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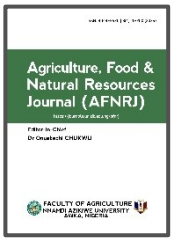


Original Article

# Impact of livelihood diversification on climate change resilience among rural households in Kebbi State, Nigeria

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**ABSTRACT**

*In the face of increasing climate variability, rural households in sub-Saharan Africa are adopting diverse livelihood strategies to enhance their resilience. This study explores the relationship between livelihood diversification and climate change resilience among rural households in Kebbi State, Nigeria. Anchored in the broader discourse on rural adaptation, the research adopts a descriptive design to assess how engaging in multiple income-generating activities influences household capacity to withstand and recover from climate-related shocks. A multistage sampling technique was used to select 348 respondents from selected rural communities. Primary data were gathered through structured questionnaires and interviews, and analyzed using descriptive statistics, multinomial logistic regression, and a climate resilience index. Results show that 74.4% of respondents were male and 58.6% had only a primary education. A significant proportion (67.8%) engaged in both farm and non-farm livelihood activities, with petty trading (51.1%) and artisanal work (38.5%) being most prevalent. Regression analysis revealed that education level ($p<0.01$), access to credit ($p<0.05$), and prior climate shock experience ($p<0.01$) significantly influenced diversification choices. Non-farm activities contributed over 45.3% of total household income, correlating positively with indicators of well-being, such as food security and children's education. Notably, 62.4% of households with diversified livelihoods were classified as highly resilient, compared to 38.1% of non-diversified households. Major barriers to diversification included limited access to credit (61.5%) and inadequate infrastructure (54.3%). The study concludes that livelihood diversification plays a critical role in enhancing rural households' adaptive capacity to climate change. It recommends expanding rural financial inclusion and supporting adaptive livelihoods through targeted microcredit and infrastructure development programs.*

**KEYWORDS:** *Climate change resilience, Kebbi State, Livelihood diversification, Rural households*

## INTRODUCTION

Climate change is the most significant environmental challenge of the 21st century, with wide-ranging implications for food security, water availability, livelihoods, and economic development, especially in developing countries. In sub-Saharan Africa, including Nigeria, the consequences of climate change are particularly severe due to the region's overdependence on climate-sensitive sectors such as agriculture, low adaptive capacity, and limited access to financial and technological resources (IPCC, 2022; Oduniyi, 2023). The adverse impacts of changing climate patterns, such as delayed rainfall, prolonged dry spells, flooding, and increased temperature, have been observed to disrupt traditional rural livelihoods, predominantly those dependent on rain-fed agriculture (Apata, 2020). Nigeria's agricultural sector employs over 70% of the rural population and contributes significantly to household income and national Gross Domestic Product

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(GDP). However, in recent decades, increasing climate variability has undermined farming productivity, leading to lower yields, land degradation, and heightened food insecurity (Ayanlade *et al.,* 2021).

Diversification of livelihoods has been identified in the literature as a means of reducing household vulnerability and enhancing resilience to climate change. Resilience, in this context, refers to the capacity of rural households to absorb, adapt, and transform in the face of climate-related disturbances while maintaining or improving their well-being (Bahadur *et al.,* 2022). Studies have shown that households that diversify into less climate-sensitive or off-farm activities tend to have more stable income sources, improved food security, and greater ability to invest in adaptation technologies such as irrigation and drought-tolerant crop varieties (Deressa *et al.,* 2021; Adebayo & Onu, 2023). Moreover, access to assets such as education, credit, extension services, and infrastructure has been found to influence the ability of households to diversify their livelihoods effectively (Babatunde & Qaim, 2022; Nhemachena & Hassan, 2022). However, the success of diversification strategies is often constrained by social, institutional, and economic factors, including market access, land tenure systems, gender norms, and inadequate policy support (Scoones, 2023). In Nigeria, particularly in the Northwest zone, the challenges posed by climate change are compounded by high poverty rates, low levels of education, and limited access to formal employment opportunities (Nbemachena & Hassan, 2022).

The resilience of these households is largely determined by their ability to engage in alternative income-generating activities and adapt to changing environmental conditions. While several studies have examined climate change adaptation in other regions of Nigeria (e.g., Ogunniyi *et al.,* 2018; Ayanlade *et al*., 2019; Apata, 2021), empirical research focusing specifically on livelihood diversification and its role in enhancing climate resilience in Kebbi State remains scarce. According to Ogunniyi *et al.* (2018), most existing literature tends to focus on general adaptation strategies without isolating the influence of non-farm activities on rural households' adaptive capacity and well-being. Additionally, little is known about the perceptions, motivations, and barriers influencing households' choices regarding livelihood diversification in the face of climate threats (Ayanlade *et al*., 2019). Despite increasing awareness of the threats posed by climate change, rural households in Kebbi State, Nigeria, continue to face significant challenges in adapting effectively. While some households have adopted income diversification strategies, others remain highly vulnerable due to limited access to capital, information, and supportive infrastructure. The overarching objective of this study is to examine the impact of livelihood diversification on climate change resilience among rural households in Kebbi State, Nigeria.

## METHODOLOGY

### Study Area

Kebbi State is located in north-western Nigeria, approximately between latitudes 10°N and 13°N and longitudes 3°E and 5°30′E. The state has a predominantly agrarian population, practicing crop farming, livestock rearing, and fishing. It has a tropical climate with distinct wet and dry seasons, making it vulnerable to climate variability (Kebbi State Agricultural Development Programme, 2022). The mean annual rainfall ranges from 400 to 800mm, and the mean annual temperature varies from 21 °C to 38 °C (KSG, 2024). Kebbi State has an estimated population of 3,662,103 people. The major ethnic groups in the state include the Fulani, Hausa, Dakarkari, and Kambari. Islam is the dominant religion of the people. Kebbi State has an agriculturally viable environment since it is endowed with high soil fertility, vast farmland, and economically viable rivers such as the River Niger, and it is also sheltered by a fine tropical climate. Owing to these factors, Agriculture has remained the major source of revenue and indeed the backbone of the economy of the state. Major food crops produced in the area are millet, guinea corn, maize, cassava, potatoes, rice, beans, onions, and vegetables (KSG, 2008).

### Sampling Procedure and Sample Size

A multi-stage sampling technique was used in the study. The first stage was the purposive selection of the Agricultural zones (Argungu, Bunza, Zuru, and Yauri zones) in the state. The second stage was the random selection of eight Local Government Areas from the four Agricultural zones in the state. The third stage was the random selection of two villages from each of the Local Government Areas selected, and lastly, the respondents were drawn from each of the villages, and a total of 348 respondents were drawn as the sample size from a sampling frame of 2400 respondents.

### Data Collection and Analysis

The primary data for the research were collected with the aid of an interview schedule, and secondary information was sourced from relevant documented literature. Data analyses were

Carried out using descriptive statistics (frequency, mean, and per cent), Multinomial Logistic Models, Income Share and Well-being Index, and Climate Resilience Index (CRI),

### Models Specification

To achieve this objective, a binary logistic regression model was used, where the dependent variable is livelihood diversification (1 = diversified, 0 = not diversified). The model evaluates the influence of socio-economic and contextual factors on the likelihood of households diversifying their livelihoods.

Let Y=1 Y =1 if a household diversifies its livelihood, and Y=0 otherwise.

The logistic regression model is specified as:

$$\text{Logit}(p) = \ln\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_n X_n + \varepsilon \quad (1)$$

Where: $P$= probability of livelihood diversification, $X_1 \ldots X_n$ = independent variables (e.g., age, education, income) *see Table 1 and* ε = error term

**Table 1: Independent variables used in the model**

| Variable Code | Description | Type |
|---|---|---|
| $X_1$ | Age of household head (years) | Continuous |
| $X_2$ | Gender (1 = Male, 0 = Female) | Dummy |
| $X_3$ | Household size | Continuous |
| $X_4$ | Educational level (years of schooling) | Continuous |
| $X_5$ | Monthly income (₦) | Continuous |
| $X_6$ | Access to credit (1 = Yes, 0 = No) | Dummy |
| $X_7$ | Extension contact (1 = Yes, 0 = No) | Dummy |
| $X_8$ | Farm size (hectares) | Continuous |
| $X_9$ | Distance to market (km) | Continuous |
| $X_{10}$ | Membership in cooperative (1 = Yes, 0 = No) | Dummy |

**Models Specification**

Multinomial Logistic Model: One of the underlying motivations for a household's alternative livelihood strategies is to maximize utility from the expected earnings of a particular strategy (Eneyew & Bekele, 2012). The model determining the choice of the probability that the household chooses an alternative livelihood strategy set a is the multinomial logit (MNL) if the sets are not ordered (Ying & Warren, 2010). The model exhibits a superior ability to predict livelihood diversification and pick up the differences between the livelihood strategies of rural households (Keane, 1992; Chan, 2005). However, for one to use MNL, the households must be clustered into different categories, and the basic assumption is that households in each category participate in some given livelihood strategies, and hence, cannot participate in strategies chosen by households in another category Brown *et al.*, 2006). Therefore, the MNL was used to examine factors determining the respondents' choice of livelihood strategy. Thus:

Let *Pij* be the probability of household *i* choosing livelihood strategy *j*.

The model is given by:

$$\ln\left(\frac{Pij}{Pi0}\right) = \beta + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + \epsilon \quad (2)$$

Where: *Pi*0 = base category, *Xk* = explanatory variables (age, gender, household size, education level, monthly income, access to credit, extension contact, farm size, distance to market, cooperative membership)

*Income Share and Well-being Index*

$$\text{Income share} = (\text{non-farm income} / \text{Total income}) \times 100 \quad (3)$$

Well-being is measured using a Composite Well-being Index (CWI) based on access to food, health, education, and housing.

*Climate Resilience Index (CRI)*

CRI is calculated using indicators such as income stability, food security, coping capacity, and social capital. CRI = Weighted sum of normalized scores of each indicator.

A Livelihood Resilience Index **(**LRI**)** was constructed to assess the resilience level of households based on indicators like income stability, food security, and access to credit, livelihood diversity, and adaptive capacity. Respondents were grouped into three resilience categories:

Low resilience (score 0.00–0.39), Moderate resilience (score 0.40–0.69), and High resilience (score 0.70–1.00).

Livelihood diversification was measured by the Number of Income Sources (NIS) each household had (e.g., farming, trading, remittances, crafts, labour, and transport). Cross-tabulation was used to analyse the relationship between NIS and resilience level.

**RESULTS AND DISCUSSIONS**

Table 2 show the socio-economic profile of the respondents offers crucial insights into the demographic and livelihood context in which rural households in Kebbi State operate. The result in the table above shows that the majority (65.5%) of the respondents were male, which reflects the gender dominance in agricultural and other livelihood activities in northern Nigeria. This finding is in agreement with the study by Yusuf *et al*. (2019), who observed a similar male dominance in farming households in the region. This pattern reflects traditional roles where men engage more in physically demanding and public economic activities. Most respondents (32.8%) were between 31–40 years, followed by the 41–50 age group (30.2%). This indicates that the rural workforce in the study area is largely composed of individuals in their economically productive years, which aligns with findings by Ayanlade *et al.* (2017), who reported that age is positively correlated with livelihood adaptation, as middle-aged individuals are more likely to take risks and adopt new income-generating strategies.

Large percentages (78.4%) of respondents were married, reflecting the common cultural practice of early and widespread marriage in rural communities. The average household size was also large, with 48.3% having between 6–10 members and 29.6% with more than 10. Large households may serve as both a support system and a labor resource, but they may also intensify the burden on household income and food security, as noted by Apata (2011). On education, 32.2% of the respondents had no formal education, while only 19% attained tertiary education. This low educational attainment is consistent with Oduniyi (2018), who reported that low literacy levels limit rural

households' access to information, new technologies, and climate adaptation knowledge. The limited access to formal education may reduce the capacity of households to diversify into more skilled non-farm activities, which often require basic literacy and numeracy.

Farming was the primary occupation for 63.5% of the respondents, reaffirming the agrarian nature of Kebbi State's rural economy. However, the presence of other occupations such as trading (14.1%), fishing (9.2%), and artisan (8%) indicates a degree of livelihood diversification. This supports Ellis's (2000) assertion that rural households rarely rely on a single income source. In terms of income, 41.1% of respondents earned below ₦20,000 monthly, suggesting widespread poverty. This low-income level limits households' capacity to invest in climate-resilient strategies and non-farm ventures. This agrees with findings by Ogunniyi *et al.* (2018), who reported that financial constraints are a major barrier to livelihood diversification and climate adaptation in rural Nigeria. Farming experience shows that a majority (85.9%) of respondents had more than 5 years of experience, indicating strong agricultural knowledge. However, experience alone may not be sufficient to withstand the shocks of climate change without complementary strategies like diversification. Deressa *et al.* (2009) noted that while experience improves awareness, it must be combined with innovation for effective adaptation.

The findings in Table 3 reveal a diverse array of livelihood activities pursued by rural households in Kebbi State. As expected, crop farming (91.4%) and livestock rearing (72.4%) remain the dominant activities, underscoring the agro-based nature of the rural economy. These findings align with those of Ellis (2000) and Adepoju & Obayelu (2013), who observed that agriculture forms the backbone of rural livelihoods in sub-Saharan Africa, particularly in semi-arid zones like northern Nigeria. A high proportion (41.1%) of respondents also engage in fishing, particularly in areas around the Kainji and Shiroro dams. This supports the work of Ayanlade *et al.* (2017), who emphasized the importance of aquatic resources in enhancing rural food security and livelihoods in riparian communities.

Non-farm income-generating activities such as petty trading (36.8%), artisan jobs (26.7%), and food processing (20.4%) were also reported. These findings are in agreement with Barrett et al. (2001), who reported that non-farm diversification provides important risk-coping strategies for rural households exposed to climate shocks, especially where farming alone cannot sustain the household year-round. The involvement in transport services (13.5%) and remittances from family members (16.1%) reflects adaptive strategies to increase economic uncertainty. According to Reardon *et al*. (2007), remittances and transportation services have emerged as critical diversification paths in rural Africa, especially among youth and younger households seeking faster income returns. Interestingly, 30.2% of respondents reported engaging in agricultural labor on others' farms, an indication of informal labor exchange systems, which can help cushion economic hardship, particularly during lean seasons. This echoes findings by FAO (2014), which highlighted casual farm labor as a form of diversification and survival strategy in resource-constrained settings.

**Table 2: Distribution of the respondents based on their socio-economic characteristics (N = 348)**

| Variable | Category | Freq. | % |
|---|---|---|---|
| Gender | Male | 228 | 65.5 |
| | Female | 120 | 34.5 |
| Age (Years) | 18–30 | 62 | 17.8 |
| | 31–40 | 114 | 32.8 |
| | 41–50 | 105 | 30.2 |
| | 51 and above | 67 | 19.2 |
| Marital Status | Single | 48 | 13.8 |
| | Married | 273 | 78.4 |
| | Widowed/Divorced | 27 | 7.8 |
| Household Size | 1–5 members | 77 | 22.1 |
| | 6–10 members | 168 | 48.3 |
| | Above 10 members | 103 | 29.6 |
| Level of Education | No Formal Education | 112 | 32.2 |
| | Primary Education | 79 | 22.7 |
| | Secondary Education | 91 | 26.1 |
| | Tertiary Education | 66 | 19.0 |
| Primary Occupation | Farming | 221 | 63.5 |
| | Fishing | 32 | 9.2 |
| | Trading | 49 | 14.1 |
| | Artisan/Crafts | 28 | 8.0 |
| | Civil Service | 18 | 5.2 |
| Monthly Income (₦) | <₦20,000 | 143 | 41.1 |
| | ₦20,000–₦40,000 | 119 | 34.2 |
| | ₦41,000–₦60,000 | 52 | 14.9 |
| | >₦60,000 | 34 | 9.8 |
| Farming Experience (Years) | <5 years | 49 | 14.1 |
| | 6–10 years | 111 | 31.9 |
| | 11–20 years | 97 | 27.9 |
| | >20 years | 91 | 26.1 |

*Source: Field Survey, (2025)*

Membership in cooperative societies or savings groups (24.7%) also highlights the role of social capital in supporting diversified livelihoods. This is supported by Nnadi *et al*. (2013), who stressed the importance of rural institutions in mobilizing resources and information necessary for livelihood expansion and adaptation to climate variability. Despite the wide range of strategies, the relatively low percentages in sectors such as civil service (10.3%) suggest that structural constraints like limited access to education and formal jobs still hinder a full transition into more stable non-agricultural livelihoods. This supports Oluwatayo (2009), who noted that limited human capital and infrastructure restrict rural households' ability to diversify into high-return ventures.

**Table 3: Livelihood Diversification Strategies Adopted by Rural Households in the study area (N = 348)**

| Livelihood Strategy | Freq. | % |
|---|---|---|
| Crop farming (rain-fed and irrigated) | 318 | 91.4 |
| Livestock rearing (goats, sheep, cattle, poultry) | 252 | 72.4 |
| Fishing (rivers, dams, and ponds) | 143 | 41.1 |
| Petty trading (retail of foodstuffs, groceries) | 128 | 36.8 |
| Artisan jobs (carpentry, tailoring, mechanics) | 93 | 26.7 |
| Civil service or government employment | 36 | 10.3 |
| Transport services (okada, keke, cart pulling) | 47 | 13.5 |
| Food processing (grinding, milling, oil extraction) | 71 | 20.4 |
| Remittances from migrant family members | 56 | 16.1 |
| Agricultural labor on others' farms | 105 | 30.2 |
| Participation in cooperative societies/Savings groups | 86 | 24.7 |

***Source: Field Survey, (2025)**. Note: Multiple responses were allowed, as households may engage in more than one strategy.*

The regression results in Table 4 show that several factors significantly influence the decision of rural households to diversify their livelihoods. Education Level ($p < 0.01$) had a strong positive influence, indicating that more educated household heads are more likely to diversify. This aligns with Oluwatayo (2009) and Adepoju & Obayelu (2013)**,** who reported that education enhances awareness of opportunities and capacity to engage in non-farm enterprises. Access to Credit emerged as one of the most influential variables (Odds Ratio = 3.43), indicating that financial capital greatly increases the likelihood of diversification. This supports the findings of Barrett *et al*. (2001) and Ogunniyi *et al.* (2018), who reported that credit access facilitates entry into income-generating activities beyond farming.

Extension contact was positively and significantly related to diversification, reinforcing the importance of advisory services in helping households adopt alternative livelihood strategies. Yusuf *et al*. (2019) noted a similar relationship in their study of climate-smart adaptation in Kebbi State. Membership in Cooperative Societies also positively influenced diversification decisions. These groups often provide social networks, access to training, and microcredit. This is consistent with Nnadi *et al*. (2013)**.** Gender (being male) increased the likelihood of diversification. This is due to cultural and mobility advantages men have over women in rural northern Nigeria, as found in Ayanlade *et al.* (2017)**.** Age had a negative coefficient, meaning younger households were more likely to diversify. This reflects findings by Ellis (2000) and Adebayo *et al.* (2015) who reported that younger individuals are more likely to embrace risk and innovation. Household Size showed a positive influence, which may indicate labor availability that facilitates engagement in multiple activities. Interestingly, farm size and distance to market were negatively associated with diversification. Larger farm size may reduce the perceived need for alternative income, while greater market distance can pose logistical constraints to starting or expanding non-farm businesses, as highlighted by (FAO, 2014).

**Table 4: Multinomial Logistic Regression Results for Factors Influencing Livelihood Diversification (N = 348)**

| Variable | Coefficient (β) | Standard Error | Odds Ratio | P-value | Significance |
|---|---|---|---|---|---|
| Constant | -1.254 | 0.582 | – | 0.031 | * |
| Age | -0.028 | 0.011 | 0.972 | 0.008 | ** |
| Gender | 0.647 | 0.219 | 1.910 | 0.003 | ** |
| Household Size | 0.135 | 0.059 | 1.145 | 0.023 | * |
| Education Level | 0.101 | 0.026 | 1.106 | 0.000 | *** |
| Monthly Income | 0.0004 | 0.0001 | 1.0004 | 0.002 | ** |
| Access to Credit | 1.233 | 0.332 | 3.431 | 0.000 | *** |
| Extension Contact | 0.804 | 0.298 | 2.234 | 0.007 | ** |
| Farm Size | -0.064 | 0.022 | 0.938 | 0.004 | ** |
| Distance to Market | -0.041 | 0.017 | 0.960 | 0.017 | * |
| Cooperative Membership | 0.671 | 0.289 | 1.957 | 0.019 | * |

***Source: Field Survey, (2025)** ***Significant at 1% ($p < 0.01$), **5% ($p < 0.05$), 10% ($p < 0.1$)*

The results in Table 5 above indicate that non-farm income contributes significantly to household income and well-being in rural Kebbi State. Non-farm sources (both wage and self-employment) together contributed 41.6% of total household income. This supports the findings of Barrett *et al.* (2001) and Haggblade *et al.* (2010)**,** who note the increasing role of non-farm income in rural economies of developing countries.

The OLS regression results in Table 6 show that non-farm income significantly and positively affects household per capita income ($\beta = 0.553$, $p < 0.01$), indicating that higher non-farm income improves well-being. This is in line with Reardon (1997) and Oluwatayo (2009)**,** who reported that non-farm income reduces poverty and enhances consumption. Education had a strong positive influence, implying that better-educated households are more capable of securing non-farm employment and using income effectively. This finding aligns with Adepoju & Obayelu (2013)**.**

Cooperative membership positively affected income and well-being, possibly by enabling business opportunities and savings. These findings agree with Nnadi *et al.* (2013) and Ogunniyi *et al.* (2018). Household size and distance to market were negatively associated with per capita income, possibly because of the consumption burden and limited access to markets. These constraints are similar to the observations of Ayanlade *et al.* (2017) and FAO (2014). The implications of the analysis above reveal that non-farm activities are not merely supplementary but are essential to improving the economic resilience and well-being of rural households. Encouraging diversification into non-farm livelihoods through skill development, market access, and credit facilitation could enhance household living standards.

**Table 5: Distribution of the respondents based on Sources of Household Income (N = 348)**

| Income Source | Mean Monthly Income (₦) | % Contribution to Total Income |
|---|---|---|
| Farming (crop/livestock) | ₦41,600 | 49.2% |
| Non-farm wage employment | ₦18,300 | 21.6% |
| Non-farm self-employment | ₦16,900 | 20.0% |
| Remittances | ₦5,000 | 5.9% |
| Others (rents, aid, etc.) | ₦2,800 | 3.3% |
| Total | ₦84,600 | 100% |

**Table 6: OLS Regression Results of Non-Farm Income on Household Well-being Indicators (Dependent Variable: Household Per Capita Monthly Income (₦)**

| Variable | Coefficient (β) | Standard Error | t-value | P-value | Significance |
|---|---|---|---|---|---|
| Constant | 2450.75 | 652.80 | 3.75 | 0.000 | *** |
| Non-farm Income (₦) | 0.553 | 0.083 | 6.66 | 0.000 | *** |
| Household Size | -115.23 | 35.12 | -3.28 | 0.001 | ** |
| Education Level (years) | 289.55 | 72.43 | 3.99 | 0.000 | *** |
| Access to Credit | 1740.32 | 534.21 | 3.26 | 0.001 | ** |
| Cooperative Membership | 1123.44 | 471.19 | 2.38 | 0.018 | * |
| Distance to Market (km) | -89.23 | 28.90 | -3.09 | 0.002 | ** |

*$R^2$ = 0.486, F-stat = 18.73, p < 0.01 ***Significant at 1%, **5%, *10%.*

Findings in Table 7 show that Households with only one income source (mostly farming) had the highest percentage (54.8%) of low resilience (Table 7). The higher the income sources, the higher the levels of resilience. 65.2% of households with four or more income sources were in the high resilience category, and only 6.5% of them fell into the low resilience group. The above analysis clearly shows that livelihood diversification significantly enhances household resilience to climate change. As households adopt more income-generating activities beyond farming, such as petty trading, artisanal work, or remittance inflows, they tend to better withstand climatic shocks, such as drought, flooding, and crop failure. This finding agrees with Ellis (2000), who emphasized that rural households build resilience by combining farm and non-farm activities. Similarly, Barrett et al. (2001) noted that households with diversified income sources are less vulnerable to environmental and market shocks. The results also support the findings of Bryan *et al.* (2009) in rural Ethiopia and South Africa, where access to multiple income streams (especially non-farm activities) was significantly associated with improved food security and adaptation capacity.

In Kebbi State, where the majority depend on climate-sensitive agriculture, diversification into non-farm activities plays a buffering role, ensuring income flow during lean periods. This mirrors the conclusions of Adger (2006), who highlighted livelihood diversification as a core strategy for climate change adaptation in vulnerable rural settings. Scoones (2009) reported that over-diversification might dilute effort and reduce returns, especially when households lack adequate capital, skills, or market access to succeed in non-farm enterprises. This could lead to overburdened labor without corresponding gains. Nevertheless, in contexts like rural Kebbi State, moderate to broad diversification correlates with increased resilience.

**Table 6: Household Resilience Levels Based on Livelihood Diversification (N = 348)**

| Number of Income Sources (NIS) | Low Resilience (%) | Moderate Resilience (%) | High Resilience (%) | Total (%) |
|---|---|---|---|---|
| 1 (No diversification) | 54.8 | 40.3 | 4.9 | 100% |
| 2 | 29.1 | 54.7 | 16.2 | 100% |
| 3 | 11.8 | 52.9 | 35.3 | 100% |
| ≥4 | 6.5 | 28.3 | 65.2 | 100% |

## CONCLUSION AND RECOMMENDATIONS

Livelihood diversification has proven to be a critical mechanism for enhancing the resilience of rural households in Kebbi State to the adverse effects of climate change. The study found that households engaging in multiple income-generating activities were significantly more capable of withstanding and recovering from climate-induced shocks, ensuring food security, and maintaining a more stable income base. Despite these positive outcomes, the effectiveness of diversification strategies remains constrained by socio-economic challenges such as limited access to credit, inadequate infrastructure, low levels of education and skills, and insecurity. Therefore, to fully realize the potential of livelihood diversification as a climate adaptation strategy, targeted and coordinated efforts are required. These should focus on improving rural infrastructure, promoting financial inclusion, enhancing capacity-building initiatives, and ensuring a secure environment. The study recommended investment in roads, irrigation systems, storage facilities, and electricity to support agricultural and non-agricultural income-generating activities. Improved infrastructure will reduce post-harvest losses, enhance market access, and encourage entrepreneurship. Expand access to affordable credit, savings, and insurance services tailored to rural contexts. Financial institutions and development programs should design products that support smallholder farmers and rural entrepreneurs in diversifying their income sources.

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### Author Contributions

Author YJA conceptualized the study and supervised data collection. TAM contributed to the writing and editing of the manuscript. AMD conducted the literature review, analysed the data, and drafted the initial manuscript. All authors reviewed and approved the final version of the paper.

### Ethical Statement

This study was conducted by ethical standards for research involving human participants. Informed consent was obtained from all respondents before data collection. Participation was voluntary, and confidentiality of responses was maintained throughout the study.

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