.

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This constraint is consistent with Ojo and Akinlabi (2019) that lack of storage facilities, irrigation systems, and road networks significantly reduced farmers' resilience to climate impacts.

Table 4: Distribution of the Respondents According to Constraints to Climate Change Adaptation Strategies

Constraints Limiting adaptation	Frequency	Percentage	Ranking
Inadequate knowledge	41	82.0	1st
Limited resources (finance, labor, etc.)	36	72.0	2nd
Cultural and religious sentiment	33	66.0	3rd
Inadequate infrastructure (irrigation, storage, etc.)	32	64.0	4th

Source: Field Survey, 2024

Conclusion and Recommendations

The study concludes that climate change has significantly affected vegetable production in Bauchi Local Government Area through reduced yields, declining income, increased pest and disease pressure, and water stress, particularly for crops such as tomatoes and cucumbers. Although a majority of farmers have adopted various adaptation strategies, their level of adoption is significantly influenced by age, sex, household size, and farm size. However, inadequate knowledge, limited resources, cultural constraints, and poor infrastructure continue to limit effective climate change adaptation among vegetable farmers in the study area.

Based on the findings of the study, the following recommendations are made:

i. Government and relevant agricultural agencies should intensify extension services to improve farmers' knowledge and understanding of climate change and available adaptation strategies.

ii. Regular training, workshops, and field demonstrations tailored to vegetable production should be promoted.

iii. Financial institutions and development partners should design farmer-friendly credit schemes and grants to enable vegetable farmers to invest in climate-resilient technologies.

iv. There is a need for increased public investment in agricultural infrastructure, particularly small-scale irrigation systems, storage facilities, and rural roads, to enhance farmers' adaptive capacity and reduce post-harvest losses.

v. Policies and programs should deliberately address gender disparities by improving women farmers' access to land, credit, extension services, and climate information, thereby enhancing their participation in climate change adaptation.

vi. Timely and reliable climate and weather information should be made accessible to farmers through radio programs, mobile phone platforms, and community-based information systems to support informed decision-making.

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