



Analysis of Household Food and Nutrition Security Status in Sudano Sahelian Region of Northern Nigeria

Aminu Abba^{1,*}, Muhammad Halliru¹, Sani Ubale¹, Amina Mustapha², Amina Mustapha Lawan², Nuhu Bello Rano³, Amina Idris¹, Hauwa Ladi⁴, Muhammad Musa Bello⁵

¹Department of Agricultural Economics and Extension, Bayero University, Kano – Nigeria

²Centre for Dry Land Agriculture, Bayero University, Kano – Nigeria

³Department of Animal Science, Bayero University, Kano – Nigeria

⁴Department of Food Science and Technology, Bayero University, Kano – Nigeria

⁵Department of Community Medicine, Bayero University, Kano – Nigeria

* Email address of the Corresponding author: aabba.ext@buk.edu.ng

Received: 12 Apr 2022; Received in revised form: 06 May 2022; Accepted: 12 May 2022; Available online: 18 May 2022

©2022 The Author(s). Published by Infogain Publication. This is an open access article under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Abstract— Food and nutrition security information is a vital component and essential indicator for agriculture and livelihood development. Detailed information and stakeholders' participation in assessing food and nutrition security, especially community and household aspects, is inadequate in the Sudano-Sahelian region. This has necessitated the cross-sectional survey to assess the food and nutrition security status and factors influencing food security in the region. Cross-sectional data were collected from four (4) states (Kano, Jigawa, Bauchi and Gombe), covering 1,200 households. Primary data were collected using a structured questionnaire to elicit information on respondents' profiles, food security parameters and other household activities. Descriptive statistics, Food Consumption Score (FCS), Household Dietary Diversity Score (HDDS), Household Hunger Scale (HHS) and Coping Strategy Index (CSI) and binary logistic regression were used for data analysis. Results show that household demographic characteristics, especially education, access to credit and the market, are essential components for strengthening household income-generating activities in Northern Nigeria. Food insecurity and nutrition deficiency exist among households with average food consumption scores, poor dietary diversity associated with increased hunger and averagely weak coping strategies. The significant factors influencing food security status positively include the volume of output produced, annual income, and access to credit. The output volume produced an annual income essential for strengthening household food and nutrition security in the Sudano-Sahelian Region. The study recommends the need for massive awareness of the importance of producing essential food crops. Their utilisation at the household level is essential to strengthening the food consumption score and dietary diversity by utilising various food groups. Stakeholders, particularly Government, NGOs, INGOs, and donors, should develop and implement measures to facilitate access to Food and basic social services, especially in vulnerable households. Lastly, income diversification and strengthening incentives for increased food production are essential for the households.

Keywords— Food Security, Coping Strategy, Sudano-Sahelian.

I. INTRODUCTION

Food security, as defined by the United Nations' Committee on World Food Security, is the condition in

which all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Over the coming decades, a changing

climate, growing global population, rising food prices, and environmental stressors will have significant yet highly uncertain impacts on food security^[1]. The concept was also defined from the perspective of community and households' food security: Community Food Security has been defined as "a situation when all citizens obtain a safe, personally acceptable, nutritious diet through a sustainable food system that maximises healthy choices, community self-reliance and equal access for everyone." On the other hand, Household Food Security: A household is Food secure when it has access to the Food needed for a healthy life for all its members (adequate in terms of quality, quantity, and safety and culturally acceptable) and when it is not at undue risk of losing such access. At the global or national level, Food

Security may not usually address the household level food security problem. The relationship between national food security and household food security is less prominent in developing countries than developed ones.

The report of the United Nations mentioned on food security and nutrition in 2018 indicated that the world hunger rate has begun to rise again, threatening 815 million people in 2017, that is 11% of the world's population, after a remarkable steady decline during the past decade. Meanwhile, multiple forms of malnutrition are threatening the health of millions worldwide. The report showed that the number of people affected by hunger compared to the previous year has increased by 38 million due to extreme vulnerability in productivity decline, conflicts, pests and diseases, and climate change (WHO, 2018). The trend was similar in Africa and Nigeria, particularly in rural areas where food availability, accessibility, and utilisation have been major livelihood constraints.

World Bank^[2] estimates the population of Nigerians to be above 160 million people, the largest in Africa, almost accounting for 47% of West Africa's total population. As the population increases, the country's demand for food increases. In contrast, the ability to produce Food diminishes because pressures from the growing population in desertification, climate change, and erosion also impact the already diminishing resources and further threaten food production. Food security involves access and availability of foodstuff, stability of supplies, and diet quality^[3]. According to FAO, Nigeria has an energy intake of 1730Kcal and an average protein supply of 64g per capita per day, far below the 2500 – 3400Kcal minimum recommended daily intake. This shows that Nigeria faces the challenge of an unbalanced diet leading to various deficiency symptoms^[4]. Also, among the 109 countries assessed by the Global Food Security Index (GFSI) (2015), Nigeria is 91st with a 37.1 score based on affordability, availability, quality, and safety indices.

One of Nigeria's agricultural development policy goals is to ensure enough food reserve at the household, state and federal levels to forestall any threat to food security. Since domestic agricultural production has failed to meet the increasing demand for Food, the government had to spend on importation to feed her teeming population. For instance, food imports increased from 19.9% in 2000 to 30.6% and 22.7% in 2011 and 2012, while food exports were barely 5.3% of merchandise^[5]. The second sustainable development goal of zero hunger incorporates the need to achieve food security and improved nutrition, promote sustainable agriculture, end rural hunger, empower small scale farmers, especially women, and ensure a healthy lifestyle by 2030. Food and nutrition security information is a vital component and essential indicator for agriculture and livelihood development policies. Detailed information and stakeholders' participation in assessing food and nutrition security, especially community and household aspects, is inadequate in the Sudano-Sahelian region. This has necessitated the cross-sectional survey to assess the food and nutrition security status and factors influencing food security in the region.

Conceptual Framework

According to World Food Summit, "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life"^[6]. This widely accepted definition points to the following dimensions of food security^[7]: food availability, accessibility—utilisation and stability, respectively.

- ✓ **Food availability:** the availability of appropriate Food in terms of quantity and quality, covered by either domestic production or imports (including food aid).
- ✓ **Food access:** the accessibility of people to appropriate food entitlements defined as commodities a person can command or manage given the legal, political, economic and social arrangements of the community in which they live (including traditional rights such as access to common resources).
- ✓ **Utilisation:** consuming Food via appropriate diet, clean water, sanitation and health care to reach a state of nutritional welfare where all physiological needs are satisfied.
- ✓ **Stability:** to be Food secure, a population, household, or individual must get adequate food. They should not lack Food due to sudden shocks (e.g. an economic or climatic crisis) or cyclical events (e.g. seasonal food insecurity). Therefore,

stability refers to food security's availability and access aspects.

Food security "hot spots" include the Vulnerable and war-affected, where logistics and distribution face difficulties even in normal conditions and circumstances; Countries affected by various crises resulting from extreme weather conditions and pests such as the current locust plague – the worst in decades— affecting food manufacture in 23 countries; The poor and vulnerable, including the more than 821 million people who already suffer from food insecurity before the Covid-19 crisis impacted movement and incomes and Countries with major currency depreciation, (driving up the cost of food imports) and countries seeing other commodity prices collapse (reducing their capacity to import Food).

Many Previous studies on households' food security status focused on using the food security index and Calorie intake approach. Such similar studies that used the food security index includes [8,910]. In recent times, modern approaches (FCS, HDDS, HHS, CSI, e.t.c) are gaining popularity, and it has been widely accepted among researchers, including Food and Agriculture Organization. The approaches include food consumption, livelihood evolution, nutritional perspectives and mortality indicators. The food consumption approach involved FCS, HDDs, HHS, and CSI. Daniel and Nicolas applied the food consumption score approach to determine food security status in rural Ethiopia [11]. There was little evidence for applying FCS and other indicators to estimate food security in Nigeria. This study, therefore, employed the use of the Food Consumption Score (FCS), Household Dietary Diversity Score (HDDS), Household Hunger Scale (HHS) and Coping Strategy Index (CSI).

Ifeoma and Agwu conducted a study assessing the food security status among farming households in rural areas of Kano State, Nigeria. Data collected were analysed using percentages, mean score, logistic regression and food security index. Using the food security index approach, the study revealed that 74% of the respondents were Food secure while 26% were Food insecure. The results of the logistic regression revealed that educational level ($p_{0.05}$; $z = 1.95$), sex ($p_{0.05}$; $z = 1.99$), household size ($p_{0.05}$; -4.29) and access to credit ($p_{0.05}$; $z = 2.4$) were significant determinants of food security. Also, the major effect of food insecurity on households includes a reduction in household income/ savings due to increased expenditure on Food ($M = 3.58$). The perceived coping strategies in cushioning the effects of food insecurity include engaging in off-farm and non-farm jobs to increase household income ($M = 2.77$), among others [12].

Abu and Soom examined factors affecting household food security status among rural and urban farming households of Benue State, Nigeria. Data were collected through a structured questionnaire and analysed using descriptive statistics, Food Security Index, Surplus/Food Insecurity Gap, Factor analysis and Probit model. Using the calorie intake method, the result revealed that 53.3% and 62.2% of rural and urban households were Food secured. The rural and urban Food secure households exceeded the recommended calorie intake by 39% and 42%, respectively. In comparison, the rural and urban Food insecure households fell short of recommended calories by 24% and 26%, respectively. It was also found that the income of households head ($p < 0.10$), rural households size ($p < 0.01$), and farm size ($p < 0.10$) had a positive impact on household food security. On the other hand, the age of the household head ($p < 0.05$) and urban household size ($p < 0.10$) had a negative relationship with household food security [9].

II. METHODOLOGY

Location, Sampling and Data Collection

The study was conducted in four (4) Sudano-Sahelian States, specifically Kano, Jigawa, Bauchi, and Gombe. The study area is a potential agricultural zone with diverse economic activities within rural communities and farming households. The four (4) states were purposefully selected for their importance in Agricultural activities and fewer security challenge than other states. Stratified sampling was used to classify each state into three (3) agro-ecological zones. Ten LGAs in each Zone were selected, thus giving 36 LGAs for the study. Simple random sampling techniques were used to select 10 respondents from each LGAs, implying 300 respondents per state and 1,200 sample sizes for the study. Primary data were collected using a structured questionnaire to elicit information on respondents' profiles, food security parameters and other household activities. The distribution of sample size is depicted in Table 1 below:

Table 1: Sampling Techniques

State	Zone	No. of LGAs	No. of Respondents	Total
Kano	Zone I	3	100	300
	Zone II	3	100	
	Zone III	3	100	
Jigawa	Zone I	3	100	300
	Zone	3	100	

	II			
	Zone III	3	100	
Bauchi	Zone I	3	100	300
	Zone II	3	100	
	Zone III	3	100	
Gombe	Zone I	3	100	300
	Zone II	3	100	
	Zone III	3	100	
Total		36	1,200	1,200

Analytical Approach

Descriptive Statistics

Descriptive statistics, Food Consumption Score (FCS), Household Dietary Diversity Score (HDDS), Household Hunger Scale (HHS) and Coping Strategy Index (CSI) and binary logistic regression were used for data analysis.

Food Consumption Score (FCS) Estimation

The Food Consumption Score (FCS) is a composite score based on dietary diversity, food frequency, and relative nutritional importance of different food groups. Household food consumption is households' consumption pattern (frequency * diversity) over the past seven days. The household food consumption score is calculated by multiplying each food group frequency by each food group weight and then summing these scores into one composite score. The household score can have a maximum value of 112, implying that each food group was consumed every day for the last seven days. The FCS is calculated based on the past 7-day food consumption recall for the household and classified into three categories: *poor consumption* ($FCS = 1.0$ to 28); *borderline* ($FCS = 28.1$ to 42); and *acceptable consumption* ($FCS = >42.0$). The FCS is a weighted sum of food groups. The score for each food group is calculated by multiplying the number of days the commodity was consumed and its relative weight. The following equation indicates the mathematical representation of FCS

$$\text{Food Consumption Score (FCS)} = A_{\text{cereal}} X_{\text{cereal}} + a_{\text{legumes}} X_{\text{legumes}} + a_{\text{leg}} X_{\text{leg}} + a_{\text{fruit}} X_{\text{fruit}} + a_{\text{animal}} X_{\text{animal}} + a_{\text{sugar}} X_{\text{sugar}} + a_{\text{veg}} X_{\text{veg}} + a_{\text{fruits}} X_{\text{fruits}} \quad (1)$$

Where:

a_i = Weight attributed to the food group;

x_i = Number of days each food group is consumed (≤ 7 days).

The different Food Groups and their Weighted Score considered for the study include Cereals (*bread, rice, maize, barley* (2), Root and Tubers (*cassava, potatoes, etc.*) (2), Pulses and nuts (*beans, lentils, peas etc.*) (3), Vegetables (1), Fruits (1), Meat (4), egg (4), fish (4), Dairy products (*milk and milk products*) (4), Sugar, honey (0.5), Oil, Fat, Butter (0.5) and condiments (0).

Household Dietary Diversity Score (HDDS) Estimation

HDDS-is meant to reflect the financial ability of a household to access a variety of foods. A frequently used method to indicate food consumption quality and quantity to a lesser degree. Regroup the 16 food groups used for FCS in the 7 food groups as per the Table by simply adding frequencies. Create a new binominal variable for each food group with two possible values: 1 – yes: the household/individual consumed that specific food group, and 0 – no: they did not consume that Food. Sum all the binominal variables to create a HDDS. The new variable will range from 0 through the maximum number of food groups collected (7). IFPRI proposes to use the following thresholds: 6+: high = good dietary diversity; 4.5 – 6: medium dietary diversity and <4.5: low dietary diversity.

Coping Strategy Index (rCSI) Estimation

Coping Strategy Index (CSI)- measures behaviour: what people do when they cannot access enough food. CSI is based on a list of behaviours (coping strategies). It combines the frequency of each strategy (how many times each strategy was adopted?); and their severity (how serious is each strategy?) for households reporting food consumption problems. Household CSI scores are then determined by multiplying the number of days in the past week each strategy was employed by its corresponding severity weight and then summing the totals. The total CSI score is the basis for determining and classifying the level of coping into three categories: No or low coping ($CSI = 0-3$), medium ($CSI = 4-9$) and high coping ($CSI \geq 10$). Coping strategies, their weights and frequencies are depicted in the Table below:

Table 3: Coping Strategies and their Weights considered for the CSI estimation include Relying on less preferred and less expensive foods (1), Limiting portion size at mealtimes (1), Reducing the number of meals eaten in a day (1), Borrow Food or rely on help from relatives or friends (2) and Restricting consumption by adults for small children to eat (3)

Binary Logistic Regression Model

The binary logistic regression methodology has been employed in several agricultural, economic and extension

studies that call for the analysis and prediction of a dichotomous outcome such as fertiliser use or non-use, adoption and non-adoption, food security and food insecurity, poor and non-poor, and other general binary dependent variable. The logistic regression model has been popularly applied in analysing the factors influencing the food security status of rural farming households. Such similar studies that used a logistic or tobit model to determine factors influencing food security status include [8,9] to estimate the determinants of food security status. This section is based on Gujarati, Gujarati, and Porter [13,14]. Binary logistic regression requires the dependent variable to be converted into a dichotomous binary variable coded 0 and 1. For this study, the logistic model is developed as follows:

The logit equation based on Greene is written as

$$\Pr(Y = 1) = \frac{e^{\beta'x}}{1 + e^{\beta'x}} \quad (2)$$

With the cumulative distribution function given by

$$F(\beta'x) = \frac{1}{1 + e^{-\beta'x}} \quad (3)$$

The cumulative logistic distribution function (Eq 2) is expressed as (after Adunni and Doppler, 2007):

$$p = \frac{1}{1 + e^{-z}} \quad (4)$$

If p_i is the probability of higher paddy yield, then the probability otherwise is $1 - p_i$, which in logistic function can be expressed as

$$1 - p_i = 1 - \frac{1}{1 + e^{-z}} \quad (5)$$

$$= \frac{1}{1 + e^{-z}} \quad (6)$$

The ratio of Eq 4 and 5 will give the odd ratio

$$\frac{p_i}{1 - p_i} = \frac{1 + e^{-z}}{1 + e^z} \quad (7)$$

$$\frac{p_i}{1 - p_i} = e^z \quad (8)$$

Equation 7 is the odds ratio in favour of Food secured. It is the ratio that a is Food secured to the probability of otherwise

Taking the natural log of both sides of Eq 7

$$L_i = \ln \frac{p_i}{1 - p_i} = z \quad (9)$$

L_i = the log odds ratio, which is also referred to as the logit

$$z = \beta_0 + \beta_1 x_1 - \beta_2 x_2 + \beta_3 x_3 + \dots \dots \dots + \beta_k x_k + \mu \quad (10)$$

Where

x_i = the household-specific indicators hypothesized to food security

β_i = vector of parameters to be estimated using a maximum likelihood method

β_0 = constant term

μ = error term which is normally distributed with zero mean and variance

$$\sigma^2 = \frac{1}{N_i p_i (1 - p_i)} \quad (11)$$

N_i = number of observations

Although z it is a linear combination of variables with both upper and lower bounds, no bounds can be assigned to the variable itself, as the values assumed will also depend on the unknown parameters' values. To obtain the values of z , the likelihood of observing the sample was formed by introducing a dichotomous variable Y_i such that $Y_i = 1$ and $Y_i = 0$ if otherwise. The specific application of the logistic model for this study is specified for food security analysis.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k + U \quad (12)$$

Y = Food security status (Taking the value of 1 and 0 for the presence and absence of observed food security characteristics)

X_1 = Age of maize producers (years)

X_2 = Farming experience (years)

X_3 = Access to credit (1= access and 0= No access)

X_4 = Educational status (years)

X_5 = Farm size (ha)

X_6 = Access to market (Access 1, No access 0)

X_7 = Cooperative membership (Member 1, Non-member 0)

X_8 = Household size (Number)

X_9 = Volume of output (kg)

X_{10} = Extension contact (Contact 1, No contact 0)

X_{11} = Household annual income (₦)

β_0 = Slope or intercept

β_1 - β_{12} = Coefficient of regressors

U = error term

Results and Discussion

Demographic Profile of the Respondents

The result from figure 1 depicts that most of the respondents across the locations Kano (94.5%), Jigawa (96.4%), Bauchi (93.8%) and Gombe (89.4%) were male. This may be attributed to the culture, tradition and religion of the people living within these locations. It may also result from other social activities associated with household responsibilities that limit female engagement in other social activities outside the household. The result implies that male-dominated farming activities and other social activities within the locations deprive females of engagement in farming and social activities, which may contribute to food security and improve their livelihood. These findings are in line with Babatunde *et al.*, where most (90.4%) of the respondents considered in their study were male [15].

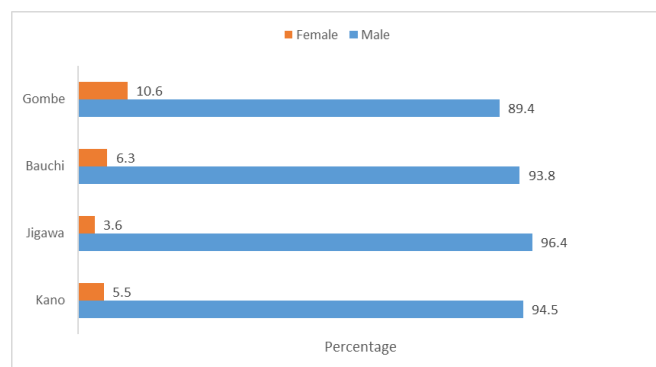


Fig.1: Gender Distribution of the Respondents

Looking at figure 2, the result shows that most of the respondents had formal education across the locations Kano (88.8%), Jigawa (84.8%), Bauchi (86.7%) and Gombe (82.3%), with respondents having one form of formal education or the other which shows that the respondents can be able to read, write and equality understand and analyse situations that came along their ways for improvement in their life. Having these forms of formal education implies that the respondents can use their knowledge to address an issue that has to do with food security by adopting different technologies that will help improve their food production to make their locations Food secure and the nation in general, which will equally improve their livelihood. These findings agreed with Babatunde et al., who found the majority (52.1%) of their respondents have one form of formal education.

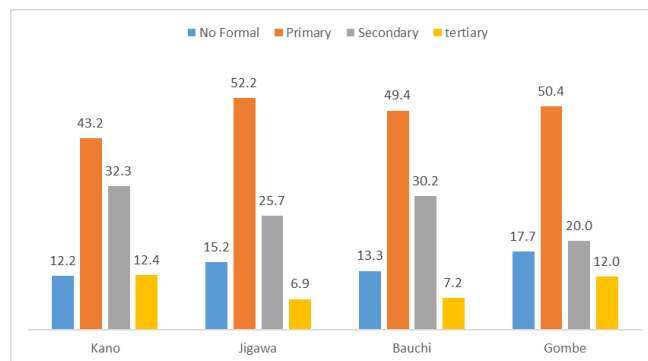


Fig.2: Distribution by Educational Status

The result in figure 3 showcases the accessibility of the market among the respondents, where most (of the respondents across the locations Kano (78.54%), Jigawa (79.45%), Bauchi (65.78%), and Gombe (69.05%) have market access. Availability of nearby marketplace plays a significant role among respondents in the study area. Having access to market among the respondents implies that they can market their produce for income or exchange; they can also engage in any marketing activities for income generation to be able to carter for the need of the household and at the same time access different kinds of Food at their disposal in ensuring food security within their household. These findings disagree with Kehinde and Kehinde, who reported that 80.67% of their respondents have access to credit [16].

The resulting form figure4 further revealed that most of the respondents across the locations Kano (78.45%), Jigawa (85.23%), Bauchi (87.25%) and Gombe (90.36%) have no access to credit. One of the constraints militating against food production, especially among small and medium-scale farmers, was inadequate capital. Accessibility to credit helps in acquiring the necessary capital for production. The respondents' poor access to credit may be associated with poor awareness of procedures to follow in accessing the credit, high-interest rates charged by commercial banks, provision of collateral, and conservativeness of farmers. Therefore, failure to access credit will significantly affect agricultural production considering the current inflation. By implication, food security will also be affected. Ogunniyi *et al.*, in their study, reported that 81% of the respondents have market access and also obtained market information. This is in line with the findings of this study [17].

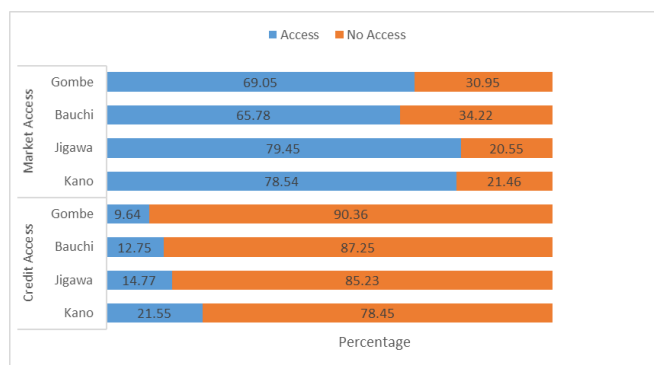


Fig.3: Access to Credit and Market

Application of Different Indicators for Food Security Status Estimation

Food Consumption Score (FCS)

Table 2 reveals the food consumption estimation as one indicator of food security status. The result revealed the findings based on categorising three zones across the locations and aggregating to the state level. Therefore based on the state level, it was found that 13.0% meet the acceptable consumption score of >42.0 in Kano, while only 41.7% meet the requirement in Jigawa. In Bauchi (59.0%) and Gombe (69.0%), the majority of respondents meet the acceptable food consumption score of >42.0 , respectively. The results show that, based on the acceptable score of >42.0 , most respondents in Kano and Jigawa were not Food secured, while in Bauchi and Gombe majority were Food secured. Going by the definition of food security by United Nations' Committee on World Food Security implies that the majority of respondents within Kano and Jigawa don't have at all times physical, social and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for active and healthy life despite commercial activities that are taking place in the state specifically Kano. This may be attributed to the fact that the two locations shared border and similarities in terms of social and economic activities, which led to the migration of people into the city of Kano and the concentration of developmental projects by previous and subsequent government administration and other development partners in the city neglecting the rural areas. These findings agreed with Nurudeen and Shaufique, where most (62.1%) of their respondents found food secure based on the food consumption score similar to an acceptable level considered in this study ^[18].

Table 2a: Food Consumption Score (FCS) Estimation

	Zone I			Zone II		
	Poor	Borderline	Acceptable	Poor	Borderline	Acceptable
Kano	45.0%	43.0%	12.0%	53.0%	38.0%	9.0%
Jigawa	32.0%	34.0%	34.0%	4.0%	30.0%	66.0%
Bauchi	3.0%	38.0%	59.0%	0.0%	25.0%	75.0%
Gombe	11.0%	26.0%	63.0%	8.0%	28.0%	64.0%

Table 2b: Food Consumption Score (FCS) Estimation

	Zone III			State (Level)		
	Poor	Borderline	Acceptable	Poor	Borderline	Acceptable
Kano	33.0%	49.0%	18.0%	43.7%	43.3%	13.0%
Jigawa	57.0%	28.0%	156.0%	28.7%	30.7%	41.7%
Bauchi	13.0%	44.0%	43.0%	15.5%	35.7%	59.0%
Gombe	0.0%	20.0%	80.0%	6.3%	24.7%	69.0%

Household Dietary Diversity Store (HDDS)

Table 3 above reveals the household dietary diversity estimated as another indicator of whether household/individual is Food secured. As revealed in the result, it shows that majority of the respondents in Kano (52.7%) and Jigawa (62.3%) location consumed more than five food groups out of the seven food groups, while in Gombe, most (80.3%) of the respondents consumed more than five food groups. The situation differs in Bauchi, where less than fifty per cent (38.0%) of the respondents consumed more than five food groups. This implies that the majority of the households in Kano, Jigawa and Gombe have the economic ability to access a variety of foods that are of good quality and at the required quantity for consumption which will strengthen their ability to think and act positively for development while in Bauchi majority of the household cannot be able to access more than five food group for consumption as their diet. This will affect their health status and economy since their capability to think and act positively for national development is affected. They cannot provide the workforce for economic development. Ajani reported that 83% (5-6) of the participants considered in their study had average/medium

dietary diversity scores, while this study reported a high dietary diversity score ^[19].

Table 3: Household Dietary Diversity Store (HDDS) Estimation

States	Zones	Minimal->= 5 food groups	Stress = 4 food groups	Crisis -3 food groups	Emergency =2 food groups	Famine-<= 1 food groups
Kano	Zone I	52.0%	9.0%	49.0%	0.0%	0.0%
	Zone II	43.0%	10.0%	47.0%	0.0%	0.0%
	Zone III	63.0%	23.0%	13.0%	0.0%	0.0%
	Pooled	52.7%	10.7%	33.3%	0.0%	0.0%
Jigawa	Zone I	82.0%	15.0%	3.0%	0.0%	0.0%
	Zone II	65.0%	20.0%	15.0%	0.0%	0.0%
	Zone III	40.0%	34.0%	26.0%	0.0%	0.0%
	Pooled	62.3%	23.0%	14.7%	0.0%	0.0%
Bauchi	Zone I	84.0%	16.0%	0.0%	0.0%	0.0%
	Zone II	94.0%	6.0%	0.0%	0.0%	0.0%
	Zone III	60.0%	27.0%	13.0%	0.0%	0.0%
	Pooled	38.0%	47.0%	15.0%	0.0%	0.0%
Gombe	Zone I	69.0%	17.0%	14.0%	0.0%	0.0%
	Zone II	90.0%	9.0%	1.0%	0.0%	0.0%
	Zone III	82.0%	17.0%	1.0%	0.0%	0.0%
	Pooled	80.3%	14.0%	5.7%	0.0%	0.0%

Household Hunger Scale (HHS)

Results from Table 4 above reveal the household hunger scale estimation across the locations where 47.7% of the households were not affected by hunger. In contrast, the majority (52.3%) of the household in the location experienced low to moderate hunger. This corresponds with the food consumption score of the households in the location where only 13% meet the acceptable food consumption score. In Jigawa, only 12% of the households experienced low to moderate hunger, with most (88.0%) of the households having no hunger. Similarly, in Bauchi, only 19% of the households experienced hunger.

In comparison, most (81%) of the households have zero hunger, while in Gombe is almost 50:50 between households with zero hunger and those with low to moderate hunger. The implication here is those in locations where the majority of the households experience hunger, their productivity in every aspect of human endeavour will be affected because hunger is a serious disease. In contrast, those with zero hunger are expected to be active, have good and sound decision-makers, and be productive. Alero, James and Victor's findings from their studies support the findings of this study, where 33.8% of the respondent have zero hunger while 41.5% have low to moderate hunger scores ^[20].

Table 4: Household Hunger Scale (HHS) Assessment

State	Zone	None 0	Low Score 1	Moderate Score 2-3	Severe Score 4	Very Severe Score 5-6
Kano	Zone I	54.0%	23.0%	23.0%	0.0%	0.0%
	Zone II	41.0%	28.0%	31.0%	0.0%	0.0%
	Zone III	48.0%	19.0%	33.0%	0.0%	0.0%
	Pooled	47.7%	23.3%	29.0%	0.0%	0.0%

Jigawa	Zone I	81.0%	16.0%	3.0%	0.0%	0.0%
	Zone II	87.0%	10.0%	3.0%	0.0%	0.0%
	Zone III	94.0%	1.0%	5.0%	0.0%	0.0%
	Pooled	88.0%	9.0%	3.7%	0.0%	0.0%
Bauchi	Zone I	66.0%	10.0%	24.0%	0.0%	0.0%
	Zone II	96.0%	3.0%	1.0%	0.0%	0.0%
	Zone III	81.0%	11.0%	8.0%	0.0%	0.0%
	Pooled	81.0%	8.0%	11.0%	0.0%	0.0%
Gombe	Zone I	33.0%	16.0%	51.0%	0.0%	0.0%
	Zone II	65.0%	17.0%	18.0%	0.0%	0.0%
	Zone III	50.0%	19.0%	31.0%	0.0%	0.0%
	Pooled	50.3%	12.0%	37.7%	0.0%	0.0%

Coping Strategy Index (CSI) Assessment

The result from Table 5 reveals the coping strategy adopted by affected households in trying to cope with the issue of food insecurity. It was found from the results that the entire locations Kano (75.7%), Jigawa (97.7%), Bauchi (91.0%) and Gombe (97.7%) were found to have adopted low coping strategies concerning food security. This may be associated with the fact that except for kano, the entire locations have no cases of food insecurity, meaning that the location was food secure base on the upper mentioned food security indicators. Adegoroye, Adewale and Aturamu, in their study, reported that withdrawal from personal savings relied on less preferred Food and cutting down expenditure on non-food items were the major coping strategies adopted by the respondents ^[21].

Table 5a: Coping Strategy Index (CSI) Assessment

States	Zone I			Zone II		
	rCSI 0-3	rCSI 4-18	rCSI ≥19	rCSI 0-3	rCSI 4-18	rCSI ≥19
Kano	66.0%	34.0%	0.0%	73.0%	27.0%	0.0%
Jigawa	100.0%	0.0%	0.0%	93.0%	7.0%	0.0%
Bauchi	88.0%	12.0%	0.0%	96.0%	4.0%	0.0%
Gombe	99.0%	1.0%	0.0%	94.0%	6.0%	0.0%

Table 5b: Coping Strategy Index (CSI) Assessment

States	Zone III			State(Level)		
	rCSI 0-3	rCSI 4-18	rCSI ≥19	rCSI 0-3	rCSI 4-18	rCSI ≥19
Kano	84.0%	16.0%	0.0%	75.7%	25.7%	0.0%
Jigawa	100.0%	0.0%	0.0%	97.7%	2.4%	0.0%
Bauchi	81.0%	11.0%	0.0%	91.0%	9.0%	0.0%
Gombe	100.0%	0.0%	0.0%	97.7%	2.3%	0.0%

Factors Influencing Food Security Status in Sudano-Sahelian Region

As shown in Table 6, the estimated logistic regression model indicated that the statistical parameters that express the "goodness of fit" of the model specified for this study are highly significant at a 5% probability level. The chi-square (χ^2) of 93.916 with its degree of freedom (df) respectively indicates support for the model and implies that the model containing the intercept and the independent variables are accepted. The Cox and Neglekerke estimates of 0.261 and 0.375 suggested that between 26.1% and 37.5% of the variance observed in the model is attributed to the regressors' contribution to the analysis. The log-likelihood of 317.305 further confirmed the validity and reliability of the estimated model in explaining the statistical influence of the selected variables.

The significant variables positively related to household food security status include access to credit, contact with extension agents and animal income. On the other hand, age and experience significantly influence food security status. The coefficient of access to credit was positive and significant at a 5% probability level with an exponentiated coefficient of 1.052. This implies that increased access to

credit can increase the food security status of farming households. This might be possible considering that credit availability will help households timely acquire appropriate and adequate production inputs, resulting in increased household productivity. The coefficient of farmers' contact with extension agents (0.674) was positive and significant at a 1% probability level. This implies that farmers with more contact with extension agents are more likely to apply good production practices leading to increased output to improve food security. Farmers with more contact with extension agents become more aware of modern agricultural innovations and put them into practice for productivity improvement, which might positively impact household food security.

The estimated coefficient of annual household income (1.312) was positive and statistically significant at a 1%

probability level. These findings cannot be disputed, considering that increased annual income of households might help in food provision either directly through purchase or indirectly through financing production and diversification of income sources. The major determinants that positively influence food security are household income, education, assets, cooperative membership, and dietary diversity. The study further revealed the farmer's age as a significant variable that negatively influences food security. With more increase in age, farmers are more likely to become older and less energetic, hence could not efficiently be active for increased productivity. Ahmed, Eugene, and Abah reported contrary findings regarding positively related age to food security [8].

Table 6: Factors Influencing Food Security Status in Sudano-Sahelian Region

Variables	B	S.E	Wald	Sign.	Exp (β)
Age of the farmer	-0.048	0.009	3.036	0.018**	0.876
Farming experience	0.008	0.119	0.514	0.014**	1.008
Access to credit	0.632	0.642	2.911	0.015**	1.052
Educational status	0.049	0.219	0.302	0.509	2.082
Household farm size	-0.065	0.168	2.211	0.764	0.703
Access to market	0.465	0.438	3.091	0.432	2.934
Cooperative Mship	-0.721	0.163	1.006	0.203	0.871
Household size	0.0326	0.024	1.156	0.395	2.036
Volume of output	0.136	0.041	5.771	0.019**	2.006
Extension contact	0.674	0.431	3.445	0.005***	2194
Annual income	1.312	0.431	10.039	0.002***	8.066
Constant	-11.238	2,987	11.318	0.003***	0.649
Model Statistics					
-2loglikelihood	317.305				
Cox & snell estimate	0.261 [^]				
Neglekerke estimate	0.375				
Model chi-square	793.916***				

Major Shocks Associated with Food and Nutrition Security in the Region

The major shocks concerning food and nutrition security observed by respective households from different locations, as revealed by the result in table 7, were high price of food items as reported by 40.2% of households from Kano, 35.0% from Jigawa, 40.2% from Bauchi and 38.6% from Gombe. The second shock observed is the covid-19

pandemic, which was reported by 36.8% from Kano, 26.9% from Jigawa, 36.6% from Bauchi, and 39.1% from Gombe. These were the major shock observed as reported by households across locations. These are attributed to inflation realised in the country and the globe, especially in line with the covid-19 pandemic, which crippled many economic activities, significantly affecting food and

nutrition security, especially among small-income households.

Table 7: Major Shocks Associated with Food and Nutrition Security

States					
	Kano	Jigawa	Bauchi	Gombe	Pooled
Loss of employment and reduced income	2.2%	2.5%	3.4%	3.3%	2.9%
Sickness of HH member	3.2%	1.9%	2.4%	2.1%	2.4%
Insecurity and conflict	2.8%	1.9%	2.1%	2.0%	2.2%
High food prices	40.2%	35.0%	40.2%	38.6%	38.5%
Heavy rains/floods	1.0%	11.6%	1.9%	1.8%	4.1%
Crop failure	11.6%	19.0%	11.2%	10.7%	13.1%
Restricted access to markets	2.2%	1.2%	2.2%	2.4%	2.0%
COVID-19 Pandemic	36.8%	26.9%	36.6%	39.1%	34.9%

III. CONCLUSION AND RECOMMENDATIONS

The study concluded that household demographic characteristics, especially education, access to credit and the market, are essential components for strengthening household income-generating activities in Northern Nigeria. Food insecurity and nutrition deficiency exist among households with average food consumption scores, poor dietary diversity associated with increased hunger and averagely weak coping strategies. The output volume produced an annual income essential for strengthening household food and nutrition security in the Sudano-Sahelian Region. The study based on the findings, therefore, recommends the following:

1. The need for massive awareness of the importance of producing essential food security crops and their utilisation at the household level is essential. This will strengthen the food consumption score and dietary diversity by utilising various food groups.
2. Stakeholders, particularly the Government, NGOs, INGOs and donors, should develop and implement measures to facilitate access to Food and basic

social services, especially in vulnerable households.

3. Promoting income diversification and strengthening incentives for increased food production is essential. This will facilitate income dependency and additional food provision for the households.

ACKNOWLEDGEMENT

This study was funded by the Nigerian Tertiary Education Trust Fund (TETFUND), National Research Fund 2019. Overall coordination was provided by the Directorate of Research and Innovation and Partnership (DRIP) of the Bayero University, Kano, Nigeria. The Centre for Dryland Agriculture (CDA) of the Bayero University, Kano, also provide technical and logistic support.

REFERENCES

- [1] IFPRI (2014) Understanding global food security of rural communities. Global perspectives for addressing food security challenges. The global food policy report, 2014. Available at ifri-info@cgiar.org.
- [2] World Bank (2012). Nigeria: Economic Report. No 2, Washington D.C: World Bank Group. <http://documents.worldbank.org/curated/en/2014/07/1988323/Nigeria-EconomicReport-No-2>.
- [3] Raphael N.E, Chigozirim N.O and Daniel C. N (2017) Effect Of Livelihood Diversification On Food Security Status Of Rural Farm Households In Abia State Nigeria., *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*. Volume 17, Issue 1, 2017, pp 159 – 168.
- [4] FAO., (2013). FAOSTAT, food security statistics, Nigeria, available online: http://www.fao.org/faostat/foodsecurity/Countries/EN/Nigeria_e.pdf. Food and Agricultural Organization of the United Nations, Rome.
- [5] World development indicators (2015): Global estimates of households' living standards. World Bank (2015). Available at: <http://data.worldbank.org/> indicator/all Accessed on 29 December 2015.
- [6] Food and Agriculture Organisation (FAO), (1996). Food security. In FAO Policy Brief: FAO of the United Nations. FIVIMS. Food Insecurity and Vulnerability Information and Mapping Systems. www.fivims.com.
- [7] Food and Agriculture Organization (2016) Resilience Index Measurement and Analysis Model: Application of parameters for measuring household resilience to food insecurity. Food and Agricultural Organization of the United Nations, Rome.
- [8] Ahmed F.F., Eugene, C.E. and Abah, P.O. (2015) Analysis of Food Security among Farming Households in Borno State, Nigeria. *Journal of Agricultural Economics, Environment and Social Sciences*. Volume 1, Number 1: 130–141 September 2015, ISSN: 2476 – 8423.

- [9] Abu, G. A and Soom, A. (2016) Analysis Of Factors Affecting Food Security In Rural And Urban Farming Households Of Benue State, Nigeria [2016] *International Journal Of Food And Agricultural Economics* [Http://www.foodandagriculturejournal.com/](http://www.foodandagriculturejournal.com/)
- [10] Thomas (2016) Estimating food security status of smallholder farming households in Northern Nigeria: Savannah Journal of Agriculture, Volume 7, Number 1, December 2011 Published by Faculty of Agriculture, Bayero University kano.
- [11] Daniel A.M and Nicolas G (2017) Aspirations and food security in rural Ethiopia. Food Security (2017) 9:371–385 - DOI 10.1007/s12571-017-0654-6
- [12] Ifeoma, J. I and Agwu, E. (2014) Assessment of Food Security Situation among Farming Households in Rural Areas of Kano State, Nigeria. Journal for Central European Agriculture, 2014. 15(1) Pp 94 – 107
- [13] Gujarati, D.N. (2004). **Basic Econometrics**: fourth edition. Tata McGraw-Hill Publishing Company Limited, New Delhi, pp: 580-625.
- [14] Gujarati, D.N. and Porter, D.C. (2009): Basic Econometrics, New York, United States of America, Mc-Graw- Hill Education, 922p.
- [15] Babatunde, R.O., Omotesho, O.A. and Sholoten ,O.S (2007). Socio-Economic Characteristics and Food Security Status of Farming Household in Kwara State North –Central Nigeria. *Pakistan Journal of Nutrition* (6) 1 pp 49-58.
- [16] Kehinde, A.D. And Kehinde, M.A.(2020) The Impact of Credit Access and Cooperative Membership on Food Security of Rural Households in South-Western Nigeria. *Journal of Agribusiness and Rural Development*. 3(57), 255–268.
- [17] Ogunniyi, A.I., Omotoso, S.O. Salman, K.K. Omotayo, A.O. Olagunju, K.O Aremu, A.O (2021). Socio-economic Drivers of Food Security among Rural Households in Nigeria: Evidence from Smallholder Maize Farmers. *Social Indicators Research*. Springer 155: 583–599.
- [18] Nurudeen, A. M. and Shaufique, F.A. S, (2019). Determinants of Food Security among Households in Nigeria. *Pakistan Journal of Nutrition*, 18: 1042-1052.
- [19] Ajani, S.R. (2010) An Assessment of Dietary Diversity in Six Nigerian States. *African Journal Biomedical Research* 13(3):161-167.
- [20] Alero, A. R., James, O. O. and Victor, A. I. (2019). Hunger in the midst of plenty: A survey of household food security among urban families in Lagos State, Nigeria. *Journal of Public Health in Africa*; volume 10:885. Pp 35-39.
- [21] Adegoroye, A. O., Adewale, I. and Aturamu, O. A.(2021) Determinants of Food Security Status and Coping Strategies to Food Insecurity among Rural Crop Farming Households in Ondo State, Nigeria. *European Journal of Nutrition & Food Safety*. 13(7): 39-5.