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ASSESSING THE SOCIO-ECONOMIC IMPACT OF CLIMATE CHANGE AND POVERTY IN BIRNIN KUDU LOCAL GOVERNMENT, JIGAWA STATE, NIGERIA

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ABSTRACT: *This study investigates the intertwined socio-economic impacts of climate change and entrenched poverty in the Birnin Kudu Local Government Area, Jigawa State, Nigeria. Employing a mixed-methods approach, the research examines how climate change exacerbates existing poverty vulnerabilities, leading to decreased crop yields, reduced water availability, increased health risks, and heightened economic insecurity. The research found that climate change disproportionately affects the poorest households with limited adaptive capacity. Farmers and livestock owners face severe challenges due to unpredictable rainfall, increased temperatures, pest infestations, and declining land productivity, which directly impact income and food security. Water scarcity intensifies existing resource conflicts and further marginalises impoverished communities. The study also reveals a rise in heat-related illnesses, vector-borne diseases, and malnutrition, which compound the health burdens already faced by impoverished populations. These findings underscore the urgent need for climate change adaptation strategies that explicitly address poverty, including targeted social protection programs, improved access to resources and technology for vulnerable households, and strengthened public health systems.*

KEYWORDS: Climate Change, Poverty, Livelihood, Socio-Economic Vulnerability, Adaptation, Food Security, Jigawa State.

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INTRODUCTION

Global warming, a key aspect of climate change, involves the sustained increase in Earth's surface temperature due to greenhouse gases (GHGs). This phenomenon, driven primarily by human activities, has severe and disproportionate impacts on vulnerable populations, particularly those living in poverty. While the global temperature rise of approximately 1.1°C above pre-industrial levels (IPCC, 2021) affects all regions, its consequences are amplified in areas with pre-existing socio-economic challenges.

The consequences of global warming are diverse and severe, with significant impacts on agriculture, health, and economic stability. However, these impacts are not evenly distributed. Poverty acts as a multiplier, exacerbating the vulnerabilities of those struggling to meet basic needs. For instance, despite contributing minimally to global GHG emissions, Africa faces heightened vulnerability due to its reliance on agriculture, limited resources, and pervasive poverty (AfDB, 2022). Climate change is projected to reduce agricultural yields across the continent by up to 15% by 2050, directly impacting impoverished rural populations' food security and livelihoods. West Africa, including Nigeria, is particularly affected by erratic rainfall and increased droughts, further eroding vulnerable households' coping mechanisms (IPCC, 2021).

In Nigeria, agriculture is vital, employing about 70% of the population, but it is increasingly vulnerable to climate change. Critically, this vulnerability is compounded by high levels of poverty, which limit farmers' ability to invest in adaptive measures. Rising temperatures and variable rainfall have reduced crop yields, leading to food insecurity and income loss, particularly among the poorest farmers. For example, Jigawa State has experienced a temperature increase of 0.8°C over three decades, with severe implications for agriculture and food security (NiMet, 2021). Health impacts are also significant, with rising temperatures contributing to the spread of vector-borne diseases such as malaria, which disproportionately affect impoverished communities with limited access to healthcare (Federal Ministry of Environment, 2020).

Birnin Kudu, a rural area in Jigawa State, exemplifies the challenges posed by the intersection of global warming and poverty. The region faces declining agricultural productivity, water scarcity, and increased disease prevalence, exacerbating poverty. Studies reveal that 78% of farmers, many already living below the poverty line, report reduced crop yields, increasing food insecurity and debt. Water sources like the Hadejia-Jama'are River Basin have experienced a 35% flow reduction (Jigawa State Water Board, 2021), limiting access to clean water for the poorest households. Additionally, migration to urban areas has intensified as residents seek better opportunities, but this often leads to the transfer of rural poverty to urban slums (Nigerian Economic Summit Group, 2021).

Addressing these challenges requires adaptive measures that explicitly target poverty reduction. This includes providing drought-resistant crops and improved irrigation systems to vulnerable farmers, strengthening social safety nets to buffer against climate shocks, and investing in public health infrastructure to combat disease outbreaks. Research highlights the urgent need for integrated strategies addressing climate change and poverty to build resilience and ensure sustainable development in areas like Birnin Kudu. These efforts are essential to mitigate the socio-economic impacts of global warming and break the cycle of poverty in vulnerable regions (Abdullahi et al., 2019).

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LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Conceptual Review

Global Warming and Climate Change: Global warming, a significant aspect of climate change, refers to the persistent rise in Earth's average surface temperature primarily due to the accumulation of greenhouse gases (GHGs) such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) in the atmosphere. This phenomenon is primarily driven by human activities, including fossil fuel combustion, deforestation, and industrial processes, which have intensified since the Industrial Revolution (Sule et al., 2024). Climate change encompasses global warming and the broader spectrum of long-term changes in weather patterns, sea levels, and natural ecosystems (Sabiu & Magaji, 2024). These changes have profound implications for natural systems and human societies, contributing to extreme weather events, biodiversity loss, and socioeconomic challenges such as food insecurity and health risks (AfDB, 2022; World Bank, 2022). Addressing global warming is critical for mitigating the adverse effects of climate change and ensuring sustainable development globally.

The Socio-Economic Dimensions of Climate Change

The socio-economic dimensions of climate change encompass the intricate interplay between societal structures, economic systems, and the impacts of climate change. These dimensions highlight how climate change exacerbates existing inequalities, disproportionately affecting vulnerable populations, particularly in developing countries with limited adaptive capacity (Ismail et al., 2019). Economic consequences include agricultural, energy production, and infrastructure disruptions, reducing productivity and heightened poverty (Magaji & Musa, 2024). Socially, climate change intensifies health risks, displacement, and resource conflicts, requiring integrated policy responses that address environmental and socio-economic challenges. Understanding these dimensions is essential for developing equitable and sustainable mitigation and adaptation strategies (Intergovernmental Panel on Climate Change [IPCC], 2021; United Nations Framework Convention on Climate Change.

Theoretical Framework

Vulnerability theory explores the inherent fragility of human existence and the systemic factors that influence individual and collective susceptibility to harm. Rooted in the idea that all humans are inherently vulnerable due to dependence on social, economic, and environmental systems, this theory underscores the importance of structural conditions that mitigate or exacerbate risks. It highlights how socio-economic inequalities, institutional failures, and environmental hazards disproportionately impact marginalised populations, intensifying their risk exposure. In the context of climate change, the vulnerability theory provides a framework for examining how intersecting factors such as poverty, governance, and social capital shape the capacity to respond to crises (Musa et al., 2024). By addressing these systemic disparities, vulnerability theory advocates for policies prioritising equity, inclusion, and resilience (Fineman, 2008; Adger, 2006).

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Empirical Literature Review

Ibrahim and Ibrahim (2024) examine the impact of climate change on food security and the attainment of sustainable development goals in Nigeria. Climate change has continued to decimate food security plans in Nigeria. Despite many policies and programmes to stem the tide and its impact on food security, food productivity has shrunk. The climate change crisis has been causing severe hunger and deprivation due to food shortages as food and commodity prices continue to soar daily. The paper adopts the environmental security theory as a theoretical framework, while secondary sources obtained relevant data. The paper found that climate change has a significant impact on food security. Increased climate variability and increased frequency and intensity of extreme events hamper food supply access and utilisation stability. The paper recommends sustainable agricultural practices by advocating that governments at both national and sub-national should encourage private investments in the agricultural sector by providing incentives that apply to both primary and secondary food producers, adequate funding of agriculture, transparency and accountability in the allocation and disbursement of resources in the agricultural sector, investment in climate-resilient or smart agriculture, adequate sensitisation of farmers on climate change and provision of extension services and farming inputs, access to credit facilities, adequate provision of modern storage facilities, mechanised farming and empowerment of women and youth to enhance self-sufficiency in food production.

Ucheje, Okolo and Chukwueloka (2024) investigate the effect of climate change on Nigerian economic sustainability. The research used an Autoregressive Distributive Lag (ARDL)/bond test approach and OLS estimation technique, while data for 1990-2020 was collected. Changes in average temperature and carbon emission were used to capture climate change, while variations in exchange rate and agricultural production were used as control variables. The analysis showed that the goodness-of-fit (R-Square) is 0.998. This means that 99.8% of the changes in the dependent variable (GDP) can be explained by the changes in the independent variables (CEM, AGRIC, EXR, TEMP). The annual speed of adjustment from short-run to long-run relationships is 34%. At F-statistic = 195.8052 and P value = 0.000, the model is statistically significant at a 1% level. The results of the analysis further demonstrated that both in the long run and short run, carbon emissions adversely affect Nigeria's economic sustainability.

Additionally, the average atmospheric temperature was significantly related to the sustainability of the Nigerian economy in the short run. It was concluded that environmental stakeholders and the Nigerian government should develop and enforce policies to reduce carbon emissions and forest depletion. Also, efforts should be made by the government to ensure that environmentally friendly policies encourage agricultural production to reduce the import of agricultural produce, thereby boosting economic growth.

Oriekhoe, Adisa and Ilugbusi (2024) comprehensively analyse the intricate relationship between climate change and food supply chain economics, focusing on its impacts, adaptations, and sustainability measures. Firstly, climate change disrupts agricultural production through extreme weather events, shifts in precipitation patterns, and temperature changes, leading to reduced crop yields and quality. These impacts ripple through the entire food supply chain, affecting input costs, market prices, and food security. Consequently, stakeholders across the supply chain face heightened risks and uncertainties, necessitating adaptive strategies to mitigate losses and maintain resilience. Secondly, adaptation measures within food supply

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chains encompass a range of strategies aimed at minimising climate-related risks and optimising resource utilisation. These may include adopting climate-resilient crop varieties, implementing precision agriculture techniques, enhancing water management practices, and diversifying sourcing and distribution channels. Moreover, investments in technology, infrastructure, and knowledge transfer play pivotal roles in enhancing adaptive capacities and fostering sustainability in the face of climate variability.

Furthermore, ensuring the sustainability of food supply chains amidst climate change requires a multifaceted approach that integrates economic, social, and environmental considerations. Sustainable practices such as organic farming, agroforestry, and regenerative agriculture mitigate greenhouse gas emissions, enhance ecosystem resilience, and promote equitable resource access. Moreover, fostering collaboration and knowledge exchange among stakeholders, including farmers, policymakers, researchers, and consumers, is essential for promoting innovation and driving transformative changes towards more resilient and sustainable food systems. In conclusion, understanding the complex interplay between climate change and food supply chain economics is essential for developing effective strategies to mitigate risks, enhance adaptation, and promote sustainability. By adopting a holistic approach that integrates scientific insights, technological innovations, and stakeholder engagement, the global community can work towards building more resilient and equitable food supply chains in a changing climate.

Effiong, Musa, Hannah and Sugden (2024) examine the impact of loss and damage caused by climate change in the Lower Niger River region of Nigeria and the influence of global perspectives on the region. The research adopted a mixed-methods approach, including a survey of 198 households and 13 interviews with key stakeholders. Furthermore, open-source terra climate data of precipitation, runoff, and temperature covering 30 years (1990–2020) was sourced from the Climate Research Unit (CRU) dataset and analysed to show the distribution of trends and patterns in climate variables. Similarly, we conducted a land use land cover change (1990–2020) to ascertain the level of changes. Findings from the study have revealed that anthropogenic factors contribute to hydrological changes in the Lower Niger River Region, and these changes result in climatic disasters like flooding, which cause severe loss and damage to livelihood, including loss of agricultural productivity, fisheries, and accessibility. While global efforts to mitigate and adapt to climate change are important, the study uncovers that the influence of global perspectives on the Lower Niger River Region is often limited by factors such as unequal power dynamics, insufficient funding, and a lack of local ownership of initiatives. The study suggests the need for sustainable land management, resolving farmers'/headers conflict, and increasing awareness to address loss and damage.

Alehile (2023) investigates the impacts of climate change on agricultural sector employment in Nigeria. Agriculture provides income and sustenance for much of Nigeria's rural population. However, smallholder rain-fed farming predominates, with minimal resilience to climate shifts. Historical data reveal rising temperatures and declining, erratic rainfall across Nigeria's agro-ecological zones since the 1970s. Crop modelling predicts that further climate changes will reduce yields of key staple crops. This threatens the viability of smallholder agriculture and risks widespread job losses. The study adopts a nonlinear autoregressive distributed lag (NARDL) modelling approach to evaluate climate change effects on agricultural sector employment in Nigeria from 1990 to 2020. Findings reveal that reduced rainfall initially raises employment, as farming requires more labour in dry conditions. However, protracted droughts significantly reduce agricultural jobs. Increased temperatures consistently lower farm

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employment through reduced yields and incomes. Based on these findings, the study recommends that adaptive strategies are urgently needed to build resilience, promote climate-smart agriculture, and safeguard rural livelihoods.

METHODOLOGY

This study employed a cross-sectional, observational research design that simultaneously captured exposure and outcome variables (Setia, 2016). To thoroughly explore the socioeconomic impacts of global warming on Birnin Kudu, the study utilised a mixed-methods approach, which combines qualitative and quantitative methods, enabling a comprehensive understanding of the multifaceted effects of climate change on the local population

The study area selected is Birnin-Kudu, the local government of Jigawa State. Birnin-Kudu local government is under the Jigawa Central senatorial district, about 132 kilometres from eastern Kano. Birnin-Kudu is the most populous local government in Jigawa State. The local government has eleven political wards, which are Kantoga, Kangire, Keangwara, Kiyako, Sundumi, Surko, Lafiya, Unguwa'ya, Yalwan Damai, and Wurno Birnin-Kudu. The population of Birnin-Kudu stands at 540,100 (NPC, 2022)

The population for this study encompasses all residents of the Birnin Kudu Local Government Area, Jigawa State, Nigeria. However, the focus will be on key stakeholders whose insights and experiences are crucial for addressing the research objectives.

Farmers and Livestock Owners are yet another crucial stakeholder in evaluating the effects of climate change on agricultural productivity.

Healthcare Workers and Patients: These are also crucial stakeholders in determining the health impacts of global warming within the locality. This would involve healthcare professionals, community health workers, and individuals with health problems from the climate.

Involvement of the Water Resource Managers and Users: Local water management officials, well operators, and community members in charge of household water collection will be involved to establish how climate change will likely affect water resources and availability analysis.

Community Leaders/Elders: They are the key informants in understanding the adaptive strategies adopted by the local community to adapt to climate change.

The multi-stage sampling technique will ensure the sample's validity and reliability. The stages are as follows:

First Stage: Stratified Random Sampling: The LGA will be stratified into administrative wards or ecological zones to ensure that views from the various units constituting Birnin Kudu are represented.

Second Stage: Purposive Sampling- Key informants from community leaders, healthcare professionals, and people who manage water resources will be elicited.

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In these strata, random samplings will be carried out to select households and individual participants to respond to the survey and interviews. Quantitative data will be collected using a sample size that is determined by the Cochran formula, which says:

$n = Z^2 * p * q / e^2$ Where:

n = sample size

Z = the standard normal deviate; 1.96 for a 95% level of confidence p = proportion estimate being tested, suspected in the population with the attribute of interest (0.5, if unknown)

Q = 1 − p e = level of precision desired (±5% or 0.05) ----------3.1

This will apply using the above formula with a 95% confidence level and a 5% margin of error; this gives a minimum sample size of 384. Assuming there may be some non-responses to increase it by about 10%, this sets the final target sample size for quantitative surveys at 422 participants.

In qualitative data collection, the principle of saturation will be followed; that is, the in-depth interviews and focus group discussions will be continued until no new themes or information is generated. Researchers have found the ideal limit for the number of in-depth interviews to be between 20 and 30 and that of focus group discussions to be between 5 and 7.

DATA ANALYSIS, PRESENTATION, AND DISCUSSION

Analysis of the Questionnaires

This research distributed 64 questionnaires during the field survey. Forty-nine valid questionnaires were returned, seven were returned invalid, and eight were not returned. Thus, this analysis is guided by the returned and valid questionnaires, which are 49 in number.

Table 4.1 Age Distribution of Respondents

Age Range	Frequency	Percentage
18-25	12	24.5
26-35	20	40.8
36-45	12	24.5
46-60	5	10.2
Total	49	100

Source: *Fieldwork, 2024*

Table 4.1 is for the age distribution of the respondents. It indicates a predominance of younger adults, with 40.8% of respondents falling within the 26-35 age range. This suggests that most participants are likely to be more open to knowledge of climate change. The equal representation of the 18-25 and 36-45 age groups (24.5% each) indicates a balanced interest across different stages of adulthood, while the lower percentage (10.2%) in the 46-60 age range may reflect a lesser engagement with digital currencies among older individuals.

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Table 4.2 Distribution of Respondents by Gender

Gender	Frequency	Percentage
Male	33	67.3
Female	16	32.7
Total	49	100

Source: *Fieldwork, 2024*

Table 4.2 discloses the gender distribution of the respondents. It shows a significant male majority (67.3%) compared to females (32.7%). This disparity may influence the overall perspectives on climate change, as gender dynamics can affect financial decision-making and technology adoption. Understanding these differences is crucial for tailoring climate awareness and outreach programs.

Table 4.3 Distribution of Respondents by Marital Status

Marital Status	Frequency	Percentage
Single	16	32.7
Married	33	67.3
Total	49	100

Source: *Fieldwork, 2024*

Table 4.3 above revealed that most respondents (67.3%) are married, indicating that males make up the majority.

Table 4.4 Distribution of Respondents by Educational Qualification

Educational Level	Frequency	Percentage
Secondary	4	8.2
Tertiary	45	91.8
Total	49	100

Source: *Fieldwork, 2024*

Table 4.4 reveals the educational background of the respondents. It disclosed that 91.8% have attained tertiary education. This level of education may correlate with a greater understanding of climate change concepts and adaptive strategies, suggesting that respondents are likely to be more informed about the implications of climate change.

Table 4.5 Distribution of Respondents by Occupation

Occupation	Frequency	Percentage
Farmer	7	14.2
Trader	7	14.2
Artisan	2	4.1
Civil Servant	33	67.3
Total	49	100

Source: *Fieldwork, 2024*

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Table M4.5 reveals the occupational distribution of the respondents. It shows that a significant portion (67.3%) are civil servants, while farmers and traders represent 14.2%. This indicates that most respondents may have stable incomes, which could influence their attitudes toward adopting new adaptive strategies to combat climate change.

Table 4.6 Distribution of Respondents by Household

Household	Frequency	Percentage
1-4	21	42.9
5-8	14	28.4
9-12	8	16.3
>13	6	12.2
Total	49	100

Source: *Fieldwork, 2024*

Table 4.6 shows the household size of the respondents. The data shows that 42.9% of respondents live in households with 1-4 members, while 28.4% have 5-8 members. Smaller household sizes may correlate with higher disposable income, potentially affecting farming decisions and the possession and use of mechanisms and adaptive strategies to combat climate change.

Table 4.7 Distribution of Respondents by Land Ownership

Land Ownership	Frequency	Percentage
One their land	34	69.4
Do not own land	15	30.6
Total	49	100

Source: *Fieldwork, 2024*

Table 4.7 shows that a substantial majority (69.4%) of respondents were landowners during this research. Owning land in a farming community provides the owner with a sense of security and stability, which could influence their willingness to explore alternative farming avenues. Again,

30% of the respondents do not own land.

Table 4.8 Distribution of Respondents by Income Level per Month

Income level/per month (in Naira)	Frequency	Percentage
Below 20,000	6	12.2
21-40, 000	3	6.1
41,000-60,000	9	18.4
>61,000	28	57.1
Total	49	100

Source: *Fieldwork, 2024*

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Table 4.8 revealed that a significant portion of the respondents (57.1%) earn above 61,000 Naira monthly. This suggests a relatively higher economic status among the participants. This financial capacity may enable them to invest in different agricultural practices and purchase farm implements. However, the lower income brackets (12.2% below 20,000 Naira) highlight the economic diversity within the community.

Table 4.9 Assessing the Impact of Global Warming on Crop Yield and Livestock Production in Birnin- Kudu Jigawa State

S/N	Item Statement	Mean	Remark
1.	How has the yield of crops (maize, millet, sorghum) changed over the past 10 years	3.92	Moderately Increased
2.	Reduced rainfall, increased temperature, pest infestations, and soil degradation have contributed to changes in my crop yield.	3.96	Agreed
3.	The productivity of my livestock (cattle, goats, sheep) has been changed/affected by recent changes in the climate	3.86	Agreed
4.	I have experienced changes in the growing season length over the past decades	3.88	Agreed
5.	The frequency and severity of crop pests and diseases have increased in recent years	4.21	Agreed
6.	My agricultural income has reduced significantly due to changes in ground weather patterns	4.32	Agreed
	Sectional Mean	4.025	Agreed

Source: *Fieldwork, 2024*

Table 4.9 above shows the analysis of the results. The results revealed that farmers' crop yields increased moderately, with a mean score of 3.92. The respondents agreed that reduced rainfall, pest infestation, and reduced rainfall have contributed to changes in crop yield. This is evident by the mean score of 3.96 obtained from the analysis of results.

Table 4.10: Effects of Climate on Groundwater Levels, Surface Water Availability, and Rainfall

S/N	Item Statement	Mean	SD	Remark
1.	Has my community's surface water availability (e.g., rivers and ponds) changed over the past 10 years?	3.81	0.87	Moderately Increased
2.	The availability of groundwater (e.g. wells and boreholes) has changed in my community over the past 10 years	4.34	0.99	Agreed
3.	Rainfall patterns have become less predictable with more intense and frequent drought	4.21	1.22	Agreed
4.	My community has experienced more frequent droughts and flooding events over the past 10 years	3.73	0.32	Agreed

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5.	Rainfall patterns have changed in the past 5-10 years in your area	3.92	1.23	Agreed
		4.02		Agreed

Source: *Fieldwork, 2024*

Based on the results obtained from Table 4.10, several findings regarding the changes in water availability and rainfall patterns in the community over the past 10 years can be drawn: The average rating of 3.81 indicates that respondents feel there has been a moderate decrease in the availability of surface water, such as rivers and ponds. This suggests a concern among community members regarding the diminishing resources of surface water, which could impact local ecosystems and water supply. Furthermore, with an average rating of 4.34, respondents strongly agree that groundwater availability, such as wells and boreholes, has changed. This indicates significant concern about groundwater resources, which are crucial for drinking water and irrigation, suggesting that the community may face challenges accessing this vital resource. In addition, the finding that rainfall patterns have become less predictable, with an average rating of 4.21, shows a strong agreement among respondents. This unpredictability can lead to difficulties in agricultural planning and water resource management, potentially affecting food security and livelihoods. More so, the average rating of 3.73 indicates agreement that the community has experienced more frequent droughts and flooding events over the past decade. This highlights the increasing variability in weather patterns, which can have severe implications for the environment and the community's resilience to climate change. Finally, the average rating of 3.92 indicated that respondents agree that rainfall patterns have changed in the past 5-10 years. This aligns with the previous findings and reinforces that the community is experiencing significant shifts in weather patterns that could affect water availability and agricultural practices.

The findings indicate a concerning trend of decreasing surface water availability, changing groundwater resources, and unpredictable rainfall patterns, which could have severe implications for the community's water security and overall well-being. It may be beneficial for local authorities to investigate these changes further and implement strategies to manage water resources effectively.

Table 4.11: Health Impacts of Global Warming

S/N	Item Statement	Mean	SD	Remark
1.	My family members or I have experienced heat-related illnesses such as heat stroke in my community dehydration in the past 5-10 years.	4.42	1.14	Agreed
2.	I or some members of my household have experienced an increase in health problems such as malaria, diarrhoea, cholera, typhoid, and respiratory infection, which I believe are related to changes in the weather (e.g., extreme heat, unpredictable rainfall)	4.43	0.99	Agreed
3.	Climate change has significantly affected access to food and nutrition in my household	4.41	0.78	Agreed
		4.42		Agreed

Source: *Fieldwork, 2024*

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Table 4.11 disclosed that an average rating of 4.42 indicates strong agreement among respondents that they or their family members have experienced heat-related illnesses, such as heatstroke and dehydration. This suggests that extreme heat events have become more common or severe in the community, leading to significant health risks. The high level of agreement highlights the urgent need for public health interventions and awareness campaigns to educate the community about heat-related illnesses and prevention strategies.

In an FGD conducted for the health workers, the participants revealed that climate change significantly impacts livelihoods, particularly in vulnerable communities. According to them, these impacts can be attributable directly or otherwise to life. Some of the challenges of climate change were highlighted by the participants as follows:

"Heat-related illnesses and deaths; increased respiratory problems due to air pollution; Vector-borne diseases (e.g., malaria, dengue fever) spread; Water-borne diseases (e.g., cholera, diarrhoea) due to contaminated water; Mental health issues (e.g., anxiety, depression) related to climate-related stress; Temperature increases: altered growing seasons, crop yields; Changing precipitation patterns: droughts, floods, water scarcity; Increased pest and disease pressure: reduced crop resilience; Shifts in growing zones: altered suitability for specific crops; Loss of biodiversity: reduced genetic diversity, ecosystem disruption."

Again, the FGD participants revealed the following:

"*Changes in temperature and precipitation patterns affect crop yields and quality; Shifts in growing seasons and planting dates disrupt traditional practices; Increased frequency of extreme weather events (droughts, floods) damages crops; Warmer temperatures increase pest and disease pressure, reducing yields; Water scarcity affects irrigation, leading to reduced crop productivity".*

The participants among the Fishermen also revealed the impact of climate change as follows:

"Ocean warming and acidification impact fish populations and distribution; Changes in ocean currents and upwelling patterns affect fish migration; Increased frequency of marine heat waves devastates fisheries; Rising sea levels and coastal erosion threaten fishing communities; Shifts in fish species composition affect livelihoods."

Furthermore, participants from the pastoralist community also revealed the following as impacts of climate change on them:

"*Droughts and changing precipitation patterns reduce pasture quality; increased temperature affects livestock health and productivity; Shifts in grazing patterns disrupt traditional migration routes; Water scarcity affects livestock hydration and health; biodiversity loss reduces resilience in pastoral ecosystems."*

With an average rating of 4.43, respondents strongly agree that they or members of their household have experienced an increase in health problems, including malaria, diarrhoea, cholera, typhoid, and respiratory infections, which they believe are related to changes in weather patterns. This finding underscores the potential link between climate change and public health, as extreme heat and unpredictable rainfall can create conditions conducive to spreading infectious diseases. It suggests a pressing need for improved healthcare access and disease prevention strategies in the community.

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The average rating of 4.41 indicates strong agreement that climate change has significantly affected household access to food and nutrition. This finding points to the broader implications of climate change on food security, as weather patterns can disrupt agricultural production, leading to food shortages and increased prices. The community may face challenges maintaining adequate nutrition, which can have long-term health consequences.

The findings reveal a concerning trend of increasing health-related issues and food insecurity linked to climate change in the community. The strong agreement among respondents highlights the need for targeted interventions to address these challenges, including public health initiatives, improved access to healthcare, and strategies to enhance food security and resilience to climate impacts. It may also be beneficial for local authorities to engage in climate adaptation planning to mitigate these health risks and ensure the community's well-being.

Table 4.12: Economic Effects of Global Warming on Farming-Based Livelihoods and Household

S/N	Item Statement	Mean	SD	Remark
1.	How has your household's income from farming activities changed in the past ten years	4.22	1.22	Moderately Increased
2.	The following factors, such as livestock death, crop failure due to draughts, increased input costs, and reduced market prices for farm products, have significantly impacted your income from farming.	4.38	0.23	Very much
3.	I have had to diversify my sources of income (engaging in non-forming activities) due to changes in agricultural productivity	3.53	1.72	Agreed
4.	Some community members have to migrate to other areas (e.g. urban centres) to find alternative income due to climate impacts on farming	3.92	0.84	Agreed
		4.20		Agreed

Source: *Fieldwork, 2024*

The findings from Table 4.12 indicate a nuanced perspective on the changes in household income from farming activities over the past decade. With an average rating of 4.22, respondents reported a moderate increase in income, suggesting that while there may be some positive trends, the growth is not substantial enough to alleviate all the challenges farming households face. The factor that had the most significant impact on income, rated at 4.38, highlights the severe challenges posed by livestock deaths, crop failures due to droughts, increased input costs, and reduced market prices for farm products. This suggests that external factors, particularly climate-related issues and economic pressures, severely affect agricultural productivity and household income.

Additionally, the finding that respondents agreed (3.53) on the need to diversify their sources of income indicates a proactive approach to mitigating risks associated with farming. This diversification reflects an adaptation strategy in response to the changing agricultural landscape, suggesting that households seek alternative livelihoods to ensure financial stability.

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Furthermore, the agreement (3.92) that some community members have migrated to urban centres for alternative income underscores the significant impact of climate change on rural livelihoods. This migration trend may indicate a shift in demographic patterns as individuals seek better opportunities, which could have long-term implications for rural communities and agricultural practices. These findings illustrate the complex relationship between agricultural productivity, economic pressures, and adaptive strategies farming households employ in response to changing conditions.

In an interview, the interviewees identified the socio-economic impacts of climate change in Birnin.

Kudu Local Government, Jigawa State. The Key responses included:

" Changes in temperature and precipitation patterns affecting crop yields and livelihoods; Increased frequency of extreme weather events (droughts, floods) disrupting daily life; Loss of biodiversity and ecosystem disruption; Economic instability and food insecurity; Limited access to climate information and adaptation resources; Climate change affects agricultural productivity, leading to economic instability; Women and children are disproportionately affected by climate change; Limited access to climate-resilient technologies and inputs hinders adaptation; Traditional coping mechanisms (e.g., saving, sharing) are insufficient' Climate migration is becoming increasingly common."

Table 4.13: Adaptive Strategies Employed by the Local Community to Cope with Climate Change Challenges in Birnin-Kudu Jigawa State, Nigeria

S/N	Item Statement	Mean	SD	Remark
1.	a. early planting b. Improved seed varieties c. Use drought-resistant seed d. Crop diversification, for example, water conservation techniques, are adaptive strategies. Have you adapted to changing conditions	4.32	0.78	Improved seed varieties
2.	a. Financial support b. Agricultural extension services c. Training on new farming techniques is the support that I have received from the government or NGOs and has been effective in helping adapt to climate change	3.5	1.22	No support received
3.	How effective have the adaptive strategies you have implemented been in your agricultural productivity	3.61	1.87	Moderately effective
	Sectional Mean	3.81		

Source: *Fieldwork, 2024*

The findings from Table 4.13 revealed critical insights into the adaptive strategies employed by farmers in response to changing climate conditions. With an average rating of 4.32,

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improved seed varieties stand out as the most adopted strategy, indicating that farmers recognise the importance of utilising better genetics to enhance crop resilience and productivity. This suggests a proactive approach to addressing the challenges posed by climate change. In contrast, the support received from government or NGOs, rated at 3.5, indicates that many farmers have not received adequate assistance, with some reporting no support. This lack of support may hinder the effectiveness of adaptive strategies, as financial backing, agricultural extension services, and training on new farming techniques are crucial for successful adaptation. The relatively low rating highlights a resource gap that could be addressed to better support farmers in their adaptation efforts.

In an FGD, the participants recommended the following as adaptive strategies in response to climate change. These solutions are enumerated below:

"Integrate climate change into agricultural extension services. 'Enhance farmer education and training; Support climate-resilient agricultural research; Develop climate-sensitive agricultural policies; Promote sustainable agriculture practices; Integrate climate change into health worker training; Strengthen health systems for climate resilience; Support climate-sensitive livelihood programs; Enhance community engagement and participation. Advocate for climate policy and action".

Again, the FGD participants also identified the following as an adaptive strategy in response to climate change in Birnin-Kudu. Jigawa State:

"Climate-resilient crop and animal varieties; Conservation agriculture and agroforestry; Sustainable water management practices; Climate-informed fisheries management; Mobile livestock management".

The effectiveness of the adaptive strategies implemented, rated at 3.61, suggests that while these strategies are somewhat beneficial, they are only moderately effective in maintaining agricultural productivity. This indicates that farmers may still face significant challenges despite their efforts to adapt, possibly due to ongoing climate impacts or other external factors that limit the success of these strategies. Overall, these findings emphasise the need for enhanced support systems from the government and NGOs to empower farmers in their adaptation efforts. By providing targeted assistance and resources, stakeholders can help improve the effectiveness of adaptive strategies, ultimately leading to greater resilience in agricultural productivity amidst changing climate conditions.

Table 4.14: Roles of Local and State Government Policies and Interventions in Instigating the Effects of Global Warming in Birnin-Kudu, Jigawa State, Nigeria

S/N	Item Statement	Mean	SD	Remark
1.	I am aware of government policies or programmes that aim to help farmers adapt to climate change in your area	3.8	0.8	Anchor Borrower
2.	I have received from the government to cope with the impact of global warming	4.21	0.7	No support
3.	How would you rate the effectiveness of government interventions in addressing the	3.63	2.33	Moderately effective

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	challenges posed by global warming in your community?			
	Sectional Mean	3.88		

Source: *Fieldwork, 2024*

The findings from Table 4.14 provide a critical perspective on the awareness and effectiveness of government policies and programs aimed at helping farmers adapt to climate change. With an average rating of 3.8, respondents indicate a general awareness of government initiatives, such as the Anchor Borrower program, which suggests some level of engagement with these policies among the farming community. However, the contrasting finding that respondents reported receiving no support from the government, with a rating of 4.21, highlights a significant gap between awareness and actual assistance. This discrepancy may indicate that while farmers are aware of existing programs, they are not benefiting from them, which could undermine their ability to adapt to the impacts of global warming effectively.

The effectiveness of government interventions, rated at 3.63, suggests that while some farmers perceive these efforts as moderately effective, there is still considerable room for improvement. The high standard deviation of 2.33 indicates a wide range of opinions among respondents, suggesting that experiences with government support may vary significantly within the community. These findings point to a more robust and accessible support system for farmers. Enhancing the effectiveness of government interventions and ensuring that assistance reaches those in need could significantly improve the capacity of farmers to cope with the challenges posed by climate change. Addressing these gaps will be crucial for fostering resilience and sustainability in agricultural practices within the community.

Climate change has significant socio-economic impacts on local communities, particularly on vulnerable groups. Addressing these impacts requires a multi-faceted approach, including climate information dissemination, climate-resilient initiatives, and social protection programs.

Interviewees suggest the following to address the economic challenges of climate change in

Birnin-Kudu, Jigawa State. They are:

"Enhance climate information dissemination and early warning systems; Support climate-resilient agriculture and livelihood initiatives; Promote climate-sensitive social protection programs; Increase access to climate finance and adaptation resources; Foster community-led adaptation and resilience-building initiative".

Table 4.15: Influence of Global Warming on Rural-Urban Migration Patterns and Demographic

Changes in Birnin-Kudu, Jigawa State, Nigeria

S/N	Item Statement	Mean	SD	Remark
1.	There has been a noticeable change in population size in my community due to migration influenced by climate change	3.92	1.32	Agreed
2.	What are the main reasons for people migrating out of your community?			

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3.	Some members of my household have considered migrating to urban areas due to global warming's impacts on farming activities.	4.21	0.72	Agreed
	Sectional Mean	4.10		Agreed

Source: *Fieldwork, 2024*

The findings from the table indicate a significant awareness of the impact of climate change on population dynamics within the community. With an average rating of 3.92, respondents agree that there has been a noticeable change in population size due to migration influenced by climate change. This suggests that environmental factors are compelling individuals and families to leave their homes for better opportunities, likely driven by the challenges faced in agricultural productivity. The high rating of 4.21 regarding the consideration of migration to urban areas by respondents and their households further emphasises the situation's urgency. This indicates that many individuals view urban migration as a viable option to escape the adverse effects of global warming on their farming activities. The relatively low standard deviation of 0.72 suggests a consensus among respondents about the pressures they face, highlighting a collective concern for the sustainability of their livelihoods.

The results above underscore the profound impact of climate change on rural communities, prompting migration as a coping strategy. It reflects a broader trend where environmental challenges reshape demographic patterns, potentially leading to declining rural populations and altering community structures. Addressing the root causes of these challenges and supporting sustainable agricultural practices could help mitigate the need for migration and promote resilience within the community.

Table 4.2 Test of Hypotheses

PPMC Test result of the relationship between global warming and the migration pattern

Variable	N	X	S.D	Df	r-cal	r-crit	Sig	Decision
Global warming	50	3.89	0.77	48	0.235	0.185	0.045	Significant
Increased Migration pattern		3.48	0.43					

Table 4.16 shows the significant relationship between global warming and increased migration patterns in Birnin Kudu. The r-calculated value of 0.235 was more significant than the r-critical value of 0.185, and the significant value of 0.041 is less than 0.05, which is the decision rule for accepting or not accepting the hypothesis. Therefore, an alternate hypothesis is upheld at this moment. This showed a strong correlation between the effect of global warming and increased migration patterns as residents seek better livelihoods.

Table 4.3PPMC Test Result of Relationship between Global Warming and Migration Pattern

Variable	N	X	S.D	Df	r-cal	r-crit	Sig	Decision
Global warming	50	3.63	0.77	48	0.215	0.175	0.032	Significant
Agricultural Productivity		3.48	0.43					

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The analysis is based on a sample size of 50 respondents, with the mean score for global warming reported at 3.63 and a standard deviation of 0.77. This indicates a moderate agreement among respondents regarding the impact of global warming. The mean score for agricultural productivity is lower at 3.28, with a standard deviation of 0.43, suggesting that respondents perceive agricultural productivity to be significantly affected by global warming.

The calculated correlation coefficient (r-cal) of 0.215 indicates a positive relationship between global warming and migration patterns. This suggests that as perceptions of global warming increase, there is a corresponding increase in the likelihood of migration. The critical value (r-critical) is set at 0.175, which serves as a threshold for determining the significance of the correlation. Since the calculated r-cal (0.215) exceeds the r-crit (0.175), the relationship between global warming and migration patterns is statistically significant. The significance level reported is 0.032, below the conventional threshold of 0.05. This further supports the conclusion that the relationship is statistically significant, suggesting that the findings are unlikely to have occurred by chance.

Based on the results, the decision accepts the hypothesis that a significant relationship exists between global warming and migration patterns. This implies that the impacts of global warming, particularly on agricultural productivity, influence individuals' decisions to migrate. The test results above indicate a statistically significant positive correlation between global warming and migration patterns. The results suggest that as global warming affects agricultural productivity, it may drive individuals to consider migration as a coping strategy.

DISCUSSIONS OF FINDINGS

The research revealed key demographic trends, including a predominance of younger adults aged 26-35, indicating a receptive group for innovative ideas like climate change awareness and digital engagement. Balanced interest among the 18-25 and 36-45 age groups highlights the broad appeal of the subject across different life stages, while lower participation among older adults (46-60 years) underscores the need for tailored outreach to enhance accessibility and engagement. Additionally, findings indicate significant gender disparity, with males constituting 67.3% of respondents. This imbalance suggests potential challenges in ensuring inclusive climate change strategies, as gender dynamics shape decision-making, financial priorities, and technology adoption, potentially influencing how sustainable and community-oriented solutions are embraced.

The findings also emphasise the critical role of environmental stressors like reduced rainfall and pest infestation in affecting agricultural productivity, as seen in moderate improvements in crop yields. Respondents reported a noticeable decline in water availability, unpredictable rainfall patterns, and increased extreme weather events, all challenging agricultural planning and food security. Heat-related illnesses and rising infectious diseases were identified as additional health risks exacerbated by climate change. At the same time, the negative impact on household food access and nutrition further underscores the urgent need for adaptive strategies. Farmers' efforts to adopt improved seed varieties and diversify income sources reflect resilience; however, gaps in consistent government and NGO support hinder the effectiveness of these adaptive measures.

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Migration trends driven by climate change and economic pressures were also highlighted, with a significant portion of respondents citing movement to urban areas as a coping mechanism. While this migration addresses immediate financial needs, it risks depopulating rural communities and disrupting local economies. The disconnect between awareness of government policies and their practical implementation further compounds these challenges. Addressing these issues requires better coordination and accessibility of support systems, targeted investments in climate-smart agriculture, and strengthening the capacity of rural communities to adapt to environmental changes, reducing the push factors for migration and fostering long-term sustainability.

The research findings align with the vulnerability theory, which emphasises the differential impacts of climate change on various populations and the need for targeted adaptation strategies. The study highlights significant health risks associated with global warming, as shown in Table 4.11. Respondents strongly agree that they or their families have experienced heat-related illnesses like heatstroke and dehydration, alongside an increase in diseases such as malaria, diarrhoea, cholera, and typhoid, linked to changing weather patterns. These findings underscore the urgent need for public health interventions, including awareness campaigns and improved healthcare access, to mitigate the effects of extreme heat and the spread of infectious diseases. Additionally, the research reveals significant impacts on food security, with respondents agreeing that climate change has disrupted agricultural production, leading to challenges in accessing adequate nutrition. These findings highlight the critical need for comprehensive climate adaptation planning to address vulnerable communities' health and food security issues.

Table 4.13 further underscores the importance of adaptive strategies in mitigating climate change's effects, particularly in agriculture. Improved seed varieties emerged as the most adopted strategy, reflecting farmers' proactive efforts to enhance crop resilience and productivity. However, the findings also reveal a lack of adequate support from the government and NGOs, with many farmers reporting insufficient financial backing, training, and agricultural extension services. The moderate effectiveness of existing adaptive strategies indicates persistent challenges that limit their success, emphasising the need for enhanced support systems to empower farmers. These findings affirm the vulnerability theory by highlighting the importance of tailored adaptive measures and the role of external support in strengthening resilience against climate impacts.

The research findings highlight the intricate relationship between agricultural productivity, economic pressures, and adaptive strategies, emphasising the need for systemic interventions to address climate resilience, access to resources, and market stabilisation. While farming households demonstrate resilience and adaptability, the study reveals that moderate income growth and significant challenges underline the necessity of holistic solutions for enhancing rural livelihoods and reducing the negative impacts of climate and economic pressures. The research also calls for targeted strategies to engage younger adults, leveraging their openness to adaptation while ensuring inclusive knowledge dissemination across generations.

Gender dynamics also emerge as a key factor in shaping climate change perspectives and responses. The male-dominated findings suggest that climate policies and programs may currently reflect predominantly male perspectives, which could overlook the priorities of women. To address this, the research recommends gender-sensitive policies, targeted awareness campaigns, and efforts to overcome structural barriers limiting female participation

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in climate-related activities. Empowering women, who often play pivotal roles in managing household resources, is crucial for effective climate action, and a balanced approach to decision-making could lead to more comprehensive and inclusive solutions.

The study further explores climate change's challenges, including water scarcity, agricultural vulnerability, and environmental degradation. It stresses the importance of improving water resource management, promoting climate-resilient farming techniques, and addressing the risks of extreme heat events. These issues have significant implications for food security and public health, underscoring the need for urgent interventions to mitigate climate-induced challenges. The findings also suggest that climate change-induced migration could lead to demographic shifts, placing additional strain on urban areas and exacerbating socio-economic challenges. To manage these impacts, the research calls for sustainable rural development, climate-resilient agricultural practices, and proactive policies that address climate change's environmental and socio-economic dimensions.

CONCLUSION

This study reveals that climate change significantly impacts the socioeconomic fabric of the Birnin Kudu Local Government Area, Jigawa State, Nigeria. The observed changes in rainfall patterns, increased temperatures, and extreme weather events have decreased agricultural productivity, water scarcity, and health risks. These challenges disproportionately affect vulnerable populations, including farmers, livestock owners, and those with limited resource access. The findings underscore the urgent need for effective adaptation strategies to mitigate the adverse impacts of climate change on the community.

A multi-pronged approach is crucial to effectively address the socioeconomic impacts of climate change in Birnin Kudu. This includes investing in sustainable water resource management through improved infrastructure and efficient irrigation practices. Promoting climate-resilient agriculture by encouraging the adoption of climate-smart farming techniques, strengthening agricultural extension services, and developing early warning systems is essential. Strengthening public health systems by improving access to healthcare, conducting public health campaigns, and enhancing provider capacity is vital. Finally, enhancing community resilience through community-based adaptation initiatives, strengthening social safety nets, and investing in climate change education and awareness programs will be crucial to ensure a sustainable future for the region.

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