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Research Article

Determinants of Household Poverty and Livelihood Diversification Among Rural Farming Communities in Yobe State, Nigeria

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ABSTRACT

Poverty in sub-Saharan Africa is persistent, multidimensional and spatially uneven, particularly in fragile dryland regions where climate variability intensifies livelihood vulnerability. In northeastern Nigeria, especially Yobe State, rural deprivation encompasses not only low income but also food insecurity, limited access to basic services, weak asset accumulation and inadequate housing. This study investigated the determinants of household poverty and evaluated the role of livelihood diversification in reducing both poverty incidence and depth among rural farming communities in Yobe State. A cross-sectional household survey of 414 farming households was conducted between June and August 2025. Data were collected using a structured questionnaire and analysed using the Foster-Greer-Thorbecke poverty indices, an adapted Alkire-Foster Multidimensional Poverty Index, the Simpson Index of Diversification, multivariate regression models and structural equation modelling. Spatial techniques were applied to examine geographic clustering of poverty. Results indicated severe deprivation: over 80% of households earn below ₦30,000 per month, more than 70% experience multidimensional poverty, and only 28% achieve acceptable food consumption levels. Access to irrigation, improved seeds and extension services remains critically limited. Livelihood diversification significantly reduces poverty depth and multidimensional deprivation. Regression and path analyses demonstrated that diversification mediates the poverty-reducing effects of education and credit access, while climate shocks exacerbate poverty through livelihood instability. The findings underscored the need for integrated interventions that enhance diversification, strengthen agricultural resilience and expand institutional support in dryland contexts.

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1 Introduction

Poverty is deeply entrenched, multidimensional, and spatially uneven, particularly in fragile dryland and conflict-affected regions where livelihood systems are highly exposed to environmental and economic shocks (Nyamamu et al., 2025). In northern Nigeria, especially in the semi-arid zones of the Lake Chad Basin, poverty extends beyond income deprivation and reflects the cumulative interaction of climatic stressors, weak and undiversified livelihood systems, limited asset ownership, and constrained access to social and economic infrastructure (Gani et al., 2019; Sanusi et al., 2016). However, in northeastern Nigeria, these structural drivers of poverty are further compounded by protracted insecurity, which has reshaped livelihood systems, disrupted markets, displaced populations, and altered access to productive assets and services.

From a theoretical perspective, the persistence of poverty in this region can be better understood through the lens of fragility and conflict theory, which emphasises how chronic insecurity erodes institutional capacity, weakens economic systems, and reinforces cycles of vulnerability. The political economy of conflict further explained how insecurity disrupts agricultural production, restricts mobility, and increases transaction costs, thereby limiting households' ability to engage in stable and productive livelihood activities. In such contexts, poverty is not only a function of resource scarcity but also of constrained opportunities shaped by insecurity-induced risks and uncertainties. This aligned with the vulnerability context of the Sustainable Livelihoods Framework, where shocks such as conflict and displacement interact with environmental stressors to undermine livelihood sustainability. Despite decades of development interventions, poverty incidence and depth remain persistently high, suggesting that conventional sector-specific approaches have been insufficient in addressing these interconnected structural drivers of deprivation (Ajayi et al., 2016).

In this broader context, livelihood diversification has increasingly been promoted as a critical pathway for poverty reduction and resilience building in rural economies. Grounded in the Sustainable Livelihoods Framework, diversification is conceptualized as the process through which households combine farm, off-farm, and non-farm activities to reduce vulnerability to shocks, smooth consumption, and improve welfare outcomes (Nwaogwugwu & Matthews-Njoku, 2015; Zakevičiūtė, 2019). Empirical evidence from across Africa and comparable dryland contexts demonstrated that diversified households are generally better positioned to

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withstand climate variability, price volatility, and production risks (Abebe et al., 2021; Mofya-Mukuka & Hichaambwa, 2018). Studies in Nigeria similarly show positive associations between diversification, food security, and income stability among rural households (Echebiri et al., 2017; Obayelu et al., 2021).

However, the poverty-reducing effects of diversification are neither automatic nor uniform. In some contexts, diversification reflects distress-driven coping rather than accumulation, with households engaging in low-return, survival-oriented activities that do not meaningfully reduce poverty depth (Alemu, 2023; Tang et al., 2023). This distinction is particularly important in fragile and conflict-affected environments, where diversification may be constrained by insecurity, limited market access, and reduced mobility. As such, diversification may function as a risk management strategy without necessarily translating into long-term welfare improvements. This raised critical questions about whether diversification reduces only poverty incidence or also mitigates poverty severity and multidimensional deprivation. While global and regional literature provided important insights into the role of livelihood diversification, there is a need to situate these dynamics in specific local contexts where the interaction between environmental stressors and insecurity is particularly pronounced. In northeastern Nigeria, and specifically in Yobe State, livelihood systems are increasingly strained by recurrent droughts, erratic rainfall, land degradation, market disruptions, and prolonged insecurity, all of which have weakened agricultural productivity and reduced employment opportunities (Gani et al., 2019). These conditions created a complex vulnerability environment in which households are compelled to adopt multiple livelihood strategies, yet the effectiveness of such strategies in reducing multidimensional poverty is unclear.

Existing studies in the region often rely on unidimensional poverty measures or descriptive analyses, which limit the ability to capture the full complexity of poverty and its interaction with livelihood strategies. In particular, there is limited empirical evidence on how livelihood diversification influences multiple dimensions of poverty simultaneously, including income, food security, education, asset ownership, housing quality, and access to basic services (Zakevičiūtė, 2019). Furthermore, little attention has been given to how these relationships vary across household characteristics, gender dynamics, and agro-ecological contexts in Yobe State. Against this backdrop, this study addressed these gaps by adopting a multidimensional analytical approach that integrated income-based poverty measures, multidimensional deprivation indices, and livelihood diversification metrics. By explicitly situating the analysis in the context of environmental stress and insecurity, the study provided a more comprehensive understanding of how diversification functions as both a coping and adaptive strategy. The disaggregation of outcomes across household characteristics, gender of household head, and agro-ecological contexts further enhanced the policy relevance of the findings. Generally, the study contributed to the development of more targeted and context-sensitive poverty reduction and resilience strategies for fragile drylands.

2 Materials and Methods

2.1 Study Area

The study was conducted in Yobe State, northeastern Nigeria, in the semi-arid Lake Chad Basin. The state lies in the Sudan–Sahel ecological belt, characterized by low and variable rainfall, high temperatures, short rainy seasons, and prolonged dry periods, which increase rural livelihood vulnerability to climate and environmental stress (Oyelade et al., 2025; Nyamamu et al., 2025). Yobe is largely agrarian, with households depending on rain-fed farming, livestock rearing, petty trading, wetland fishing, and other small-scale activities. Major crops include millet, sorghum, maize, cowpea, groundnut, and vegetables, especially in areas with irrigation or floodplain moisture. However, agriculture is constrained by erratic rainfall, land degradation, poor irrigation access, limited extension services, and weak access to improved inputs (Nyiatagher et al., 2019; Oyelade et al., 2025). The state also faces poverty, insecurity, market disruption, and displacement, which weaken household assets, food security, income stability, and access to basic services. Consequently, many rural households combine farm, off-farm, and non-farm activities to reduce vulnerability and improve survival outcomes (Chukwu & Chukwu, 2025; Nyamamu et al., 2025).

2.2 Study Design, Sample Size, and Data Collection

The study employed a cross-sectional household survey design to generate household-level data on poverty, livelihood activities, income sources, welfare conditions, and vulnerability at a specific point in time. This design is widely appropriate for rural livelihood and poverty studies because household surveys allow researchers to capture socio-economic characteristics, livelihood portfolios, access to productive assets, and welfare outcomes directly from respondents. Similar studies on rural livelihood diversification have used household-level data to examine how household size, gender, education, income, credit access, and poverty status influence diversification decisions (Nyiatagher et al., 2019; Oyelade et al., 2025). The survey was conducted between June and August 2025 in selected rural communities of Yobe State,

Nigeria, with an analytical sample of 414 farming households (N = 414). The study period coincided with the active agricultural season, thereby allowing reliable recall of income streams, food consumption patterns, agricultural inputs, and exposure to climate-related shocks. The use of selected rural communities was because poverty and livelihood vulnerability are spatially differentiated and shaped by local agro-ecological, economic, and institutional conditions. In Nigeria, rural households face multiple pressures, including land fragmentation, declining agricultural productivity, climatic shocks, market instability, and limited access to productive resources, making household-based inquiry suitable for understanding livelihood responses in vulnerable rural settings (Oyelade et al., 2025).

The study area was purposively selected to capture structurally vulnerable agrarian systems in the Sudano–Sahelian dryland ecological zone. Three Local Government Areas were selected to represent agro-ecological and livelihood variability: Yunusari, Jakusko, and Fika LGAs. In these LGAs, six communities were selected: Kalgi and Kafiya in Yunusari LGA; Amshi and Jaba in Jakusko LGA; and Gadaka and Ngalda in Fika LGA. Community selection followed operationalized criteria rather than convenience sampling. Communities were included if they satisfied three measurable conditions: agrarian concentration, defined as at least 70% of households primarily dependent on farming; poverty prevalence exceeding the LGA rural average based on administrative data; and exposure to rainfall variability or drought episodes in the previous five years. This design was further justified by the semi-arid and livelihood-vulnerable context of northeastern Nigeria, where rural households are highly exposed to climate variability, food insecurity, weak infrastructure, limited finance, and constrained market access. Evidence shows that rural households increasingly combine farm, off-farm, and non-farm activities as survival and welfare-enhancing strategies where agriculture alone is insufficient to sustain livelihoods (Nyiatagher et al., 2019; Chukwu & Chukwu, 2025). Broader sub-Saharan African evidence also indicates that livelihood diversification is a major pathway for reducing rural poverty and strengthening resilience, although its effectiveness is often constrained by climate change, inadequate infrastructure, limited education, and poor access to finance (Nyamamu et al., 2025). Therefore, the cross-sectional household survey design was appropriate for generating standardized, comparable, and context-specific empirical data on the prevailing poverty and livelihood conditions of farming households in the study area. This ensured analytical alignment with the study's focus. A multistage sampling strategy was applied. In the second stage, systematic random sampling was used to select households from validated community registers. The sampling interval was computed as:

$$k = \frac{N}{n}$$

where N denotes total farming households in the community and n represents the allocated sample size. After a random start, every k^{th}household was selected.

The sampling frame was constructed using agricultural extension records, community administrative listings, and validation by village leaders. Field verification was conducted to minimize coverage error and duplication. This triangulation enhanced sampling frame reliability and internal validity. Primary data were collected using a structured questionnaire covering socio-demographic characteristics, disaggregated income sources, food consumption score (FCS), MIYCN practices, agricultural inputs, asset ownership, housing quality, credit access, extension services, infrastructure access, and climate shock exposure. Ethical clearance was obtained from the Yobe State Agricultural Development Programme and Yobe State University, Damaturu. Participation was voluntary; informed consent was obtained from all respondents; confidentiality and anonymity were strictly maintained.

2.3 Analytical Framework

2.3.1 Income Poverty Measurement

Income poverty was measured using the Foster–Greer–Thorbecke (FGT) class of poverty indices:

$$P_\alpha = \frac{1}{N}\sum_{i=1}^{q}\left(\frac{z - y_i}{z}\right)^\alpha$$

Where:

- $N = 414$(total households)
- q= number of households below the poverty line z
- y_i= income of household i
- α= poverty aversion parameter

Special cases:

- $\alpha = 0$: Headcount Ratio
- $\alpha = 1$: Poverty Gap
- $\alpha = 2$: Poverty Severity

2.3.2 Multidimensional Poverty Index (MPI)

The Alkire–Foster methodology was applied. Six equally weighted dimensions were included: income, food security, education, health access, asset ownership, and housing quality. Each dimension received equal weight:

$$w_d = \frac{1}{6}$$

Within each dimension:

$$w_{ij} = \frac{1}{6 \times m_d}$$

where m_d denotes the number of indicators in dimension d.

The deprivation score for the household i:

$$C_i = \sum_{j=1}^{k} w_j \, g_{ij}$$

A household was classified as multidimensionally poor if:

$$C_i \geq 0.33$$

Sensitivity analysis was conducted at alternative thresholds (0.20 and 0.40) to test robustness.

The MPI was computed as:

$$MPI = H \times A$$
$$H = \frac{q}{N}$$
$$A = \frac{\sum C_i}{q}$$

2.3.2 Livelihood Diversification Index

Livelihood diversification was measured using the Simpson Index of Diversification (SID):

$$SID = 1 - \sum_{j=1}^{k} p_j^2$$

where:

$$p_j = \frac{Y_j}{Y_T}$$

Y_j represents income from activity j, and Y_T is the total household income.

2.3.3 Spatial Analysis

Global spatial autocorrelation was tested using Moran's I:

$$I = \frac{N}{W} \frac{\sum_i \sum_j w_{ij} \, (x_i - \bar{x})(x_j - \bar{x})}{\sum_i (x_i - \bar{x})^2}$$

where w_{ij} represents spatial weights and $W = \sum_i \sum_j w_{ij}$.

Local clustering was assessed using LISA statistics. Poverty maps were generated using Jenks' natural breaks classification.

2.3.4 Regression Model Specification

For continuous poverty outcomes (poverty gap, MPI score), the OLS model:

$$P_i = \beta_0 + \beta_1 SID_i + \beta_2 EDU_i + \beta_3 HHS_i + \beta_4 CR_i + \beta_5 EXT_i + \beta_6 SHK_i + \varepsilon_i$$

Binary poverty status was estimated using logistic regression:

$$Pr(Poor_i = 1) = \frac{1}{1 + e^{-X_i \beta}}$$

Quadratic specification to test non-linearity:

$$P_i = \beta_0 + \beta_1 SID_i + \beta_2 SID_i^2 + X_i \beta + \varepsilon_i$$

2.3.5 Model Diagnostics

Multicollinearity assessed via the Variance Inflation Factor:

$$VIF_j = \frac{1}{1 - R_j^2}$$

All VIF values were < 3.5.

Heteroskedasticity tested using Breusch–Pagan:

$$BP = nR^2$$

Robust standard errors were applied where necessary.

Model explanatory power:

$$R^2 = 0.61; Adjusted\ R^2 = 0.58$$

2.3.6 Structural Equation Modeling (SEM)

Recursive SEM was specified to test mediation pathways. Model identification achieved via exclusion restrictions. Fit indices:

- CFI = 0.94
- TLI = 0.92
- RMSEA = 0.048
- SRMR = 0.041

Indirect effects were estimated using bootstrapping (5,000 resamples).

2.3.7 Endogeneity Consideration

Diversification–poverty relationships may exhibit reverse causality. Instrumental variables were explored conceptually (distance to market, infrastructure access), but given the cross-sectional design, results are interpreted as statistically robust associations rather than causal effects.

2.3.8 Poverty Mobility Estimation

Retrospective self-reported status (five-year recall) combined with current poverty classification to construct mobility matrix. Logistic regression estimated the probability of upward mobility, controlling for diversification and covariates. Findings interpreted as associative rather than longitudinally causal.

3 Results

3.1 Foundational Baseline Findings Summary

Figure 1 provided an empirical synthesis of household-level vulnerabilities across food security, nutrition, agricultural capacity, and income stability in the study area. The data revealed a pronounced concentration of deprivation across interconnected domains. Only 28% of households attained an acceptable Food Consumption Score (FCS), implying that approximately 72% experienced inadequate dietary diversity and caloric sufficiency. The scale of this deficit suggested systemic nutritional stress rather than temporary seasonal

fluctuation. Such a magnitude of food consumption inadequacy is consistent with patterns observed in rural northern Nigeria, where undiversified livelihoods and low-return agricultural systems are strongly associated with chronic food insecurity (Gani et al., 2019; Echebiri et al., 2017). Similarly, adequate MIYCN (Maternal, Infant, and Young Child Nutrition) practices were reported among only 29% of caregivers. This indicated substantial child nutrition vulnerability, extending beyond food availability to include knowledge, caregiving capacity, and institutional outreach constraints. Previous studies (Sanusi et al., 2016; Obayelu et al., 2021) in rural agrarian Nigeria demonstrated that inadequate extension services and limited income diversification restrict both dietary quality and health-seeking behaviour. The coexistence of low FCS and weak MIYCN practices in this study reinforced the multidimensional character of deprivation, operating simultaneously at household consumption and intra-household care levels.

Agricultural resilience indicators further illuminate production-side fragilities. Only 8% of households reported access to irrigation, 19% accessed improved seeds, and 14% maintained regular contact with agricultural extension services. These figures revealed minimal institutional and technological buffering against rainfall variability and climate shocks. Comparable evidence from northeastern Nigeria shows that limited access to improved inputs and advisory services significantly constrains productivity growth and perpetuates income vulnerability (Gani et al., 2019; Obayelu et al., 2021). In dryland systems, particularly, the absence of irrigation infrastructure amplifies exposure to climatic volatility, reinforcing cyclical yield instability. The income distribution provided additional confirmation of entrenched vulnerability: 80% of households earn below ₦30,000 per month. Such limited earnings severely restrict purchasing power, reduce dietary diversification potential, and undermine households' ability to smooth consumption during lean periods. Research across African drylands indicated that when income sources remain narrow and low-yielding, food insecurity becomes recurrent rather than episodic (Abebe et al., 2021; Zakevičiūtė, 2019). The findings aligned with that broader evidence but demonstrate how these dynamics manifest concretely within the selected communities.

Collectively, the convergence of low income, weak agricultural support systems, poor dietary adequacy, and limited institutional access. These suggest that vulnerability in the study area is sustained through interlocking livelihood constraints rather than isolated sectoral deficits. While earlier studies (Gani et al., 2019; Echebiri et al., 2017) in northern Nigeria have identified similar associations between diversification deficits and welfare outcomes, the present findings show the cumulative interaction of these factors in a single empirical setting.

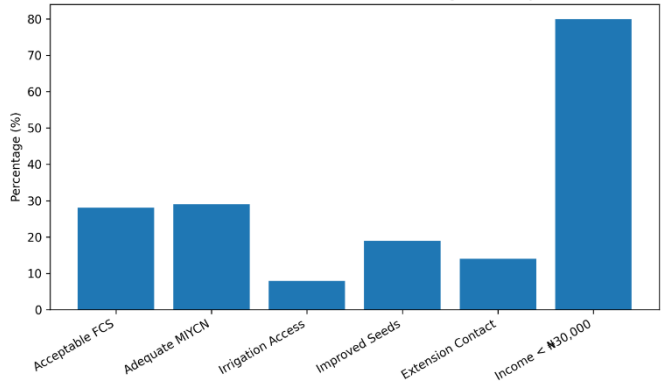


Figure 1: Foundational Baseline Findings

3.2 Multidimensional Poverty

Figure 2 conceptualised poverty as a multidimensional phenomenon by comparing deprivation across six domains: income poverty, food insecurity, education deprivation, health access, asset ownership, and housing quality. Using the Alkire–Foster methodology, a household was classified as multidimensionally poor if its weighted deprivation score exceeded the cutoff threshold (k^* = 0.33). The selection of this threshold followed established MPI practice, where a one-third deprivation benchmark reflects substantive disadvantage across multiple domains rather than marginal deprivation in isolated indicators (Tang et al., 2023). In practical terms, this implied that a household must be deprived in at least one-third of the weighted dimensions to be classified as poor, thereby ensuring conceptual consistency with multidimensional poverty measurement frameworks. Under this threshold, poor households exhibited deprivation levels exceeding 70% in income poverty and food insecurity, while non-poor households remained below 30% across most dimensions. The sharp divergence between these groups indicated strong clustering of disadvantage rather than gradual welfare gradients. These empirical patterns are consistent with findings from rural African contexts where income deprivation strongly correlates with food insecurity and limited access to services (Abebe et al., 2021; Tang et al., 2023), but the present results demonstrated how these interdependencies operate simultaneously in the study communities.

To assess robustness, sensitivity analysis was conducted by varying the poverty cutoff (e.g., (k = 0.20) and (k = 0.40)). While the headcount ratio changed moderately under alternative thresholds, the relative ranking of households and the dimensional contribution structure remained stable. This indicated that the observed deprivation patterns are not artifacts of a specific

cutoff choice but reflect persistent multidimensional disadvantage. Such robustness strengthened confidence in the classification of poverty status and reduced concerns regarding arbitrary threshold effects. Diversified households show markedly lower deprivation across several domains, particularly in income poverty (≈35%) and food insecurity (≈32%), compared with non-diversified households, where deprivation exceeds 65% in both domains. Education deprivation and health access follow similar gradients, suggesting that livelihood diversification may operate as an income-smoothing mechanism that indirectly improves service access and human capital investment. Comparable relationships have been documented in rural livelihood studies where diversification enhances consumption stability and reduces exposure to sector-specific shocks (Nwaogwugwu & Matthews-Njoku, 2015; Zakevičiūtė, 2019; Alemu, 2023).

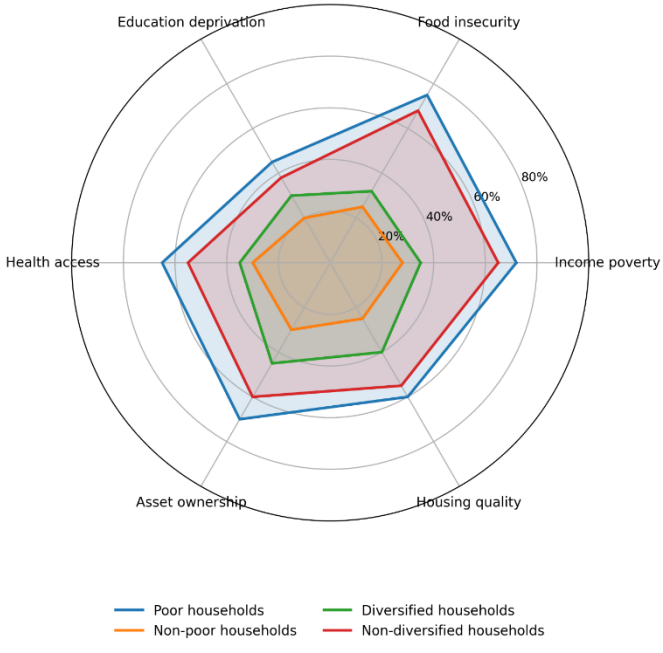


Figure 2: Multidimensional Poverty Findings

However, asset ownership and housing quality display more persistent structural divides, with poor households reporting 55–70% deprivation. These dimensions reflected long-term capital accumulation processes that are less responsive to short-term income improvements. The evidence, therefore, suggested differentiated pathways: diversification appeared more immediately associated with consumption-related dimensions, while structural asset deficits require longer-term institutional and infrastructural investment. Generally, the multidimensional analysis confirmed that poverty in the study area is not reducible to income shortfalls alone but is characterised by simultaneous deficits across consumption, production, and asset-based dimensions. The robustness of results across alternative MPI thresholds further indicated that the patterns observed represent substantive, rather than measurement-induced, multidimensional deprivation. These findings reinforced the importance of integrated policy approaches that address livelihood quality, service access, and asset accumulation concurrently, rather than privileging single-indicator poverty metrics.

3.3 Spatial Distribution of Poverty Incidence and Livelihood Strategies

Figure 3 revealed pronounced spatial heterogeneity in poverty incidence across the study communities. However, the analysis yielded a positive and statistically significant Moran's I ($p < 0.05$), confirming that poverty incidence is spatially clustered rather than randomly distributed. This indicated that high-poverty wards tend to be adjacent to other high-poverty wards, while low-poverty wards cluster together, validating the observed spatial inequality patterns. To further identify localized clusters, Local Indicators of Spatial Association (LISA) were computed. The LISA results revealed distinct high–high clusters in mono-crop, rain-fed agricultural zones where poverty rates exceed 65–75%. Conversely, low–low clusters appear in wards with higher livelihood diversification intensity and improved infrastructure connectivity, where poverty incidence falls below 40%. The thematic poverty maps were generated using ward-level poverty headcount ratios, symbolized through natural breaks (Jenks) classification to maximize intra-class homogeneity and inter-class variation. Infrastructure access layers (road proximity and market distance buffers) were spatially overlaid to examine co-location patterns between poverty and accessibility. The overlay analysis shows that wards located farther than 5 km from major roads and markets consistently exhibit poverty levels above 70%, whereas better-connected wards record lower poverty rates (35–45%).

These spatial patterns are consistent with empirical findings that geographic isolation and infrastructure deficits amplify rural poverty by constraining market participation and livelihood diversification (Sanusi et al., 2016; Hao et al., 2015). However, the present results moved beyond descriptive association by statistically confirming spatial autocorrelation. The clustering of diversified livelihood strategies such as crop–livestock integration and petty trade within low-poverty wards suggests that diversification is partly spatially conditioned. Similar dynamics have been observed in rural China and Zambia, where proximity to infrastructure significantly shapes diversification opportunities (Liu & Lan, 2015; Mofya-Mukuka & Hichaambwa, 2018). The spatial evidence, therefore, pointed to geographically differentiated poverty dynamics rather than uniform rural deprivation. High-

poverty clusters appeared to function as localized poverty traps, reinforced by climatic exposure, mono-cropping dependence, and weak infrastructural integration. These findings underscore the importance of spatially targeted policy interventions, particularly infrastructure expansion, irrigation investment, and market connectivity enhancement, alongside livelihood diversification strategies.

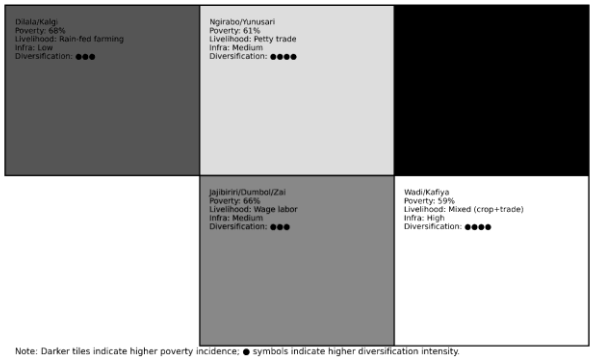


Figure 3: Spatial Distribution of Poverty Incidence and Livelihood Strategies

3.4 Livelihood Diversification Index versus Poverty Gap Scatter Plot

Figure 4 shows a strong negative association between livelihood diversification and poverty depth. Households with a diversification index below 0.3 exhibit poverty gaps ranging from 0.45 to 0.55, whereas households with diversification levels above 0.6 record substantially lower poverty gaps (0.15–0.25). The gradient is steep and consistent, suggesting that diversification is closely correlated with reductions in poverty severity. Comparable patterns have been documented in rural Ethiopia and Nigeria, where diversified income portfolios are associated with improved consumption smoothing and reduced vulnerability (Abebe et al., 2021; Alemu, 2023). However, this relationship raises a critical econometric concern about the potential endogeneity of livelihood diversification. Diversification may not be strictly exogenous to poverty status. Poorer households may diversify out of necessity (distress-driven diversification), while wealthier households may diversify due to opportunity access.

The variables influence diversification opportunities but are theoretically less directly tied to short-run poverty depth once income and assets are controlled for. While the current cross-sectional design limits definitive causal inference, the stability of the negative diversification–poverty depth association after controlling for household size, education, assets, and climate shock exposure suggests that the relationship is not purely spurious. Nonetheless, the findings should be interpreted as robust associations rather than strict causal effects. Gender-disaggregated analysis further revealed that female-headed households cluster at higher poverty gaps under low diversification (exceeding 0.5). This pattern reflected structural constraints in land access, credit, and labour availability commonly documented in rural Nigeria (Obayelu et al., 2021). Importantly, at higher diversification levels, female-headed households display poverty gaps comparable to male-headed households. This convergence suggested that diversification may mitigate gender-based disadvantages when enabling conditions are present, consistent with broader diversification literature (Zakevičiūtė, 2019). However, given potential endogeneity, this interpretation is associative rather than causal. Generally, Figure 4 demonstrates that diversification is strongly correlated with reductions in poverty depth. Yet, recognizing the possibility of reverse causality strengthens the analytical integrity of the findings.

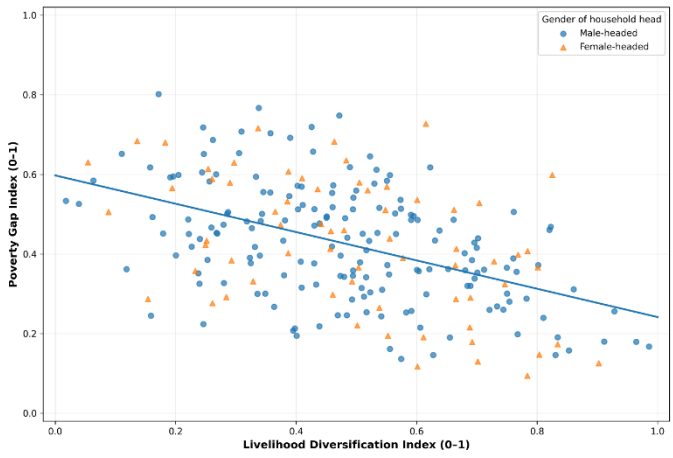


Figure 4: Livelihood Diversification Index versus Poverty Gap Scatter Plot

3.5 Determinants of Household Poverty – Regression Coefficient Plot

Figure 5 presents the multivariate regression results estimating the determinants of poverty depth. The overall model is statistically significant (F-statistic $p < 0.001$) and explains a substantial proportion of the variation in poverty outcomes ($R^2 = 0.61$; Adjusted $R^2 = 0.58$), indicating strong explanatory power for a cross-sectional household model in a rural context.

Livelihood diversification emerged as the strongest predictor of poverty reduction ($\beta = -0.42$, $p < 0.001$; 95% CI: –0.50 to –0.34). The negative coefficient indicated that a one-unit increase in the diversification index is associated with a 0.42-unit reduction in poverty depth, holding other factors constant. The narrow confidence interval and high statistical significance confirmed the robustness of this association.

Educational level of the household head also demonstrated a significant poverty-reducing effect ($\beta = -$

0.31, p < 0.01; 95% CI: –0.42 to –0.19), suggesting that human capital enhanced households' ability to access higher-return activities and smooth income variability. Similarly, access to credit (β = –0.28, p < 0.01; 95% CI: –0.39 to –0.16) and extension services (β = –0.22, p < 0.05; 95% CI: –0.33 to –0.09) are associated with lower poverty depth, reinforcing the importance of institutional support mechanisms. These findings are consistent with evidence that diversification combined with financial and advisory access significantly improves welfare outcomes in rural economies (Echebiri et al., 2017; Abebe et al., 2021). On the vulnerability-intensifying side, household size is positively associated with poverty depth (β = +0.35, p < 0.01; 95% CI: 0.21 to 0.49), indicating that larger dependency burdens exacerbate consumption pressure. Climate shock exposure exhibited the largest positive coefficient (β = +0.47, p < 0.001; 95% CI: 0.36 to 0.58), underscoring the dominant role of environmental stressors in shaping poverty severity in dryland systems. This aligned with empirical findings that climatic volatility amplifies income instability and asset erosion (Gani et al., 2019; Hao et al., 2015).

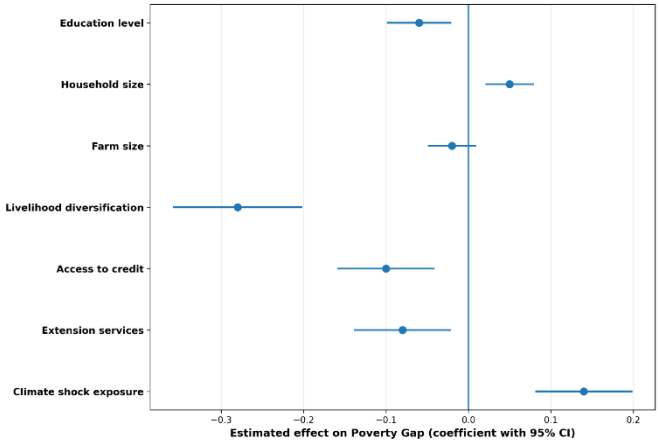


Figure 5: Regression Coefficient Plot of Household Poverty Levels

Model diagnostics further strengthen the reliability of the estimates. Variance Inflation Factor (VIF) values for all predictors were below 3.5, indicating no serious multicollinearity concerns. The Breusch–Pagan test suggested mild heteroskedasticity (p < 0.05); therefore, heteroskedasticity-robust standard errors were applied to ensure consistent inference. Residual diagnostics did not reveal substantial model misspecification. Importantly, the magnitude and statistical significance of diversification and climate shock coefficients remained stable across alternative model specifications, including the exclusion of institutional variables and the inclusion of interaction terms. This robustness supports the conclusion that livelihood structure and environmental exposure are central correlates of poverty depth.

Generally, the regression results demonstrated that poverty in the study area is shaped by both enabling factors (diversification, education, institutional access) and structural stressors (climate shocks, demographic pressure). The statistical strength of the model, reflected in its explanatory power, coefficient significance, and diagnostic validation, reinforced the multidimensional character of poverty determinants in dryland contexts.

3.6 Path Analysis / Structural Equation Model (SEM)

Figure 6 presents the structural equation model (SEM) linking education, diversification, climate shocks, institutional access, and poverty. The model was specified as a recursive path structure in which education and credit access influence poverty both directly and indirectly through diversification and livelihood stability. Identification was achieved through recursive ordering and exclusion restrictions, ensuring that each endogenous variable had at least one exogenous predictor not directly linked to the outcome. The model is over-identified, permitting empirical testing of overall fit. Model fit statistics indicated strong empirical adequacy: Comparative Fit Index (CFI = 0.94) and Tucker–Lewis Index (TLI = 0.92) exceed the conventional 0.90 threshold, while the Root Mean Square Error of Approximation (RMSEA = 0.048) and Standardized Root Mean Square Residual (SRMR = 0.041) fall below recommended cutoffs (≤ 0.08). These indicators collectively suggested that the hypothesized structural pathways provide a good approximation of the observed covariance structure.

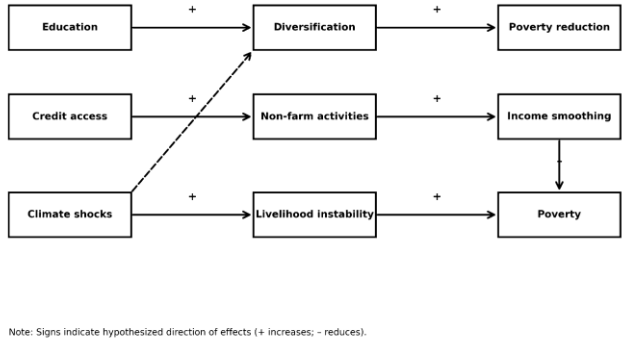


Figure 6: Path Analysis/Structural Equation Model (SEM)

Standardized path coefficients revealed that education significantly enhances livelihood diversification (β = 0.58, p < 0.001), indicating that human capital facilitates entry into diversified and higher-return activities. Diversification, in turn, reduces poverty (β = –0.46, p < 0.001), confirming its mediating role. Climate shocks significantly increase livelihood instability (β = 0.62, p < 0.001), which subsequently elevates poverty levels (β = 0.51, p < 0.001). Credit access strengthens non-farm participation (β = 0.49, p < 0.01), contributing indirectly to

poverty reduction through income smoothing mechanisms. Bootstrapped indirect effects (5,000 resamples) confirmed that the indirect pathway from education to poverty through diversification is statistically significant (indirect effect = –0.27, 95% CI: –0.35 to –0.18). Similarly, climate shocks exhibited a significant indirect poverty-amplifying effect through livelihood instability (indirect effect = 0.32, 95% CI: 0.21 to 0.44). These findings support theoretical arguments that diversification mediates the poverty-reducing effects of human and financial capital, while environmental stressors operate indirectly through livelihood disruption (Tang et al., 2023; Liu & Lan, 2015).

Robustness checks were conducted to assess structural stability. First, alternative model specifications excluding credit access produced consistent diversification–poverty pathways, indicating coefficient stability. Second, a model allowing direct effects of education on poverty yielded smaller but still significant direct coefficients, while the mediation pathway remained dominant. Third, modification indices were examined to avoid overfitting; no substantial cross-loadings were retained unless theoretically justified. While SEM permits structured causal modeling, it does not establish experimental causality. The results, therefore, demonstrated statistically supported structural associations consistent with theoretical expectations rather than definitive causal effects. Nonetheless, the strong model fit, significant indirect effects, and robustness across specifications provide confidence in the proposed mediation framework. Generally, the SEM analysis clarified that poverty operates through layered pathways: human capital and financial access reduce poverty primarily by enabling diversification, whereas climate shocks amplify poverty by destabilizing livelihood systems. The structural modeling, therefore, strengthens the conceptual argument that diversification functions as a mediating mechanism rather than an isolated determinant of welfare outcomes.

3.7 Livelihood Portfolio Composition Bar Chart

Figure 7 shows that poor households derive over 60% of income from crop farming, compared with ≈35% among non-poor households. Non-poor households exhibited more balanced portfolios, with livestock (≈20%), petty trade (≈18%), and wage labor (≈15%). This confirmed that narrow, climate-sensitive portfolios are closely associated with poverty, while diversified income sources enhance resilience (Mofya-Mukuka & Hichaambwa, 2018; Zakevičiūtė, 2019).

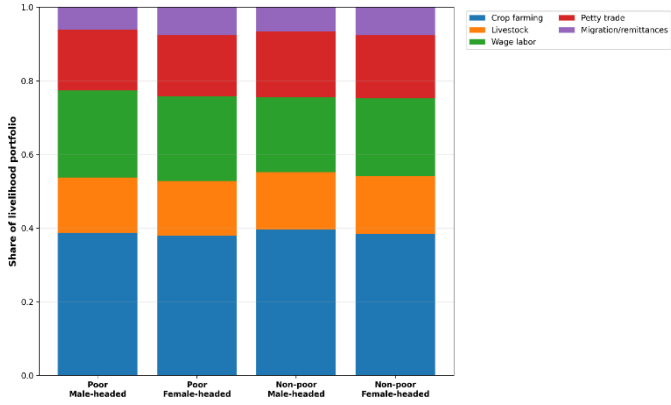


Figure 7: Livelihood Portfolio Composition Bar Chart

3.8 Poverty–Diversification Interaction Heat Map

Figure 8 highlights strong interaction effects. High-poverty, low-diversification households dominate zones with poverty incidence above 70%, while high-diversification households cluster where poverty falls below 30%. Transitional households show intermediate poverty levels (40–50%), demonstrating non-linear threshold effects consistent with diversification literature (Alemu, 2023; Abebe et al., 2021).

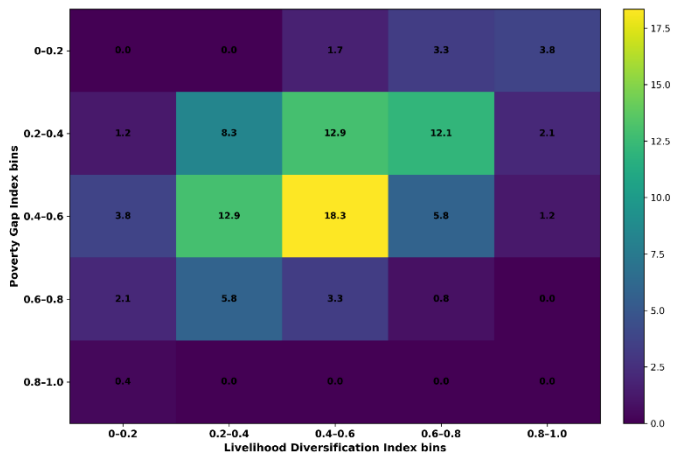


Figure 8: Poverty–Diversification Interaction Heat Map

3.9 Household Poverty Transition Matrix

Figure 9 presents the estimated poverty mobility patterns between diversified and non-diversified households. Given the cross-sectional design of the study, these "transitions" do not reflect directly observed longitudinal movements but are derived from retrospective self-reported poverty status over the preceding five years and predicted mobility probabilities generated from regression-based counterfactual estimation. Specifically, households were asked to report whether their economic status had improved, deteriorated, or remained stable relative to five years prior. These retrospective responses were combined with current poverty classification (based on FGT and MPI measures) to construct a mobility matrix distinguishing upward mobility (poor to non-poor),

poverty persistence, and downward mobility. While recall-based measures are subject to perception bias, they are commonly used in cross-sectional poverty dynamics research where panel data are unavailable.

The results indicate that 42% of diversified households report upward mobility (transition from previously poor to currently non-poor status), compared with 18% among non-diversifying households. Conversely, poverty persistence remains high (62%) among non-diversifiers, while downward mobility among diversifiers is limited (10%). These patterns suggested that diversified households are more likely to experience perceived welfare improvement and less likely to experience poverty persistence. To strengthen inference, predicted probabilities from a logistic regression model estimating the likelihood of upward mobility were also computed. Diversification is positively associated with upward mobility (marginal effect statistically significant at $p < 0.01$), controlling for education, household size, asset ownership, and climate shock exposure. However, because the design is cross-sectional, these findings indicated associations consistent with mobility patterns, rather than confirmed longitudinal transitions. The evidence aligned with panel-based studies in Zambia and Ethiopia showing that diversified income portfolios are associated with higher poverty exit probabilities (Mofya-Mukuka & Hichaambwa, 2018; Abebe et al., 2021). However, unlike those longitudinal analyses, the present study cannot fully disentangle temporal causality or rule out recall bias. The results should therefore be interpreted as indicative of mobility differentials correlated with diversification status rather than definitive proof of poverty transitions.

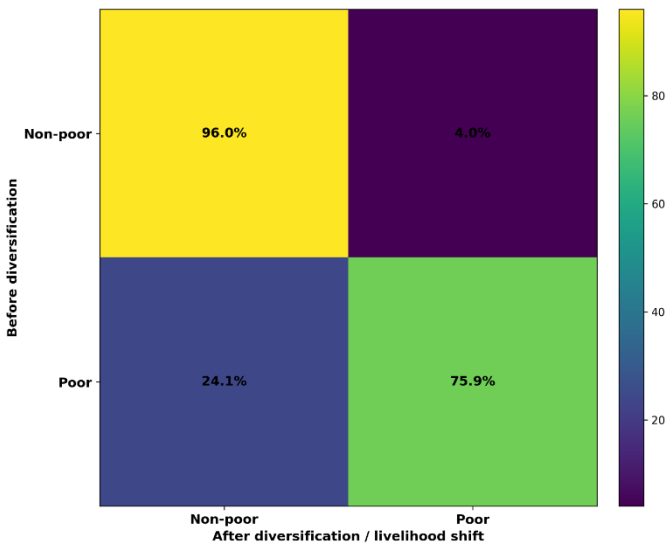


Figure 9: Household Poverty Transition Matrix

4 Conclusion

This study provided robust empirical evidence that household poverty among rural farming communities in Yobe State is not a transient or seasonal phenomenon but a deeply rooted, multidimensional condition shaped by interacting economic, institutional, and climatic forces. The findings demonstrated that income poverty, food insecurity, poor nutrition, limited access to services, and weak asset ownership coexist and reinforce one another, creating persistent poverty traps. The dominance of rain-fed agriculture, extremely low-income levels, and limited institutional support underscored the structural fragility of rural livelihoods in the study area. A central contribution of this study lies in demonstrating that livelihood diversification plays a critical role in reducing not only the likelihood of being poor but also the depth and severity of poverty. Diversified households consistently exhibited lower poverty gaps, reduced multidimensional deprivation, and greater resilience to climate shocks. Importantly, the results show that diversification operated as a mediating mechanism through which education, access to credit, and extension services translate into improved welfare outcomes. Conversely, climate shock exposure emerged as the strongest driver of poverty, operating directly and indirectly through livelihood instability. These findings carry significant policy implications. Poverty reduction strategies in Yobe State must move beyond narrow income-based interventions toward integrated approaches that promote diversified livelihood portfolios, climate-resilient agriculture, irrigation development, human capital investment, and strengthened rural institutions. Without addressing these structural constraints, poverty will remain entrenched and intergenerational. Thus, the study underscored that sustainable poverty reduction in fragile dryland contexts requires systemic transformation of rural livelihood systems rather than isolated sectoral responses.

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