

EXTENT AND CAUSES OF LIVELIHOOD DIVERSIFICATION BY INTEGRATED CROP-LIVESTOCK FARMING HOUSEHOLDS IN NORTH-WEST, NIGERIA

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ABSTRACT

This study investigates the extent and determinants of livelihood diversification among integrated crop-livestock farming households in North-West Nigeria. The study aimed at assessing the integrated crop-livestock farming practices and analyse the factors influencing the livelihood activities of the farmers in the study area. The study used a multistage sampling procedure consisting of 3 states, 3 agricultural zones, 21 LGAs and 84 villages. Data were collected from 405 respondents through structured questionnaires and analysed using descriptive statistics, the Simpson Diversification Index (SDI) and Tobit regression. Findings revealed a moderate level of livelihood diversification, with an average SDI of 0.58. Farmers engaged in diverse on-farm, off-farm, and non-farm income-generating activities, with on-farm income accounting for 66.66% of the total annual household income, followed by non-farm (23.57%) and off-farm (9.77%) sources. Tobit regression results showed that household size, gender of the household head, and access to credit were significant at the 5% level, respectively while education level and income from various sources were significant at the 1% level, all positively influencing livelihood diversification. Conversely, farm size had a negative and significant relationship, suggesting that larger farms often reduce the likelihood of engaging in alternative livelihood strategies. The study concludes that diversification is a critical strategy for income stability and risk management among smallholders. It recommends enhancing access to credit, promoting rural farmer education and improving rural infrastructure to sustain and expand livelihood diversification.

Key words: crop-livestock systems, integrated farming, livelihood diversification, non-farm/off-farm activities

INTRODUCTION

Agriculture remains a key sector in Nigeria's economy, employing a large share of the labour force and serving as the main source of livelihood for rural households (FAO, 2022; World Bank, 2023). Although its contribution to Gross Domestic Product (GDP) has declined from about 40% in the 1960s to around 25.5% in recent years, it continues to play an important role in ensuring food security, employment and income generation (World Bank, 2023). The sector is largely dominated by smallholder farmers who cultivate relatively small landholdings and contribute substantially to domestic food production (Lowder *et al.*, 2016; NBS, 2023). In addition, livestock production forms an integral part of rural livelihoods, providing income, food and a form of financial security for many households (FAO, 2022).

In North-West Nigeria, where agriculture is the mainstay of the rural economy, many households engage in both crop and livestock production as part of their livelihood strategies. Integrated crop-livestock farming, which involves the use of crop residues as animal feed and the application of livestock manure to improve soil fertility, is commonly practiced to varying degrees across the region. This

system has the potential to improve resource use efficiency, enhance resilience to climate variability and support income diversification (Herrero *et al.*, 2010; Makate *et al.*, 2019). However, despite its presence, the extent of livelihood diversification among farming households remains uneven. A significant number of farmers still rely heavily on single sources of income, making them vulnerable to climate shocks, price fluctuations and production risks.

This situation is further compounded by persistent rural poverty and structural challenges in the agricultural sector. A substantial proportion of Nigeria's population continues to live below the poverty line, with rural areas experiencing higher levels of poverty and vulnerability than urban areas (World Bank, 2022, 2023). Although several government interventions, such as the National Agricultural Technology and Innovation Policy (NATIP), the Anchor Borrowers' Programme (ABP) and the Nigeria COVID-19 Action Recovery and Economic Stimulus (NG-CARES) programme, have been introduced to improve agricultural productivity and rural livelihoods, their impacts among many smallholder farmers have remained limited due to implementation challenges and unequal access to programme

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benefits (FMARD, 2022; World Bank, 2023). Consequently, many farming households continue to face constraints such as limited access to credit, land fragmentation, inadequate extension services, and market imperfections, which hinder their ability to diversify and improve their livelihoods.

Livelihood diversification, which involves engaging in multiple income-generating activities, has been identified as an important strategy for reducing risk and enhancing household welfare (Scoones, 2015). A sustainable livelihood is one that can cope with and recover from shocks while maintaining or improving its asset base (Chambers and Conway, 1992). Empirical studies have shown that factors such as education, access to credit, farm size, household characteristics and institutional support significantly influence livelihood choices among rural farmers (Tesfaye and Tirivayi, 2020). Environmental conditions, including climate variability and natural resource availability, also play an important role in shaping livelihood strategies and adaptation decisions among rural households (Below *et al.*, 2012; Lavik *et al.*, 2020). Despite these insights, there remains limited empirical evidence on the extent of livelihood diversification and the key factors driving it among integrated crop-livestock farming households in North-West Nigeria.

Against this background, this study seeks to examine the extent and determinants of livelihood diversification among integrated crop-livestock farming households in the North-West geopolitical zone of Nigeria. The specific aims of the study are to (i) identify the pattern of integrated crop-livestock farmers' livelihood activities, (ii) assess the level of livelihood diversification among integrated farming households, and (iii) determine the socio-economic and institutional factors influencing their livelihood diversification decisions.

LITERATURE REVIEW

Conceptual Review

The concept of integrated crop-livestock farming has received increasing attention in recent years because of its potential to promote sustainable agricultural practices and improve rural livelihoods. Integrated crop-livestock farming (ICLF) involves the deliberate integration of crop and animal production within the same farming system, thereby facilitating efficient resource utilisation and nutrient recycling. In this system, crop residues serve as livestock feed, while livestock manure is returned to agricultural fields to improve soil fertility, thereby reducing waste and dependence on external inputs (Herrero *et al.*, 2010; Martin *et al.*, 2016). Evidence from Nigeria also suggests that household socioeconomic characteristics and access to productive resources significantly influence agricultural productivity and food security outcomes among farming households (Onasanya and Obayelu, 2016).

This approach is widely recognised as a climate-smart agricultural strategy because of its ability to improve food security while reducing environmental degradation and enhancing resource-use efficiency (Makate *et al.*, 2019; FAO, 2022). Evidence from sub-Saharan Africa indicates that farmers who adopt integrated farming systems tend to be more resilient because diversified production activities provide multiple income sources and reduce vulnerability to climate-related shocks (Tesfaye *et al.*, 2021). However, the adoption of such systems in Nigeria remains constrained by limited access to finance, inadequate institutional support, and information barriers among smallholder farmers (Fadeyi *et al.*, 2022; Falola *et al.*, 2022). Similarly, access to financial support mechanisms and risk-reducing institutions has been shown to play an important role in encouraging technology adoption and farm investment among rural farmers (Fadeyi *et al.*, 2022; Falola *et al.*, 2022).

Closely related to this is the concept of livelihood, which refers to the means through which individuals and households secure their basic needs such as food, shelter, and income. A livelihood comprises the capabilities, assets, and activities required for a means of living, and it is considered sustainable when it can withstand shocks without degrading natural resources (Chambers and Conway, 1992). In rural areas, livelihood activities typically include crop production, livestock rearing, trading, wage employment, and other off-farm activities (Babatunde and Qaim, 2010).

To cope with uncertainties such as climate variability and economic instability, many rural households adopt livelihood diversification strategies. Livelihood diversification involves engaging in multiple income-generating activities within and outside agriculture to reduce risk and improve household welfare and income stability (Loison, 2015). It encompasses agricultural intensification, mixed farming, off-farm employment, and rural entrepreneurship. Empirical evidence from sub-Saharan Africa indicates that livelihood diversification contributes to household resilience and helps reduce vulnerability to climatic and economic shocks among rural households (Asfaw and Maggio, 2018; Knippenberg *et al.*, 2019).

In North-West Nigeria, many rural households already combine crop and livestock production as part of their livelihood strategies, although the level of integration and diversification varies across farmers. Recent evidence shows that integrated farming systems are widely practiced in states such as Kano, Kaduna and Katsina, where they contribute significantly to income generation and livelihood improvement (Sulaiman *et al.*, 2025). However, a substantial proportion of farmers still operate at sub-optimal levels of integration, limiting the full benefits in terms of income stability and resilience (Sulaiman *et al.*, 2021). This suggests that while

crop-livestock integration exists in the study area, its effectiveness in stabilising income depends on the extent of adoption and resource utilisation.

Within this context, smallholder farmers, who typically operate relatively small landholdings and depend largely on family labour, play a crucial role in food production and rural development in developing countries (Lowder *et al.*, 2021). Despite their importance, they often face significant challenges, including limited access to markets, agricultural inputs, financial services, and improved technologies. Consequently, the adoption of sustainable and integrated farming practices has become increasingly important for enhancing resilience, improving productivity, and promoting sustainable livelihoods among rural households (Nwobodo *et al.*, 2022).

Empirical review

Several empirical studies have examined the factors influencing farmers' livelihood activities within integrated crop-livestock systems (ICLS), particularly in developing regions like sub-Saharan Africa.

In a study conducted in Ethiopia, Admasu *et al.* (2022) found that household size, education level, and access to productive assets significantly influenced livelihood diversification among rural households. Larger households were more likely to engage in multiple livelihood activities to meet increasing consumption needs and improve household welfare. Similarly, education enhanced households' capacity to access information, adopt improved farming practices, and diversify income sources.

Likewise, Musumba *et al.* (2022) reported that livelihood diversification among rural households in Africa is strongly associated with human capital, access to productive resources, and institutional support. The study emphasised that education and access to information facilitate the adoption of improved agricultural practices and contribute to greater income diversification and household resilience among smallholder farmers.

Recent reviews indicate that integrated crop-livestock systems enhance resource-use efficiency, improve food security, strengthen household resilience, and promote sustainable livelihoods among smallholder farmers in developing countries. Livestock assets provide income, manure, and insurance against shocks, while crop enterprises contribute food and feed resources, making integrated systems an important strategy for rural livelihood improvement (Sekaran *et al.*, 2021; Mabhaudhi *et al.*, 2023).

Evidence from developing countries indicates that access to credit and agricultural advisory services significantly influence the adoption of improved agricultural technologies and climate-smart practices among smallholder farmers. Access to financial services enables farmers to invest in productive technologies, while extension services facilitate information dissemination and improve the adoption of improved farming practices (Omotoso *et al.*, 2023). Despite the potential benefits of integrated and

sustainable farming systems, institutional constraints such as inadequate extension support, poor rural infrastructure, limited market access, and climate variability continue to hinder agricultural productivity and livelihood improvement among rural households in Nigeria (Amankwah, 2023).

METHODOLOGY

Research Design

This study employed a cross-sectional survey design to examine the factors influencing livelihood activities among integrated crop-livestock farming households in North-West Nigeria. The design was deemed appropriate because it facilitates the collection of data from a large and geographically dispersed population at a single point in time. It enables the assessment of existing farming practices, socio-economic characteristics, and livelihood outcomes while capturing their natural variation across households. Cross-sectional surveys are particularly useful for describing populations and examining relationships among variables within a specified period (Creswell and Creswell, 2018; Saunders *et al.*, 2019).

The Study Area

Nigeria is located in the tropical region of West Africa, extending approximately between latitudes 4°N and 14°N and longitudes 3°E and 15°E, with a total land area of about 923,768 km². Administratively, the country is divided into six geopolitical zones, 36 states and the Federal Capital Territory (National Population Commission, 2023). This study was conducted in the North-West geo-political zone, which comprises seven states; Jigawa, Kaduna, Kano, Katsina, Kebbi, Sokoto, and Zamfara. The zone is the most populous geopolitical region in Nigeria and is predominantly rural, with agriculture serving as the principal economic activity and major source of livelihood for the majority of households (National Population Commission, 2023).

The North-West zone experiences a tropical continental climate characterised by distinct wet and dry seasons. Annual rainfall ranges from ca. 600 mm in the northern areas to about 1,000 mm in the southern parts, with the rainy season occurring between May and October and the dry season from November to April (Nigerian Meteorological Agency, 2024). Ecologically, the region lies mainly within the Sudan Savannah vegetation zone, although parts of southern Kaduna State fall within the Northern Guinea Savannah belt (Federal Ministry of Environment, 2020). The vegetation supports both crop and livestock production, which constitute the dominant livelihood activities in the region. Major crops cultivated include maize, millet, sorghum, rice, cowpea, wheat, and cotton, while livestock production involving cattle, sheep, goats, and poultry is also widespread. Consequently, integrated crop-livestock farming systems are commonly practiced and form an important component of rural livelihood strategies in the North-West zone.

Data Collection and Sampling Procedure

This study utilised primary data collection through structured questionnaires and interview schedules administered to crop-livestock farmers in the study area. A multi-stage sampling technique was used to select respondents, following a systematic approach. In the first stage, three states, Kaduna, Kano and Katsina were purposively selected from North-West zone based on their contiguous borders, similar agro-ecological conditions, and prevalent crop-livestock production systems. In the second stage, within these states, specific agricultural zones, Kaduna North, Kano South, and Katsina South were purposively selected for their comparable farming characteristics. In the third stage, seven local government areas (LGAs) were randomly selected from each state; Kubau, Kudan, Lere, Makarfi, Soba, Sabon-Gari and Zaria (Kaduna State); Bebeji, Doguwa, Garko, Kibiya, Kiru, Rogo, and Tudun-Wada (Kano State); and Bakori, Dandume, Danja, Funtua, Kafur, Malumfashi, and Sabuwa (Katsina State).

In the fourth stage, 84 villages (four per LGA) were randomly selected, prioritising those with a high prevalence of integrated crop-livestock farming. While in the final stage, from each village, 33% of integrated crop-livestock farmers were randomly sampled, yielding a final sample size of 428 farmers as shown in Appendices 1, 2 and 3. The survey achieved a high response rate of 94.63%, with 405 farmers successfully participating. Using Yamane formula, the sample size is expressed as:

$$n = \frac{N}{1 + N(e)^2} \dots\dots\dots (1);$$

where n is sample size, N is population size, and e is level of precision (5%). The minimum sample size (n) was determined as follows:

$$n = \frac{1296}{1 + 1296(0.05)^2} = \frac{1296}{1297(0.0025)} \\ = \frac{1296}{3.2425} = 399.69, \therefore n = 400.$$

The final sample comprised 168, 121 and 116 crop-livestock farmers from Kaduna, Kano, and Katsina States, respectively.

Analytical Techniques

To achieve the study's objectives, descriptive statistics, the Simpson Diversification Index (SDI), and Tobit regression models were employed.

Descriptive statistics

To address the first and second objectives of the study, which focus on identifying the pattern of integrated crop-livestock farmers' livelihood activities and assessing their level of livelihood diversification, descriptive statistics such as frequency distributions, percentages, means and standard deviations were employed.

Simpson diversification index (SDI)

To address the third objective of determining the socio-economic and institutional factors influencing integrated farming households livelihood diversification decisions, the SDI, adapted from Shiyani and Pandya (1998) and modified by Oladimeji (2018), was employed to quantify the degree of diversification in household income sources. The index is specified as follows:

$$SDI = 1 - \sum_{i=1}^n P_i^2 \dots\dots\dots (2);$$

where SDI is Simpson diversification index, ranging from 0 to 1, n is total number of livelihood activities (income sources) in the study area, and P_i is proportion of income derived from livelihood activity, i . Based on Shiyani and Pandya (1998), the degree of diversification was classified as low, moderate and high diversifications, with SDI values of 0.01-0.38, 0.38-0.63 and above 0.63, respectively.

Tobit regression model was used to assess factors influencing integrated crop-livestock farmers' livelihood activities in the study area. Following Amore and Martinu (2019), Tobit model is defined thus:

$$Y_i^* = \beta X_i + e_i, i = 1, 2, \dots, n \dots\dots\dots (3);$$

$$Y_i = Y_i^* = \begin{cases} Y_i = Y_i^* & \text{if } Y_i^* > 0 \\ Y_i = 0 & \text{if } Y_i^* \leq 0 \end{cases} \dots\dots (4);$$

where e_i is the normally and independently distributed error term with zero mean and constant variance σ^2 ($\epsilon_i | X_i \sim N(0, \sigma^2)$), and Y_i^* represents the latent variable and is generated through traditional linear regression model according to the formula:

$$I_i = \beta' X_i.$$

It is a non-observable when $Y_i^* < 0$; Y_i is the dependent variable while X_i is the independent variable, $i = 1, 2, \dots, n$; β' is a vector of estimable parameters, and $\beta' X_i$ denotes the scalar product of two vectors. For this study, the model was expressed as follows:

$$Y^* = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 \\ + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + e \dots\dots\dots (5);$$

where Y^* is the estimated livelihood diversification index. This was measured by the share of on-farm income (from all activities including crop-livestock integration) in total household heads' income (including on-, off- and non-farm incomes). This takes values from 0.0 to 1.0; X_1 is farm size (ha); X_2 is age of household head (years); X_3 is gender of household head (a binary variable where male = 1, female = 0); X_4 is household size (numbers); X_5 is level of education (years); X_6 is on-farm income (₦); X_7 is off and non-farm income (₦); X_8 is loan obtained (₦); e is error term; β_0 is intercept to be estimated, and $\beta_1 - \beta_8$ are coefficients to be estimated. Tobit regression model was estimated using computer programme software known as STATA 15.

RESULTS AND DISCUSSION

Pattern of Integrated Crop-livestock Farmers' Livelihood Activities

The distribution of on-farm activities among integrated crop-livestock farmers is presented in Table 1. Farmers engaged in multiple agricultural enterprises, the range of 3-6 per household. With a mean 4.62 activities per household and a coefficient of variation of 21.21%, the diversification levels were moderately consistent across the sample. By the frequency distribution, 35.56%, 27.90% and 23.95% of farmers maintained 4, 5 and 6 activities, respectively.

These findings demonstrate that integrated farming systems provide diversified income sources, with even the least diversified farmers (12.59%) participating in three distinct activities, typically combining two crop enterprises (e.g., cereals and legumes) with one livestock enterprise (large ruminants, small ruminants, or poultry). This multi-enterprise approach enhances income stability and reduces farmers' vulnerability to production and market risks compared with specialised farming systems. The findings support recent evidence that farm diversification and integrated agricultural systems improve household resilience, strengthen food security, and enhance livelihood sustainability among smallholder farmers in developing countries (Sekaran *et al.*, 2021; Mabhaudhi *et al.*, 2023).

The observed average of five livelihood activities per farm exceeds the diversification level commonly reported among rural farming households in Nigeria. This relatively high level of enterprise diversification suggests that integrated crop-livestock farmers adopt multiple livelihood activities as a strategy for reducing production and income risks. Such diversification may reflect farmers' responses to climatic variability, market uncertainties, and economic shocks. Similar findings have been reported among Nigerian farming households, where livelihood diversification and the adoption of multiple agricultural enterprises were found to enhance resilience, improve income stability and strengthen household welfare (Baiyegunhi *et al.*, 2022; Omotoso *et al.*, 2023).

The predominance of crop-livestock integration (100% of sampled farms) underscores the importance of mixed farming systems as a major livelihood strategy among rural households. Integrated farming systems provide multiple sources of income and enhance the efficient utilisation of available resources, thereby reducing farmers' exposure to production and income risks. Similar evidence from Nigeria indicates that livelihood diversification and the adoption of multiple agricultural enterprises contribute positively to farmers' welfare and livelihood sustainability (Olawuyi and Olawuyi, 2022; Onuwa *et al.*, 2022). The relatively low coefficient of variation (21.21%) further suggests that diversification patterns are fairly consistent across the study area, possibly reflecting similar agroecological conditions, production environments, and livelihood strategies among farming households.

Distribution of Farmers by Off-Farm Activities

Table 2 shows the distribution of off-farm activities among integrated crop-livestock farmers. Livelihood diversification was large, with 83.70% of respondents participating in at least one off-farm activity, while only 16.30% relied solely on farming operations. This finding suggests that off-farm employment is an important livelihood strategy among rural households, serving to supplement farm income, reducing income risk, and enhancing house-hold welfare. This is a common practice in Nigeria, usually to improve livelihood security and cope with economic and production uncertainties (Onuwa *et al.*, 2022).

Table 1: Distribution of farmers in the study area according to on-farm activities

On-farm activity	No. of activities	F	%	Ranking
3 crops-LR-SR-P Farming	6	97	23.95	1
3 crops-SR-P Farming	5	62	15.31	2
2 crops-SR-P Farming	4	61	15.06	3
2 crops-LR-P Farming	4	38	9.38	4
2 crops-P Farming	3	34	8.40	5
3 crops-P Farming	4	28	6.91	6
3 crops-LR-SR Farming	5	21	5.19	7
3 crops-LR-P Farming	5	19	4.69	8
2 crops-LR-SR Farming	4	13	3.21	9
2 crops-SR Farming	3	11	2.72	10
2 crops-LR-SR-P Farming	5	11	2.72	10
2 crops-LR Farming	3	6	1.48	12
3 crops-LR Farming	4	4	0.99	13
No of Activities:		405	100	
Farmers with 6 on-farm activities		97	23.95	
Farmers with 5 on-farm activities		113	27.90	
Farmers with 4 on-farm activities		144	35.56	
Farmers with 3 on-farm activities		51	12.59	
Total		405	100	
Mean	4.62			
Maximum	6			
Minimum	3			
Coefficient of variation	21.21			

Source: Field Survey (2025). LR - large ruminants, SR - small ruminants, P - poultry

Table 2: Distribution of respondents according to off-farm activities (*n* = 339)

Off-farm activity	F	%	Ranking
Ridging	219	64.60	1
Harrowing	217	64.01	2
Planting	134	39.53	3
Weeding	123	36.28	4
Spraying	81	23.89	5
Harvesting	75	22.12	6
Threshing	18	5.31	7
No of off-farm activities:			
Farmers with 5 off-farm activities	7	1.73	6
Farmers with 4 off-farm activities	46	11.36	4
Farmers with 3 off-farm activities	67	16.54	2
Farmers with 2 off-farm activities	205	50.62	1
Farmers with 1 off-farm activities	14	3.46	5
Farmers with 0 off-farm activities	66	16.30	3
Total	405	100	
Mean	2.06		
Maximum	5		
Minimum	0		
Coef. of variation	31.84		

Source: Field Survey (2025). NB: Multiple responses were allowed during the survey. The two predominant off-farm activities were agricultural labour services namely ridging (engaged in by 64.60% of farmers) and harrowing (64.01%).

On average, farmers participated in two off-farm activities, with 50.62% of respondents falling into this category. This pattern reflects the livelihood diversification strategy whereby smallholder households combine farm and non-farm income sources to reduce production risks, stabilise household consumption, and improve income security. The engagement in multiple livelihood activities is an important risk-management mechanism, enabling households to cope with economic and agricultural uncertainties. Similar observations have been reported in rural Africa, where farm households diversify their income portfolios to reduce vulnerability and enhance livelihood resilience (Barrett, *et al.*, 2001).

The prevalence of agricultural labour exchange, particularly in ridging, harrowing, and planting services, suggests the existence of active local labour markets within the study area. Such labour-sharing arrangements provide additional income opportunities for rural households while simultaneously reducing labour constraints during peak farming periods. These arrangements may therefore serve both as income-support mechanisms and as strategies for managing production risks. Similar evidence from rural farming communities in developing countries indicates that participation in agricultural wage labour and other rural labour markets contributes to livelihood diversification and household resilience (ILO, 2023).

The mean of two off-farm activities per household indicates a relatively high level of livelihood diversification among the sampled households. This finding may reflect the increasing importance of non-farm income opportunities and adaptive livelihood strategies among rural households facing agricultural, climatic, and economic uncertainties. The substantial participation rate (83.70%) further emphasises the critical role of off-farm income in enhancing household resilience and reducing dependence on agricultural production alone. Recent evidence suggests that livelihood diversification and participation in non-farm activities contribute significantly to income stability, risk reduction and rural household resilience in developing countries (IFAD, 2021; FAO, 2023).

Distribution of Respondents according to Non-Farm Activities

The results in Table 3 highlight the diversification of income sources among integrated crop-livestock farmers, showing that most of them engage in non-agricultural activities to supplement their earnings. Specifically, the findings indicate that about 97% of the farmers (96.79%) rely on additional income streams beyond agriculture for their livelihood. This finding shows that participation in non-farm activities enhances household resilience and reduces vulnerability to agricultural and climatic shocks. In Nigeria, non-farm employment can improve farmers' adaptive capacity and strengthen livelihood security among smallholder households (Danso-Abbeam *et al.*, 2021).

Distribution of Respondents according to On-Farm, Off-Farm and Non-Farm Incomes

Table 4 presents the annual income distribution of integrated crop-livestock farming households across three primary sources of incomes namely on-farm, off-farm and non-farm activities.

The results in Table 4 indicate that all the farmers (100%) derived income from on-farm activities, with ca. 45.43% earning above ₦1,000,000 yearly, while a small minority (0.99%) earned ≤ ₦100,000. The average annual on-farm income for farmers in the study area was ₦1,073,439. Furthermore, on-farm income constituted 66.66% of the total annual household income, underscoring its role as the primary livelihood source for most integrated crop-livestock farmers. This finding is consistent with Musumba *et al.* (2022) which indicates that rural households commonly combine crop, livestock and non-farm activities while still relying primarily on agricultural production for their livelihoods.

The findings further revealed that 96.79% of the farmers supplemented their on-farm income with earnings from non-farm activities. A large proportion of respondents (87.76%) generated at least 500,000 yearly from these non-farm sources, with an average annual contribution of ₦379,480 per farmer. Notably, non-farm income constituted 23.57% of the total annual household income, highlighting its significance as a key livelihood diversification strategy among integrated crop-livestock farmers in the study area. This suggests that while agriculture remains the primary income source, non-farm activities play a crucial role in enhancing financial stability for rural households. This finding consists with the work of Loison (2015) who found that livelihood diversification through non-farm employment improves household resilience and strengthens farmers' capacity to cope with production, climatic, and economic shocks.

Table 3: Distribution of respondents according to non-farm activities (*n* = 392)

Non-farm activity	<i>F</i>	%	Ranking
Trading	263	67.09	1
Commercial motorcycle/tricycle rider	92	23.47	2
Civil servant	81	20.66	3
Commercial vehicle driver	62	15.82	4
Tailoring	16	4.08	5
Carpentry	13	3.32	6
Pensioner	12	3.06	7
Butcher/Fisher	11	2.81	8
Mechanic	9	2.30	9
Barbing/hair-weaving	6	1.53	10
No. of non-farm activities:			
Farmers with 3 non-farm activities	9	2.22	4
Farmers with 2 non-farm activities	157	38.77	2
Farmers with 1 non-farm activities	226	55.80	1
Farmers with 0 non-farm activities	13	3.21	3
Total	405	100	
Mean	1.31		
Maximum	3		
Minimum	0		
Coeff. of variation	29.92		

Source: Field Survey (2025)

NB: Multiple responses were allowed during the survey.

Table 4: Respondents' on-farm, non-farm and off-farm incomes

Income/year (₦'000)	On-farm (Freq)	Percentage	Off-farm (Freq)	Percentage	Non-farm (Freq)	Percentage
< 101	4	0.99	59	17.40	63	16.07
101-300	19	4.69	197	58.11	156	39.80
301-500	43	10.62	83	24.48	125	31.89
501-700	59	14.57	0	0.0	25	6.38
701-1,000	96	23.70	0	0.0	16	4.08
> 1,000	184	45.43	0	0.0	7	1.79
Total	405	100	339	100	392	100
Mean	1,073,439	66.66	157,400	9.77	379,480	23.57
Maximum	2,649,358		478,500		3,268,950	
Minimum	81,456		22,850		78,300	
Coeff. of variation	21.37		29.04		33.75	

Source: Field Survey (2025)

The results in Table 4 further indicate that 83.70% of the farmers generated income from off-farm activities in addition to on-farm and non-farm sources. A significant majority (75.51%) earned at least ₦300,000 annually from off-farm work, with an average annual contribution of ₦157,400 per household. However, off-farm income represented only 9.77% of the total annual income of integrated crop-livestock farmers, suggesting that it played a relatively minor role in livelihood diversification compared to other income sources. These findings imply that off-farm activities primarily serve as supplementary sources of income rather than the principal livelihood strategy among farming households. Similar studies in developing countries have shown that rural households engage in off-farm activities to complement agricultural income and strengthen household resilience, although agriculture often remains the dominant source of livelihood (Yussuf and Mohamed, 2022).

Distribution of Respondents according to Level of Livelihood Diversification

Table 5 shows the livelihood diversification levels by the farmers, measured using the Simpson diversification index (SDI). The data showed an average diversification level of 0.58, with a maximum of 0.86, a minimum of 0.12, and a coefficient of variation of 23.38%, indicating moderate variability in diversification strategies. No farmer (0%) had an SDI below 0.01 (complete specialisation), 6.42% exhibited low diversification (limited livelihood sources), 42.47% had moderate diversification while 51.11% achieved high diversification. These findings confirm that all respondents engaged in multiple income sources, with the pooled average SDI of 0.58, reflecting a moderate overall diversification level. This aligns with Adebayo *et al.* (2023), who found similar patterns among Nigerian agro-pastoralists, reporting an average SDI of 0.61 and emphasising that high diversification is a risk-mitigation strategy for smallholder farmers facing climate and market uncertainties.

Factors Influencing Integrated Crop-Livestock Farmers' Livelihood Activities

Table 6 presents the robustness test results for the Tobit regression model, which exhibited strong statistical validity. Key indicators included log-likelihood = 397.311, LR Chi² = 198.141 (significant at 1% level) and Pseudo R² = 0.78. These results

confirm that at least one predictor variable significantly influences livelihood diversification, demonstrating the model's strong explanatory power. Also, the Jarque-Bera test for residual normality yielded an insignificant *p*-value (0.356, *p* > 0.05), indicating that the residuals followed a normal distribution, a critical assumption for reliable regression analysis.

The analysis revealed that farm size had a significant negative coefficient (−0.0253), implying that a one-unit increase in farm size reduces livelihood diversification by 0.0253 units. This suggests that farmers with larger landholdings tend to diversify less, possibly because larger farms require greater labour, management time, and financial commitments, thereby limiting engagement in alternative income-generating activities. Similar findings have been reported in recent studies indicating that households with greater dependence on agricultural land often participate less in non-farm livelihood activities, as farming activities absorb a larger share of household resources and labour (Admasu *et al.*, 2022).

Table 5: Distribution of respondents according to level of diversification

SDI Range	F	%	Diversification level	Ranking
≤ 0.01	0	0.00	No diversification	4
0.01 > 0.38	26	6.42	Low diversification	3
0.38 ≥ 0.63	172	42.47	Mod. diversification	2
> 0.63	207	51.11	High diversification	1
Total	405	100		
Mean	0.58			
Maximum	0.86			
Minimum	0.12			
Coeff. of var.	23.38			

Source: Field Survey (2025)

Table 6: Tobit estimates of the factors influencing livelihood diversification

Variable	Coeff.	SE	t-statistic	P-values
Constant	0.6127	0.1316	4.6558	0.0000
Farm size	−0.0253**	0.0131	−1.9313	0.0413
Gender	0.0342**	0.0146	2.3425	0.0205
Household size	0.0262**	0.0108	2.4259	0.0176
Educational level	0.0495***	0.0157	3.1529	0.0000
On-farm income	0.0675***	0.0089	7.5843	0.0000
Off/non-farm income	0.0659***	0.0079	8.3418	0.0000
Credit obtained	0.0238**	0.0106	2.2453	0.0213
Diagnostic Statistics				
No. of observs.	405			
LR Chi ² (8)	198.141			
Log-likelihood	397.311			
Prob > Chi ²	0.000			
Normality test	0.356			
Pseudo R ²	0.78			

Source: Field Survey (2025). LR - large ruminants, SE - std. error. Note: *** and ** denote significant at 1% and 5%, respectively.

The study found that the gender of the household head had a significant ($p < 0.05$) positive influence on livelihood diversification, with a coefficient of 0.0342. This suggests that male-headed households were more likely to engage in diversified livelihood strategies than female-headed households. This may be attributed to prevailing gender roles and unequal access to productive resources, labour, information, and economic opportunities. In many rural communities, male household heads possess greater mobility, access to social networks, and control over productive assets, enabling them to participate in a wider range of livelihood activities. Similar findings have been reported in recent studies indicating that gender significantly influences livelihood diversification decisions among rural households (Musumba *et al.*, 2022; Akintunde *et al.*, 2023).

The study revealed a significant ($p < 0.01$) positive relationship between household size and income diversification, with a coefficient of 0.0262. This implies that larger households were more likely to engage in diversified livelihood strategies, possibly due to the availability of additional labour that could be allocated to different income-generating activities. Farmers with larger households may assign family members to various agricultural and non-agricultural activities, thereby enhancing household income and economic resilience. Similar finding has been reported, indicating that larger households tend to diversify their livelihood activities because of increased labour availability and greater consumption requirements (Damtie *et al.*, 2022).

The analysis revealed a significant ($p < 0.01$) positive relationship between education level and income diversification, with a coefficient of 0.0495. This suggests that farmers with higher education were more likely to engage in diversified livelihood strategies, with each additional year of schooling increasing the probability of diversification by ca. 0.053 units. Educated farmers may possess better skills, access to information, and decision-making abilities, enabling them to explore multiple income sources such as value-added agribusiness, off-farm employment, or innovative farming techniques. This aligns with the findings of Emeru *et al.* (2022), who reported that education enhances households' ability to access information, adopt innovations and participate in diverse livelihood activities.

Also, on-farm income had a significant ($\beta = 0.0675$, $p < 0.01$) positive effect on livelihood diversification among integrated crop-livestock farmers. This suggests that as farmers' earnings from on-farm activities increased, they were more likely to explore additional income sources. The finding emphasises the role of financial capacity in enabling diversification, as higher on-farm income provides the necessary capital to invest in alternative livelihood ventures. Increased agricultural earnings may enhance farmers' ability to bear risks, finance new enterprises, and participate in additional income-

generating activities. This finding is consistent with the livelihood diversification framework whereby households possessing greater financial assets and income resources are better positioned to pursue multiple livelihood opportunities and diversify their income portfolios (Ellis, 2000; Barrett *et al.*, 2001).

The study found that the coefficient of off-farm and non-farm income had a significant ($\beta = 0.0659$, $p < 0.01$) positive impact on livelihood diversification among integrated crop-livestock farmers. This indicates that as farmers earned additional income from non-agricultural sources, they were more likely to engage in diversified livelihood strategies. The result highlights the importance of alternative income streams in enhancing economic resilience, as financial resources from off-farm and non-farm activities enable farmers to invest in multiple income-generating opportunities. This finding aligns with Iqbal *et al.* (2021), that participation in non-farm activities enhances household income, reduces dependence on agriculture and improves livelihood resilience among rural households.

The findings further revealed that access to credit had a significant ($\beta = 0.0238$, $p < 0.01$) positive influence on livelihood diversification among integrated crop-livestock farmers. This suggests that farmers who secured credit were more likely to expand into diverse income-generating activities, as financial resources enabled them to invest in new ventures or scale existing ones. Access to credit reduces liquidity constraints and enhances households' ability to undertake productive investments. This finding is supported by Adesugba and Mavrotas (2020) who indicate that inadequate access to agricultural finance limits investment opportunities among smallholder farmers, while improved financial access promotes productive activities and strengthens household resilience.

CONCLUSION

The study assessed the determinants of livelihood diversification among integrated crop-livestock farming households in North-West, Nigeria. The results revealed that the majority of farmers engage in multiple income-generating activities, with an average Simpson diversification index (SDI) of 0.58, indicating a moderate level of livelihood diversification. On-farm income remained the primary source of household earnings, accounting for over 66% of total income, while non-farm and off-farm activities contributed 23.57% and 9.77%, respectively. The findings further established that livelihood diversification was influenced by several socio-economic factors, such as household size, education level, gender, access to credit, and income from both on-farm and off/non-farm activities. From these it can be concluded that integrated crop-livestock farmers pursue livelihood diversification as a risk management strategy, income augmentation tool and resilience mechanism against agricultural uncertainties in the study area.

RECOMMENDATIONS

From the findings, the followings are recommended:

- 1) Improving access to affordable agricultural credit should be prioritised, as credit was found to significantly enhance livelihood diversification. Therefore, government and financial institutions need to expand low-interest and flexible credit schemes tailored to smallholder farmers to enable investment in both farm and non-farm activities.
- 2) Promoting farmer education and skill development programmes is essential, given the positive influence of education on diversification, and this can be achieved through increased investment in training, adult education and extension services focusing on business management, value addition, and alternative income opportunities.
- 3) In addition, there is a need to support the development of rural non-farm and off-farm opportunities by strengthening rural infrastructure and creating an enabling environment for small-scale enterprises such as trading, agro-processing and transport services, thereby reducing over-dependence on farming.
- 4) Moreover, policies aimed at encouraging efficient land use and addressing land fragmentation should be implemented, as the negative relationship of farm size with diversification suggests that land constraints influence livelihood decisions and improving land access, consolidation, and management practices will help farmers better balance multiple income sources.
- 5) Finally, strengthening integrated crop-livestock farming systems should be emphasised through extension services promoting improved crop and livestock management systems and stronger crop-livestock linkages to enhance productivity, increase on-farm income and provide a solid foundation for further livelihood diversification.

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Appendix: Sampling frame and sample size of farmers in Kaduna, Kano and Katsina States of the study

States/LGAs	Village	Integrated crop-livestock sample frame							Total sample frame (TSF)	Integrated crop-livestock sample size							Total sample size (0.33TSF)	
		M - Sg - C - L	M - Sg - L	M - C - L	Sb - M - L	Sb - Sg - L	R - M - L	R - Sg - L		M - Sg - C - L	M - Sg - L	M - C - L	Sb - M - L	Sb - Sg - L	R - M - L	R - Sg - L		
Kaduna State	Kubau	Damau	4	3	3	2	0	4	1	17	1	1	1	1	0	1	0	5
		Haskiya	3	2	3	0	2	2	2	14	1	1	1	0	0	1	1	4
		Kargi	5	3	3	4	2	2	2	23	2	1	1	1	1	1	1	8
		Magami	5	3	2	2	4	3	0	20	1	1	1	1	1	1	1	7
	Kudan	Sub-total:	18	11	12	10	7	11	5	74	6	4	4	3	2	3	2	24
		Rimin-Biso	4	2	4	2	1	3	0	16	1	1	1	1	0	1	0	5
		Doka	6	2	4	2	3	3	2	23	2	1	1	1	1	1	1	8
		Hawan-Maimashi	3	2	4	2	3	3	1	18	1	1	1	1	1	1	1	6
	Lere	Danbami	5	2	4	2	0	2	0	15	2	0	1	1	0	1	0	5
		Sub-total:	18	8	16	9	7	11	3	72	6	3	4	4	2	4	1	24
		Dan-Alhaji	4	3	3	2	2	4	0	18	2	1	1	1	0	1	0	6
		Saminaka	6	3	5	2	3	4	1	24	2	1	2	1	1	1	0	8
	Makarfi	Goron-Dutse	4	0	3	3	2	4	0	16	1	0	1	1	1	1	0	5
		Bisallah-Hausa	3	3	3	3	3	3	2	20	1	1	1	1	1	1	1	7
		Sub-total:	17	9	14	10	10	15	3	78	6	3	5	4	3	4	1	26
		Dandamisa	6	4	3	3	4	3	3	26	2	1	1	1	1	1	1	8
Soba	Gangara	5	2	4	3	1	1	1	17	2	1	1	1	1	0	0	6	
	Gimi	7	2	4	3	2	2	1	21	2	1	1	1	1	1	0	7	
	Marke	4	2	3	2	2	2	2	17	1	0	1	1	1	1	1	6	
	Sub-total:	22	10	14	11	9	8	7	81	7	3	4	4	4	3	2	27	
S/gari	Fagachi	7	3	4	3	2	6	3	28	2	1	1	1	1	2	1	9	
	Marwa	5	4	4	5	3	0	0	21	2	1	1	2	1	0	0	7	
	Alhazawa	7	0	6	3	0	5	0	21	2	0	2	1	0	2	0	7	
	Gamagira	6	5	3	5	1	3	1	24	2	2	1	2	0	1	0	8	
Zaria	Sub-total:	25	12	17	16	6	14	4	94	8	4	5	6	2	5	1	31	
	Bomo	6	1	3	5	0	5	0	20	2	0	1	1	0	2	0	6	
	Sakadadi	3	1	3	3	2	3	0	15	1	0	1	1	1	1	0	5	
	Gwanda	3	0	3	2	2	1	3	14	1	0	1	1	1	0	1	5	
Kano State	Bebeji	Katanga	6	1	5	3	1	2	0	18	2	0	2	1	0	1	0	6
		Sub-total:	18	3	14	13	5	11	3	67	6	0	5	4	2	4	1	22
		Bizara	3	0	5	0	0	5	1	14	1	0	2	0	0	2	0	5
		Bogari	4	1	5	3	0	5	0	18	1	0	2	1	0	2	0	6
	Doguwa	Dambo	2	3	3	4	0	4	0	16	1	1	1	1	0	1	0	5
		Gabari	3	2	6	6	1	7	1	26	1	1	2	2	0	2	0	8
		Sub-total:	12	6	19	13	1	21	2	74	4	2	7	4	0	7	0	24
		Total	130	59	106	82	45	91	27	540	43	19	34	29	15	30	8	178
	Garko	Durumawa	3	3	2	2	3	0	0	13	1	1	0	1	1	0	0	4
		Gwarmai	5	5	2	0	3	1	2	18	1	2	1	0	1	0	1	6
		Ranka	6	5	2	1	3	1	1	19	2	2	1	0	1	0	0	6
		Yakun	5	3	2	4	3	3	0	20	2	1	1	1	1	1	0	7
	Kiru	Sub-total:	19	16	8	7	12	5	3	70	6	6	3	2	4	1	1	23
		Dadin-kowa	4	3	0	1	3	0	2	13	1	1	0	0	1	0	1	4
		Falgore	3	3	0	0	3	0	1	10	1	1	0	0	1	0	0	3
		Mahuta	2	4	1	1	0	1	2	11	1	1	0	1	0	0	1	4
Rogo	Tagwaye	4	2	0	0	2	0	3	11	1	1	0	0	1	0	1	4	
	Sub-total:	13	12	1	2	8	1	8	45	4	4	0	1	3	0	3	15	
	Garin-Ali	4	3	2	0	1	3	2	15	1	1	1	0	0	1	1	5	
	Lamire	4	2	1	0	3	2	4	16	1	1	0	0	1	1	1	5	
Kibiya	Sarina	3	1	0	2	3	1	3	13	1	0	0	1	1	0	1	4	
	Zakarawa	5	3	3	1	3	2	0	17	2	1	1	0	1	1	0	6	
	Sub-total:	16	9	6	3	10	8	9	61	5	3	2	1	3	3	3	20	
	Burmini	4	2	3	0	1	3	3	16	1	1	1	0	0	1	1	5	
Tudun-Wada	Dususu	3	2	1	3	0	1	5	15	1	1	0	1	0	0	2	5	
	Gadako	2	0	2	0	1	1	1	7	1	0	1	0	0	0	0	2	
	Sarari	4	1	2	1	2	2	3	15	1	0	1	0	1	1	1	5	
	Sub-total:	13	5	8	4	4	7	12	53	4	2	3	1	1	2	4	17	
Dandum	Daurawa	3	3	0	2	2	0	4	14	1	1	0	1	1	0	1	5	
	Kadangaru	3	2	0	0	4	0	4	13	1	1	0	0	1	0	1	4	
	Maska	3	1	2	0	3	0	3	12	1	0	1	0	1	0	1	4	
	Tsaudawa	3	2	0	0	0	3	3	11	1	1	0	0	0	1	1	4	
Bakori	Sub-total:	12	8	2	2	9	3	14	50	4	3	1	1	3	1	4	17	
	Dalawa	4	3	1	1	3	2	3	17	1	1	0	0	1	1	1	5	
	Jan-dutse	3	2	0	0	0	0	1	6	1	1	0	0	0	0	0	2	
	Shuwaki	3	3	0	0	3	2	0	11	1	1	0	0	1	1	0	4	
Rogo	Yelwa	5	3	2	2	1	1	3	17	2	1	1	1	0	0	1	6	
	Sub-total:	15	11	3	3	7	5	7	51	5	4	1	1	2	2	2	17	
	Beli	4	6	1	0	3	0	3	17	1	2	0	0	1	0	1	5	
	Nasarawa	3	3	1	1	2	0	3	13	1	1	0	0	1	0	1	4	
Katsina State	Bakori	Fulatan	0	5	2	3	1	2	4	17	0	2	1	1	0	1	6	
		Zarewa	2	3	0	0	4	0	2	11	1	1	0	0	1	0	1	4
		Sub-total:	9	17	4	4	10	2	12	58	3	6	1	1	3	1	4	19
		Total	97	78	32	25	60	31	65	388	31	28	11	8	19	10	21	128
Dandum	Guga	3	3	3	2	0	0	0	11	1	1	1	1	0	0	0	4	
	Kakumi	2	3	1	1	1	1	1	10	1	1	0	0	0	0	1	3	
	Makera	3	4	2	3	1	1	1	15	1	1	1	1	1	0	0	5	
	Tsiga	6	0	4	2	1	1	1	15	2	0	1	1	0	1	0	5	
Danja	Sub-total:	14	10	10	8	3	3	3	51	5	3	3	3	1	1	1	17	
	Dantakari	2	2	1	1	2	1	1	10	1	1	0	0	1	0	0	3	
	Jiruwa	3	3	1	0	1	0	2	10	1	1	0	0	0	0	1	3	
	Ilalla	3	3	0	1	0	2	1	9	1	1	0	1	0	1	0	4	
Sabuwa	Mahuta	1	1	2	1	2	0	2	9	0	0	1	0	1	0	1	3	
	Sub-total:	9	9	4	3	5	3	6	39	3	3	1	1	2	1	2	13	
	Dabai	7	5	3	1	2	4	2	24	2	2	1	0	1	1	1	8	
	Jiba	4	5	3	3	0	3	0	18	1	2	1	1	0	1	0	6	
Kafur	Kahutu	3	1	5	2	1	3	1	16	1	0	2	1	0	1	0	5	
	Yakaji	2	7	0	0	0	4	2	15	1	2	0	0	0	1	1	5	
	Sub-total:	16	18	11	6	3	14	5	73	5	6	4	2	1	4	2	24	
	Dandutse	3	1	3	1	2	3	2	15	1	0	1	0	1	1	1	5	
Malumfashi	Goya	6	3	3	3	1	3	1	19	2	1	1	1	0	1	0	6	
	Maska	4	5	3	3	1	0	2	18	1	2	1	1	0	0	1	6	
	Tudun-Iya	3	3	1	0	1	2	1	11	1	1	0	0	1	1	0	4	
	Sub-total:	16	12	10	6	5	8	6	63	5	4	3	2	2	3	2	21	
Sabuwa	Dankwaro	5	3	2	1	1	3	16	22	2	1	1	0	0	0	1	5	
	Kagara	1	3	4	0	2	0	2	12	0	1	1	0	1	0	1	4	
	Masari	4	4	3	0	3	1	0	15	1	1	1	0	1	1	0	5	
	Yarman	3	3	2	2	1	1	1	13	1	1	1	1	0	0	0	4	
Sabuwa	Sub-total:	13	13	11	3	7	3	6	56	4	4	4	1	2	1	2	18	
	Barin-Dawa	3	3	1	1	0	1	0	9	1	1	0	0	0	1	0	3	
	Gangara	3	2	1	0	1	0	1	8	1	1	0	0	0	0	1	3	
	Salihawa	3	3	3	1	1	1	1	13	1	1	1	1</					