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Analyses of Geospatial Variability Effect on Food Security Status of Cassava Producers in Nigeria, and its Determinants

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ABSTRACT: *Production, and consumption of Agricultural crops remains an important tool in cushioning the random effect of food insecurity, poverty and unemployment in households as these are prevalent in both urban and rural Nigerian households. In this regard, data collected by National Bureau of statistics on General Household Survey (GHS, wave 3) was used to profile the food security status in four Geopolitical Zones as they were representative of large samples for the study that comprised 1000 cassava - based farming households, while descriptive statistics, Foster, Greer, and Thorbecke (FGT), and logistic regression were utilised as analytical tools. The result shows that food insecurity incidence of the study area was 0.41 and although relatively higher (59%) of the households were food secure, a fair high proportion (41%) were food insecure in the study area. However, geospatial variation analyses across the zones showed that food insecurity incidence was at 0.66, 0.44, 0.43 and 0.34 for North-Central, South-West, South-South and South - East respectively, while it is canonically highest in the rural areas, relative to the urban areas, while Gender, age, years of schooling, crop consumed from own production, household size, marital status, per capita non-food expenditure, cost of meal taken away from home and regional, and locational factors are significant determinants of food security among the cassava-based farming households across the geopolitical zones in Nigeria. The study concluded that socioeconomic and geospatial variability significantly influence food security among cassava-based farming households in Nigeria, and further recommended useful policy options.*

KEYWORDS: Cassava-based farmers, Food security, Geospatial variations.

INTRODUCTION

Challenges related to food security across Nigeria over the years continues to be a difficult one. The Food and Agricultural Organization (FAO) identifies different levels of food insecurity:

mild, moderate, and severe. Mild insecurity means that there is an uncertainty regarding the ability to find food, moderate food insecurity applies to populations that do not have enough money or resources to acquire healthy foods, lack certainty in obtaining food and regularly skip meals and are at risk of running out of food. Lastly, the category of severe food insecurity is defined as going without food for a day or more at certain times of the year or running out of food (FAO, 2021). Also, according to initial United Nation's (UN) estimates that at a minimum, an additional 83 million people, and possibly as many as 132 million, went hungry in 2020 due to the economic recession triggered by COVID-19 (FAO, 2020).

As all these abide, conflicts associated with herdsmen and Boko Haram insurgency also continues to threaten the farming household and their settlement across the nation spreading from Northern to southern part of Nigeria, thus production of certain crop begin to decline with increasing competition for land and water resources, and also poses environmental challenges to farming households (Godfray et al., 2010). Amidst all these, Nigeria currently maintains the record of the largest producer of this cassava globally, but the yield trend (per hectare) remains low. This decrease may be linked to the ineffective agronomic practices and existing inefficient management in its production processes (Fakayode et al., 2008, Tadele and Assefa, 2012; and FAO, 2018). In spite of this, the current production is far from being able to meet the rising food needs of the geometrical population growth rate in the sub-region (Poverty, Oxford and Human Development Initiative, 2017; and FAO, 2018). Today, over Nine Million Nigerians are facing food insecurity and unless proper actions are taken, millions of Nigeria are expected to suffer in the coming years. (FAO, 2021).

Further on the significance of cassava, the products are dietary staple food, especially in Nigeria and some other countries in SSA. Nigeria has a population of about 200 million people, and 70% of Nigerians consumes a cassava product at least once daily (Njoku and Muoneke, 2008), usually in form of cassava flour (pupuru, and lafun), cassava flakes (gari), cassava paste (fufu), boiled cassava root, etc., as derived from cassava roots. It is widely patronised energy food source among over 600 million global cassava consumers (Hershey et al., 2001; and FAO, 2015).

As research advances to reinforce food security in Nigeria, questions on food security of households are relatively simple to ask, and food insufficiency has been found to be a strong correlate of money-metric poverty (Falkingham, 2002; McKenzie 2005). Food security status at the household level thus involves the state of reliability and or sufficiency of qualitative and quantitative nutritionally adequate food (Hadley 2014; Sirotin et al., 2014). According to the United Nations Human Settlement Programme (UN-HABITAT, 2006), urban population expansion are going to be more pronounced in developing countries as a results of high birth rates and immigration from rural areas as people flock to cities in search of food, employment and security. The trend is accelerating, and by 2050, it is expected that about 66% of the planet population are going to be living in cities. UN-HABITAT (2006) also suggests that the speed of increase will cause a rise in urban slum areas, with high levels of unemployment, food insecurity and malnutrition, but according to according to FAO (2018),

cassava production and consumption is a choice crop for poverty alleviation, rural development, economic growth and ultimately, food security.

Major cassava producing states in Nigeria are Benue, Kwara, & Kogi (North central); Cross River (South East); Ondo, Osun, Ogun, & Oyo (South west); Imo, Akwa Ibom, & Rivers (South south).

To this end, this study seeks to analyse geospatial variability effect on food security status of Cassava producing households in Nigeria, and its determinants, with specific objectives to;

1. describe the food security indices of the rural cassava farming households
2. conduct a geospatial analysis across the major cassava producing zones and profile their socioeconomic characteristics by their food security statuses, and
3. estimate factors determining food security status of the cassava based farming households.

METHODOLOGY

Study area/Data collection

The study was conducted in Nigeria, using a panel data set collected on general household survey (GHS), 2015 wave 3 administered by the National Bureau of Statistics in association with the world Bank. The data contains information on socio-economic characteristics like age (in years), sex, educational level (years of formal education), household size, farming experience (years), legal status and monthly income" in addition to food security indicators like expenditure on food, calorie intake, while resilience indicators such, access to basic service, access to infrastructure, assets, formal and informal safety nets, etc. are included. A two-stage sampling design was adopted for the survey. At the first stage, Enumeration Areas (EAs) were selected according to probability proportional to size (PPAs) in each state and total household in those EAs. At the second stage, selection of households was done. 10 households were randomly selected from each EAs. An overall of 1000 households were covered during this study.

Analytical techniques

Food security indices

Food security status was elucidated by using Food security index with FGT to estimate the food security status of every household as follows:

This principally adopts the a methodology that is capable of integrating limits of concerns on poverty via the "food poverty escape" parameter, "α", or "the Food poverty gap index" as used by Joanna et al.,(2016), and Balogun et.al., 2015, denoted as;

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$$P_1 = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{Z - y_i}{Z}\right)$$ …… (1)

Z = the set food insecurity line =2/3∑yi, Q = the number of food insecure households, N= sum total of sample population, n= sum total of poor population, Yi = the household income, and α = FGT value, that assumes the values 0, 1 and 2, which is dependent on the incidence of concern on poverty. The bracketed amount is the proportionate income below the set poverty line. When we increase "α" the "aversion" to poverty as a measure of this index is raised. For example, when there exists zero poverty aversion, α = 2, the index is denoted as;

H=q/N…… (2)

Equation 3 equals to the poverty head count ratio and the index also measures the incidence of poverty. If the poverty aversion degree is increased such that when α = 1, the index will become or be denoted as;

$$P0 = q\frac{1}{N} = q\frac{H}{N}$$ ……..……(3)

Here, the head count ratio is the product of poverty-line and the income gap between the average poor person.

Furthermore, food consumption expenditure may be a better indicator than income for 3 reasons: (1) it is more closely associated with well-being of a person; (2) consumption could also be better measured than income and are often more reliable; and (3) consumption better reflects a household's actual standard of living and capacity to satisfy basic needs. Aigbokhan (1997) and Anyanwu (1997) also submitted that total "consumption expenditure is preferred to income because it's usually better reported in household budget surveys.

Determinants of food security status

Logistic regression was adopted to determine the factors affecting household food security status. The rationale behind this model selection was adopted due to the presence of the dichotomous dependent variables and since the technique has no restrictive distribution assumptions. This was therefore used to identify the variables that significantly affect household food security status as stated below

$$p(y) = \beta_0 + \sum_{i=1}^{k}\beta_i x_i + \varepsilon_i$$ ……(4)

P(y) = F (Zi) =1, the probability that an household is food secure is calculated from Pi value

Where Xi – Xn are the independent variables

Pi springs by giving a score of 1 to i^{th} household if her food security status is bigger than

the mean and 0, if otherwise.

b0 = constant

bi = the coefficient of X's variables

The explicit function is;

$$Y_i = \beta_0 + \beta_1 X1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots\ldots\ldots\ldots\ldots + \beta_{15} X_{15} + \mu_i \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

μi Represents the independent distributed error term The explanatory variables are defined as follows:

X_1= Age of households in years

X_2 = Per capita non-food expenditure (₦).

X_3 = Gender of the Household head (D =1 if married; 0 = otherwise)

X_4 = No of years of formal education (Years)

X_5 =Monthly farm income (₦)

X_6 = quantity of farm produce consumed from own production (kcal)

X_7 = Regional factor

X_8 = Size of total cultivated farm land for cassava production (Hectares)

X_9 = Number of Household Member (Number)

X_{10} = Meal cost away from home

X_{11} = Annual off-farm income (₦)

RESULTS AND DISCUSSION

Food insecurity incidence

The result in table 1. showed that the food insecurity incidence for the study area was at 0.41. This result is in coherence with earlier findings on food insecurity in Nigeria as submitted by Sanusi et.al., (2006) that the incidence of household food insecurity in Nigeria has risen from 18% in 1986 to 40% in 2005. However, the food insecurity incidence across the zones in terms of regional factor range from 0.34 to 0.66, which is tandem to the findings of Jabo et. al., (2021) who reported the food insecurity incidence of farming households in Sokoto Nigeria to be 48.18%.

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Table1: Food security indices profile.

Variables	Value
Total household	**1000**
Mean Per Capita Household Food Expenditure(MPCHHFE)	**₦749.81K**
Food Security Line	**₦499.87K**
Food secure households	**590 (59.0%)**
Food insecure households	**410 (41.0%)**
Head count ratio food secure	**0.59**
Head food ratio insecure	**0.41**

Source: DHS data analysis result

Geospatial, and socioeconomic factors influence on food security statuses.

From table 2, geospatial variation analyses across the zones showed that food insecurity incidence was at 0.66, 0.44, 0.43 and 0.34 for North - Central, South - West, South-South and South - East respectively, wherein food insecurity incidence is higher for cassava-based farmers within the North Central at 0.66, and least for those within the Southeast zone at 0.34 and generally highest in the rural areas (0.41), relative to the urban areas (0.36).

Furthermore, socioeconomic variability response showed that food insecurity incidence is higher among male- headed households at 0.44, relative to female-headed cassava-based farming households which is at 0.31. This attunes the findings of Ogunniyi et.al, (2021), and however contradicts Negesse et. al., (2020). Also, food insecurity incidence with worth of Asset in naira is lowest when household assets are within the range of N50001-60000 at 0.32 and is highest when asset worth is more or less equal to N10000 at 0.44.

Food insecurity incidence is found to decrease with increase in years of schooling because it is highest when household didn't attend school in the least (None) at 0.46 and least when individuals' years of schooling are within the range of 13-18 years at 0.19 being the same of a tertiary education. This result corroborates the findings of other scholars (Babatunde et al., 2010; Adeyemo and Olajide 2013; Adamu et al.,2015;) as they all reported that higher years of schooling will make households to be more food secure. Also, when household's consumption from own production is bigger than 5kcal, food insecurity incidence is least at 0.22 and highest when consumption from own production are within the range of 0-2kcal at 0.42.

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Table 2: Summary of the Geospatial and Socio-economic variables influences on food security statuses.

Variables	**Food secure**		**Food insecure**		**Pooled (insecure)**	
	Freq.	**Perc.**	**Freq.**	**Perc.**	**Food Insecurity Indices**	**Total(N)**
Geospatial variations						
North - central	38	6.44	74	18.05	0.66	112
South - east	327	55.42	166	40.49	0.34	493
South - South	190	32.2	142	34.63	0.43	332
South - west	35	5.93	28	6.83	0.44	63
Urban	94	15.93	53	12.93	0.36	147
Rural	496	84.07	357	87.07	0.41	853
Variables	**Food Secure**		**Food Insecure**		**Pooled (insecure)**	
Gender of household head	**Freq.**	**Freq.**	**Freq.**	**Perc.**	**Food insecurity indices**	**Total(N)**
Male	160	27.12	71	17.32	0.31	231
Female	430	72.88	339	82.62	0.44	769
Age						
20-39	60	10.17	22	5.37	0.27	82
40-59	272	46.1	233	56.83	0.46	505
60-79	218	36.95	218	32.2	0.38	350
80-89	38	6.44	38	5.37	0.37	60
100-119	2	0.34	52. 1	0.24	0.33	3
Mean	57.8		57.3			
Standard	13.57		12.41			
Output consumed (kcal)						
≤ 2kcal	440	74.58	320	78.05	0.42	760
3-5kcal	105	17.58	77	18.78	0.42	182
75. >5kcal	45	7.63	13	3.17	0.22	58
Mean	1.67		1.74			
Standard	0.89		1.25			
Credit						

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No	472	80	318	77.56	0.4	790
Yes	118	20	92	22.44	0.44	210
Household size						
1-6	357	60.51	140	34.15	0.28	497
07-12	225	38.14	250	60.98	0.53	475
13-18	7	1.19	15	3.66	0.68	22
19-24	1	0.17	4	0.98	0.8	5
25-30	0	137. 0	1	0.24	1	1
Mean	1.41		1.72			
Standard	0.52		0.6			
Years of Education						
None	177	30	150	36.59	0.46	327
1-6	235	39.83	195	47.56	0.45	430
07-12	115	19.49	50	12.2	0.3	165
13-18	63	10.68	15	3.66	0.19	78
Mean	6.07		4.68	Mean		
Variables	**Food Secure**		**Food Insecure**		**Pooled (insecure)**	
Farm size (Hectares)	**Freq.**	**Freq.**	**Freq.**	**Perc.**	**Food insecurity indices**	**Total(N)**
≤ 0.5	253	42.88	173	42.2	0.4	426
0.5-0.99	218	36.95	159	38.78	0.42	377
1.0-1.49	59	10	35	8.54	0.37	94
1.5-1.99	30	5.08	16	3.9	0.34	46
>1.99	30	5.08	27	6.59	0.47	57
Mean	0.72		0.73			
Standard	0.66		0.73			
Marital status						
Married	332		203	49.51	0.37	537
Married	49	8.31	67	16.34	0.57	116
Divorced	5	0.85	4	0.98	0.44	9
Separated	11	1.68	12	2.93	0.52	23
Windowed	144	24.41	68	16.59	0.32	212
Never married	7	7.79	58	13.66	0.54	103

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Farm income(₦)						
≤10000	202	34.24	132	34.2	0.4	334
10001-20000	66	11.19	44	10.73	0.41	110
20001-30000	46	7.8	27	6.59	0.37	73
30001-40000	50	8.47	40	9.76	0.44	90
40001-50000	27	4.58	32	7.8	0.54	59
50001-60000	29	4.92	19	4.63	0.4	48
>60000	170	28.81	116	28.29	0.41	286
Mean	32839.6		33572.91			
Standard deviation	29186.2		28660.4			
Total	**590**	**100**	**410**	**100**	**0.41**	**1000**

DHS data analysis result.

Factor determining food security level of cassava based farming households in Nigeria

The results of the multivariate analysis is presented in table 3. The diagnostic statistics revealed that the model features such as log-likelihood of -558.9379 and a chi-square of 234.06 are significant at 1% indicates a good fit for the data.

Result showed that cassava-based farmer altogether in other zones (Southeast, South south, and South west) are better-off, relative to North central regions. These findings, harmonises with that of Ibrahim et al., (2009) on the food security and resource allocation of farming households in North central Nigeria and submitted that majority of the farming households from this zone were food insecure and thus recommended the necessity to increase the production of cassava within the zone to reinforce household food security.

Furthermore, households with own farm production above 5kcal significantly increase their food security at 5% compared to an amount lesser or equal to 2kcal. This result harmonizes the findings of Saediman et al., (2016), who reported that cassava has proven suitable with the farming system and native food system and thus served as key food security crop in Southeast Sulawesi.

Also, with reference to per capita Non-food expenditure of the farmers, compared to the bottom category (≤ N 500), individuals with per capita Non-food expenditure of between 501-N 1000 and above N1000 are more likely to be food secure as this was significant at 1% in increasing food security of farmers, however from the estimated coefficients, per capital non- food expenditure above N1000 has the very best estimate (1.5432) which shows that the more per capital non-food expenditure, the more the probability of being food secure. This might imply that households who plan to increase their expenditure on non-food items might have made sufficient allocation for food items in their income budget—enough to boost

their food security before spending more of their income increase on non-food items. An identical view to the present finding was also submitted by Lambert and Sahn (2002) that households in lower income earning in Tanzania who are likely to be food insecure assign a little share of their income on education (non-food) compared to higher income households. However, there may exist some altruistic feature in some household preferring the forfeiture of current consumption so as to invest into non-food and welfare work items like education of younger household member for posterity sake. (Umeh, 2012).

Besides, age can also predispose households to extend their savings whose backlog may rescue such households from the incidence of food insecurity in future if productivity decline is envisaged as households advance in age of farming operation. This result harmonises earlier findings by Ahmed et.al., (2015) who submitted that advancement in age increases food security, and contradicts the findings of Agboola et al., (2004). Also, with regards to gender, male headed cassava-based farmer increases food security status at 5% as compared to being a female. More so, the work of Meludu et al., (2009) submitted that ladies contribute 53 percent of the agricultural labour work while men are found more often in agricultural wage labour and crop production.

Household size of between 1-6 individuals was found to be significant with a negative effect on household food security. "This indicates that household with many individuals are less likely to be food secure as against those with few individuals. This result is in line with the findings of Obamiro et al., (2002) and Akukwe (2020). However, farm size (≥1hectares) was found to possess a positive and significant relationship (5%) with food security, and this corroborates the findings of a study conducted by Bogale (2009) in Ethiopia.

Also, years of schooling was found to positively effect food security of household and therefore the levels (1-6, 6-12& >12) significantly make the households to be more food secure as against those with no schooling. This result corroborates the findings of Ajaero (2017) and Dawit and Zeray (2017), Akukwe (2020), but opposing to the findings of Yusuf et al., (2015) and Djangmah (2016), who reported food security to decrease with increasing number of years spent in education.

Table 3: Factors Determining Food Security Statuses of Cassava Based Farming Households in Nigeria.

Predictor variable (individual level factor)	**Coefficients**	**Standard error**	**Marginal effects**
Regional factors (b: North Central)			
South east	1.2822	0.2549	0.2525***
South-south	0.7699	0.2631	0.1528***
South west	0.7797	0.3751	0.1548**
Crop consumed in kcal (b: 0-2kcal)			
3-5kcal	0.0862	0.1917	0.0165

>5kcal	0.5806	0.2726	0.1069**
Per capita Non-food expenses (b: ≤ ₦500)			
501- 1000	0.6571	0.1758	0.1380***
> N1000	1.5432	0.2194	0.2939***
Age square of cassava farmers(b:30-59years)			
>59	0.2882	0.1212	0.0547**
Gender (b: Female)			
Male	-0.4453	0.1983	-0.0836**
Household size(b: 1- 6)			
07-12	-0.8702	0.1546	-0.1729***
13-18	-1.4944	0.5438	-0.03892**
>18	-2.5616	1.3021	-0.4793***
Credit utilization (b: No)			
Yes	0.2845	0.1917	0.0545
Access to Extension service (b: No)			
Yes	0.8064	0.7606	0.1431
Years of Schooling (b: None)			
1-6years (primary equivalent)	0.0118	0.1771	0.0023
7-12 years (secondary equivalent)	0.6938	0.2429	0.1320***
>12years (Tertiary equivalent)	1.4360	0.3564	0.2496***
Predictor variable (individual level factor)	**Coefficients**	**Standard**	**Marginal**
Cost of Meal away from home (b: ≤ ₦ 100)			
101- 200	0.6522	0.4745	0.3708
200- 300	0.5695	0.2421	0.3567**
> 300	1.5203	0.3319	0.0991***
Farm size (b: ≤0.5ha)			
0.5-0.99ha	0.3221	0.2205	0.0603
≥1ha	1.4857	0.3658	0.0897***
Farm income (b: ≤ ₦10000)			
10001- N 20000	0.0632	0.2594	0.0121
> N 20000	0.5933	0.3172	0.1149**
Monthly Off-farm income (b: ≤ ₦10000)			
10001- N 20000	0.2078	0.169	0.0395

> 20000	0.1398	0.0175	0.0263***
Constant	0.9257	0.3174	
Log likelihood	558.9379	0.026	
Chi-square	234.06	0.052	
Probability	0.000		
Pseudo R^2	0.1731		

DHS data analysis result. . * if P≤0.1, ** if P≤0.05, *** if P≤0.01

SUMMARY AND RECOMMENDATIONS

The study provides empirical evidence that food security status across the respective geospatial and socioeconomic factors varies among cassava-based farming households in Nigeria. The results of the logistic regression also provided useful evidences that marital status, output consumed from own production, education, household size, cost of meal consumed away from home, farm size, and gender be put into consideration when making household's decision, owing to their significant effect on food security of cassava-based farming households in Nigeria. These also spiked the recommendations that; concerted efforts be made by Government, Non-governmental institutions operating within the country to accentuate existing cassava promotion plans such that highly nutritious cultivars that adapts to specific climatic conditions within country are developed, and adopted for agricultural production, commercialization and processing to boost the existing level of production and consumption of economic viable crop varieties. Furthermore, grass-root capacity building programs approach should be provided, while creating incentives that will motivate the unemployed, and willing youths to key into cultivation of numerous improved varieties that will sustainably salvage the country from the inherent national food insecurity quagmire. Besides, the cassava value chain should be fortified, to boost the product supply towards eliminating the existing geospatial food insecurity gap in the Country.

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