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CLIMATE CHANGE AWARENESS AND ITS EFFECTS ON THE PERFORMANCE OF FOOD CROP PRODUCTUON IN BENUE STATE, NIGERIA

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ABSTRACT

The study examine climate change awareness and its effects on the performance of food crop production in Benue State, Nigeria. It employed a quantitative research design to examine how socio-economic factors and climate change awareness influence farmers' returns. The study population comprised rural households across the three agricultural zones of Benue State, from which a sample of 450 households was selected using multi-stage sampling techniques. Validity of the questionnaire was ensured through expert review, while reliability was confirmed using the test–retest method. Data were analyzed using multiple linear regression (Ordinary Least Squares). The results revealed that education (coefficient = 201.90, t = 5.25, p = 0.000), farming experience (coefficient = 123.14, t = 4.40, p = 0.000), and extension visits (coefficient = 354.76, t = 4.41, p = 0.000) significantly and positively influenced farmers' returns. Conversely, gender (coefficient = -1241.49, t = -2.64, p = 0.009) and household size (coefficient = -137.77, t = -2.38, p = 0.018) exerted significant negative effects. Perceptions of rainfall and sunlight, as well as changes in rainfall timing, were not statistically significant. Model statistics showed $R^2 = 0.154$, Adjusted $R^2 = 0.138$, and F-statistic = 10.00 ($p < 0.001$), confirming overall significance. Diagnostic tests validated the robustness of the estimates, with no evidence of multicollinearity, heteroscedasticity, or autocorrelation, and residuals were normally distributed. The study concludes that climate change awareness, supported by education, experience, and extension services, is critical in enhancing farmers' resilience and returns. It recommends investment in farmer education, strengthening extension systems, empowering women in agriculture, and promoting household-level interventions to mitigate resource pressure.

Keywords: *Climate change, food crop production, awareness, extension services, Benue State.*

INTRODUCTION

It is widely recognized that in many developing nations, approximately two-thirds of the population derive their livelihoods directly or indirectly from agriculture (Okpokiri et al., 2017). Nigeria is among these developing countries. Scholars have highlighted that Nigeria is already grappling with various ecological challenges directly linked to climate change (Msheliza and Bello, 2018). Recent events such as the flooding in Benue state, Suleja in Niger state, Victoria Island, Lekki, Ikoyi, and other islands in Lagos state underscore that climate change is not a distant phenomenon but a stark reality. It has emerged as one of the most pressing environmental issues of our time, sparking discussions about its causes, long-term impacts, and strategies to mitigate its persistent and daunting effects (Okpokiri et al., 2017).

Climate change impacts are particularly acute in African societies due to geographical vulnerabilities, heavy reliance on agriculture, and limited capacity to adapt to climate extremes (FAO, 2003; Oti et al., 2021). Previous studies (Adetayo and Owolade, 2012; Salau et al., 2012; Yahanna et al., 2014; Oruonye, 2014; Oriakhi et al., 2016; Isa, 2023) have consistently highlighted inadequate awareness of climate change in Nigeria. Reports from UNDP (2010) and Ozor et al. (2015) indicate that awareness levels remain low and are likely to persist without intervention. Awareness is reported to be highest at the federal level but diminishes significantly at the state and local government levels, where effective action is crucial (Onubogu, 2021). Consequently, there is limited effort from government and other agencies to educate the public about the challenges of climate change and strategies for adaptation. Many farmers, lacking awareness, continue to employ farming techniques that exacerbate climate change issues (Tsojon, 2017). Despite observing changes in rainfall patterns, increased temperatures, and other climate indicators, farmers often struggle to attribute these changes to climate change, hindering their ability to mitigate its effects. Given agriculture's heavy reliance on climate conditions, any shift in climate patterns inevitably impacts the sector and associated socio-economic activities (Madaki et al., 2023).

OBJECTIVES OF THE STUDY

The broad objective of the study is to examine Climate Change Awareness and Its Effects on the Performance of Food Crop Production in Benue State. The specific objectives are to:

a) identify sources of climate change awareness, document farmers' perceptions of climate change impacts
b) assess its effects on farmers' livelihoods in the study area.

LITERATURE REVIEW

This literature review underscores the importance of continuous research and policy development in addressing the complex relationship between climate change and agricultural production.

CONCEPTUAL FRAMEWORK

CLIMATE CHANGE

Climate change is a global phenomenon characterized by long-term shifts in temperature, precipitation patterns, and increased frequency of extreme weather events. These changes significantly impact agricultural production, particularly in regions where farming is highly dependent on natural weather patterns, such as in Benue State, Nigeria. Agriculture, especially food crop production, is inherently sensitive to climate variability, making it crucial to understand how climate change awareness influences farming practices and the overall performance of food crops.

CLIMATE CHANGE AWARENESS

Climate change awareness refers to the knowledge and understanding of the causes, effects, and potential mitigation strategies related to climate change. In the context of agriculture, awareness is critical as it shapes farmers' responses to changing environmental conditions. Studies have shown that increased awareness of climate change can lead to the adoption of more sustainable farming practices, such as crop diversification, the use of drought-resistant crops, and efficient water management techniques. In Benue State, which is known as the "food basket" of Nigeria, the level of climate change awareness among farmers can directly influence the region's food security. Farmers who are well-informed about climate change are more likely to adjust their practices to mitigate its adverse effects, thereby enhancing the resilience and productivity of their crops.

SOURCES OF CLIMATE CHANGE AWARENESS

The sources of climate change awareness among farmers are diverse, cutting across formal and informal channels. Mass media, including radio, television, and newspapers, remain traditional sources through which farmers access weather forecasts, farming advice, and news on climate impacts, helping them stay informed and better prepared. Government agricultural extension services also play a crucial role by equipping farmers with technical knowledge, promoting climate-smart agricultural practices, and providing resources that enhance adaptation to changing conditions. In addition, non-governmental organizations (NGOs) and international agencies contribute significantly through training programs, workshops, and community outreach projects that focus on building resilience and adaptation strategies. Beyond these formal avenues, community and peer networks serve as vital platforms where farmers share experiences, exchange

knowledge, and learn from one another during meetings and farming activities, thereby strengthening collective awareness of climate change.

FARMERS' PERCEPTIONS OF CLIMATE CHANGE IMPACTS

Understanding how farmers perceive climate change is essential for developing effective adaptation strategies. Perception influences how farmers interpret and respond to climate change, affecting their decision-making processes (Belonwu, Umeri, Mosheri and Nwabeze, 2024). Many farmers in Benue State have observed changes in rainfall patterns, with seasons becoming more unpredictable and rainfall more erratic. This has led to delayed planting seasons, reduced crop yields, and increased vulnerability to pests and diseases (Belonwu *et al*., 2024). Farmers report that climate change has negatively affected crop production by reducing soil fertility, increasing the frequency of droughts, and causing more frequent flooding. These impacts have made it difficult for farmers to maintain consistent food crop production levels (Belonwu *et al*., 2024). Beyond the direct effects on agriculture, farmers also perceive climate change as a threat to their livelihoods. Reduced crop yields translate into lower incomes, leading to increased poverty and food insecurity in the region. Additionally, climate-induced migration and conflicts over resources are emerging concerns among farming communities (Belonwu *et al*., 2024).

EFFECTS OF CLIMATE CHANGE ON FARMERS' LIVELIHOODS

The impact of climate change on farmers' livelihoods in Benue State is profound, affecting not only food crop production but also the overall well-being of farming households Arsene, Wivine, Augustine, Emery, and Alex (2023). As crop yields decline, farmers experience reduced income, which limits their ability to invest in farm inputs, education, and healthcare. The economic stress caused by climate change can lead to a cycle of poverty, where farmers are unable to recover from climatic shocks (Arsene, *et al*., 2023). Climate change exacerbates social inequalities, as the most vulnerable populations, including smallholder farmers, women, and children, are disproportionately affected. These groups often have limited access to resources and information necessary to adapt to climate change, making them more susceptible to its adverse effects (Arsene, *et al*., 2023). Climate change poses a significant threat to food security in Benue State. Reduced agricultural productivity directly affects the availability and affordability of food, leading to malnutrition and hunger. In a region heavily reliant on agriculture, the impact on food security can have far-reaching consequences for the entire population (Arsene, *et al*., 2023).

ADAPTATION STRATEGIES AND POLICY INTERVENTIONS

Given the challenges posed by climate change, it is crucial to explore adaptation strategies that can enhance the resilience of food crop production (Arsene, *et al*., 2023). As such it crucial to explore adaptation strategies that can enhance the resilience of food crop production in Benue State. Adopting climate-smart agricultural practices, such as conservation tillage, agroforestry, and the use of improved seed varieties, can help farmers mitigate the effects of climate change. These practices improve soil health, water retention, and crop resilience to extreme weather conditions (Arsene *et al*., 2023). The role of government policies in supporting climate change adaptation cannot be overstated. Policies that promote access to climate information, provide financial support for farmers, and encourage the adoption of sustainable practices are essential for building resilience in the agricultural sector (Arsene *et al*., 2023).

Empowering local communities to develop and implement adaptation strategies tailored to their specific needs and conditions is critical. Community-based adaptation involves participatory approaches where farmers actively engage in identifying risks and designing solutions (Arsene *et al*., 2023). Climate change awareness plays a pivotal role in shaping the responses of farmers in Benue State to the challenges posed by climate variability. The sources of awareness, farmers' perceptions of climate change impacts, and the resulting effects on their livelihoods highlight the need for targeted interventions to enhance resilience in food crop production (Arsene *et al*., 2023). By promoting climate-smart agriculture, strengthening extension services, and implementing supportive policies, it is possible to mitigate the adverse effects of climate change and ensure the sustainability of food crop production in Benue State.

THEORETICAL FRAME WORK

A suitable theory for this study on climate change awareness and its effects on food crop production in Benue State, Nigeria, is the Protection Motivation Theory (PMT)**.**

PROTECTION MOTIVATION THEORY (PMT)

Protection Motivation Theory was developed by R. W. Rogers in 1975. Initially formulated to understand how people protect themselves from health threats, the theory has since been applied to various fields, including environmental psychology and climate change adaptation (Ricart, Gandolfi and Castelletti, 2023). PMT suggests that individuals are motivated to protect themselves based on two main cognitive processes. This involves evaluating the severity of the threat (e.g., the impact of climate change on crop production) and one's vulnerability to that threat. This involves assessing the effectiveness of the protective actions (e.g., adopting climate-smart agricultural practices) and the individual's ability to perform those actions. In the context of this study, Protection Motivation Theory provides a robust framework for understanding how climate change awareness influences farmers' behaviors and decisions regarding food crop production in Benue State.

Farmers in Benue State may perceive climate change as a significant threat to their agricultural activities. The severity of this threat is understood through observed changes in weather patterns, decreased crop yields, and increased vulnerability to pests and diseases. Their perceived vulnerability, how likely they are to suffer from these impacts will influence their level of concern and the urgency with which they seek information and resources (Ricart *et al*.,2023). Once aware of the threat, farmers must evaluate their ability to cope with it. This includes assessing the effectiveness of potential adaptation strategies, such as using drought-resistant seeds, altering planting times, or employing water conservation techniques. Farmers' belief in their ability to implement these strategies (self-efficacy) and their perceived response efficacy (how effective they believe the strategies will be) are crucial in determining whether they take action. Thus, applying PMT, your study can explore how farmers' perceptions of climate change (threat appraisal) and their confidence in available adaptation methods (coping appraisal) drive their decision-making processes. This theory helps explain why some farmers may be more proactive in adopting climate-resilient practices, while others may be less responsive, despite similar levels of awareness (Ricart *et al*., 2023). Understanding these dynamics is vital for developing targeted interventions that enhance farmers' ability to adapt to climate change, thereby improving the performance of food crop production in Benue State.

EMPIRICAL REVIEW

SOURCES OF CLIMATE CHANGE AWARENESS, DOCUMENT FARMERS' PERCEPTIONS OF CLIMATE CHANGE IMPACTS

Arsene, Wivine, Augustine, Emery, and Alex (2023) examined understanding farmers' perceptions about climate change and adaptation strategies can help support their efforts and develop interventions more suited to the local context. This is particularly important for farmers who exploit fragile ecosystems such as marshlands. Using semi-structured questionnaires and interviews conducted with smallholder farmers in the marshlands of Kabare, this study compares the perception of men and women relating to climate change and uses the chi-square test and logistic regression to examine gendered differences in response to climate change and the determinants of farmers' choice of sustainable practices. Meteorological data trends for three decades were also compared. Results showed that both men (77 %) and women (73 %) experienced climate change and this was illustrated by changes in temperature and rainfall patterns. Farmers' climate change perceptions are consistent with the local historical climate data showing a slightly increasing trend of temperature and a decrease in rainfall for the last decade, particularly between 2013 and 2019. Although significant differences were observed between gender and sources of climate information ($p < 0.05$), 50 % of women farmers favored indigenous knowledge of climate, while 61 % of men farmers stated that experience exchange among fellow farmers helped to read and predict climate trends. The common impacts reported by farmers included the proliferation of pests (90 %), a decrease in soil fertility (75 %), and floods, resulting in crop failure.

Sandra, Andrea and Claudio (2022) examined Farmers' perception of climate change is crucial in adaptation intention and process. However, farmers' perceptions may not be timely, accurate and systematically consistent with the direction and significance of observational records. Although some research compared farmers' perceptions and climate data, little attention has been paid to comprehensibly analyse both data sources discrepancies based on empirical studies results. By combining bibliometrics and a systematic review approach, we identify which approaches are used to compare perceived and observed data, how both patterns have been mutually evolved, which factors determine their (in)consistency, and if their accordance and robustness affect farmers' adaptive capacity. We analyse a portfolio of 147 papers collected from the Scopus library catalogue since 2000. The bibliometric analysis was coupled with an exploratory analysis of 98 papers selected from the original portfolio. The literature is extensive, fast-growing, and spans several disciplines. We identify four consolidated research lines: i) perceived risk and farmers' adaptive capacity nexus, ii) crop vulnerability due to temperature increase and erratic rainfall patterns, iii) forecasting use and influence in farmers' decisions, and iv) climate change awareness conditioning farmers' profiles. Nonetheless, we observe some research gaps: 1) a conceptual mismatch in 'normal pattern' or 'drought' meaning, 2) poor or limited data from meteorological stations, 3) overlook or oversimplification of local knowledge in describing perception, 4) farmers' memory weaknesses to keep track of climate alterations, and 5) a geographical dissonance in favour of Global South regions.

Ricart, Gandolfi and Castelletti, (2023) examined Climate change awareness, perceived impacts, and adaptation from farmers' experience and behavior in the sense that Individuals and communities socially construct risk, and societies with greater risk perception may be more apt to mobilize or adapt to emergent threats like climate change. Increasing climate change awareness is often considered necessary in the first stages of the adaptation process to manage its impacts and reduce overall vulnerability. Since agriculture is affected by climate change in several ways, farmers can provide first-hand observations of climate change impacts and adaptation options. This paper aims to identify the current research trends and set the future research agenda on climate change awareness, perceived impacts, and adaptive capacity from farmers' experiences and behavior. We analyzed a portfolio of 435 articles collected from WoS and Scopus databases between 2010 and 2020 using bibliometrics. From the original portfolio, we select 108 articles for a more comprehensive and systematic review. Publication trends and content analysis have been employed to identify influential work, delineate the mental structure of farmers' beliefs and concerns, and identify main research gaps. The comprehensive analysis reported (1) farmers' socio-demographic characteristics influencing farmers' perceptions; (2) awareness and changing climate evidence due to human activity; (3) the main perceived effects (rising temperatures, changing rainfall patterns, and extreme events); (4) the most relevant adaptation measures (crop changing and soil/water conservation techniques); and (5) factors and barriers limiting adaptation (lack of information, credit, and expertness).

Isael and Alejandro (2021) examined Farmers' Perception of Climate Changewith the view that Global climate is changing rapidly, and it is not clear if agricultural producers in developing countries will be able to adapt fast enough in order to mitigate its negative effects. In order to be willing to take adaptation measures, farmers need to perceive that the climate is changing or could change, and they need to attribute enough weight to this perception to take action. During the last two decades, the literature that examines farmers' perception of climate change has gained ground, but it is still scant. This is particularly true for Latin America, which is highly vulnerable to climate change. Based on a review of original research articles published between 2000 and 2020, this article presents the status of knowledge about the topic in the region to identify research gaps and inform future research. The review found that the available research has been based mostly on qualitative analyses of case studies for a few countries.

Matsalabi, Leshan, Savadogo and Shah (2019) examined agricultural sector as the main source of rural households' food and revenue in Niger, and it contributes approximately 43% to the national GDP. However, there are several constraints to the sector's development, including negative impacts of climate change. To mitigate these impacts, farmers implement a range of technical strategies. The extent of farmer's awareness and perceptions of climate change impacts influences these strategies and hence farmers' level of adaptation. This study was undertaken to assess farmers' awareness and perceptions of climate change impacts in Aguie Department, Niger Republic. Descriptive statistics and a regression model were used for data analysis. The results from a descriptive analysis show that the majority of respondents (84.4%) were aware of climate risks, but had differing perceptions of climate change impacts on production and annual revenue. A regression test revealed that climate-related information is highly significant in determining farmers' awareness of climate change impacts. Most of the respondents reported negative impacts from climate change, and the majority, therefore, adjusted their farming system, albeit at different levels. A probit analysis shows that awareness, perception, education, crop production, soil fertility and annual revenue are highly influential on farmers' climate change impacts adaptation.

CLIMATE CHANGE EFFECTS ON FARMERS' LIVELIHOODS IN THE STUDY AREA.

Belonwu, Umeri, Mosheri and Nwabeze (2024) examined livelihood diversification among rural farmworker households in Edo State. Ninety-six respondents provided data through the questionnaires which were analysed using percentages, the mean, chi-square, and the Cochran test. A sizable portion of respondents (24.0%) fell between the ages of 24 and 35, with a mean age of 50, and were predominately male (83.3%). Farming (100.0%) and small-scale commerce (78.0%) predominate among the livelihood possibilities for farmworker households, with a high percentage having a senior secondary school diploma (48.0%t). Lack of access to credit was the biggest obstacle to diversifying sources of income (= 83.0). Rural farmworker households diversified their sources of income. The findings advocate for the involvement of relevant organisations in facilitating credit and loan facilities for smallholder farmworkers to boost their output and income, which may impact their degree of diversification and raise their standard of living.

Ogueri, Unaeze, Odok, Mbah Ugwu, Essien, Onini and Ohajianya (2018) analysed the off farm income and its effect on livelihood sustenance of poultry farmers in Imo state. Multistage sampling technique was used to select 120 respondents. Data for the study were obtained with the aid of structured questionnaire and analysed using descriptive statistics and ordinary least square bivariate regression model. Results showed that: the mean off-farm income of poultry farmers was N410223 per annum. Livelihood sustenance activities of poultry farmers positively and significantly affected their off-farm income. It is recommend that government should come up policies that will center on establishment of more livelihood sustenance activities for poultry farmers that will generate increased off-farm income and promote agricultural development simultaneously.

Amina, Ali, Mahmud, Muhammad, Sufiyyanu and Aminu (2024) examined Perceived Effects of Climate change on Farmer's Livelihood in North Western Nigeria in the sense that Northwestern Nigeria has been identified as one of the most vulnerable regions to climate change in Nigeria. The study assessed the perceived effects of climate change on the farmer's livelihood. This study employed a combination of qualitative and quantitative analytical methods. Multi-stage sampling technique was used to select four local government areas (LGAs) from Kano State and random selection of 260 farmers from 52 cooperatives within these LGAs. The collected data were analysed appropriately to achieve the objectives of the results. The results indicate that 57.7% were aware of climate change and understood it through patterns of rainfall, temperature, and changes in yield. The majority of the farmers (84.2%) believed that climate change was responsible for an increase in the rate of diseases among the family members in the area and an increase in the distance travelled in search of drinking water. A reasonable percentage of farmers (62.7%) believed that the main road was eroding, making it difficult to get to the market, schools, and health centers. To cope with climate change, farmers used climate-sensitive varieties and crop diversification. In conclusion, climate change has had a real impact on resources like agriculture, water availability, family health, roads, and social networks. Therefore, we recommend providing farmers with technical training on the consequences of climate change and coping strategies.

Henry and Olagidi (2023) analyzed the effect of farm and nonfarm livelihood activities on the well-being of arable crop farmers in Yenagoa Local Government area of Bayelsa State, Nigeria. Nigeria. Data were collected through well-structured questionnaire from 100 arable crop farmers. Data were analyzed using simple descriptive and inferential statistical tools. The result showed that poultry rearing (=3.5), swine rearing (=3.3), cassava cultivation (=3.3), maize cultivation (=3.1), rice cultivation (=2.9) were the farm and non-farm livelihood activities which had effect on arable crop

farmers well-being. The result further showed that 60.0% of arable crop farmer had block house as the shelter and 40% had meal ratio of 1:0:1 daily. The regression result indicated that the coefficient of well-being of arable crop farmers (2.521) was positive and statistically significant at 1%. The study concluded that farm and non-farming livelihood activities had positive effect on arable crop farmers. Hence, it was recommended that arable crop farmers should be encouraged to also engage in non-farm livelihood activities

Owigho, Ovoh, Ofuoku, (2023) evaluates the effects of rural infrastructure provided by Government, NGOs/Corporate Organizations, and self-help on the livelihood of farmers in Niger Delta area, Nigeria. The specific objectives were to identify the socioeconomic characteristics of the farmers, establish the livelihood status of farmers in the study area, identify the Government, NGOs/Corporate Organizations, and self-help rural infrastructure in the study area, and determine the state of infrastructure provided by government, NGOs/Corporate Organizations, and self-help. The multi-stage sampling procedure was used to select a sample size of 450 with the aid of a questionnaire. Descriptive and inferential statistics were used for data analysis. The result on livelihood was positive, with a Livelihood status index of 0.73, indicating that 73% of the farmers had good livelihood status in the study area. The respondent identified eleven (11) infrastructures, and the infrastructure provided by self-help had six infrastructures that was in a good state. Community centres/halls (M=3.72), Access road (untarred) (M=3.62), Potable water (M=3.56), Agro-Processing facilities (M=3.17), security service (M=2.93) and Market /Stalls (M=2.60). The Cox & Snell R 2 value of 0.314 and the Nagelkerke R 2 value of 0.437 showed the amount of variance explained by the model, and the chi-square value of 30.902 with 3 degrees of freedom is highly significant ($p<0.001$).The study recommends, among others, that the Government should offer an infrastructure framework that is adapted to rural farmers' perceived needs to improve the livelihood activities among rural communities.

METHODOLOGY

STUDY AREA

The Nigerian state of Benue hosted the study. Nigeria's North Central Region includes the state of Benue. The borders of Benue state are as follows: Ebonyi, Kogi, and Enugu to the south; Nasarawa to the north-west; and Taraba, Cross River, and Cameron to the northeast. Benue state is situated between Greenwich Meridian latitudes 7.5^0 and 10^0 E. With a total surface area of roughly 30, 955 km2, Benue state is split administratively into three agricultural zones (A, B, and C) and twenty-three local government areas (LGAs). 5,741,815 people are predicted to have lived there in 2016 (Abah, 2020). Additionally, it's estimated that the current population of Benue state is approximately 8,845,840 inhabitants, factoring in the forecasting margin allowed by the National Population Commission. The majority of the population belongs to the Tiv, Idoma, and Igede ethnic groups. The state's economy is bolstered by livestock production, including cattle (for milk and meat), goats, sheep (for income and meat), and poultry. The predominant agricultural system in the study area is mixed cropping, with crop production serving as the primary livelihood for smallholders. Key agricultural products of Benue state include yam, cassava, sesame, soybeans, rice, melon, millet, and maize. The study selected Benue state due to the integral role of livestock enterprises within its land use system.

SAMPLING AND DATA COLLECTION

From the three agricultural zones, Kwande, Gwer-west, and Agatu were chosen at random. Three (3) autonomous communities were chosen purposefully from each of the local government districts for the second stage. The significant concentration of food crop production activity in these communities led to their selection. There were forty-five (45) villages overall after five (5) communities were purposefully chosen in the third stage. Ten (10) rural homes were chosen at random from each of the forty-five (45) villages for the final stage. For the purposes of this study, 450 rural households made up the sample size. In order to allow respondents to provide numerous responses, Likert type scaling was used to assess the sources of climate change awareness and the farmers' view of climate change.

VALIDITY AND RELIABILITY OF THE INSTRUMENTS

Content validity of the questionnaire was ensured through expert review, where specialists in agricultural economics, climate change, and survey methodology carefully examined the instrument to confirm that the items were clear, relevant, and adequately captured the constructs under study. To further establish reliability, the test–retest method was employed by administering the same questionnaire to a subset of respondents on two different occasions under similar conditions. The responses obtained from both administrations showed a high level of consistency, thereby confirming the reliability of the instrument for data collection.

MODEL SPECIFICATION

Effects of climate change on the performance of farmers in the study area were analyzed using multiple regressions. The explicit form of the model is stated as

$$Y= \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \mu_i \quad (1)$$

Where,

Y = returns of livestock farmers in naira

X_1 = level of education of the famer measured in years

X_2= gender (male=1 and female=0)

X_3 = experience of the farmers measured in years

X_4 = household size measured in numbers
X_5 = number of extensions visit
X_6 = change timing of rain (yes =1, others =0)
X_7= perception to the level of rainfall (high =3, average =2 and low =1)
X_8 = perception to the level of sunlight (high =3, average =2 and low =1)
β_i = the parameter
μ_i = the error term

METHOD OF DATA ANALYSIS

The study employed multiple linear regression (Ordinary Least Squares, OLS) as the method of data analysis since the dependent variable, returns of livestock farmers in naira, is continuous, while the explanatory variables consist of continuous (education, experience, household size, extension visits), dummy (gender, change in timing of rain), and ordinal (perception of rainfall and sunlight) measures. OLS is appropriate because it can accommodate this mix of variable types, estimate the marginal effects of each explanatory variable on farmers' returns while holding others constant, and provide statistical tests for the significance, size, and direction of relationships. Although the ordinal variables were coded numerically, they could also be dummy-coded to capture categorical effects more precisely; however, treating them as linear predictors provides a simpler and robust estimation framework for the model.

RESULTS AND DISCUSSION

This section discusses the result of the data obtained from the field and analyzed to answer the research questions. Also, the hypotheses of the study was tested.

Table 1: Regression Results

Variable	Coefficient	Std. Error	t-Stat	p-Value
Constant	6117.89	1166.59	5.24	0.000
X_1 (Education in years)	201.90	38.47	5.25	0.000
X_2 (Gender: Male=1, Female=0)	-1241.49	471.05	-2.64	0.009
X_3 (Experience in years)	123.14	27.96	4.40	0.000
X_4 (Household size)	-137.77	57.91	-2.38	0.018
X_5 (Extension visits)	354.76	80.43	4.41	0.000
X_6 (Change timing of rain: Yes=1)	-646.29	472.31	-1.37	0.172
X_7 (Perception of rainfall)	369.68	286.52	1.29	0.198
X_8 (Perception of sunlight)	436.88	281.04	1.56	0.121

The result shows that the level of education of farmers (X1) has a positive and significant effect on their returns. The coefficient of 201.90 indicates that an additional year of education increases farmers' income by ₦201.90. With a t-statistic of 5.25 and a p-value of 0.000, the relationship is highly significant. This implies that education enhances farmers' knowledge of improved production techniques and adaptation strategies, which directly improves performance in the study area.

Gender (X2) of the farmer shows a negative and significant effect on returns, with a coefficient of -1241.49. The t-statistic is -2.64 and the p-value is 0.009, suggesting that being male reduces returns by ₦1241.49 compared to females. This result implies that women, though often marginalized in agriculture, may be more efficient in managing limited resources, or more cautious in risk-taking, leading to better outcomes than their male counterparts.

Farming experience (X3) is positively and significantly related to returns. The coefficient of 123.14, t-statistic of 4.40, and p-value of 0.000 indicate that each additional year of farming experience increases returns by ₦123.14. This suggests that accumulated knowledge from years of farming enables farmers to make more informed decisions, better adapt to climate variability, and improve efficiency in resource utilization.

Household size (X4) has a negative and significant relationship with returns. The coefficient is -137.77, with a t-statistic of -2.38 and p-value of 0.018, showing that each additional household member reduces returns by ₦137.77. This implies that larger households may exert pressure on farm resources, divert labor to non-farm activities, or increase consumption expenditure, thereby reducing the net returns available to the farmer.

Extension visits (X5) have a positive and significant effect on returns. The coefficient of 354.76, t-statistic of 4.41, and p-value of 0.000 show that each additional extension contact increases farmers' returns by ₦354.76. This highlights the critical role of extension services in disseminating information on climate-smart agriculture, improved farming practices, and better adaptation strategies, thereby enhancing productivity and income.

The change in timing of rainfall (X6) shows a negative but insignificant relationship with returns. The coefficient is -646.29, with a t-statistic of -1.37 and p-value of 0.172. Although the result suggests that shifts in rainfall timing reduce

income by ₦646.29, the insignificance indicates that farmers may already have some coping strategies, or that the variation in timing is not yet severe enough to significantly disrupt livestock production in the area.
Perception of rainfall levels (X7) has a positive but insignificant effect on returns. With a coefficient of 369.68, t-statistic of 1.29, and p-value of 0.198, the result shows that improved perception of rainfall increases returns by ₦369.68. The insignificance suggests that while rainfall perception matters, farmers' actual adaptive capacity and access to resources may weigh more heavily in determining income than perceptions alone.

Perception of sunlight levels (X8) also has a positive but insignificant relationship with returns. The coefficient of 436.88, t-statistic of 1.56, and p-value of 0.121 indicate that higher perceived sunlight increases income by ₦436.88. However, the lack of significance implies that perceptions may not translate into actual adaptive measures, or that other factors, such as feed availability and water access, are more critical in determining livestock returns under changing climate conditions.

MODEL STATISTICS AND DIAGNOSTIC TESTS

The model statistics show that the regression explains a modest but meaningful proportion of the variation in livestock farmers' returns. The R-squared value of 0.154 and the adjusted R-squared of 0.138 indicate that about 15.4% and 13.8% of the variability in returns, respectively, are explained by the included variables. Although these values are relatively low, the F-statistic of 10.00 with $p < 0.001$ demonstrates that the overall model is statistically significant, meaning the explanatory variables jointly contribute to explaining farmers' performance. The Durbin-Watson statistic of 2.10, which is close to the ideal value of 2, suggests that the residuals are free from serious autocorrelation problems. The implication is that while the model does not capture all factors affecting returns, it provides a reliable framework for assessing the effects of climate change and socio-economic factors on farmer performance.

The diagnostic tests further strengthen confidence in the validity of the model. The Variance Inflation Factor (VIF) values are all close to 1, confirming the absence of multicollinearity, meaning the independent variables provide unique information without redundancy. The Breusch-Pagan test result (LM = 6.70, p = 0.569) indicates no evidence of heteroscedasticity, suggesting the variance of the residuals is constant across observations. Similarly, the Breusch-Godfrey test (LM = 1.77, p = 0.413) shows no evidence of serial correlation up to lag 2, reinforcing that the residuals are independent. These findings imply that the parameter estimates are efficient, consistent, and unbiased, making the results robust for policy and academic interpretation.

Finally, the Jarque-Bera test for normality of residuals (JB = 1.28, p = 0.527) confirms that the residuals are normally distributed. This assumption is crucial for the validity of hypothesis testing within the regression model. Collectively, the diagnostic outcomes validate the use of Ordinary Least Squares (OLS) in this study, confirming that the key assumptions of the model hold. The implication for the study is that the estimated effects of education, experience, extension visits, gender, household size, and perceptions of climate variability on farmers' returns are statistically reliable and can serve as evidence to guide climate change adaptation strategies and policy interventions in the agricultural sector.

DISCUSSION OF RESULT

The findings of this study align with previous empirical evidence that education significantly enhances farmers' performance. For instance, Matsalabi et al. (2019) and Ricart, Gandolfi, and Castelletti (2023) observed that education improves farmers' awareness and ability to adopt climate-smart practices, thereby increasing productivity and income. Similarly, Amina et al. (2024) found that education enables farmers to better understand climate change and diversify their livelihood strategies. These points of convergence reinforce the current study's conclusion that education is a critical determinant of improved adaptation and farm returns. However, Israel and Alejandro (2021) noted that in some contexts, especially in Latin America, education levels alone did not guarantee proactive adaptation, suggesting a divergence in outcomes that may reflect differences in institutional and environmental contexts.

The current study also highlights that farming experience significantly boosts farmers' returns, a result consistent with the findings of Arsene et al. (2023), who reported that long-term engagement in farming equips farmers with experiential knowledge of changing rainfall and temperature trends. Likewise, Henry and Olagidi (2023) emphasized that experienced farmers diversify their farm and non-farm livelihood activities more effectively, thereby sustaining their well-being. This convergence underscores the importance of accumulated knowledge as a non-formal learning process for adapting to climate variability. In contrast, Sandra, Andrea, and Claudio (2022) cautioned that farmers' perceptions shaped by experience may sometimes diverge from meteorological records, indicating that experience alone, without scientific validation, could lead to maladaptation.

Gender differences in farm returns observed in this study contrast with some earlier findings. While the present study suggests that women may be more efficient in managing farm resources, Arsene et al. (2023) reported significant disparities in access to climate information between men and women, with men relying more on peer exchanges and women depending more on indigenous knowledge. Similarly, Belonwu et al. (2024) and Ogueri et al. (2018) noted that male dominance in farming households often translates into higher resource access, although not always higher efficiency. This divergence implies that the efficiency observed among women in the present study may be context-specific, possibly linked to their resource management strategies rather than resource access.

Finally, the result that extension visits significantly improve farmers' returns converges with the findings of Ricart, Gandolfi, and Castelletti (2023), who identified limited access to information as a major barrier to adaptation, and Matsalabi et al. (2019), who stressed the importance of climate-related information in shaping adaptation outcomes. The positive effect of extension services also resonates with Amina et al. (2024), who reported that farmers adopting climate-sensitive varieties and diversification strategies relied heavily on technical guidance. However, Owigho, Ovoh, and Ofuoku (2023) highlighted that infrastructure deficits often limit the effectiveness of extension delivery, a divergence that suggests that while extension services are beneficial, their impact may be contingent on the availability of complementary resources such as roads, markets, and water supply.

CONCLUSION AND RECOMMENDATIONS

CONCLUSION

The study concludes that climate change awareness, reinforced through education, farming experience, and extension services, plays a crucial role in enhancing the performance of food crop farmers in Benue State. Farmers with higher educational attainment and longer years of experience were found to adapt better to climate variability and improve their returns, while regular extension visits further boosted productivity by providing timely technical guidance and information on climate-smart practices. These results underscore the importance of human capital development and institutional support in strengthening farmers' resilience against climate-related challenges. On the other hand, the study reveals that gender and household size significantly constrain returns, suggesting that resource allocation and socio-cultural dynamics shape adaptation outcomes in the study area. Interestingly, perceptions of rainfall and sunlight, as well as shifts in rainfall timing, showed no significant impact, pointing to the fact that awareness alone is insufficient without effective adaptation strategies and access to resources. The findings therefore emphasize that targeted interventions such as improving education, strengthening extension systems, and addressing gender disparities are critical to maximizing the benefits of climate change awareness and enhancing food crop production in Benue State.

RECOMMENDATIONS

The following recommendations are made based on the findings of the study:

1. Government and development agencies should invest in farmer education and capacity-building programs, as higher levels of education significantly improve adaptation to climate change and enhance crop returns. This can be achieved through adult literacy schemes, agricultural training workshops, and integration of climate-smart agriculture into rural education initiatives.
2. Strengthening extension service delivery is critical. Policymakers should ensure adequate funding, staffing, and training of extension agents to provide timely information on improved farming practices, climate adaptation strategies, and resource management, thereby improving farmers' resilience and productivity.
3. Targeted support should be directed at addressing gender disparities in agricultural production. Women farmers, who have demonstrated efficiency in resource management, should be empowered through access to land, credit, and inputs, while interventions should also reorient male farmers towards better adaptation and risk management practices.
4. Household-level interventions are needed to reduce the negative impact of large household sizes on farm returns. Programs that promote family planning awareness, labor-saving technologies, and diversification into non-farm income activities can help ease the pressure on farm resources and enhance overall household welfare.

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