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EFFECT OF AGRICULTURAL DIVERSITY ON FARMING HOUSEHOLDS' FOOD SECURITY IN KEBBI STATE

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ABSTRACT

*This study examined the effect of agricultural diversification on food security among farming households in Kebbi State, Nigeria. Using primary data collected from 142 households across eight rural communities, the analysis employed Simpson's Diversity Index (SDI) and a binary Logit regression model. The results showed that food insecurity is prevalent, with 51.4 % of households classified as food insecure, a 12.78 % food security gap**,** and **a** severity index of 7.31 **%.** The food security line was estimated at ₦45,521.55 per month, indicating the minimum income required for basic food access. Simpson's Diversity Index revealed a high level of agricultural diversification (SDI = 0.8680), characterised by a mix of crops (maize, sorghum, millet and livestock (cattle, goats, poultry. The Logit regression analysis identified farm size ($p<0.01$), family labour ($p<0.05$), years of diversification (negatively, $p<0.01$), cooperative membership ($p<0.10$), diversification index ($p<0.10$), and farming experience ($p<0.05$) as significant determinants of household food security. Notably, longer years of diversification had a negative effect, possibly due to inefficient*

enterprise combinations or low productivity. The model demonstrated strong explanatory power (pseudo R^2 = 0.5890). It is concluded that while high agricultural diversity exists, it does not uniformly translate to improved food security, suggesting the need for more strategic, resource-efficient diversification. Policy recommendations include promoting well-informed enterprise combinations, cooperative membership, and sustained extension support to improve rural food security outcomes.

Keywords: Farming households, Agricultural diversification, Food security, Kebbi State, Logit regression

INTRODUCTION

Achieving global food security by 2030 is increasingly threatened by rising hunger, particularly in sub-Saharan Africa. Recent estimates indicate that the number of undernourished people worldwide rose to 815 million in 2024, with the highest rates recorded in sub-Saharan Africa, South-Eastern Asia, and Western Asia (FAO *et al.*, 2023). Nigeria, as Africa's most populous country, faces persistent food insecurity, worsened by climate variability, poverty, conflict, and low agricultural productivity (*Ogunleye et al.*, 2023). In response to economic challenges, such as declining oil revenues, Nigeria has prioritised agricultural diversification to enhance food security. However, production patterns remain skewed toward a few staple crops, which account for over 90% of cultivated crops, while high-value food items such as dairy, tomatoes, and fish make up less than 4% (Explore Kebbi, 2023). This limited diversity weakens food systems, restricts nutritional intake, and increases vulnerability to shocks.

Agricultural diversification is the cultivation of multiple crops and livestock, and the adoption of integrated farming systems, which serves as a foundational strategy for strengthening food security. It enables farmers to spread risk across species and production cycles, reduces dependence on a few staple commodities, and improves year-round food supply. Beyond food production, diversified systems enhance soil health, improve income streams, and increase dietary variety, which is vital for nutrition. In areas like Kebbi State, where monoculture is common, promoting crop-livestock integration, intercropping, and the inclusion of high-value or climate-resilient crops could significantly improve food access and household resilience (Yusuf *et al.*, 2022). Yet, in many parts

of Nigeria, including Kebbi State, diversification remains low due to limited mechanisation, inadequate extension support, poor access to inputs, and growing insecurity.

Despite interventions such as the Anchor Borrowers' Programme and the Fadama initiatives in Kebbi State, a major rice-producing region, many smallholder farmers remain constrained by traditional farming practices and subsistence-level operations. Climate-related challenges, such as flooding and drought, combined with poor post-harvest infrastructure, further reduce productivity and food availability (GAERSHUB, 2025). Food security involves consistent physical, social, and economic access to safe and nutritious food, and is built on four pillars: availability, access, utilisation, and stability (FAO, 2008). Ensuring food security requires not only boosting food production but also promoting agricultural diversification and strengthening local food systems.

Objectives of the study

The broad objective of this study is to analyse the effect of agricultural diversity on the food security of farming households in Kebbi State. The specific objectives are to:

1. analyse the Food security status of respondents
2. determine the effect of agricultural diversity on Farming households' levels of food
3. Assess the **level of agricultural diversification** among farming households in the study area.

RESEARCH METHODOLOGY

The Study Location

The study was conducted in Kebbi State. The capital of the state is Birnin Kebbi, located in northwestern Nigeria. A part of Sokoto State was divided to create the state in 1991. Kebbi State is bordered by Sokoto State, Niger State, Zamfara State, the Dosso Region in the Republic of Niger, and Benin. Its total area is 36,800 km² (14,200 sq mi), making it one of the largest states in Nigeria by landmass. Its location within the Sudan–Sahel ecological zone contributes to its predominantly savannah vegetation and semi-arid climate. Thirty-five districts, twenty-one Local Government Areas (LGAs), and the four emirate councils of Yauri, Zuru, Gwandu, and Argungu comprise Kebbi State. And 4,440,050 individuals were residing there as of the 2016 population census,

projected to a 2024 growth rate (NPC, 2006). As of 2024, Kebbi State's estimated population is approximately 6.0 million, based on an annual growth rate of 3.98% from the 2022 figure of 5.56 million. This projection aligns with demographic trends observed in northern Nigeria. Geographically, Kebbi State lies approximately between latitudes 10°00′ and 13°00′ North and longitudes 3°30′ and 6°00′ East, while the state capital, Birnin Kebbi, is situated at around 12.4661° N latitude and 4.1995° E longitude.

Sampling Procedure and Sample Size

This study employed a multistage sampling technique to select farming households in Kebbi State to examine the effect of agricultural diversity on food security. In the first stage, four Local Government Areas (LGAs), Argungu, Birnin Kebbi, Zuru, and Yauri**,** were purposively selected due to their high agricultural diversity and ecological variation. These LGAs represent the diverse agroecological zones of Kebbi State, making them suitable for the study's objectives. In the second stage, two rural farming communities were randomly selected from each LGA using simple random sampling, yielding a total of eight communities. This approach ensured an unbiased representation of farming households across the LGAs. In the final stage, a comprehensive list of farming households was obtained from agricultural extension officers in each selected community. Simple random sampling was applied to select individual households to participate in the study, thus ensuring each farming household had an equal probability of selection and minimising sampling bias.

Sample Size Determination

The sample size was calculated using **Yamane's (1967)** formula for finite populations:

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

Where:

n= sample size

N = total population of farming households in the selected communities

e= desired level of precision (0.05), corresponding to a 95% confidence level

Based on data obtained from the Kebbi State Agricultural Development Programme, the estimated total population of farming households across the selected communities was 500**.** Applying Yamane's formula:

$$n = \frac{500}{1+500(0.05)2} = \frac{500}{1+500\times0.0025} = \frac{500}{2.25} \approx 142$$

To ensure equitable representation, a sample of 142 farming households was deemed appropriate for the study. Proportionate sampling was applied based on the size of the farming household population (sampling frame) in each selected community. Consequently, the number of households selected per community was calculated as a proportion of the total number of households across all eight communities. Household selection within each community was conducted using simple random sampling, drawing from updated household registers.

Table 1: Sampling Frame and Sample Size

S/N	Local Government Area	Selected Communities (Villages)	Sampling Frame (Households)	Proportional Sample Size
1	Argungu	Alwasa, Giyawa	180	37
2	Birnin Kebbi	Fadama Sarki, Zauro	150	31
3	Zuru	Dabai, Senchi	120	25
4	Yauri	Shanga, Tondi-Gada	100	21
	Total	**8 Communities**	**550**	**114**

Source: Author Construct, 2025

Data Collection Procedures

Primary data for this study were collected through structured questionnaires administered to the sampled farming households across the selected communities in Kebbi State. The questionnaire was designed to gather information on household demographics, types and quantities of crops and livestock produced (to assess agricultural diversity), farming practices, and various dimensions of food security, including food availability, access, utilisation, and stability. Additionally, key informant interviews with agricultural extension officers and community leaders supplemented the household survey, providing qualitative insights into local agricultural practices and food security challenges. The questionnaire was pre-tested in a pilot community to validate its effectiveness and clarity, and necessary adjustments were made prior to the main data collection.

Data Analysis Procedures

Data collected were first checked for completeness and consistency before being coded and entered into statistical software (SPSS) for analysis. Data were analysed using both descriptive and inferential statistics.

Simpson Diversification Index

The Simpson Diversification Index (SDI) was used to measure the level of livelihood diversification among the respondents. The Simpson index was used to assess the diversity of household strategies in the study area. The Simpson index was used because the index is simple to compute, robust, and widely applicable.

The Simpson index ranges from 0 to 1. The index value is zero when there is complete specialisation, and it approaches 1 as the level of diversification increases (Ashfaq *et al.*, 2018).

The formula for the Simpson Diversification Index is given as:

$$\text{SDI} = 1 - \frac{\sum n-1}{\text{N}(\text{N}-1)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where SDI is the Simpson Diversification Index, N is the total number of livelihood sources. Based on the SDI values, the level of livelihood diversification is defined as:

- No diversification (SDI = 0)
- Low level of diversification (SDI = 0.00001 - 0.2500.
- Medium level of diversification (SDI=0.2501-0.4500)
- High level of diversification (SDI= >0.4501)

Logit Regression Analysis Specification of the Model

Logit Regression Analysis is an inferential statistical tool that describes the relationship between a censored continuous dependent variable yi and a vector of independent variables xi.

Yi is the dependent variable, and X1– X10 are the independent variables.

The general Logit regression model is mathematically expressed as:

$Y = \alpha + \beta o + \beta 1X1 + \beta 2\ X2 + \beta 3X3 + \beta 4X4 + \ldots + \beta 10X10 + U$…….. (2)

Where Y = Food security (Implying a binary dependent variable valued as 1= when households are food secure and 0= when otherwise

.X_1 = Farm size (ha)

X_2 = Extension visit (1 for access 0, otherwise)

X_3 = Family labour (Man days)

X_4 = Years of diversification (Number)

X_5 = Age (Years)

X_6 = Distance to market (KM)

X_7 = Cooperative Membership (1 for member, 0 otherwise

X_8 = Household size (Number)

X_9 = Diversification index (1 for diversification, 0 otherwise)

X_{10} = Farming experience (Years)

U = Error term

Bi = Constant term

$B_1 - \beta_{11}$ = Regression coefficients estimated.

RESULTS AND DISCUSSION

Table 1: Food security status classifies households based on their ability to access adequate and nutritious food. The food security line defines the minimum level required to meet basic dietary needs. Food security incidence shows the proportion of households below this line. The gap and severity indices measure how far and to what extent households fall below the threshold.

Table 1: Food security status of respondents

Variable	Frequency	Percentage
Food secure	69	48.6
Food insecure	73	51.4
Total	157	100.0
Food security line / month	₦45,521	
Food security incidence	0.4814	
Food security gap	0.1278	
Severity of food insecurity	0.0731	

Source: Field Survey, 2024

Table 2: Binary logistic regression estimates the effect of agricultural diversity on the likelihood of a household being food secure. Households were classified as either food secure (1) or food insecure (0). Variables like crop variety and livestock types were analysed. Results show how these factors increase or decrease the chances of food security.

Table 3: The Simpson Diversification Index quantifies the variety and balance of crops and livestock produced by households. Higher values indicate greater agricultural diversity. This diversity enhances resilience, nutrition, and risk management. The respondents' results reveal their level of crop and animal diversification.

Table 2: Logit regression analysis of the effect of agricultural diversity on Farming households' levels of food security

Variables	Coefficients	Standard Error	z – value
Constant	-8.3145 ***	2.0909	-3.98
Farm size (X_1)	1.2268 ***	0.4591	2.67
Extension visits (X_2)	0.2082	0.3208	0.65
Family labour (X_3)	0.0212 **	0.0091	2.34
Years of diversification (X_4)	-0.1213 ***	0.0431	-2.82
Age (X_5)	-0.0133	0.0452	-0.29
Distance to market (X_6)	-0.1960	0.1339	-1.46
Cooperative membership (X_7)	1.8238 *	0.9626	1.89
Household size (X_8)	-0.0672	0.0620	-1.08
Diversification index (X_9)	2.2587 *	1.2972	1.74
Farming experience (X_{10})	0.1045 **	0.0486	2.15
Pseudo R-squared	0.5890		
Chi-squared	0.0000		
Log likelihood function	-40.429264		

Source: Field survey, 2024. *p < 0.10 **p < 0.05 *** p < 0.01

DISCUSSION

Respondents' Status Regarding Food Security The food security line for each household was calculated to determine the respondents' food security status. The households were then classified

as either food-secure or food-insecure. The findings, as shown in Table 1, indicate that the majority of respondents (51.4%) experienced food insecurity. Amaza's (2016) study in Borno State reported an index of 0.58 (58.0%), according to Fidausi *et al*. (2020). The food security line, on the other hand, represents the minimum monthly household income needed to be food secure and is currently set at ₦45,521.55

Table 3: Simpson Diversity Index Components for Crop and Livestock Species among Farming Households in Kebbi State

S/N	Agricultural Variable	Category	Mean Proportion (p)	Squared Proportion (p^2)
1	Maize	Crop	0.25	0.0625
2	Sorghum	Crop	0.15	0.0225
3	Millet	Crop	0.10	0.0100
4	Rice	Crop	0.05	0.0025
5	Cowpea	Crop	0.08	0.0064
6	Groundnut	Crop	0.07	0.0049
7	Vegetables	Crop	0.03	0.0009
8	Cattle	Livestock	0.12	0.0144
9	Sheep	Livestock	0.06	0.0036
10	Goats	Livestock	0.07	0.0049
11	Poultry	Livestock	0.02	0.0004
	Total		**1.00**	**0.1320**
	Simpson's Diversity Index (SDI)			**0.8680**

Source: Field survey, 2025 ($126).

Furthermore, the degree to which households fell below the food security line was indicated by the food security gap of 0.1278 (12.78%), and the severity of food insecurity was 0.0731 (7.3%). The

study's implications are that over half of the respondents are food insecure, indicating a significant challenge in meeting basic food needs. The depth and severity indices highlight both the financial burden and inequality among food-insecure households. These findings call for targeted agricultural, financial, and social interventions to improve food access and resilience. The findings are in line with those of Amaza (2016), who found that the differences in food security and its severity were 13.6% and 8.2%, respectively.

Effect of Agricultural Diversification on Respondents' Food Security Situation

The influence of agricultural diversification on respondents' food security status was empirically determined using the Logit regression analysis in Table 2. The findings showed that the pseudo-R-square was 0.5890, meaning that the independent variables in the model accounted for 58.9% of the variation in food security status. Out of the ten variables in the model, six independent variables (farm size (1.2268), family labor (0.0212), years of diversification (-0.1213), cooperative membership (1.8238), diversification index (2.2587), and farming experience (0.1045) were statistically significant at different probability levels The number of years that the respondents had engaged in agricultural diversification, the age of the heads of the households, the distance to the market, and the size of the households all indicated a negative correlation with their level of food security. On the other hand, the respondents' food security status was directly correlated with factors such as farm size, number of extension visits, family labour, cooperative membership, diversity index, and farming experience, all of which had positive coefficients. However, the cooperative membership and diversification index were not very significant. Ashfaq *et al*. (2018) found a direct correlation between respondents' food security status and socioeconomic characteristics, including family size, employment status, gender, and income.

A negative coefficient for years of diversification indicates that longer diversification does not always lead to improved food security. This could be due to limited access to quality inputs, poor farming practices, or environmental challenges that erode the benefits of diversification over time. It may also reflect that simply diversifying for many years without adopting modern techniques or market access fails to significantly improve household food security.

Simpson Diversification

Table 3 shows that the calculated Simpson’s Diversity Index (SDI) of 0.8680 suggests that farming households in Kebbi State maintain a high level of agricultural diversification. This implies that

agricultural activities are distributed among a variety of crops and livestock species rather than being concentrated on a few dominant ones. The closer the SDI value is to 1, the greater the diversity, reflecting reduced dependence on a single commodity and increased resilience to economic and environmental shocks. The results show that maize (25%), sorghum (15%), and cattle (12%) constitute the most significant components of agricultural production. However, other crops (e.g., millet, cowpea, groundnut, vegetables) and livestock (e.g., goats, sheep, poultry) are also represented, albeit in smaller proportions. This pattern aligns with Amaza's (2016) findings, which argue that mixed farming systems improve household income stability and food security in semi-arid zones of sub-Saharan Africa.

Furthermore, diversification strategies have been recognised by organisations like the FAO (2018) as a key coping mechanism for climate variability and market fluctuations. In contexts like Kebbi State, where agro-climatic risks are prevalent, the observed diversity indicates a conscious adaptation strategy by farmers to buffer against uncertainties. In summary, the SDI value supports the conclusion that farming households in Kebbi State employ broad-based production systems that enhance their ecological and economic sustainability.

CONCLUSION AND RECOMMENDATIONS

Based on the findings, it is determined that a sizable portion of the rural population in the study area experienced food insecurity, that there is a high level of agricultural diversification, and that enterprise diversification and other social and economic factors contribute to food security in rural households. Based on the findings, the study recommends that the government should:

1. Implement land reform policies that facilitate access to larger and more productive farm plots for smallholder farmers, alongside promoting sustainable intensification practices such as improved seed varieties and efficient input use.

2. Establish regular extension programs and workshops to educate farming households on effective combinations of crops and livestock enterprises, emphasising evidence-based enterprise appraisal to maximise the benefits of agricultural diversification.

3. Support and strengthen farmer cooperatives and community groups to foster knowledge sharing, joint investment in inputs, and collective marketing, which can enhance enterprise diversification and improve food security outcomes.

Future Research Directions

Future studies should explore the impact of climate-smart diversification strategies on household food security under varying environmental conditions. Additionally, investigating the role of gender dynamics and access to credit in agricultural diversification could provide deeper insights into tailored interventions. Longitudinal research assessing the sustainability of diversification benefits over time would also help inform policy design.

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