DOI: https://doi.org/10.67203/jerd.2026.elbcy0hy

SOCIO-ECONOMIC DETERMINANTS OF LIVELIHOOD DIVERSIFICATION AMONG MAIZE FARMERS IN KADUNA STATE, NIGERIA

***[1]Yakubu, I., [2]Dnladi, B., [1]Adamu, Z, [1]Sule, M., [1]Dahiru, I., and [1]Abdulhamid, H.**

[1]Department of Agricultural Education, School of Science, Vocational and Technical Education; Nuhu Bamalli Polytechnic, Zaria, Kaduna State, Nigeria
[2]Department of General Education, School of Science, Vocational and Technical Education, Nuhu Bamalli Polytechnic, Zaria, Kaduna State, Nigeria
*Corresponding Author: ibrahimyakubu07@gmail.com; 08069295701

Abstract

This study assessed the effect of livelihood diversification on income security among smallholder maize farmers in Kaduna State, Nigeria. Specifically, it described farmers' socio-economic characteristics, examined factors influencing diversification, assessed the level of diversification, and determined the relationship between diversification and household income. Data were collected from 213 maize-farming households using structured questionnaires and analyzed with descriptive statistics, the Livelihood Diversification Index (LDI), logit regression, and OLS regression. Results showed that maize farming is predominantly male (73.8%), middle-aged (mean 45.01 years), married (83.2%), and educated (58.8% with tertiary education), with an average household size of 7.08 persons. The mean total farm size was 4.09 hectares, and maize farm size averaged 2.25 hectares, with 53.3% producing more than 50 bags. Logit regression revealed that education, household size, total farm size, and access to credit significantly increased the likelihood of diversification, with odds ratios of 1.122, 1.054, 1.161, and 1.816, respectively. Among the 107 diversified farmers, the mean LDI was 0.899, with 37.4% and 28.0% classified as highly and very highly diversified, respectively. OLS regression showed that participation in non-farm activities ($\beta = 0.325$, $p < 0.01$) and higher LDI scores ($\beta = 0.298$, $p < 0.01$) significantly enhanced household income (mean ₦193,874). In conclusion, livelihood diversification, supported by education, farm resources, and access to credit, improves income security. Therefore, agencies should promote non-farm opportunities, expand financial services, and support household-level diversification strategies to strengthen rural livelihoods.

Keywords: Livelihood diversification, maize farmers, income security, Kaduna State, smallholder agriculture

Introduction

Agriculture remains a major source of livelihood for rural households in sub-Saharan Africa, contributing significantly to employment, income generation, and food security (Pawlak & Kołodziejczak, 2020). In Nigeria, the sector plays a central role in rural development, with maize (Zea mays L.) ranking among the most important staple crops for food, feed, and industrial purposes (Fatai et al., 2023; Oba et al., 2025; Adiaha, 2018). Kaduna State is one of the leading maize-producing areas in the country, where smallholder farmers depend heavily on maize cultivation as their primary source of income (Muhammad et al., 2026). Despite its importance, maize production in Nigeria is constrained by low productivity, climate variability, market price fluctuations, and limited access to credit and extension services, exposing farmers to income instability (Issa *et al*., 2016). Heavy reliance on rain-fed agriculture further increases vulnerability to shocks, thereby threatening household income security.

Livelihood diversification has therefore emerged as a critical strategy for reducing risk and improving income stability. It involves the combination of farm and non-farm income-generating activities to enhance household resilience and welfare (Belay & Lebeza, 2024). Diversification may be driven by necessity (push factors) such as low farm income or by opportunity (pull factors) such as access to non-farm employment (Kurantin & Osei-Hwedie, 2022). Empirical evidence shows that diversification can improve household income and reduce poverty, although participation is often shaped by socio-economic characteristics including education, farm size, household size, access to credit, and extension contact (Sultana *et al*., 2015).

However, limited empirical evidence exists specifically on maize farmers in Kaduna State, particularly regarding how socio-economic factors influence participation in livelihood diversification and how diversification relates to income security. Addressing this gap is important for designing policies aimed at strengthening rural income

resilience. This study therefore examines the socio-economic characteristics of maize farmers engaged in diversification, analyzes the factors influencing participation in livelihood diversification, and investigates the relationship between diversification and income security in Kaduna State, Nigeria.

Methodology

The study was conducted in Kaduna State, Nigeria. The state is located in the northwestern region of the country between latitudes 9°02′ and 11°32′ N and longitudes 6°15′ and 8°50′ E (Kaduna State Government [KDSG], 2022). It shares boundaries with Katsina and Kano States to the north, Bauchi and Plateau States to the east, Nasarawa State and the Federal Capital Territory to the south, and Niger State to the west. Kaduna State covers approximately 46,000 square kilometers and lies within the Northern Guinea Savannah agro-ecological zone (Oyinbo *et al*., 2019).

The state experiences a tropical continental climate characterized by distinct wet and dry seasons. The rainy season typically lasts from April to October, with average annual rainfall ranging between 1,000 mm and 1,500 mm, while the dry season spans from November to March (Nigerian Meteorological Agency [NiMet], 2021). Average temperatures range between 25°C and 35°C. These climatic conditions, combined with relatively fertile soils, support the cultivation of major crops such as maize, sorghum, millet, rice, and groundnut (Muhammad et al., 2026; FAO, 2021). Agriculture is the dominant occupation of the rural population in Kaduna State, with maize serving as both a staple food and an important cash crop (National Bureau of Statistics [NBS], 2021).

A multi-stage sampling technique was adopted for this study. In the first stage, Kaduna State was purposively selected due to its prominence in maize production. In the second stage, one Local Government Area (LGA) was purposively selected from each of the Northern, Central, and Southern agricultural zones of the state based on the intensity of maize farming activities. The LGAs selected were Soba, Kudan, and Lere, respectively. In the third stage, maize-producing communities were randomly selected from each of the chosen LGAs. In the final stage, smallholder maize farmers were randomly selected from each community using farmers' registers obtained from agricultural extension offices and recognized farmer associations.

The sample frame comprised 455 registered smallholder maize farmers across the selected communities. The sample size was determined using Yamane's (1967) formula for finite populations at a 5 percent level of precision, specified as:

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

where *n* is the sample size, *N* is the population size (455), and *e* is the level of precision (0.05).

Substituting into the formula:

$$n = \frac{455}{1 + 455(0.05)^2} = \frac{455}{2.1375} \approx 213$$

Thus, a total of 213 smallholder maize farmers were selected for the study. The sample size represents approximately 46.8% of the sampling frame and was proportionately distributed across the selected communities.

Table 1: Population and Sample Size of Smallholder Maize Farmers in the Study Area

Zone	LGA	Community	Sample Frame	Sample Size (46.8%)
Northern Zone	Soba	Bele	46	22
		Liwawa	44	21
		Takalafiya	42	20
		Awai	39	18
		Bauda	35	16
Central Zone	Kudan	Gwibi	48	22
		Hayin Shara	46	22
		Tashar Ya'u	43	20
		Kyaudai	40	19
Southern Zone	Lere	Raminkura	30	14
		Jaja	28	13
		Luwuma	27	13
		Kadere	27	13
Total		**13 Communities**	**455**	**213**

Field survey, 2025

Primary data were collected from the selected smallholder maize farmers using a structured questionnaire designed to capture information on socio-economic characteristics, farm activities, access to resources, participation in livelihood diversification, and indicators of income security. The questionnaire consisted mainly of close-ended questions to facilitate quantitative analysis and was pre-tested in a similar community outside the study area to ensure clarity and reliability. Trained enumerators conducted face-to-face interviews in the local language to enhance accuracy and minimize errors. Secondary data were also obtained from relevant sources, including the National Bureau of Statistics (NBS), Kaduna State Ministry of Agriculture, FAO reports, and scholarly publications, to complement the primary data.

Descriptive statistics were used to summarize the socio-economic characteristics of the maize farmers and provide a clear profile of the respondents. Variables such as age, gender, household size, education level, farm size, farming experience, access to credit, extension contact, and cooperative membership were analyzed using frequency, percentage, mean, and standard deviation. This approach facilitated a straightforward understanding of the distribution and central tendencies of the data, and helped identify patterns relevant for further analysis of livelihood diversification.

The Binary Logit Regression Model was used to identify socio-economic factors influencing farmers' participation in livelihood diversification. The dependent variable is binary, taking a value of 1 if a farmer participates in diversification activities and 0 otherwise. The logit model is specified as follows:

$$\ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_9 X_9 + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where:

P_i = Participation in non-farm income activities (1 = yes, 0 = no)

X_1 = Sex (1=male, 0=female)

X_2 = Age of household head (years)

X_3 = Years of formal education of household head

X_4 = Household size (number of household members)

X_5 = Marital status (1=married, 0=single)

X_6 = Total farm size (hectares)

X_7 = Access to extension services (1 = yes, 0 = no)

X_8 = Access to formal credit (1 = yes, 0 = no)

X_9 = Membership in cooperative society (1 = yes, 0 = no)

β_0 = Intercept term

$\beta_1 - \beta_9$= Coefficients of the explanatory variables

ε_i = Error term

The model coefficients were interpreted based on their signs and significance, while odds ratios were used to measure the likelihood of participation in livelihood diversification associated with each socio-economic factors.

Measurement of Livelihood Diversification Index (LDI)

The Livelihood Diversification Index (LDI) was computed to quantify the degree of diversification among households. It was calculated using the Simpson Index of Diversity:

$$LDI = 1 - \sum_{i=1}^{n} P_i^2 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3)$$

Where P_i is the proportion of income derived from activity i relative to total household income. Higher LDI values indicate greater diversification. In this study, 14 income sources were included, covering both farm and non-farm activities such as crop farming, trading, artisanal work (blacksmithing, carpentry, crafts), services (barbing), formal employment, remittances, pensions, leasing revenue, wage labor, gifts, and other miscellaneous sources. Higher LDI values indicate greater livelihood diversification.

Ordinary Least Squares (OLS) Regression

The Ordinary Least Squares (OLS) regression model was used to examine the relationship between livelihood diversification and household income among maize farmers. In this model, the dependent variable is household income (continuous), which serves as a proxy for income security. The OLS model is specified as:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_8 X_8 + \varepsilon_i \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (4)$$

Where:

$Y_i =$ Household income (dependent variable; proxy for income security)

X_1= Participation in non-farm income activities (1 = yes, 0 = no)

$X_2 =$ Sex (1=male, 0=female)

X_3 = Age of household head (years)

X_4 = Years of formal education of household head

X_5 = Household size (number of household members)

X_6 = Marital status (1=married, 0=single)

X_7 = Total farm size (hectares)

X_8 = Access to extension services (1 = yes, 0 = no)

X_9 = Access to formal credit (1 = yes, 0 = no)

X_{10} = Livelihood diversification index

X_{11} = Membership in cooperative society (1 = yes, 0 = no)

β_0 = Intercept term

$\beta_1 - \beta_9$= Coefficients of the explanatory variables

ε_i = Error term

Results and Discussion

Socio-economic characteristics of maize farmers engaged in diversification

Table 2 presents the socio-economic characteristics of smallholder maize farmers in Kaduna State, distinguishing between those who engage in livelihood diversification and those who do not. The mean age of respondents was 45 years, with a higher proportion of older farmers (>50 years) participating in diversification (38.3%), suggesting that experience enables households to manage risk through multiple income sources. This aligns with Billa (2022), who noted that age influences livelihood strategies in rural households, and Adegbite, Olusegun, and Seyi (2023), who observed that older farmers are more likely to combine farm and non-farm activities to stabilize income.

Similarly, males dominate both non-diversified (81.1%) and diversified (73.8%) groups, reflecting male predominance in maize farming, consistent with Marechera, Sedi, and Adebayo (2022), who found that male-headed households have greater access to resources and opportunities in maize production. Nevertheless, female participation in diversification (26.2%) indicates that women are increasingly involved in non-farm income activities, supporting Lawi, Omolehin, and Adeniyi (2025), who highlighted women's contribution to supplementary rural livelihoods in Northern Nigeria.

Marital status also appears relevant, as married farmers were slightly more likely to diversify (83.2%) than single farmers (16.8%), suggesting that pooled household labor and resources facilitate engagement in multiple income-generating activities. This is consistent with Amaka and Muhammad (2021), who reported that marital status enhances households' ability to adopt diversified livelihoods.

Furthermore, household size averaged seven members, with 64.5% of diversified farmers in the 6–10 member category, indicating that larger households provide the labor necessary to combine farm and non-farm activities. This agrees with Baah *et al*. (2026), who observed that household labor capacity positively influences adoption of multiple livelihood strategies.

Education clearly influences diversification, as farmers with tertiary education were more likely to diversify (58.8%) compared with those with no formal education (36.4%). Education improves access to information, entrepreneurial skills, and non-farm opportunities, enabling greater participation in diversified activities. This finding aligns with Sallawu *et al*. (2024), who reported that education significantly increases the probability of engaging in off-farm activities.

Regarding farm resources, the average total farm size was 4.09 ha, with 78.5% of diversified farmers cultivating more than 3 ha. While larger farms provide resources for investment, smallholders with ≤3 ha also participate, indicating that diversification is driven by both necessity and opportunity, consistent with Omotilewa *et al*. (2021). Average maize farm size was 2.25 ha, and diversified farmers were more represented in the >3 ha category (32.7%), suggesting that larger maize plots may generate surplus for sale and support engagement in non-farm activities, in line with Adegbite, Olusegun, and Seyi (2023).

Similarly, diversified farmers were more likely to produce >50 bags of maize (53.3%), indicating that higher productivity facilitates non-farm participation, consistent with Baah *et al*. (2026). Average household income was ₦193,874, with similar distributions across both groups, showing that diversification complements rather than substitutes farm income, as observed by Lawi, Omolehin, and Adeniyi (2025).

Finally, slightly more non-diversified farmers were cooperative members (51.9%) compared with diversified farmers (42.9%), suggesting that some households pursue diversification independently. This aligns with Balana and Oyeyemi (2022), who found that cooperative membership enhances access to resources but does not always directly drive diversification. Likewise, extension contact was higher among non-diversified farmers (49.1%) than diversified ones (36.5%), implying that diversified households may rely more on non-farm opportunities, consistent with Alam *et al*. (2024), who reported that extension access does not necessarily correspond to higher non-farm participation when households prioritize off-farm income.

Table 2: Socio-Economic Characteristics of Diversified and Non-Diversified Maize Farmers

Variable	Non-Diversified n (%)	Diversified n (%)	Mean	Std. Dev.
Age (years)			45.01	11.47
≤30	14 (13.21)	15 (14.02)		
31–40	29 (27.36)	28 (26.17)		
41–50	29 (27.36)	23 (21.50)		
>50	34 (32.08)	41 (38.32)		
Sex				
Female	20 (18.87)	28 (26.17)		
Male	86 (81.13)	79 (73.83)		
Marital status				
Married	83 (78.30)	89 (83.18)		
Single	23 (21.70)	18 (16.82)		
Household size (persons)			7.08	2.46
≤5	35 (33.02)	25 (23.36)		
6–10	61 (57.55)	69 (64.49)		
>10	10 (9.43)	13 (12.15)		
Education level				
No formal education	4 (36.36)	7 (63.64)		
Primary education	50 (56.82)	38 (43.18)		
Secondary education	38 (47.50)	42 (52.50)		
Tertiary education	14 (41.18)	20 (58.82)		
Total farm size (ha)			4.09	1.3
1.01–3.0	21 (19.81)	23 (21.50)		
>3.0	85 (80.19)	84 (78.50)		
Maize farm size (ha)			2.25	0.98
≤1	10 (9.43)	17 (15.89)		
1.01–3.0	74 (69.81)	55 (51.40)		
>3.0	22 (20.75)	35 (32.71)		
Maize output (bags)			50.24	22.47
≤50	59 (55.66)	50 (46.73)		
>50	47 (44.34)	57 (53.27)		
Total household income (₦)			193,873.70	86,700.00
≤200,000	56 (52.83)	55 (51.40)		
200,001–600,000	50 (47.17)	52 (48.60)		
Cooperative membership				
No	51 (48.11)	61 (57.01)		
Yes	55 (51.89)	46 (42.99)		
Extension visits				
No	54 (50.94)	68 (63.55)		
Yes	52 (49.06)	39 (36.45)		

Factors influencing participation in livelihood diversification

Table 3 presents the logit regression results of factors influencing participation in livelihood diversification among maize farmers in Kaduna State. The model was statistically significant (LR $chi^2(9) = 45.78$, $p < 0.001$), with a pseudo R^2 of 0.154, indicating that the included socio-economic variables explain about 15% of the variation in diversification participation. The results show that sex was positive but not statistically significant (OR = 1.141), suggesting that male farmers were slightly more likely to diversify than female farmers. This is consistent with Abdullahi et al. (2022) and Marechera et al. (2022), who reported that male-headed households generally have greater access to agricultural resources and income-generating opportunities.

Age had a negative and significant effect (OR = 0.977, $p < 0.05$), indicating that older farmers were less likely to participate in non-farm activities. This aligns with Billa (2022) and Lawi et al. (2025), who observed that younger farmers are more flexible, responsive to new income opportunities, and more likely to engage in diversified livelihood strategies. Education positively influenced diversification and was highly significant (OR = 1.122, $p < 0.01$), showing that each additional year of schooling increases the likelihood of participation by about 12%. This

supports findings by Sallawu *et al*. (2024) and Amaka and Muhammad (2021), who emphasized that education equips farmers with the knowledge and skills necessary to pursue off-farm income-generating activities.

Similarly, household size had a positive effect (OR = 1.054, $p < 0.1$), suggesting that larger households are more likely to diversify due to greater labor availability. This aligns with Baah *et al*. (2026), who reported that household labor capacity positively influences engagement in multiple livelihood activities. Marital status was positive but not significant (OR = 1.347), implying that married farmers may be more likely to diversify due to pooled household resources, though the effect is not strong. This finding is consistent with Amaka and Muhammad (2021), who noted that marital status can facilitate participation in multiple income-generating activities.

Total farm size positively and significantly influenced diversification (OR = 1.161, $p < 0.1$), indicating that farmers with larger farms have more resources to invest in non-farm activities. This agrees with Omotilewa *et al*. (2021), who observed that farm size provides both the means and the capacity to participate in complementary livelihood strategies. Extension access was negative and not significant (OR = 0.82), suggesting that households with extension contact were slightly less likely to diversify. This aligns with Alam *et al*. (2024), who reported that access to agricultural extension does not always translate to higher participation in non-farm activities, particularly when households prioritize farm intensification.

Credit access positively and significantly affected diversification (OR = 1.816, $p < 0.05$), showing that farmers with access to formal credit were nearly twice as likely to participate in off-farm activities. This supports findings by Balana and Oyeyemi (2022) and Amegnaglo *et al*. (2024), who highlighted credit access as a key enabler of investment in non-farm income-generating activities.

Table 3: Logit Regression result of Factors Influencing Participation in Livelihood Diversification among Maize Farmers

Variable	Coef.	Std. Error	z-value	Odds Ratio
Sex	0.132	0.256	0.516	1.141
Age (years)	-0.023	0.01	-2.30**	0.977
Education (years)	0.115	0.048	2.396***	1.122
Household size (persons)	0.053	0.031	1.71*	1.054
Marital status	0.298	0.278	1.072	1.347
Total farm size (ha)	0.149	0.072	2.069*	1.161
Extension access	-0.198	0.254	-0.78	0.82
Credit access	0.597	0.28	2.132**	1.816
Cooperative membership	-0.345	0.248	-1.391	0.708
Constant	-0.842	0.415	-2.028	0.431
Log-likelihood	-145.872			
LR chi2(9)	45.78			
Prob > chi2	0.000			
Pseudo R2	0.154			

*Note: ***, **, and * implies statistically significance at 1%, 5%, and 10% level*

Livelihood diversification among among Diversified Maize Farmers

Table 4 presents the level of livelihood diversification among the 107 maize farmers who engage in multiple income-generating activities. The mean Livelihood Diversification Index (LDI) was 0.899 with a standard deviation of 0.010, indicating a generally high degree of diversification among these households. Specifically, 11.2% of farmers were classified as having low diversification, 23.4% moderate, 37.4% high, and 28.0% very high, showing that most diversified farmers combine several sources of income.

This pattern suggests that households do not rely solely on maize production but actively engage in complementary non-farm activities to enhance income stability. This aligns with Baah *et al*. (2026) and Lawi et al. (2025), who reported that livelihood diversification among smallholder farmers increases household resilience and spreads risk across multiple income sources. The relatively high mean LDI indicates that maize farmers in Kaduna State are effectively adopting both necessity- and opportunity-driven strategies to manage risk and improve household welfare, consistent with findings by Sallawu *et al*. (2024) and Amaka and Muhammad (2021), who emphasized that diversification contributes to food security, income stability, and adaptive capacity in rural agricultural households.

Table 4: Level of Livelihood Diversification (LDI) among Diversified Maize Farmers

LDI Category	LDI Score Range	Freq.	%
Low	0.870 – 0.880	12	11.2
Moderate	0.881 – 0.890	25	23.4
High	0.891 – 0.900	40	37.4
Very High	0.901 – 0.917	30	28.0
Total		**107**	**100**
Mean LDI		0.899	
Std. dev		0.010	

Relationship between diversification and income security

Table 5 presents the OLS regression results examining the relationship between livelihood diversification and household income, used as a proxy for income security. The model was statistically significant ($F(11,201) = 14.3$, $p < 0.001$) with an adjusted R^2 of 0.408, indicating that the explanatory variables explain approximately 41% of the variation in household income. The results show that participation in non-farm activities positively and significantly influences household income ($\beta = 0.325$, $p < 0.01$), suggesting that farmers engaged in off-farm income-generating activities earn higher total incomes. Similarly, the Livelihood Diversification Index (LDI) had a positive and significant effect ($\beta = 0.298$, $p < 0.01$), indicating that households with greater diversification achieve higher income security. These findings are consistent with Lawi et al. (2025) and Baah *et al*. (2026), who reported that diversification through non-farm activities enhances household resilience, reduces vulnerability, and stabilizes income among smallholder farmers.

Education also showed a positive and significant effect ($\beta = 0.125$, $p < 0.1$), suggesting that more educated farmers are better able to increase household income through both farm and non-farm activities. This aligns with Adegbite et al. (2023) and Issa et al. (2016), who highlighted the critical role of education in improving farmers' capacity to adopt multiple livelihood strategies and optimize income. Access to formal credit was also significant ($\beta = 0.145$, $p < 0.05$), indicating that households with credit facilities are better positioned to invest in diversified activities, supporting findings by Amegnaglo et al. (2024) and Balana and Oyeyemi (2022), who emphasized that access to financial resources facilitates off-farm engagement and improves household economic outcomes.

Table 5: OLS Regression result for the relationship between diversification and income security

Variable	Coefficient	Std. Error	t-value
Participation_non-farm	0.325	0.085	3.824***
Sex	-0.045	0.065	-0.692
Age (years)	-0.03	0.055	-0.545
Education (years)	0.125	0.068	1.838*
Household size	-0.06	0.08	-0.75
Marital status	0.022	0.06	0.367
Farm size	0.055	0.075	0.733
Extension access	0.018	0.062	0.29
Credit access	0.145	0.066	2.197*
Livelihood diversification index (LDI)	0.298	0.081	3.679***
Cooperative membership	-0.02	0.061	-0.328
Constant	42500	17800	2.388
Log likelihood	-1,067.30		
R^2	0.428		
Adjusted_R^2	0.408		
F(11,201)	14.3		
Root_MSE	21100		

*Note: ***, **, and * implies statistically significance at 1%, 5%, and 10% level*

Conclusion and Recommendations

The study concludes that livelihood diversification among maize farmers in Kaduna State is significantly shaped by socio-economic factors such as education, household size, farm size, and access to credit. Participation in non-farm activities and higher diversification levels positively enhance household income, demonstrating that diversification is an effective strategy for improving income security and reducing vulnerability. Policies aimed at strengthening rural livelihoods should therefore focus on promoting educational opportunities, facilitating access to credit, and supporting both farm and non-farm income-generating activities to build resilient and sustainable household economies. Based on these findings, the following recommendations are proposed to enhance livelihood diversification and income security among smallholder maize farmers in Kaduna State:

1. Given that education significantly increased the likelihood of participation in diversification and contributed to higher household income, extension services and training programs should focus on providing both formal and informal education opportunities to equip farmers with the knowledge and skills necessary for engaging in off-farm activities.
2. The positive effect of credit access on diversification and income security highlights the importance of financial support in enabling farmers to invest in additional income-generating activities. Policymakers and microfinance institutions should design targeted credit schemes for smallholder maize farmers to facilitate investment in both farm and non-farm enterprises.
3. Since larger household and farm sizes were associated with greater participation in diversified activities, and higher LDI values improved income security, agricultural policies should encourage households to combine crop production with complementary off-farm activities, providing technical assistance and market linkages to strengthen income stability and resilience.

References

Abdullahi, H. A., Mahmud, W. A., & Oba, A. I. (2022). Appraisal of career agricultural students' perception on farm practical year training experience in University of Ilorin, Nigeria. *Journal of Curriculum and Instruction, 14*(1), 9–18

Adegbite, A., Olusegun, J. I., & Seyi, O. O. (2023). Performance and profitability analysis of maize production: A case of smallholder maize farmers in Osun State, Nigeria. *Chemical Engineering, 3*(1), 9–20.

Adiaha, M. S. (2018). Economic value of maize (*Zea mays* L.) in Nigeria and its impacts on global food production. *International Journal of Scientific World, 6*(1), 27–30.

Alam, M. J., Sarma, P. K., Begum, I. A., Connor, J., Crase, L., Sayem, S. M., & McKenzie, A. M. (2024). Agricultural extension service, technology adoption, and production risk nexus: Evidence from Bangladesh. *Heliyon, 10*(14), 342–360.

Amaka, O. C., & Muhammad, F. (2021). Impact of rural livelihood diversification among rural households in Nigeria. *OIRT Journal of Humanities and Social Sciences, 1*(2), 11–16.

Amegnaglo, C. J., Akpa, A. F., Adjimonti, G. O., & Yessoufou, A. W. (2024). Do credit constraints affect non-farm entrepreneurship entry decisions of rural agricultural households in Benin? *Heliyon, 10*(24).

Baah, A. T., Amewuda, R., Amfo, B., & Esther, N. (2026). Livelihood diversification and food security of maize-growing households in Techiman Municipality of Ghana. *Discover Food.*

Balana, B. B., & Oyeyemi, M. A. (2022). Agricultural credit constraints in smallholder farming in developing countries: Evidence from Nigeria. *World Development Sustainability, 1*, Article 100012.

Belay, T., & Lebeza, T. M. (2024). Livelihood vulnerability of rural households to climate variability and change: An agroecological system-based approach in northwestern Ethiopia. *Heliyon, 10*(23).

Billa, R. N. (2022). Age as a determinant of livelihood strategies and poverty in Maroua. *The Journal of Social Sciences Research, 8*(1), 9–21.

Fatai, K., Issa, F. O., Abdullahi, H. A., & Oba, A. I. (2023). Assessment of the effect of farmer field school activities on the livelihood of smallholder rural cocoa farmers in Kwara State, Nigeria. *Ife Journal of Agriculture*, Special Issue, 93–103.

Food and Agriculture Organization of the United Nations. (2021). *FAOSTAT*

Issa, F. O., Kagbu, J. H., & Abdulkadir, S. A. (2016). Analysis of socio-economic factors influencing farmers' adoption of improved maize production practices in Ikara Local Government Area of Kaduna State, Nigeria. *Agrosearch, 16*(2), 15–24.

Kaduna State Government. (2022). *Kaduna State official profile*. https://kdsg.gov.ng/

Kurantin, N., & Osei-Hwedie, B. Z. (2022). Rural nonfarm income diversification: Implications on tree-crop agricultural sector inequalities and sustainable development in Ghana. In *Globalization, income distribution and sustainable development: A theoretical and empirical investigation* (pp. 117–130). Emerald Publishing Limited.

Lawi, M. B., Omolehin, R. A., & Adeniyi, O. R. (2025). Impact of non-farm livelihood diversification on food security and nutrition: Evidence from North-Eastern Nigeria. *Cogent Food & Agriculture, 11*(1), Article 2534223.

Marechera, G., Sedi, M., & Adebayo, M. A. (2022). Assessment of existing gaps among genders in maize value chain in northern Nigeria. *International Journal of Agriculture Technology, 2*(1), 1–10.

Muhammed, A. O., Abdullahi, H. A., Mani, J. B., Muhammed, A. Z., & Oba, A. I. (2026). Effect of animal traction technology on medium-scale maize farmers' livelihood in Kaduna State, Nigeria. *Zamfara International Journal of Education, 6*(1), 237–244. https://doi.org/10.64348/zije.2026270

National Bureau of Statistics. (2021). *Agricultural performance survey report*. https://nigerianstat.gov.ng/

Nigerian Meteorological Agency. (2021). *Annual climate review bulletin*. https://nimet.gov.ng/

Oba, A. I., Abdullahi, H. A., Afolabi, K. O., Shuaib, S. B., Fatai, K., & Adisa, R. A. (2025). The effects of climate-smart agriculture on rice farmers' food security: Evidence from Nigeria. *Journal of Agricultural Science and Technology, 28*(4).

Omotilewa, O. J., Jayne, T. S., Muyanga, M., Aromolaran, A. B., Liverpool-Tasie, L. S. O., & Awokuse, T. (2021). A revisit of farm size and productivity: Empirical evidence from a wide range of farm sizes in Nigeria. *World Development, 146*, Article 105592.

Oyinbo, O., Damisa, M. A., & Rekwot, G. Z. (2019). Determinants of maize production among smallholder farmers in Northern Guinea Savannah, Nigeria. *Journal of Agricultural Extension, 23*(2), 1–13.

Pawlak, K., & Kołodziejczak, M. (2020). The role of agriculture in ensuring food security in developing countries: Considerations in the context of the problem of sustainable food production. *Sustainability, 12*(13), 5488.

Sallawu, H., Nmadu, J. N., Coker, A. A. A., Mohammed, U. S., & Shuaibu, M. K. (2024). Livelihood diversification strategies and their prioritization among farmers in North Central Nigeria. *South Asian Journal of Social Studies and Economics, 21*(12), 1–9.

Sultana, N., Hossain, M. E., & Islam, M. K. (2015). Income diversification and household well-being: A case study in rural areas of Bangladesh. *International Journal of Business and Economics Research, 4*(3), 172–179.