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Measurement and determinants of food insecurity in northeast Nigeria: Some empirical policy guidelines

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Abstract

The objectives of the study were to identify and analyze the food security measures of rural households in Borno State of Nigeria. Using multi-stage sampling techniques, 1,200 households spread across 30 communities located in four Local Government Areas of Borno State were selected through a random sample selection procedure. Cost-of-calories method and Logit model were used as analytical techniques for the study. Based on the recommended daily energy levels of 2250 kcal, a food insecurity line of ₦23,700.12 or US $176.87 per adult equivalent per year was obtained for the households. Over 58% of the sample households are therefore food insecure. The logit analysis revealed that the major determinants of food insecurity in the study area are household size, gender, educational level, farm size and type of household farm enterprise. A large household size was observed to affect household food insecurity. Therefore, the government should give adequate priority and attention to policy measures directed towards the provision of better family planning. In addition, there is the need for a policy to promote formal education at little or no cost as a means of enhancing efficiency in food crop production over the long-term period. In the short term, informal education could be effective, especially when targeted at farmers who have had limited formal educational opportunities. Also a policy, which provides adequately trained and equipped extension workers to disseminate improved agricultural technologies, has the potential to raise efficiency in food crop production and so enhance food security.

Key words: Determinants, measures, calorie, food intake, households, food security, food production, consumption, policy, Nigeria.

Introduction

The Food and Agriculture Organization (FAO) was given the mandate, 16 October 1945, to advise on techniques of agriculture, fisheries and forestry for securing higher nutritional standards throughout the world. Food security has been defined as "access by all people at all times to safe and nutritious food needed to maintain a healthy and active life" [1]. Food security is thus people-oriented and it implies a situation in which all households have both physical and economic access to adequate food for all members and where households are not at risk of losing such access [2]. If food security is attained, the result will be a contented, patriotic and more productive populace and, therefore, an ideal environment in which to thrive [3].

Mustafa [4] viewed food security as a major element in national security alongside domestic law and order as well as territorial defence and other forms of security. Furthermore, according to the check list of fundamental human rights; the right or easy access to food means more to households who are food insecure than the right to basic education, participation in the political and social life, and so on. Relating food security to the security of the state, Omole [5] indicated that food is not an ordinary commodity, but a powerful instrument of state policy that can be employed to punish enemy and recalcitrant nations, reward friendly states and influence the political and economic decisions of nations. Beer [5] asserted, food is an instrument of power and hence government must be much concerned with how to increase its availability. If there is a shortage of food then the power of the state becomes weak. The level of food security is therefore, one of the indicators of the level of development. It is imperative to group the level of world economic development into high, medium and low-income food deficit countries [7]. Food security can be seen to have social, economic and political implications for any nation. Food insecurity is synonymous to not knowing where your next meal is going to come from [8].

Several authors have investigated the determinants of food security in sub-Saharan Africa. Nyangwesoi *et al.* [9] in a study of household food security in Vihiga district of Kenya found that household income, number of adults, ethnicity, savings behaviour and nutrition awareness significantly influence household food security. In a similar study, Kahoi *et al.* [10] established that the significant determinants of food security in the Mwingi district of Kenya were participation of households in the food for work program, marital status of the household head and their

educational level. In a study of food security in the Lake Chad Area of Borno State, Nigeria, Goni [11] reported that factors influencing household food security, including household size, stock of home produced food and number of income earners in the household, were positively related to food security. In addition, in a study of food security in Nigeria, Olayemi [12] categorized factors affecting food security at the household level into supply-side factors, demand-side factors and stability of access to food, which includes household food and non-food production variability; household economic asset; household income variability; quality of human capital within the households; degree of producer and consumer price variability and household food storage and inventory practices.

Despite the growing concern of improving food security, the measurement and determinants of food insecurity among the rural households of Nigeria is not well-documented. As a result, there is a need to empirically measure and examine the determinants of food insecurity among rural households in northeast Nigeria. The extent that the study will identify the determinants of household food security will help in providing information for the formulation of appropriate policies that can mitigate food insecurity, especially amongst rural households.

Methodology

Study area and data: Borno State, the study area, is located in the northeast of Nigeria, covering an area of 69,435 km^2. It has 3.64 million people in 2004 distributed into four agro-ecological zones: southern and northern Guinea savanna, Sudan savanna and Sahel savanna.

The study area has relatively humid weather; annual rainfall ranges between 700 and 1500 mm with 140-150 rainy days. Temperature range is 15-20°C during harmattan (December to February), while in the hot dry season (March to May) it is 32-38°C. Major crops grown are maize, sorghum, cowpea, groundnut and vegetables. The livestock kept include cattle, sheep, goats, pigs and poultry.

A multi-stage sampling technique was employed in the selection of sample households used in the survey. The data were obtained through a household survey of 30 communities located in four Local Government Areas (LGAs) of the State. In each selected community, 40 households were randomly selected, giving a total of 1,200 sampled households. The main instruments for data collection were well-structured questionnaires administered to heads of households.

Data measurement and analytical technique: Descriptive statistics and inferential statistics (the cost-of-calories [COC] and Logit models) are the analytical techniques used for the study. The COC method proposed by Greer and Thorbecke [13] was used to estimate the food security line. The method yields a value that is usually close to the minimum calorie requirements for human survival. A minimum level of nutrition necessary to maintain healthy living was identified. This minimum level is referred to as the 'food insecurity line' for the area under study, below which people are classified as food insecure, subsisting on inadequate nutrition. Calorie adequacy was estimated by dividing the estimated calorie supply for the households by the household size adjusted for adult equivalence using the consumption factor for age-sex categories [14, 15]. The food insecurity line is given as:

$$\ln X = a + bC \quad (1)$$

where X is the adult equivalent food expenditure (in Naira), C is the actual calorie consumption per adult equivalent of a household (in kcal).

The calorie content of the recommended minimum daily nutrients level was used to determine the food insecurity line S using the equation:

$$S = e^{(a+bL)} \quad (2)$$

where S is the cost of buying the minimum calorie intake (food insecurity line), a and b are parameter estimates from Equation 2 and L is recommended minimum daily energy (calorie) level†.

Based on the S calculated, households were classified as food secure or food insecure, depending on which side of the line they fell. Due to differences in household composition in terms of age and sex, there was a need to calculate the levels of expenditure required by households with different compositions. One of the easiest ways to achieve this was to divide the household expenditure by household size to get the per capita expenditure, as used by the World Bank [17] and several other studies. The household expenditure was decomposed on per adult equivalent basis using the conversion factor adapted by Storck *et al.* [18]. The factors are presented in Table 1.

Table 1. Conversion factors for calorie requirement for different age groups [18].

Age group	Male	Female
<10 years	0.6	0.6
10-13	0.9	0.8
14-16	1.0	0.75
17-50	1.0	0.75
>50	1.0	0.75

Empirical model for the determinants of food insecurity: A Logit model was used to examine the determinants of household food insecurity, which is specified as:

$$Y_1 = g(I_1) \quad (3)$$

$$I_i = b_0 + \sum_{j=1}^{n} b_j X_{ji} \quad (4)$$

where Y_i is the observed response for the ith observation (i.e., the binary variable, $Y_i = 0$ for a food secure household and $Y_i = 1$ for a food insecure household). I_i is an underlying and unobserved stimulus index for the i^{th} observation (conceptually, there is a critical threshold (I_i^*) for each household; if $I_i > I_i^*$ the household is observed to be food secure, if $I_i \leq I_i^*$ the household is observed to be food insecure), g is the functional relationship between the field observations (Y_i) and the stimulus index (I_i) which determines the probability of being food secure.

The Logit model assumes that the underlying stimulus index (I_i^*) is a random variable, which predicts the probability of being food insecure. Therefore, for the ith observation (a household):

$$I_i = \ln \frac{P}{1 - P_i} = b_0 + \sum_{j=1}^{n} b_j X_{ji} \quad (5)$$

The relative effect of each explanatory variable (X_{ji}) on the probability of being food insecure is measured by differentiating with respect to $X_{ji,}$ using the quotient rule [19].

† The FAO 16 recommended minimum daily energy requirement per adult equivalent is 2250 kcal.

$$\frac{dP_i}{dX_{ji}} = \left[\frac{e^{I_i}}{(1+e^{I_i})^2}\right]\left[\frac{I_i}{X_{ji}}\right] \quad (6)$$

where Pi = the probability of an i[th] household being food insecure stands for dummy, Xi = vector of explanatory variables which are defined as: AGE = Age of head of household (Years); FARMINC = Farm income of a household per annum (₦)†; FARMSZ = Farm size of a household (ha); HHSZ = Household size of a farmer; FAMEX = Farming experience (years); COOP = Co-operative membership; (D = 1, if yes; D = 0, otherwise)‡; EDUC= Level of education of a farmer (years); DIST = Distance to input source (km); GEND = Gender of head of household (D = 1 for male, D = 0 for female); DIVER = Diversification index (Using Herfindhal index); ASSETS = Total value of household disposable assets (₦); FARMEN = Household production enterprise (D = 1 if farm enterprises alone, otherwise D = 0); COOP = Membership of cooperative societies D = 1 if yes, otherwise D = 0); CREDIT = Household head's access to credit facilities (D = 1 if yes, otherwise D = 0); CDR = Child dependency ratio; EXTAG = Household head's access to extension agents (D = 1 if yes, otherwise D = 0); EXCOM = Extent of produce commercialization (proportion of farm produce sold); REMIT = Total value of remittances received per adult equivalent per annum by household (₦); HLAB = Hired labour (mandays); FLAB = Family labour (mandays).

The diversification extent (DIVER) was measured using Herfindahl index [20] defined as:

$$\text{DIVER} = \sum_{i=1}^{n} R_i^2 \quad (7)$$

$$\text{where, } R_i = \frac{A_i}{\sum_{i=1}^{n} A_i} \quad (8)$$

A_i = share of farm revenue from enterprise i cultivated by the household, n = number of enterprises owned by household.

Results and Discussion

Socioeconomic characteristics of households: This section examines the major socioeconomic characteristics of households in the study area. The socioeconomic characteristics of the sampled households are presented in Table 2. Respondent household heads' mean age was 45.6 years and had an average farming experience of 25 years. Also, there was a low level of education among the household heads with mean formal education of 4 years. Households in the study area generally had an average household size of 12.8 persons, most of them children.†

Household food insecurity statistics: The summary statistics of food insecurity measures among the households is presented in Table 3. Based on the recommended daily energy levels (L) of 2250 kcal, the food insecurity line (S) for the households was found to be ₦ 63.71 per day per adult equivalent (₦1975.01 per month per adult equivalent). On an annual basis, this is equivalent to ₦ 23700.12 per adult equivalent. From the food insecurity line, it was shown that 58% of the sampled households are food insecure by headcount (H). Furthermore, the aggregate income gap (G) of –375.74 indicates the amount (₦375.74) the food insecure households would need to meet their monthly basic food requirements.

Determinants of household food insecurity: The various variables included as the determinants of food insecurity in the Logit model were as defined previously. From the Logit results (Table 4), eleven variables were significant at $p<0.05$ level. Some variables, which were already conceptualized, were dropped from the analysis because of the problem of multicollinearity.

The results show that the major determinants of food insecurity were household size, gender of the head of household, educational level of the head of household, farm size of the household and type of household farm enterprise. Others include ratio of quantity produced to quantity of consumed food, extent of agricultural output commercialization, expenditure on education by the household, households' access to extension agent and credit, households' head membership of cooperatives or farmers' organizations and value of household assets.

The gender of the head of household (GEND) reveals a significant positive relationship with household's food insecurity status. Households headed by males have a higher probability of being food insecure. Household size (HHSZ) is negatively correlated at 1% to food insecurity. This shows that households with large size have a higher possibility of being food secure than those with a smaller size, and vice versa.

Educational level of head of household (EDUC) is negatively correlated at 1%, which suggests that the higher the educational level of a head of household, the more food secure the household, and vice versa. The coefficient of the expenditure on education (EDUCEX) is positively significant and suggests that the higher a household's expenditure on education, the higher the probability of food insecurity and vice versa. This is plausible, as education of children is a priority for which the households could deny itself some comfort in the short run. Households sometimes sell from their food reserve to provide for this educational need and consequently expose themselves to food shortages in the short term.

The total farm size (FARMSZ) of a household is significant and exhibits a negative relationship with the food insecurity status of the household, showing that households with larger farm size are more food secure than those with smaller size and vice versa. Type of household enterprise (FARMEN) is positively related to food insecurity. Households who are into farming alone had a higher probability of food insecurity than those that have diversified from farming into some other non-farm enterprises and vice versa. This is plausible because households that have other sources of income in addition to farming are more resilient in times of food crisis than those that are into farming alone. Ratio of quantity produced to the ratio of quantity consumed of food (RQPQC) is significant at 1% and shows a negative correlation with food insecurity. This shows that the higher the ratio, the lower the probability of food insecurity and vice versa. The extent of agricultural output commercialization (EXCOM) is an income-enhancing variable and thus is expected to mitigate food insecurity. The coefficient of the variable is significant at 1% and exhibits a positive correlation to food insecurity suggesting that the higher the extent of commercialization, the higher the probability of food insecurity, and vice versa. This is contrary to *a priori* expectations

† One dollar equivalent to ₦134.00
‡ D in the description of variables stands for dummy
† Children are defined as household members that are equal or less than 15 years old.

Table 2. Selected socioeconomic characteristics of the sample households, Borno State, Nigeria.

Variable	Mean	Standard deviation	Minimum	Maximum
Age (years)	45.6	13.7	15.6	75.2
Farming experience (years)	25.1	13.8	1.0	60.2
Educational level (years)	4.2	4.08	0	16.0
Household size (number)	12.8	6.1	2.0	40.0
Adult household members (number)	6.3	4.3	2.0	30.0
Children ≤ 15 years in household (number)	6.7	4.1	0	18.0

Source: Computed from field survey data, 2004.

Table 3. Summary statistics and food insecurity measures among households, Borno State, Nigeria.

Variable	Value
Cost-of-calories equation	Constant= 4.154 (0.534) *
	Slope coefficient=0.0019 (0.0004)
FAO recommended daily energy levels (L)	2250 kcal
Food insecurity line Z: cost of the minimum	₦ 63.71 per day
energy requirements per adult equivalent	₦1975.01 per month
	₦ 23700.12 per year
Head count (H)	0.58
Aggregate income gap (G)	-375.74

Source: Calculations from OLS estimates and cost-of-calories equation. *Figures in parenthesis are t-values.

Table 4. Result of the Logit function for household food insecurity status.

Variable	Parameter estimate	t-value
Constant	2.388	1.373
HHSZ	-0.014	-2.031**
GEND	0.946	2.097*
EDUC	-0.8957	-3.226**
CDR	-0.003	-0.054*
RFETE	1.317	1.367
FARMSZ	-0.1184	-1.899
CREDIT	-0.009	-0.403
FARMEN	1.025	1.743*
FLAB	-0.471	-0.345
HLAB	0.018	0.088
PERCUL	0.651	1.56
RQPQC	-0.220	-3.766**
DIVER	-0.234	-1.396
EXCOM	0.261	2.946**
EDUCEX	0.034	3.860**
EXTAG	-0.1308	-2.623**
COOP	-0.034	-3.928**
ASSETS	-0.3E-04	-4.396**
REMIT	-0.5E-04	-0.086

** Significant at 1%; * at 5% Source: Computer printout of data analysis.

because most of the households produce at a scale meant for home consumption and are forced to sell when a need arises, thus depleting the stock for home consumption and thereby exposing the household to food insecurity.

Households' access to extension agents (EXTAG) is significant at 1% and has a negative relationship with the food insecurity status. Households that have access to extension agents have a higher probability of being food secure than those that do not have such access and vice versa. This is because access to extension agents enhances the chances of households having better crop production techniques, improved inputs, as well as other production incentives and these affect their output vis-à-vis their food security status. Household heads' membership of a cooperative society or farmers' organization (COOP) is negatively significant at 1%. It implies that households whose heads are members of a cooperative or other farmers' organizations have higher probability of being food secured than those who are not. This can be closely linked to the beneficial effects of their memberships in terms of production and other welfare-enhancing services that these cooperatives or other associations offer.

Household assets holding (ASSETS) is considered one of the measures of household resilience, which cushions the effects of adverse circumstances, such as crop failure or drought on household food security. Some of the assets could be sold if need be. The variable is also an important factor affecting food security in the study area. The coefficient of the variable was negatively significant which implies that the higher the value of household assets, the lower the probability of food insecurity.

Conclusions

Based on the results of the analysis carried out in this study, the following policy recommendations are suggested to reduce food insecurity. First, a large household size is observed to affect household food insecurity. Therefore, the government should give adequate priority and attention to policy measures directed towards the provision of better family planning. In view of this, education that encompasses all aspects of training and which brings about attitudinal changes is important for households in the study area. Strategies are recommended for an effective community participation in the design of concepts and messages aimed at imparting knowledge about family planning.

Second, educational level of the household head was found to be a significant factor that influences household food security. Hence, there is the need for government to promote formal education as a means of improving food security over the long-term period. In the short term, informal education could be effective, especially when targeted at households who have had limited formal educational opportunities.

Third, because households that have access to extension agents have a higher probability of being food secure, policy should target to provide adequately trained and equipped extension workers who disseminate improved agricultural technologies to farmers. This has the potential to raise efficiency in food crop production and so enhance farmers' household food security.

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