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## ASSESSING FOOD SECURITY STATUS OF RURAL HOUSEHOLDS IN NORTH EASTERN NIGERIA: A COMPARISON OF METHODOLOGIES

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## ABSTRACT

This study analyzed food security status of rural households in North Eastern Nigeria. Secondary data were employed. The data were accessed from the General Household Survey (GHS) for years 2013 and 2016, waves 2 and 3. 451 households were considered in each wave. The objective of the study was to determine the food security status of rural households, analyze factors influencing their food security and compare the output of different methodologies used to measure food security during the periods. Frequency and Percentages were used to analyze the socioeconomic characteristics of respondents. Mean *per Capita* Food Expenditure (MPCE), Dietary Diversity Score (DDS), Foster, Greer and Thorbecke (FGT) index were used to analyze household food security status while Logit regression model was used to analyze factors influencing household food security status. Results from the descriptive statistics showed that male household heads, married household heads and literate household heads were food secure in both waves. Results from Mean *per Capita* Food Expenditure (MPCE), and Foster, Greer and Thorbecke (FGT) showed that more than half of the selected households were food secure in both waves but reverse was the case with Dietary Diversity Score (DDS). Age, level of education, and household size were found to be factors influencing food security in both waves and models. The results from the logistic regression showed that an increase in age of household head and household size will reduce the food security status of the North-Easterner's rural households. Also, the result revealed that the food security status was higher in Borno, Gombe and Yobe compared to Taraba and tertiary education increased the level of food security status for MPCE but reduced the same for DDS. Based on these findings, the study recommends sensitizations on the importance of education and family planning for the rural household in North Eastern states of Nigeria.

**Key words:** Food security status, rural household, North Eastern Nigeria



## INTRODUCTION

Global food security is a major concern of our time and this is a reflection of the effects of food insecurity on human development particularly the health and productive capabilities of people [1-3]. The global rate of food insecurity as recorded since 2000 has slowed down in recent years. The number of undernourished people in the world increased from 777 million in 2015 to about 815 million in 2016 [4,5]. Food security is defined as “people having at all times physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life” [6,7]. People are considered food secure if there is availability and accessibility of safe, sufficient and nutritious food at all times to keep them active and healthy [8-10]. The definition emphasizes the dimensions of food security, availability, access, utilization and stability. Household food security is a major determinant of nutritional security that can only be fully understood through a multi-level analysis taking into account global, national/regional and local, household and individual level factors. Agricultural activities are carried out in rural areas where there are poor infrastructural facilities [11]. Many rural households and poorer households rely on their own production to be food secure which is prone to natural disasters like flooding and drought also man-made disasters like conflicts and can negatively affect the rate of production [12, 13].

The Boko Haram (an islamist militant organization based in northeastern Nigeria) insurgencies started in 2009 and Maiduguri the capital of Borno state has been the epicenter of key events. There are 4.4 million food insecure people in Borno, Yobe and Adamawa states according to the August 2016 cadre harmonised analysis of which 1.1 million are severely food insecure in Borno and Yobe states [14]. The escalation of the Boko Haram insurgency has caused many farmers to abandon their farms for fear of attacks by marauding Boko Haram insurgents. Most of the local population farmers have fled their homes [15]. The worst-hit states which are Borno, Yobe and Adamawa have often produced staple foods such as cowpeas, rice, millet, sorghum, corn, yams, tomatoes, onions, fish and livestock and the farmers are no longer able to produce sufficient quantities to meet the demand from other parts of Nigeria [15].

An issue that has developed from other studies is whether there exists an indicator of food security that satisfies its multidimensional nature of food security as specified by the definition [16, 17]. No single indicator can incorporate all the dimensions of food security because a combination of measures and indicators are needed to fully reflect the complex reality of the food insecurity problem in any



given context [18-20]. Also, it was argued that there is no best indicator because the characterization of an indicator in a generally termed as “best” depends ultimately on whether or not it is the most appropriate for the decision to be made [21,22].

Dietary Diversity Score (DDS) and Food Consumption Score (FCS) have been established in diverse countries as measures of household *per capita* food intake [23-26]. The tools are both used for observing and analyzing household economic access to food [27] and in both methods, collected data can be used to categorize dietary patterns and intake of specific foods. Primrose [28] used Dietary Diversity Score (DDS) to evaluate status of household food security.

Fakayode *et al.* [29] examined the food security status of farm households in Ekiti State. The USDA approach for the analysis of farm food security was used to measure the focus of food insecurity among farming households. Adeniyi and Ojo [30] examined extent of food insecurity and factors that affected household food security in some selected Local Government Areas (LGAs) of Osun State. Head count Method, Food Insecurity Gap and Squared Food Insecurity Gap were used to measure the food security status of the households.

Olayemi *et al.* [31] studied food security in Ogun State, Nigeria using the absolute (naira equivalent of a dollar was used as the benchmark) and relative (two-third of the average food expenditure per person per day was used as the benchmark) food security lines.

Despite the variety of food security indicators that exist in literature, there is lack of consensus on the core household food security indicators that are needed to adequately measure and monitor food security around the world both at the micro and macro levels [32], given that these indicators only focus on one dimension at a time. Consequently, there is a need to analyze food security status of households using different methodologies to have a full glimpse of food security status during different waves, examine the determinants of food security in data and compare the results of each food security methodology used in each wave.

## MATERIALS AND METHODS

### Study Area

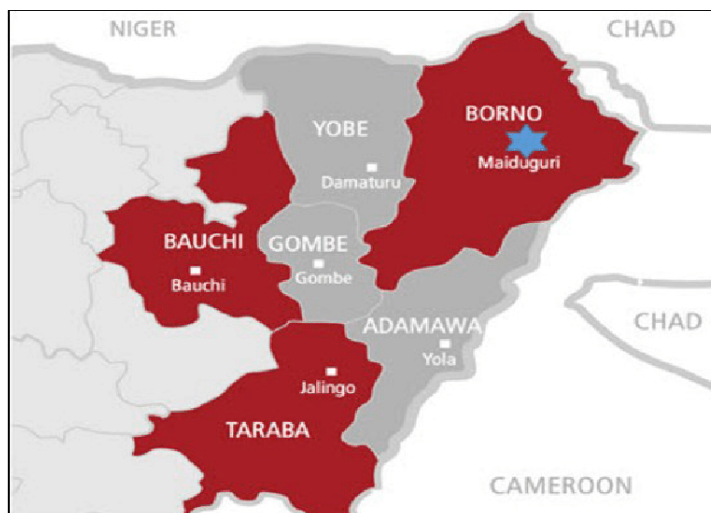
The study was conducted in North Eastern Nigeria. North East (NE) is one of the geopolitical zones of Nigeria and consists of Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe states. North East geopolitical zone of Nigeria covers about one



third (280,419 km<sup>2</sup>) of Nigeria's Land area 909,890 km<sup>2</sup> [33]. According to projections for 2011 by the National Bureau of Statistics (NBS), these States have 13.5% (23,558,674) of Nigeria's population which is put at 173,905,439 [34]. In addition, the North East Zone shares international borders with Republic of Cameroon to the East, Republic of Chad to the North East and Niger Republic to the North [35].

Although the Zone has been a major contributor to national net food production, Statistics show that the North East of Nigeria has the worst socioeconomic conditions in the country. Its average absolute poverty rate put at sixty-nine percent (69.0%) is above the national average of sixty point nine percent (60.9%) [36]. This characterizes the Zone as having the highest rate of poverty in Nigeria.

Northeastern is relevant for the study because of the prevalence of conflict and unrest in the study area.



**Diagram 1: Map of Northeastern Nigeria**

Source: Adapted from ResearchGate

### Data collection

Secondary data were used for this study from the General Household Survey (GHS), wave 2 (2012/2013) and wave 3 (2015/2016). Data collected on rural households in Northeastern Nigeria were used in this study and all the respondents that fell in this category were used to make sure there was a good representation of the study area. Northeastern Nigeria was purposely selected because of the focus of this study. The data set was cleaned to get needed information on rural households located in Northeastern Nigeria. According to the data set, in wave 2 (2012/2013) there were 624 rural households interviewed in



Northeastern Nigeria. While 537 rural households were interviewed in wave 3 (2015/2016), the reduction in households may be due to migration because of the prevalence of conflicts and attacks in the study area. Rural households that have the relevant information for this study in wave 2 and wave 3 were selected. This study used a sample size of 451 rural households in each wave of the data set.

### Analytical Techniques

The analytical technique used are Descriptive statistics, Chi-square, Mean *per capita* food expenditure, Foster, Greer and Thorbecke (FGT) index, Dietary Diversity Index and Logistic regression model.

### Descriptive Statistics

Households were classified based on their socio-economic characteristics using frequency distribution, and results were presented in tables. Percentage was used to represent the proportion of food secure and food insecure rural household populations within socio-economic classes. The tables were used to represent all information about respondents, food insecurity indices and the different results of analysis.

### Mean *per capita* food expenditure

A thorough search of literature shows that a number of studies conducted made use of household expenditure with two-thirds of mean *per capita* expenditure as threshold to construct food-poverty line or food security line [37-39]. Therefore, a household is referred to as food secure (or food insecure) when observed *per capita* food expenditure is greater (or less) than two-thirds of mean of *per capita* expenditure. Mean *per capita* expenditure is given as:

$$FE_{PC} = \sum_i^n \frac{\text{Total household food expenditure}}{\text{household size}}$$

Where:

FE\_PC = Mean *per capita* food expenditure

I = *i*<sup>th</sup> Household

n = Total number of observations

Food security index is defined as:

$$F_i = \frac{\text{per capita food expenditure for the } i^{\text{th}} \text{ household}}{2/3 \text{ mean per capita food expenditure of all households}}$$

Where  $F_i$  = Food Security Index

$F_i \geq 1$  = food secure *i*<sup>th</sup> household

$F_i < 1$  = food insecure *i*<sup>th</sup> household



### Foster, Greer and Thorbecke (FGT) analysis

The food security profile of the household as measured by its effect on incidence, depth and severity of food insecurity was determined. Food insecurity incidence shows the percentage of the household that live below the food insecurity line / food insecure. Food insecurity depth or gap index reflects the depth of food insecurity by taking into account how far the individual is from the food insecurity line [40, 41]. Also, food insecurity severity index reveals how severe the household are food insecure. The closer the FGT index is to 1, the greater the level of food insecurity [42, 43]. The FGT index is given mathematically as:

$$P_{\alpha} = \frac{1}{N} \sum_{i=1}^q \frac{z - y_i}{z} \alpha \geq 0$$

Where:

$Y_i$  = Per capita household food expenditure ( $i = 1, 2, \dots, q$ )

$Z$  = Food security line

$N$  = Total number of population

$q$  = Number of food secure households

$P_{\alpha}$  = Weighted food security index,  $\alpha \geq 0$  and can take values of 0, 1 and 2.

When  $\alpha = 0$ , the FGT index  $P_0$  measures food security incidence. When  $\alpha = 1$ , the FGT index  $P_1$  measures the food security depth of the households. This denotes the proportion of food security line that the food insecure household will require to get out of food insecurity. When  $\alpha = 2$ , the FGT index  $P_2$  measures the severity of food security status. It measures how far away the food secure households are from the food security line.

**Household Dietary Diversity Score:** Household dietary diversity can be described as the number of food groups consumed by a household over a given reference period. It is an important indicator of food security for many reasons because a more diversified household diet is correlated with caloric and protein adequacy, percentage of protein from animal sources and household income [44,45]. The following 12 food groups are used to calculate the HDDS indicator; Cereals; Roots and Tubers; Vegetables; Fruits; Meat, Poultry & offal; Eggs; Fish and sea food; Pulses, legumes, nuts; Milk and Milk products; Oil and Fats; Sugar & Honey; Miscellaneous.

Each food group is assigned a score of 1 (if consumed) or 0 (if not consumed). The household score ranges from 0 to 12 and it is equal to the total number of food groups consumed by the household.





$$HDDS = C_1 + C_2 + C_3 + C_4 + C_5 + C_6 + C_7 + C_8 + C_9 + C_{10} + C_{11} + C_{12} \quad (1)$$

where  $C_1 - C_{12}$  are different food groups

The average household dietary diversity score for the households on the study can be calculated as:

$$\frac{\text{Sum of Household Dietary Diversity Score}}{\text{Total number of households surveyed}}$$

A household is considered food insecure if their DDS is less than the average DDS of the households in the upper quintile taken as the threshold [46, 47]. Identified from the data set were 12 food groups over 7 days recall, the food groups were classified into quintiles. The average DDS of households in the upper quintile was equal to 6. The DDS threshold used to classify households into food secure and food insecure, therefore, was equivalent to 6 food groups out of the maximum 12 food groups in the sample.

**Logistic Regression Model:** The logistic regression method was used to know the determinants of food security status of households in the study area. The logistic regression model expresses a qualitative dependent variable as a function of several independent variables. It is used when the dependent variable is dichotomous and the independent variables are of any type. In this analysis, food security ( $Z$ ) is the dependent variable which takes the value of 1 if a household is food secure and 0 if otherwise.

The probability that households are food secure is calculated from  $Z_i$  value

$$Z_i = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + \dots + b_nx_n \quad (4)$$

$X_1-X_n$  are the independent variables

$Z_i$  = household food secure (1 if yes, 0 otherwise)

$b_0$  = constant

$b_1$  = is the coefficient of the  $X$ 's variables.

## RESULTS AND DISCUSSION

### Descriptive statistics

The result in Table 1 showed that 58.7% were food secure among the male-headed households while only 15.4% were food secure among the female-headed households in wave 2, In wave 3, the result showed that 61.7% of male-headed



households were food secure and 38.3% of the female-headed household were found to be food secure.

The sex of the household head is expected to affect the level of involvement in farming activities and so food security. Based on the result from the two waves, households headed by female were at least twice as likely to be food insecure compared to the households headed by male. The findings were in line with a study done in Kwara state [48].

Table 1 also revealed that 61.1% of the household heads within 21- 40 age bracket were food secure in wave 2 while 55.6% of household heads within age bracket 21-40 were food secure in wave3, and a lower proportion of those with heads over 60 were food secure in each wave. The age of the farmer is expected to influence his level of activities. It decides the quality and quantity of work he can do on the farm. This is a vital measure of farm efficiency. From waves 2 and 3 results, the farmers were between the age ranges of 21-60 years which is the active age range. At this age, the respondents are expected to be able to do a lot of farm work. This means younger household heads are likely to be more productive than older ones [34].

Households with married heads are more likely to be food secure (60.0% in wave 2 and 63.1% in wave 3). Married farmers have more dependents on the household income than single farmers [49]; this can be attributed to the fact that married couples are likely to have larger families, thus increased family labor. In subsistence agriculture, household size is determined to a large extent by the supply of labor to the farm which becomes an asset to increased food security. However, large households with many dependents (children and the elderly) could be of little or no advantage to the farming household when it comes to food security. Of households with heads who had tertiary education, 73.0% were food secure in wave 2 while 75.6% were food secure in wave 3 (table 1). The findings indicated that educational status of the household head might influence household food security [36]. Igwe *et al.* [50] examined food security incidence across income strata in Oredo Local government of Edo state and found that education enhanced food security status and improved with increased income.

The food security status of the selected locations in the study area in table 1 shows that there were more food secure households in Borno state in both waves. Being a state with the pervasiveness of crises and conflict, this state of food security can be linked to the food security intervention of various organizations and government in that state.



### Food Security Status by Mean *per Capita* Expenditure (MPCE), Foster, Greer and Thorbecke (FGT) and Dietary Diversity Score (DDS)

The mean *per capita* food expenditure of households in wave 2 and 3 were ₦ 613.20 and ₦ 533.9, respectively. Based on the threshold (two-thirds of the mean *per capita* food expenditure, which is ₦408.80 for wave 2 and ₦355.94 for wave 3), food secured households (in table 2 below) for waves 2 and 3 were estimated to be 54.8% and 51.9%, respectively. Olayemi *et al.* [31] used two thirds of the mean *per capita* food expenditure as the food secured line and found out 70.1% of the respondents in the study area were food secured.

Table 3 showed the FGT indices: the incidence of food insecurity (F0) or food insecurity head-count, depth of food insecurity and severity of food insecurity. The result showed that 45.2% and 48.1% of the total households were food insecure in waves 2 & 3, respectively. To know how far the households were from the minimum daily requirement, food insecurity depth (F1) was calculated and from the result, households were on average 19.6% and 21.7% below the recommended caloric intake for lively and healthy life in waves 2 and 3, respectively. The severity of food insecurity is measured as  $P\alpha$  ( $\alpha = 2$ ); the result indicated in table 3 showed that the severity of the food insecurity (F2) for waves 2 and 3 were 0.1193 and 0.1294, respectively for the households. The result is in line with the Sani and Kemaw study as well as Mequanent *et al.* [51, 52]. For the Dietary Diversity Score (DDS), high food group ( $\geq 6$  food groups) [53] households were ranked food secure while those below this threshold were ranked food insecure. The result in Table 4 showed that in waves 2 & 3, respectively, 24.0% and 32.0% of the households were food secure.

Comparing the result of waves 2 and 3 logit regression for the mean *per capita* expenditure (MPCE) and dietary diversity score (DDS) in Tables 5 and 6, respectively, Table 6 showed that age, and tertiary education were significant in both models. This indicated that both age and tertiary education of the household head influenced the household's food security status. The negative relationship with age indicated that an increase in the age of household head may increase the household dependency ratio hence, reducing the household food security status (same is the case with age under MPCE in wave 2 as shown in table 5). The positive relationship with tertiary education means food security increases with higher level of education, which is in agreement with wave 2 logit regression for the mean *per capita* expenditure (MPCE) and dietary diversity score (DDS) in table 5. The result aligns with Ajaero [54] but contradicts Yusuf *et al.* [55] who found food security to decrease with increasing number of years spent in school.

The Regression result of MPCE found Marital Status as well as location such as Borno and Gombe significant to food security in both waves. This implied that they had a significant contribution to the food security status of the North-eastern states. Land ownership and household size were found to be significant in both waves. Household size had a negative coefficient that is significant at 1% and 5% level at wave 2 and 3, respectively implying that the larger the household size, the lower their food security status. This observation is consistent with the result of Iorlamen *et al.* [56] that food security is influenced by household size.

Table 7 showed the summary result/comparison of the three food security measuring indices used in the study, which were MPCE, DDS and FGT. Foster, Greer and Thorbecke result showed food insecurity incidence of 0.4523 and 0.4812 in waves 2 and 3. This implied that more than half of the households in both models and waves had access to the minimum daily requirement and spent more than two thirds of the population's mean *per capita* expenditure. The result from DDS in waves 2 and 3 showed that 24.0% and 32.0% of households in waves 2 and 3, respectively consumed  $\geq 6$  of 12 food groups.

The percentage of food secure households with MPCE in both waves was higher compared to Dietary Diversity Score (DDS). Comparing the waves in both MPCE and FGT, it was found that households' food security dropped in wave 3, which could be due to increased/constant conflict in the study area which had caused displacement of most people from their work. In the midst of this conflict, we found out that dietary diversity increased in wave 3, giving us an increased food security status with DDS in wave 3. This may mean that the supply of food by various interventions diversified the dietary intake of the households thereby increasing the number of food groups consumed by households to 6 and above.

## CONCLUSION

Gender, age, education of household head, household size as well as location affected food security status of the households in North-Eastern of Nigeria. More than half of the sampled households had access to minimum daily requirement and spent above two third of the population mean *per capita* expenditure on food and on the average, about 27% of the sampled households consumed  $\geq 6$  of 12 food groups in both waves. It was discovered that age, level of education and household sizes were major factors which influenced food security with MPCE and DDS in both waves.



**Table 1: Descriptive analysis of households' socioeconomic characteristics on food security**

Socioeconomic Characteristics	Wave 2		Wave 3	
	Food secure Freq (%)	Food insecure Freq (%)	Food secure Freq (%)	Food insecure Freq (%)
<b>Sex</b>				
Female	2(15.38)	11(84.62)	4 (33.33)	8(66.67)
Male	251(58.68)	81 (41.32)	271 (61.73)	168 (38.27)
<b>Age (years)</b>				
21-40	107 (61.14)	68 (38.86)	70(55.56)	56 (44.44)
41-60	120 (57.69)	88 (42.31)	160 (68.09)	75 (31.91)
61-80	32 (51.61)	30 (48.39)	40 (50.63)	39 (49.37)
80-100	0	6 (100)	5(45.45)	6 (54.55)
<b>Marital status</b>				
Single	6(20.7)	23 (79.3)	6 (24.0)	19 (76.0)
Married	253(59.95)	169 (40.05)	269 (63.15)	157 (36.85)
<b>Household size</b>				
1-5	64(47.06)	72 (52.94)	32 (41.03)	46 (58.97)
6-10	127(58.80)	89(41.20)	126 (57.80)	92 (42.20)
11-15	63(69.23)	28(30.77)	93 (72.66)	35(27.34)
16-20	3(50.00)	3(50.00)	20 (90.91)	2 (9.09)
>20	2(100)	0	4 (80.00)	1(20.00)
<b>Educational Status</b>				
No formal Education	144(54.14)	122(45.86)	158(59.62)	107(40.38)
Primary Education	43(62.32)	26(37.68)	41(60.29)	27(39.71)
Secondary Education	45(56.96)	34(43.04)	42(57.53)	30(42.47)
Tertiary Education	27 (72.97)	10(27.03)	34(75.56)	11(24.44)
<b>Land ownership</b>				
No	29(82.66)	6 (17.14)	27(77.14)	8(22.86)
Yes	230 (55.29)	186 (44.71)	248(59.62)	168(40.38)
<b>Access to Credit</b>				
No	160 (60.84)	103 (39.16)	-	-
Yes	99 (52.66)	89 (47.34)	-	-
<b>Location</b>				
Adamawa	23(28.75)	57(71.25)	42(53.16)	37 (46.84)
Bauchi	82(65.08)	44(34.92)	85 (68.00)	40(32.00)
Borno	46(76.67)	14(23.33)	45(75.00)	15(25.00)
Gombe	41(70.69)	17(29.31)	41(70.69)	17(29.30)
Taraba	39(46.99)	44(53.01)	32(37.65)	53(62.35)
Yobe	28(63.64)	16(36.36)	30(68.18)	14(31.82)



**Table 2: Household food security status by Mean *per Capita* Expenditure (MPCE)**

Food security	Wave 2 Frequency (%)	Wave 3 Frequency (%)
Food secure	247(54.77)	234(51.88)
Food insecure	204(45.23)	217(48.12)
Total	451(100)	451(100)

**Table 3: Household food security status by Foster, Greer and Thorbecke (FGT) [40]**

Food Insecurity status	Wave 2	Wave 3
Food Insecurity Incidence	0.4523	0.4812
Food Insecurity Depth	0.1955	0.2167
Food Insecurity Severity	0.1193	0.1294

**Table 4: Household food security status by Dietary Diversity Score (DDS)**

Food security	Wave 2 Frequency (%)	Wave 3 Frequency (%)	Chisquare
Food secure	108(23.95)	144(31.93)	0.3455
Food insecure	343(76.05)	307(68.07)	(0.557)
Total	451(100)	451(100)	



**Table 5: Logit regression of factors influencing Household Food Security in Wave 2**

Food security status Food secured =1 Food insecure=0	Mean per capita expenditure/ FGT				Dietary Diversity Score			
	Coeff.	Standard Error	P value	Marginal Effect	Coeff.	Standard Error	P value	Marginal Effect
Age	-.17677	.00857	0.039	-.00353**	-.00906	.00853	0.288	-.00188
Household size	-.14797	.03199	0.000	-.02956***	.00472	.02884	0.870	.00098
Sex	1.83873	1.18745	0.122	.31687	1.32669	1.00672	0.188	.20794
Marital status	-.85446	.87428	0.328	.16547	-.89539	.61473	0.145	-.20299
Land ownership	-1.83158	.68666	0.008	-.32565***	.26126	.42614	0.540	.05210
Primary Edu	-.09001	.30939	0.771	-.01809	-.67954	.33912	0.059	-.12297*
Secondary Edu	-.11677	.30928	0.706	-.02345	.38732	.29048	0.182	.08713
Tertiary Edu	.76445	.41013	0.062	.14974*	.11064	.36054	0.759	.02396
Bauchi	.60052	.30971	0.053	.11995*	.13562	.31818	0.670	.02817
Borno	-1.13003	.42852	0.008	.22571***	.40454	.38669	0.295	.08404
Gombe	.92379	.38947	0.018	.18452**	.23817	.37456	0.525	.04948
Adamawa	-.63799	.35573	0.073	-.12743*	-.37810	.37230	0.310	-.07855
Yobe	.39576	.40141	0.324	.07905	.48998	.40017	0.221	.10179

\*, \*\*, \*\*\* significance at 10%, 5% & 1% levels respectively

**Table 6: Logit regression of factors influencing Household Food Security in Wave 3**

Food security status Food secured =1 Food insecure=0	Mean per capita expenditure/ FGT				Dietary Diversity Score			
	Coeff.	Standard Error	P value	Marginal Effect	Coeff.	Standard Error	P value	Marginal Effect
Sex of household head	.00812	.75080	0.991	.00161	.51142	.85072	0.548	.07916
Age of household head	-.31545	.15804	0.048	-.06253**	-.38524	.17448	0.027	-.06771**
Household size	-.15956	.03619	0.000	-.03163***	-.01065	.03814	0.780	-.00187
Marital status	-.42525	.26195	0.104	-.08290	.10283	.26776	0.701	.01795
Access to credit	-.26797	.21900	0.221	-.05312	.11578	.23627	0.624	.02044
Land ownership	-1.39214	.66026	0.035	-.25174**	-.58220	.45913	0.205	-.11389
Primary Edu	.41997	.30367	0.167	.08434	-.45321	.33811	0.181	-.07948
Secondary Edu	.31693	.30669	0.302	.06385	-.46369	.32181	0.154	-.08146
Tertiary Edu	1.39678	.47316	0.003	.25897***	-.91194	.49097	0.069	-.14049*
Bauchi	.27388	.31421	0.383	.05429	.32418	.35605	0.364	-.05684
Borno	1.08132	.43413	0.013	.21436**	-.45641	.45223	0.313	-.08022
Gombe	.86802	.40814	0.033	.17207**	.23218	.41235	0.573	.04081
Adamawa	-.63800	.35573	0.073	-.12743*	-.37810	.37230	0.310	-.07855
Yobe	.70774	.40730	0.082	.14029*	-.41392	.46617	0.375	-.07275

\*, \*\*, \*\*\* significance at 10%, 5% & 1% levels, respectively



**Table 7: Comparison of different food security measures used for the study**

	MPCE		FGT			DDS	
	Food secure	Food insecure	Food insecurity incidence	Food insecurity depth	Food insecurity severity	Food secure	Food insecure
<b>Wave 2 Freq(%)</b>	247(54.77)	204(45.23)	0.4523	0.1955	0.1193	108(23.95)	343(76.05)
<b>Wave 3 Freq(%)</b>	234(51.88)	217(48.12)	0.4812	0.2167	0.1294	144(31.93)	307(68.07)

**Appendix**

Household Variable	Definition
X <sub>1</sub>	Household head education
X <sub>2</sub>	Age of household head in years
X <sub>3</sub>	Marital status (0= single, 1=married)
X <sub>4</sub>	Sex of household head (1 for male, 0 for female)
X <sub>5</sub>	Household size (Total number of people living in a house)
X <sub>6</sub>	Access to Credit ( 1=yes, 0=No)
X <sub>7</sub>	Land Ownership ( 1= yes, 0 = No)
X <sub>8</sub>	Location (States in North East)
X <sub>9</sub>	No formal education
X <sub>10</sub>	Primary education
X <sub>11</sub>	Secondary education
X <sub>12</sub>	Tertiary education

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