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# DETERMINANTS OF HOUSEHOLD DIETARY DIVERSITY AND CONSUMPTION PATTERNS OF SELECTED FOOD GROUPS AMONG RURAL HOUSEHOLDS IN NIGERIA'S NORTHEAST AND NORTHWEST REGIONS

**Adeyemi KD[1]*, Ibiyemi T[2], Adeyemi B[3], Taiwo O[4] and CS Fasinasi[5]**

**Kolawole David Adeyemi**

*Corresponding author email: kolawole.adeyemi@ttu.edu

[1]Department of Nutritional Sciences, Texas Tech University, P.O. Box 41270, Lubbock 79409- 1270, Texas, USA

[2]Department of Agriculture and Nutrition Science, Southern Utah University, 351 W University Blvd, GC 203, Cedar City, UT, USA

[3]Department of Soil, Water, and Climate, University of Minnesota, 439 Borlaug Hall 1991 Upper Buford, Circle St. Paul, MN, USA

[4]Independent Researcher

[5]Department of Nutrition and Dietetics, Ambrose Alli University, Ekpoma Edo State, Nigeria

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## ABSTRACT

This study explored the factors affecting dietary diversity among rural households in Northwest and Northeast Nigeria. It utilized the fourth-round survey data from 1,418 households across five states (Adamawa, Borno, Katsina, Yobe, and Zamfara), collected by the Data in Emergencies (DIEM) Monitoring System under the United Nations Food and Agriculture Organization (FAO). Household Dietary diversity was measured on a 0–12 scale, and its determinants were analyzed using Poisson regression. The findings revealed moderate dietary diversity, with an average Household Dietary Diversity Score (HDDS) of 6.4 (SD ± 2.7) on a 0–12 scale. Households predominantly consumed starchy foods, with cereals reported by 94.7% of the respondents.

Several factors were identified to significantly influence household dietary diversity (HDDS). Larger household size was negatively associated with HDDS (β = -0.0323, SE = 0.0052, $p < .0001$), as was severe food insecurity, which was inversely related to dietary diversity (β = -0.3103, SE = 0.0635, $p < .0001$). Additionally, regional disparities were observed, with households in Yobe (β = -0.0924, SE = 0.0370, p = .0127) and Zamfara (β = -0.1171, SE = 0.0356, $p = .0010$) reporting significantly lower HDDS compared to those in Adamawa. Households engaged in crop production (β = -0.1564, SE = 0.0445, $p = .0005$), livestock production (β = -0.1458, SE = 0.0449, $p = .0012$), or combined crop-livestock farming (β = -0.1481, SE = 0.0535, $p = .0057$) also exhibited lower HDDS, likely due to the subsistence nature of agriculture in these regions. In contrast, higher income was positively associated with HDDS (β = 0.1493, SE = 0.0588, $p = .0112$). Interestingly, exposure to shocks was also linked to increased household dietary diversity (β = 0.1452, SE = 0.0236, $p < .0001$), suggesting possible short-term adaptations. These findings highlighted the urgent need to improve household dietary diversity in Northeast and Northwest Nigeria through region-specific interventions. Efforts should prioritize diversifying livelihoods by promoting income-generating activities beyond agriculture, such as small-scale businesses, while also encouraging agricultural practices that move beyond subsistence farming. Additionally, implementing safety nets, including cash transfers and food assistance, will help mitigate the impacts of shocks and build resilience. Together, these strategies will foster sustainable improvements in dietary quality and food security in the regions.

**Key words:** Dietary Diversity, Food Insecurity, Food Groups, Rural Households, Northern Nigeria

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## INTRODUCTION

Dietary diversity is a crucial indicator of household food security and nutritional adequacy, particularly in populations with limited access to diverse and nutrient-rich foods [1,2]. It reflects the range of food groups consumed over a given period, serving as a key measure of diet quality and the ability to meet essential nutritional needs [3]. A diverse diet is associated with significant health benefits, including improved child growth, enhanced birth outcomes, better micronutrient status, and reduced risks of chronic diseases such as cardiovascular conditions and certain cancers [4,5]. Thus, dietary diversity is not merely a marker of variety but a critical component of overall health and well-being.

Moreover, dietary diversity is linked to food security, defined as having reliable access to sufficient, affordable, safe, and nutritious food [6]. It serves as a proxy measure for food security because it reflects both the economic ability of households to access a variety of foods and the nutritional quality of the diet [7,8]. Previous studies have shown that households with higher dietary diversity scores are generally more food secure and have better nutritional outcomes [6,9].

Globally, food insecurity, recognized as a determinant of low dietary diversity [6,9], remains a critical global public health issue, undermining progress toward the Sustainable Development Goals (SDGs), particularly the goal to end hunger [10]. In 2022, 9.2% of the global population experienced chronic hunger, while nearly 30% faced moderate to severe food insecurity [11]. Developing regions, especially parts of Africa and Asia, bear the brunt of these challenges [11].

Nigeria, Africa's most populous nation [12], faces an alarming food insecurity crisis, ranking 109th out of 125 countries on the Global Hunger Index [10]. Over two-thirds of its population experienced moderate to severe food insecurity in 2022 [11], with the burden disproportionately affecting the Northern regions [13]. Northern Nigeria, particularly the Northeast and Northwest is grappled with acute food insecurity, compounded by low dietary diversity. Rural households in these areas predominantly consume starchy staples like cereals (maize, rice and sorghum) and tubers [14,15], resulting in diets deficient in essential micronutrients and proteins [16,17]. This nutritional gap contributes to widespread malnutrition, including stunting, wasting and underweight prevalence, which are among the highest in the country [18].

This nutrition and food security crisis in Northern Nigeria is exacerbated by shocks such as socio-economic inequalities, environmental challenges, and ongoing conflicts [19]. Factors such as household size, agricultural practices, climate variability, income levels and education significantly shape food security and dietary diversity in this region [19,20,21]. However, persistent insecurity and banditry further

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disrupt agricultural production, livelihoods, and access to food, deepening the nutritional crisis [22,23].

Despite existing research, the complex interplay of factors influencing dietary diversity in Northern Nigeria remains insufficiently understood, particularly in the conflict-affected Northwest and Northeast regions. Escalating insecurity has disrupted food systems, livelihoods and nutritional stability, highlighting the critical need for research to understand these dynamics. Gaining a deeper understanding of these interactions is vital for tackling malnutrition and food insecurity, while also guiding interventions and policies to address regional disparities and strengthen resilience in vulnerable rural communities.

This study aims to analyze regional variations in household dietary diversity scores among rural households across the Northeast and Northwest regions of Nigeria, while identifying their primary determinants of dietary diversity. By addressing these objectives, the research seeks to generate actionable, evidence-based recommendations to enhance food security and support sustainable nutrition outcomes in these vulnerable regions.

## MATERIALS AND METHODS

### Study Design

The detailed study design for the data used in this study can be found in the methodology section of the DIEM brief [24]. Specifically, this study utilized data from the fourth-round household survey of the Data in Emergencies Monitoring (DIEM) System in Nigeria, collected cross-sectional in 2023 [24]. The DIEM-Monitoring system was developed under the auspices of the Food and Agriculture Organization (FAO) of the United Nations [25]. Its primary goal is to gather data from households and key informants in countries susceptible to various shocks [25]. The DIEM-Monitoring system conducts household surveys to monitor agricultural livelihoods and food security in Nigeria and other countries.

### Study Population, Setting, and Data Collection

The DIEM methodology, previously detailed in the fourth-round Nigeria DIEM brief [24], employs a two-stage stratified cluster sampling design. In the first stage, clusters are selected using probability proportional to population size within each stratum. In the second stage, households are randomly chosen within each selected cluster. Data collection was conducted by DIEM-recruited data collectors using Computer-Assisted Telephone Interviews (CATI) across Adamawa, Borno, Katsina, Yobe, and Zamfara states in Nigeria (Figure 1). A total of 1,418 rural households were surveyed, with data collection occurring at the onset of the lean season. The data was weighted based on population counts. The weighting procedure accounts

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for demographics distribution across the selected states. This ensured the survey results were representative of the population in those states.

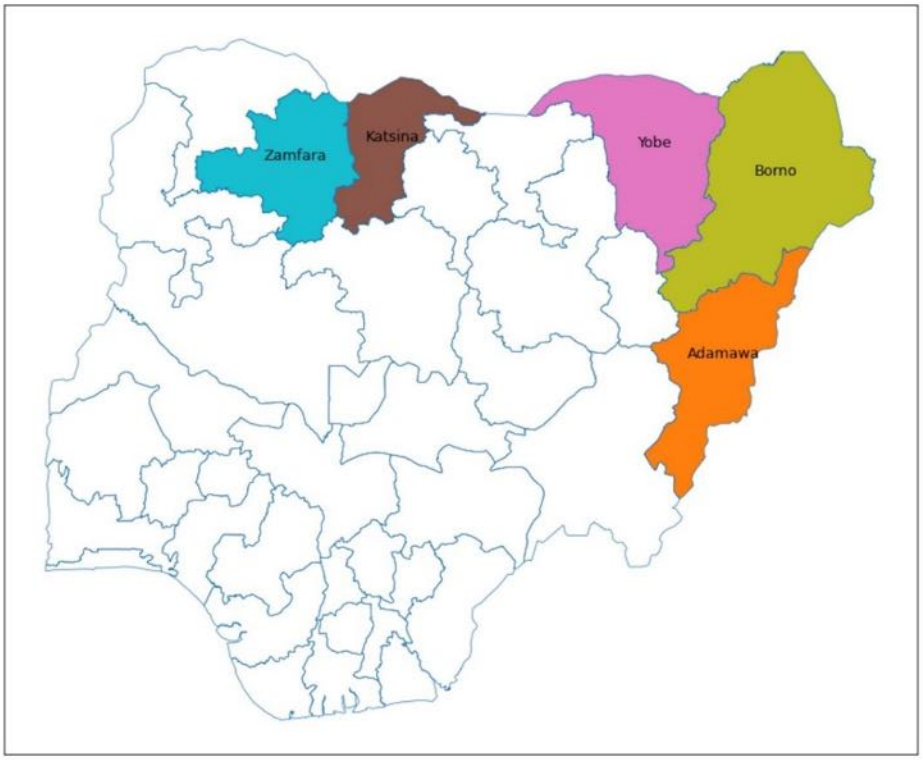


**Figure 1: Map of Nigeria showing the study locations**

## Measurements of Indicators

### *Household Dietary Diversity Score (HDDS)*

In this study, the HDDS was calculated by summing up the number of food or food groups eaten over the past 24 hours by any household member [26]. The food groups considered in the HDDS calculation included cereals, roots and tubers, vegetables, fruits, meat, eggs, fish, legumes, milk and dairy, oils, sugar, and condiments. Higher dietary diversity was indicated by a higher score, ranging from 0 to 12. The HDDS scale was used as a continuous and categorical variable for analysis. For categorical HDDS, scores were divided into categories: high dietary diversity (7-12), medium dietary diversity (4-6), and low dietary diversity (0-3) [27]. The HDDS provides insight into a household's economic capacity to access a variety of foods and has become the most widely used indicator for assessing households' economic access to food [28].

### *The Food Insecurity Experience Scale (FIES)*

The Food Insecurity Experience Scale (FIES) was used to assess food insecurity in the 30 days preceding data collection, as described in the FAO methodology [29]. Developed by the FAO, the FIES measures the severity of food insecurity as a latent

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SCHOLARLY, PEER REVIEWED
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February 2025
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trait caused by insufficient money or resources. The FIES questionnaire consists of 8 binaries (yes/no) questions, categorized into mild, moderate, or severe food insecurity. The highest possible FIES raw score is 8, with "yes" responses coded as 1 and "no" responses as 0. According to the FAO's Voices of the Hungry project [29], the raw scores are classified as follows: food secure (score of 0), mildly food insecure (score of 1–3), moderately food insecure (score of 4–6), and severely food insecure (score of 7–8) [29]. For this study, the FIES was re-classified into food secure (score of 0), mildly-moderate food insecure (score of 1-6), and severe food insecure (score of 7-8).

### *Covariates*

Households' socio-economic and demographic variables were collected through Computer Assisted Telephone Interviews (CATI) using a household-level questionnaire. Although the DIEM dataset encompasses a wide range of factors related to food insecurity (HFI) and livelihood, this analysis concentrated on a subset of variables: household size, education level of the household head, agricultural activity, household income, cultivated land size, household food insecurity status, and exposure to shocks. The gender of the household head was categorized as either male or female. Education level of the head of household was classified into five categories: no education/did not complete primary school, completed primary school, completed secondary school, completed higher education (university/college) degree, and religious or informal education. Agricultural activity was divided into four groups: none, livestock production, crop production, and livestock and crop production. Household income was measured as the total income in the three months preceding the interview. Exposure to shocks was recorded as a binary variable (yes/no). For this study, all types of shocks were combined, including higher food and fuel prices, drought, illness or death of a household member, violence and insecurity, plant and animal diseases, pest outbreak, loss of employment, floods, theft, and other economic shocks. Food insecurity was categorized as moderate food insecurity and severe food insecurity. Household size, household income, and total cultivated land size were continuous variables.

### *Statistical Analysis*

All statistical analyses were performed using R within the R-Studio environment (version 2023.06.2+561). The "Survey" package was utilized to handle the complex sampling design and weights, ensuring the population-level representativeness of the results. Consequently, findings were reported based on the weighted sample size (N). Household size, income, and total cultivated land size were reported as the mean and standard deviation (SD), while categorical data were presented as proportions. Furthermore, Poisson regression analysis was conducted to identify the factors influencing HDDS. The Household Dietary Diversity Score (HDDS) was

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February 2025
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treated as a count-dependent variable [8]. Explanatory variables include demographic and socio-economic characteristics such as location (states), household size, level of education of the head of household, total household income (USD for 3 months), household agricultural activity, household food insecurity (moderate and severe), and households' exposure to shocks. To handle outlier values in household cultivated land size and income variables, Interquartile Range (IQR) method was applied [30]. Outliers identified were replaced with the median value of the household land size and income variables. This helped to reduce the influence of extreme values and ensure a more accurate representation of the data in the analyses.

In examining the determinants of Household Dietary Diversity (HDD), literature suggests three different analytical models: the Poisson regression model, which treats HDD as count data [1], the ordered logit model, which considers HDD as ordered values [8], and the multinomial logit model, which views HDD as categorical but non-ordered values [31]. In this study, the Poisson regression model was utilized because HDDS is a count variable ranging from 0 to 12. This model is ideal for handling the discrete nature of the data [1], allowing for a more accurate examination of the factors affecting HDDS. The coefficients from the Poisson regression were interpreted as semi-elasticities, showing the percentage change in HDDS for a one-unit change in the explanatory variable. The Generalized Variance Inflation Factor (GVIF) was used to evaluate the presence of multi-collinearity in the regression analysis [32]. Multi-collinearity occurs when independent variables are highly correlated, leading to unreliable estimates of regression coefficients [32]. In this study, all variables have GVIF values close to 1, and their transformed GVIF values are also close to 1. This indicates no significant multicollinearity among the independent variables in the model. Therefore, the estimates of the regression coefficients are likely to be reliable.

## RESULTS AND DISCUSSION

### Descriptive Characteristics

In this study, as shown in Table 1, most households were male headed (95.8%), with most heads (65.3%) between 41 and 65 years old and having a secondary school education. The average household size was 7.22 members, and crop production emerged as the households' primary agricultural activity (45.6%). On average, households cultivated 1.46 hectares of land and earned $468.61 in the three months preceding the survey.

Regarding shocks, 38.5% of households reported experiencing at least one shock, with the highest prevalence observed in Borno State (55.8%). Notably, households

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SCHOLARLY, PEER REVIEWED
Volume 25 No. 2
February 2025
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in Adamawa reported the largest cultivated land size (1.64 hectares), while Zamfara had the highest household income ($510.46).

**Household dietary diversity and food insecurity status of the participants**

This study provided valuable insights into household dietary diversity and food insecurity in Northern Nigeria, highlighting regional disparities and patterns in food consumption (Table 2). The mean Household Dietary Diversity Score (HDDS) across the sample was 6.4 (SD ± 2.7) on a scale of 0–12, indicating moderate dietary diversity. Katsina recorded the highest mean HDDS at 6.8, while Yobe and Zamfara reported the lowest mean scores of 6.0, reflecting less diverse diets (Table 2). These disparities corresponded to socioeconomic conditions and food access variations across the states.

Food insecurity remains a significant challenge, with 41.56% of households categorized as moderately or severely food insecure. Zamfara exhibited the highest prevalence of food insecurity, affecting 46.5% of households (Table 2). Such findings aligned with the lower dietary diversity scores observed in the state, underscoring the relationship between food insecurity and limited dietary options.

In terms of food group consumption, cereals were the most widely consumed food group, reported by 94.7% of households, followed by condiments (85%) and oils (76.3%) (Figure 2, Table 3). While consistent across states, this reliance on staples suggests limited access to nutrient-rich food groups, which may contribute to nutritional inadequacies. These findings highlighted the need for target interventions to improve dietary diversity and reduce food insecurity, particularly in regions with lower HDDS and higher rates of food insecurity.

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February 2025
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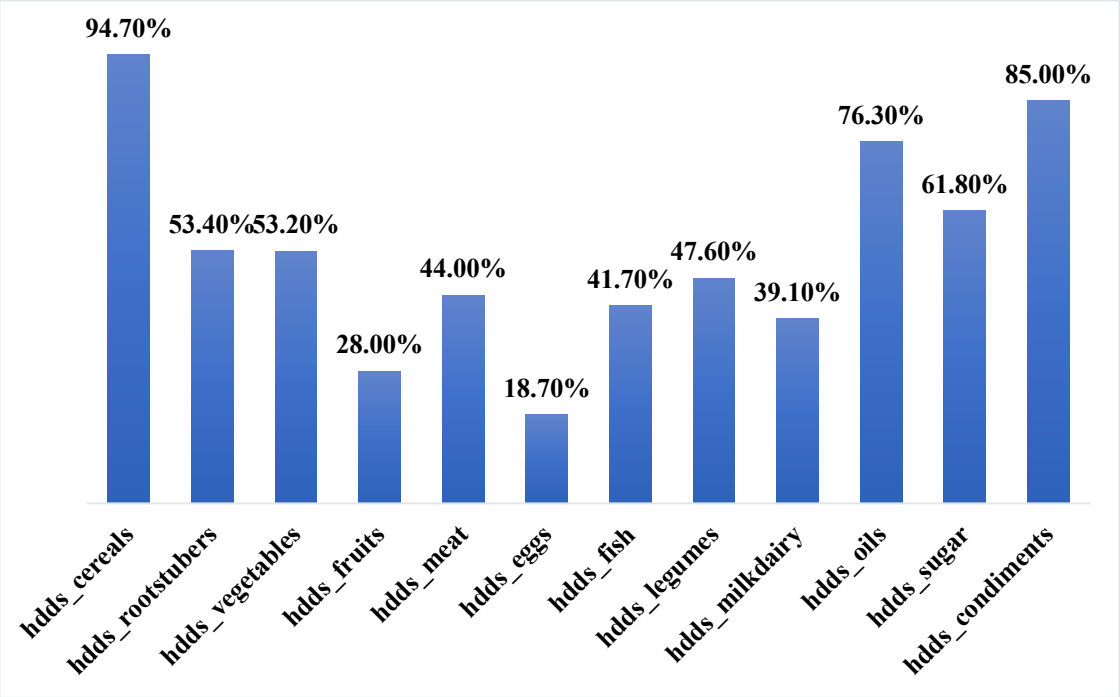


**Figure 2: Food groups consumed by sampled households**

## Predictors of Household Dietary Diversity

The findings of this paper on household dietary diversity among rural households in Northeast and Northwest Nigeria revealed critical insights into the factors influencing dietary patterns and the broader implications for food security in the regions. The Poisson regression analysis revealed several key determinants of Household Dietary Diversity Score (HDDS) among households in Northern Nigeria (**Table 4**). The intercept, with a coefficient of 2.2178 ($p < .0001$), served as the baseline HDDS when all predictors are at their reference levels. Compared to Adamawa, households in Zamfara and Yobe have significantly lower HDDS with coefficients of -0.1171 ($p = .0010$) and -0.0924 ($p = .0127$), respectively.

## Household Income and Size

Higher household income was positively associated with HDDS, with a coefficient of 0.1493 ($p = .0112$), reflecting an approximate 16.1% increase in HDDS per unit increase in household income. In contrast, Household size negatively affected HDDS, with a coefficient of -0.0323 ($p < .0001$), indicating a 3.2% decrease in HDDS for each additional household member. The finding that Household income was positively associated with dietary diversity suggests the ability of wealthier households to afford a broader range of food items. This positive relationship also emphasizes the importance of economic empowerment and livelihood diversification as strategies to enhance dietary quality. These findings also suggested that as the number of household members increased, the economic burden of feeding each individual limited access to a diverse range of foods. Larger households may also

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Volume 25 No. 2
February 2025
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face challenges in balancing food preferences and availability, particularly when resources are scarce. This finding is consistent with research conducted in Ethiopia, where larger household sizes were associated with reduced dietary diversity due to resource constraints [33].

### Agricultural activity and shocks

Households that engaged in agricultural activities, particularly crop and livestock production, had significantly lower HDDS, with coefficients ranging from -0.1458 to -0.1564 ($p < .001$ for all), indicating a reduction in household dietary diversity compared to households not engaged in these forms of agriculture activities. This counterintuitive finding may be attributed to the subsistence nature of agriculture in the region, where households may prioritize staple crops for sustenance, thus limiting their access to more diverse food options. Similar observations have been made in rural parts of Nigeria, where subsistence farming households had lower dietary diversity due to limited market integration and reliance on staple crops [34]. Households that experienced shocks had a significantly higher HDDS, with a coefficient of 0.1452 ($p < .0001$), suggesting that these shocks may have prompted changes in food-sourcing strategies, leading to increased HDDS. Shocks, including economic downturns, consistent insurgency, wars, or climate-related events, can alter household food-sourcing behaviors, potentially leading to short-term increases in dietary diversity. However, this adaptive response may not be sustainable, and prolonged exposure to shocks could exacerbate food insecurity and dietary monotony over time [35,36].

### Severe food insecurity and dietary diversity

Lastly, the study findings showed that severe food insecurity was associated with a substantial decrease in HDDS, as evidenced by a coefficient of -0.3103 ($p < .0001$), indicating a 27% reduction in household dietary diversity. This finding suggested that severely food-insecure households had limited access to various foods, due to economic constraints and limited availability. This finding aligned with existing literature, which indicates that food insecurity directly impedes dietary diversity by reducing households' purchasing power and ability to access diverse food options [6,9]. For example, a study in South-eastern Nigeria similarly found that most households consumed starchy foods over protein-rich options, with limited variety, highlighting the direct impact of food insecurity on dietary patterns [9].

## CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

The study aimed to examine regional variations in household dietary diversity among rural households across five selected states in the Northeast and Northwest regions of Nigeria, as well as to identify the key determinants influencing dietary diversity. The findings revealed that, overall, dietary diversity was moderate across the states,

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Volume 25 No. 2
February 2025
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with Katsina showing the highest level of diversity and Zamfara the lowest. Key factors influencing dietary diversity included household location (state), household size, agricultural activity and severe food insecurity, all of which were identified as significant negative predictors. In contrast, higher household income and exposure to shocks were associated with increased dietary diversity. These results highlighted the importance of regional disparities, shocks, and various socioeconomic influences on dietary diversity in rural households in these regions.

Given the complex interplay of regional disparities, socioeconomic factors, and shocks, a multi-faceted approach is needed to address the root causes of limited households' dietary diversity in these regions. First, initiatives prioritizing livelihood diversification are important to reduce dependence on agriculture and enhance household income. Initiatives should focus on promoting income-generating activities outside traditional farming, such as small-scale businesses in food processing, retail, and local crafts. These businesses can provide alternative income sources, allowing these households access to a wider variety of foods.

In addition to livelihood diversification, promoting sustainable agricultural practices is critical, as subsistence farming alone often limits dietary diversity. Interventions should encourage crop diversification, the adoption of resilient crop varieties, and the use of improved farming techniques that are better equipped to withstand environmental shocks. Providing smallholder farmers with access to quality seeds, fertilizers, and training in sustainable farming methods is crucial for improving food security and dietary diversity over the long term.

Lastly, strengthening social safety nets is crucial for mitigating the impacts of economic, environmental, and social shocks. Expanding programs such as cash transfers, food assistance, and emergency relief will help to ensure that households maintain access to diverse foods during crises. Additionally, offering credit facilities to households that lose their livelihoods due to these shocks would provide vital financial support, facilitating recovery and stability.

While exposure to shocks was associated with increased households' dietary diversity in this study, these adaptations are likely temporary and not sustainable. Therefore, expanding safety nets must go beyond immediate relief, but focus on resilience-building strategies that address the root causes of vulnerability. Investing in climate-smart agriculture and developing early warning systems are essential to help communities in these regions prepare for and mitigate the impacts of environmental shocks. Policies that improve healthcare access and promote peacebuilding efforts will also be key to reducing vulnerability to social shocks, such as illness, death, and conflicts.

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Volume 25 No. 2
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ISSN 1684 5374

For these strategies to be effective, they must be flexible and adaptive, tailored to the specific needs of communities in these regions. Collaborative partnerships with local governments and NGOs will be important to ensure resource availability, training, and technical support for the successful implementation of these initiatives. By integrating these interventions, it is possible to improve dietary diversity, enhance nutritional outcomes and contribute to the broader goal of achieving food security among rural households in Northern Nigeria.

## ETHICAL CONSIDERATIONS

This study used secondary data obtained from the Data in Emergencies (DIEM) Monitoring System in Nigeria, conducted by the Food and Agriculture Organization (FAO) of the United Nations. The dataset is publicly available, fully de-identified, and contains no personal or identifying information about households or respondents. Therefore, the Institutional Review Board (IRB) approval was not required. Ethical guidelines as outlined in the study questionnaire were strictly followed, including obtaining informed consent from participants and ensuring the confidentiality of the information they provided. Participants were also informed that they could withdraw from the interview at any time. For further details, the questionnaire can be accessed at https://data-in-emergencies.fao.org/documents/hqfao::nigeria-household-questionnaire-round-4/about.

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### Conflict of Interest

The authors of this article declare that they have no conflicts of interest regarding the research, authorship, or publication of this article.

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## Table 1: Weighted household characteristics

| Variables | Overall (N=1449) | Adamawa (N=242) | Borno (N=339) | Katsina (N= 441) | Yobe (N=184) | Zamfara (N=243) |
|---|---|---|---|---|---|---|
| **HH Gender, n (%)** | | | | | | |
| Female | 60 (4.2) | 14 (5.6) | 24 (7.2) | 8 (1.8) | 4 (2.0) | 11 (4.4) |
| Male | 1,389 (95.8) | 228 (94.4) | 314 (92.8) | 433 (98.2) | 181 (98.0) | 233 (95.6) |
| **HH Age, n (%)** | | | | | | |
| 18-40 | 435 (30.0) | 70 (28.9) | 118 (35.0) | 117 (26.6) | 55 (29.6) | 75 (30.7) |
| 41-65 | 947 (65.3) | 162 (66.8) | 202 (59.5) | 309 (70.0) | 118 (64.3) | 156 (64.2) |
| Over 65 | 68 (4.7) | 10 (4.3) | 19 (5.5) | 15 (3.4) | 11 (6.1) | 12 (5.1) |
| Household size, mean (SD) | 7.22 ± 2.34 | 7.54 ± 2.49 | 6.66 ± 2.40 | 7.39 ± 2.21 | 7.27 ± 2.40 | 7.33 ± 2.18 |
| Cultivated land size in hectares, mean (SD) | 1.46 ± 1.76 | 1.64 ± 1.72 | 1.28 ± 1.74 | 1.36 ± 1.73 | 1.62 ± 1.87 | 1.41 ± 1.2 |
| Total Household Income in USD, mean (SD) | 468 ± 288 | 459 ± 257 | 439 ± 279 | 459 ± 288 | 474 ± 310 | 510.46 ± 303 |
| **HH Education Level, n (%)** | | | | | | |
| None/did not complete primary school | 48 (3.3) | 9 (3.8) | 14 (4.2) | 12 (2.7) | 7 (3.9) | 5 (2.2) |
| Completed primary school | 249 (17.2) | 43 (17.6) | 58 (17.2) | 77 (17.5) | 27 (14.8) | 44 (18.3) |
| Completed Religious or informal education | 124 (8.5) | 14 (5.7) | 27 (8.0) | 39 (8.8) | 24 (12.8) | 21 (8.4) |
| Completed secondary education | 643 (44.3) | 112 (46.3) | 135 (39.8) | 208 (47.2) | 84 (45.8) | 103 (42.3) |
| Completed higher education | 385 (26.6) | 64 (26.5) | 104 (30.8) | 105 (23.8) | 42 (22.6) | 70 (28.7) |
| **Household Agricultural Activity, n (%)** | | | | | | |
| None | 148 (10.2) | 2 (1.0) | 84 (24.8) | 17 (3.8) | 15 (7.9) | 30 (12.3) |
| Crop production | 661 (45.6) | 133 (55.0) | 144 (42.6) | 199 (45.2) | 90 (48.7) | 95 (39.2) |
| Livestock production | 379 (26.2) | 55 (22.6) | 65 (19.1) | 155 (35.2) | 44 (24.1) | 60 (24.7) |
| Crop and livestock production | 261 (18.0) | 52 (21.5) | 46 (13.5) | 70 (15.8) | 35 (19.3) | 58 (23.8) |
| **Household Exposure to Shocks, n (%)** | | | | | | |
| No | 891 (61.5) | 147 (60.7) | 240 (70.8) | 246 (55.8) | 120 (65.3) | 138 (56.9) |
| Yes | 558 (38.5) | 95 (39.3) | 99 (29.2) | 195 (44.2) | 64 (34.7) | 105 (43.1) |

**HH**=Household head
Monthly household income was collected in Naira and was converted to United States Dollar (USD) using the 2023 exchange rate $1= 461 Naira
Total Household Income in US Dollars (in the past 3 months), mean (SD)

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**Table 2: Weighted Household Dietary Diversity Score and Food Insecurity Status across Five States**

| Variable | Overall | Adamawa | Borno | Katsina | Yobe | Zamfara |
|---|---|---|---|---|---|---|
| **Household Dietary Diversity Score (HDDS), n (%)** | | | | | | |
| **N** | 1449 | 242 | 339 | 441 | 184 | 243 |
| High | 983 (72.9) | 182 (75.0) | 241 (71.3) | 364 (82.6) | 123(66.5) | 163(66.8) |
| Medium | 284 (21.1) | 48 (19.6) | 15 (4.5) | 56 (12.7) | 46 (25.1) | 19 (7.9) |
| Low | 81 (6.0) | 13 (5.3) | 82 (24.2) | 21 (4.8) | 15 (8.3) | 62 (25.3) |
| **Household Dietary Diversity Score (HDDS)** | | | | | | |
| **N** | 1449 | 242 | 339 | 441 | 184 | 243 |
| Mean (SD) | 6.4 ± 2.7 | 6.5 ± 2.7 | 6.5 ± 2.9 | 6.8 ± 2.6 | 6.0 ± 2.7 | 6.0 ± 2.7 |
| **Food insecurity status, n (%)** | | | | | | |
| Food Secure | 856 (58.46) | 149 (61.7) | 196 (58.0) | 277 (62.8) | 104(56.3) | 130(53.5) |
| Mildly - Moderate food insecure | 513 (35.68) | 75 (30.9) | 125 (36.9) | 147 (33.3) | 68 (37.0) | 98 (40.3) |
| Severe food insecure | 80 (5.88) | 18 (7.4) | 17 (5.2) | 17 (3.9) | 12 (6.7) | 15 (6.2) |

**Table 3: Weighted Proportions of Household Food Group Consumption across Five States**

| Food Group | Adamawa N = 242 | Borno N = 339 | Katsina N = 441 | Yobe N = 184 | Zamfara N = 243 | Pooled N = 1,449 |
|---|---|---|---|---|---|---|
| Cereals, n (%) | 227 (93.7) | 320 (94.4) | 427 (97.0) | 170 (92.4) | 229 (93.9) | 1,372 (94.7) |
| Roots and tubers, n (%) | 128 (52.7) | 160 (47.3) | 261 (59.2) | 95 (51.5) | 131 (53.8) | 774 (53.4) |
| Vegetables, n (%) | 137 (56.5) | 166 (48.9) | 256 (58.1) | 88 (48.0%) | 124 (51.0) | 771 (53.2) |
| Fruits, n (%) | 70 (29.0) | 97 (28.6) | 140 (31.7) | 47 (25.3) | 53 (21.7) | 406 (28.0) |
| Meat, n (%) | 96 (39.6) | 156 (46.2) | 203 (46.0) | 75 (40.9) | 107 (44.0) | 637 (44.0) |
| Eggs, n (%) | 55 (22.9) | 71 (20.9) | 83 (18.8) | 29 (15.8) | 34 (13.9) | 272 (18.7) |
| Fish, n (%) | 111 (45.8) | 142 (42.0) | 186 (42.2) | 71 (38.5) | 94 (38.7) | 604 (41.7) |
| Legumes, n (%) | 117 (48.3) | 175 (51.7) | 204 (46.3) | 81 (43.9) | 112 (46.2) | 689 (47.6) |
| Milk and dairy, n (%) | 102 (42.2) | 132 (38.9) | 181 (41.0) | 68 (37.0) | 83 (34.1) | 566 (39.1) |
| Oils, n (%) | 182 (75.2) | 280 (82.6) | 350 (79.3) | 127 (68.8) | 167 (68.8) | 1,105 (76.3) |
| Sugar, n (%) | 146 (60.3) | 202 (59.7) | 298 (67.7) | 108 (58.4) | 141 (58.0) | 895 (61.8) |
| Condiments, n (%) | 207 (85.4) | 286 (84.4) | 397 (90.0) | 149 (80.9) | 193 (79.4) | 1,232 (85.0) |

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**Table 4: Poisson Regression Analysis of Household Dietary Diversity Score (HDDS)**

| Variables | Coefficient (SE) | *p*-Value |
|---|---|---|
| (Intercept) | 2.0420 (0.1092) *** | 0.0000 |
| **State (ref: Adamawa)** | | |
| Borno | -0.0638 (0.0365) | 0.0805 |
| Katsina | 0.0162 (0.0331) | 0.6240 |
| Yobe | -0.0924 (0.037) ** | 0.0127 |
| Zamfara | -0.1171 (0.0356) ** | 0.0010 |
| Household size | -0.0323 (0.0052) *** | 0.0000 |
| Total household income Normalized ($) | 0.1493 (0.0588) ** | 0.0112 |
| **Household Agricultural activity (ref: No agriculture activity)** | | |
| Crop and livestock production | -0.1481 (0.0535) ** | 0.0057 |
| Crop production | -0.1564 (0.0445) *** | 0.0005 |
| Livestock production | -0.1458 (0.0449) ** | 0.0012 |
| **HH Education (ref: No education)** | | |
| Completed primary school | 0.1099 (0.0912) | 0.2284 |
| Completed Religious or informal education | 0.1301 (0.0977) | 0.1830 |
| Completed secondary education | 0.1235 (0.0894) | 0.1674 |
| Completed higher education | 0.1759 (0.0911) | 0.0538 |
| Household Exposure to Shocks (Yes) | 0.1452 (0.0236) *** | 0.0000 |
| Food insecurity (Severe) | -0.3103 (0.0635) *** | 0.0000 |

SE: Standard Error in parentheses; $ = United States Dollar (USD); HH = Household head
Only variables that were statistically significant in the preliminary analysis were included in the final Poisson regression model
Asterisks denote significance levels at *** p<0.001 and ** p<0.005


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