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SOCIOECONOMIC CHARACTERISTICS AND CHARACTERIZATION OF HOUSEHOLD VULNERABILITY TO FOOD SECURITY IN SEMI-ARID REGION OF NIGERIA

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Abstract

This study was conducted to examine the effect of socio-economic variables on household vulnerability to food security in the semi-arid drylands of Nigeria. A multi-stage sampling technique was employed to select respondents. Three states and three local government areas from each state were purposively selected in the first and second stages. Communities from each local government area, from which respondent households were identified were randomly selected in the third and fourth stages respectively. Descriptive statistics and multi-category response variable regression analysis was used to organise and process the data gathered. The study revealed that the estimated coefficients on household size are positive and statistically significant at 1 percent level for all the pillars of food security in the study area. This implies that increase in household size by one member is associated with increase in [redacted] the log odds of food security, by 0.0353 for food availability, 0.0477 for food accessibility, 0.0253 for food utilization, and 0.0397 for food stability. The joint test of significance of the parameter estimates for all the models of food security shows that all the regressors are jointly statistically significant at influencing food security in the sample states. Hence, the hypothesis that the effects of socio-economic characteristics of households on food

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security based on age, sex, marital status, educational level and household size are jointly equal to 0 can be rejected[1] at the 1 percent level. The research concludes that given these findings with the current high fertilizer and fuel prices, the chances of serial vulnerability to food insecurity is imminent. The study therefore recommends the promotion of strategic, culture-friendly, and effective family regulation programme to address the monster of unsustainable household sizes that easily plunge families into poverty and food insecurity, and systematic use of social safety net.

Introduction

Nigeria is a large country with an estimated population of over 180 million (Iyangbe, 2017) with a substantial part of its area extending into the Sudano-Sahelian belt, which when put together with the neighbouring northern Guinea savannah, constitutes the dryland environment of the country. Nigeria with the huge estimated population figure carries the burden of human pressure on the land. This condition particularly in the marginal dryland areas takes a great toll on the environment, resulting in massive land degradation, deforestation, soil and water pollution, and desertification, which feeds back on climate forcing.

National Bureau of Statistics (NBS, 2010) estimated that the country has an approximate total surface area of 909,890 km^2. About 40 percent of this land area is believed to be out of use for neither settlement, agriculture, nor any other human purposes. Nigeria enjoys a warm tropical climate with relatively high temperature, and two seasons, the dry and wet season. Generally, the wet season in the semi-arid/drylands of the country hardly lasts for more than three months. In Nigeria, annual rainfall totals range from over 2,500 mm in the south to less than 400 mm in parts of the extreme north (Federal Ministry of Environment of Nigeria, 2004). According to Folaji (2007), Northern Nigeria is situated in the semi-arid areas bordering Sahara Desert with average annual rainfall of less than 600 mm. Thus, this study was conducted in three states of Northern Nigeria (Borno, Katsina, and Sokoto) in the semi-arid zone of the country.

Theoretical background

Social stratification could be described as the process of identifying individuals, households, and communities on the basis of socioeconomic factors.

[1] The degree of freedom used for the Wald Chi-Square is 5 for all the four models and the pillars of food security and the Wald statistics are reported in table 3 with the log pseudo likelihood obviously indicating the rejection of null hypotheses in all the cases.

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Socioeconomic characteristics and characterization of a population could be complex and multidimensional, including both independent objective characteristics such as income, occupation or education, and subjective classification of the population's position on the socioeconomic ladder. Socioeconomic stratification originates from the Marxist school of thought, where exploitative tendencies are central to the mode of relationship. However, functionalist theory could be seen as an amalgamation of Marxist and Weberian theories, which postulates that social stratification is necessary for societal development and sustainability.

Notwithstanding, socioeconomic investigations of a population's status often unearth inequalities in access to and control of resources, privileges, and power. Therefore, demographic classification of a population often helps in understanding household challenges and opportunities. Thus, in this case, the domains of household size, educational level, age, marital status and sex, illuminated the pathway towards understanding the household food security status in the study area. Hence the study was designed to answer key questions around the socioeconomic characteristics (features) and characterization (classification) of the food security status of the semi – arid population of Nigeria.

Methodology

Data Description and Variable Measurement

A multi-stage sampling technique was employed to select the households on which the survey instruments was administered. In the first stage, three states (Borno, Katsina and Sokoto) among the fifteen officially designated desertification frontline states of Nigeria (NBS, 2010) were purposively selected. In the second stage, three local government areas were also purposively selected from each state, to ensure that they fall within the agroecology of interest. In the third stage, communities were randomly selected from each local government area (LGA) from which households interviewed were identified in the final/fourth stage. A confidence interval of 95% was used in the determination of sample size for the study.

Table 1: Population of states and estimated number of farming households

States	Population	Estimated number of HH/Farmers
1. Katsina	5,801,584	580,158.4
2. Sokoto	3,702,626	370, 262.6
3. Borno	4,171,104	208, 555.2

Source: Nigerian Population Commission (NPC, 2006)

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Using Dillman (2007) sample size formula, the sample size of households is calculated by taking 10 per cent of the population of Katsina and Sokoto farming households and 5 per cent of the (farming households') population for Borno.[2]
Therefore, given the formula:

$$Ns = \frac{N_p(p)(1-p)}{(N_p-1)(^{B}/_{C})^2+p(1-p)}$$

Where:
Ns = completed sample size needed (notation often used is n)
Np = size of population (notation often used is N)
p = expected proportion of active respondents (50% or 0.5 is most conservative)
B = acceptable level of sampling error (0.05=±5%; 0.03=±3%)
C = Z statistic associated with confidence interval (1.96 or 95%)
Substituting the values of the total population and the significant level into the formula, the actual sample size for the study becomes:

$$N_p = 580{,}158.4 + 370{,}262.6 + 208{,}555.2$$

$$N_p = 1{,}158{,}976.2$$

$$Ns = \frac{N_p(p)(1-p)}{(N_p-1)(^{B}/_{C})^2+p(1-p)} = \frac{1{,}158{,}976.2(0.5)(0.5)}{(1{,}158{,}976.2-1)(^{0.05}/_{1.96})^2+0.5(0.5)}$$

$$= 183.3$$

$$Ns = 183.3$$

Thus, the calculated sample size to be randomly selected from each State is 183.3. accordingly, the total sample, Ts, from the selected States is as shown below;

$$Ts = 183.3 \times 3$$

$$Ts = 549.9 \approx 550$$

Therefore, the calculated total sample drawn across the three states is 550.

Both descriptive and inferential analysis were employed to organise the study data. The perception of respondents with respect to the four pillars of food security (food availability, food accessibility, food utilization and food stability) were used as indicators for the dependent variable. The key socio-economic characteristics such as the age of respondents, sex, educational level, marital status and household size were used as the explanatory variables. The regression analysis was performed using the ordered logit estimation technique. The choice

[2] The percentage is the researcher's intuition based on the massive population displacement due to insurgency. It has no scientific background.

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for the ordered logit regression model was informed by the fact that the dependent variables were ordered on a five Likert scale ranked on the scale of 1 to 5 (NV = not vulnerable; FV = fairly vulnerable; V = vulnerable HV = highly vulnerable) in order to gauge perceptions of the respondents with respect to the effect of some socio-economic characteristics of households on the pillars of food security in the study area. The ordered logit model is considered to be one of the most popular techniques for analysing ordinal outcome variables (Williams, 2016).

Empirical Discussion of the Results

Summary of the pillars of food security and socio-economic characteristics of households.

Table 2: Summary of the Pillars of Food Security and Socio-economic Characteristics of Households

	COMBINED THREE STATES								
	FAV	FAC	FUT	FST	Age	SEX	HS	EL	MS
Mean	2.784	3.064	3.548	2.962	41.893	0.880	9.970	1.232	0.903
STD.DEV	1.338	1.111	0.701	1.237	12.712	0.531	9.706	1.287	0.297
Min	1	1	1	1	14	0	1	0	0
Max	5	5	5	5	81	1	91	4	1
Obs	626	626	626	626	626	626	626	626	626
	BORNO SPECIFIC								
Mean	2.456	2.911	3.388	2.802	41.529	0.805	10.302	1.096	0.891
STD.DEV	1.417	1.157	0.796	1.089	12.247	0.667	11.358	1.338	0.312
Min	1	1	1	1	19	0	0	0	0
Max	5	5	5	5	81	1	91	4	1
Obs	384	384	384	384	384	384	384	384	384
	KATSINA SPECIFIC								
Mean	3.390	3.340	3.740	3.360	41.100	0.960	9.610	1.200	0.860
STD.DEV	0.909	0.831	0.441	0.927	13.672	0.197	6.113	1.146	0.349
Min	1	1	1	1	14	0	1	0	0
Max	5	5	5	5	79	1	32	3	1
Obs	100	100	100	100	100	100	100	100	100
	SOKOTO SPECIFIC								
Mean	3.241	3.275	3.831	3.373	43.437	1	9.324	1.676	0.958
STD.DEV	1.068	1.079	0.376	1.102	13.205	0	6.329	1.269	0.202
Min	1	1	1	1	20	0	1	0	0

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Max	5	5	5	5	80	1	40	4	1
Obs	142	142	142	142	142	142	142	142	142

Note: FAV, FAC FST, FUT, HS, EL, MS Age and Sex denote food availability, food accessibility, food stability, food utilization, household size, educational level, marital status, age (in years), sex (gender), respectively. Mean is the average value, Std.Dev is the standard deviation, min is the minimum value, max is the maximum value and Obs is the observations.
Source: Author's Field Survey, 2019

From table 2 above, the average respondent ranking of between approximately 2.5 and 3.8 with respect to their perceived level of food availability, food accessibility, food utilization and food stability across all the three sample states for both the combined and state-specific results indicates that the respondents expressed a neutral position or disagree with food availability, accessibility, utilization and stability within the study area.
The average age of the respondents was reported to be about 42 years for Borno State, 41 years for Katsina State and 43 years for Sokoto State, with the youngest age of 14 years, 19 years and 20 years for Katsina, Borno and Sokoto respectively. Meanwhile the maximum age of the respondents appears to be 79 years for Katsina, 80 years for Sokoto and 81 years for Borno. The standard deviation of the age of respondents ranges between approximately 12 and 14 suggesting substantial age variations among the respondents in the study area. Results suggest that the population of respondents is essentially youthful (16 – 45yrs) at 68 percent of the total which is meaningful for agricultural productivity.
Similarly, the average household size was estimated at approximately 10 persons per household in Borno and Katsina and 9 persons per household in Sokoto with a minimum of 1 person per household in all the sample states and the maximum of 91 persons per household in Borno, 32 in Katsina and 40 persons per household in Sokoto states. This is consistent with the tradition of having large household size that is peculiar with the northern norms, cultural and religious beliefs which permit polygamy and encourage having many wives (to a maximum of 4 wives in some culture and religion) and children, thereby keeping a large family size. If this kind of large household size is not backed with the provision of economic opportunities and deployment of modern farming technologies for improved agricultural productivity, food security can be threatened and the situation will just be

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consistent with the population theory of Thomas Malthus[3] which poses a serious policy concern.

The average level of education of approximately between 1.1 and 1.7 for the respondents in Borno, Katsina and Sokoto states suggests that most of the respondents have completed at least primary level of education. This is positive for food security in the study area because at this level of education, individuals are expected to be basically able to read and write, and understand simple instructions which will facilitate adoption of new and modern farming techniques aimed at boosting agricultural productivity. Similarly, individuals with higher levels of education are better placed to explore better opportunities within and outside their communities, either getting paid jobs or engaging in other entrepreneurial activities that will boost their income and other means of accessing, utilising, and sustaining their food needs. While about 57 percent literacy level was attained by respondents which is positive, a notable 43 percent, almost half, of the population have no formal education. This is a finding that requires urgent and deliberate policy attention by governments of the study area.

Logistic regression output for socio-economic characterization of households' vulnerability to food security.

Demographic characteristics of a population help in understanding the household challenges and opportunities. The basic composition of, for example, household size, educational level, occupation, marital status, and sex, enhance greater understanding of the household food security status. The regression analysis was performed using the ordered logit estimation technique. In the ordered logistic regression, just like the binary and multinomial logistic regression models, the use is made of a maximum likelihood estimation, which is an iterative procedure and hence the outcomes of the ordered logistic regression are the ordered log-odds (logit) regression coefficients. Interpretation of the ordered logit estimates is not dependent on the ancillary[4] parameters. The ancillary parameters are used to differentiate the adjacent levels of the response variable.

[3] The Malthusian theory of population is the theory of exponential population and arithmetic food supply growth. Thomas Malthus hypothesized that food production will not be able to keep up with the growth in the human population which may result in diseases, famine, war and calamity. He specifically stated that the human population increases geometrically, while food production increases arithmetically.

[4] The ancillary parameters are the cutpoints which are labeled as Cut1, Cut2, Cut3 and Cut4 in tables 2 to table 5. For the ordered logit (also called Ologit), the intercept is replaced by the cutpoints. For a unique set of maximum likelihood estimates to exist, an identifying assumption needs to be made about either the intercept or one of the cutpoints. Stata's Ologit commands identify the ordinal regression model (ORM) by assuming that the intercept is 0 and then estimating all cutpoints.

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The results in table 3 is a summary of the combined regression for the aggregated data for the three sample states, that is, Borno, Katsina and Sokoto. The dependent variables are the pillars of food security with each pillar having its estimated parameters as reported under model 1 to model 4. The results show for all the four models that age of the respondents has a statistically significant influence at 1 percent level on all the pillars of food security except for food utilization where the coefficient on age appears to be statistically insignificant at the conventional[5] levels of significance.

Table 3: Combined Regression Results of the Effect of Socio-Economic Characteristics of Households on Food Security in the study area.

Dependent variables:	Food Availability Model 1	Food Accessibility Model 2	Food Utilization Model 3	Food Stability Model 4
Independent variables				
Age	-0.0294^{***} (0.0057)	-0.0384^{***} (0.0060)	-0.0041 (0.0068)	-0.0296^{***} (0.0056)
Sex	-0.0705 (0.1910)	-0.0603 (0.1033)	0.8410^{***} (0.2401)	0.1173 (0.2391)
Marital status	0.4071 (0.2664)	-0.1663 (0.2019)	0.5354^{*} (0.2781)	-0.1586 (0.2638)
Educational level	0.2586^{***} (0.0566)	0.1187^{**} (0.0603)	0.1362^{**} (0.0690)	0.2838^{***} (0.0580)
Household size	0.0353^{***} (0.0089)	0.0477^{***} (0.0081)	0.0253^{***} (0.0103)	0.0397^{***} (0.0081)
/cut 1	-1.5765 (0.3655)	-4.1157 (0.3522)	-2.3502 (0.4368)	-2.7167 (0.3812)
/cut 2	-0.3811 (0.3544)	-1.7707 (0.2952)	-1.5459 (0.3993)	-0.7850 (0.3520)
/cut 3	0.3700 (0.3537)	-0.7410 (0.2892)	0.9964 (0.3873)	-0.1023 (0.3506)
/cut 4	1.9497 (0.3563)	2.2152 (0.2973)	5.8123 (0.5202)	1.7015^{***} (0.3580)
Number of Observations	625	626	626	626

[5] The conventional levels of significance are the 1%, 5% or at worse 10%.

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Pseudo R^2	0.0358	0.0414	0.0418	0.0433
Log pseudo likelihood	−948.0629	−874.8512	−561.7944	−903.8087
Wald Chi^2	62.44 [0.0000]	80.73 [0.0000]	49.06 [0.0000]	87.66 [0.0000]

Note: *, **, and *** denotes statistical significance at 10%, 5% and 1% levels respectively. Robust standard errors in () and probability values in []. Low value of Pseudo R^2 is not a concern in this type of estimation. Cut 1, cut2, cut3 and cut4 are cutpoints and their interpretation are of no use.
Source: Author's Field Survey, 2019

The direction of the effect of age on pillars of food security is inverse as indicated by the negative coefficients suggesting that there is inverse relationship between food security and age of the respondents. This implies that the older the individuals, the more food insecure they become and vice versa, holding other factors constant. In other words, an increase in the years of an individual is associated with decrease in food availability, accessibility, stability and declining nutritional intake (decrease in food utilization). In a more statistical term, it can be explained to mean that for a one-year increase in the age of the respondent, there is 0.0294 decrease in the log odds of food availability, 0.0384 decrease in the log odds of food accessibility and 0.0296 decrease in the log odds of food stability. However, there is no evidence of statistically significant effect of age on food utilization because the coefficient of age in model 3 of table 3 is not statistically significant. Considering the ordinal nature of the response variables, it can be interpreted in terms of odds ratios[6] that for a one-year increase in the age of respondent, the odds of being strongly agree versus the combined strongly disagree and disagree are 0.971 lower for food availability, 0.962 lower for food accessibility, 0.971 lower for food stability and 0.996 lower for food utilization, holding other variables in each of the models constant.
Similarly, the coefficients on sex which represents the gender of the respondents are negative for food availability and food accessibility but positive for food stability and food utilization. However, only the coefficient on sex for food

[6] Following the conventional approach, the odds ratios have been calculated by taking the exponent of each estimated coefficient. For example, the odds ratios of age in table 3 as reported in the text were obtained as: exponent of -0.0294 = 0.971, exponent of -0.0384 = 0.962, exponent of -0.0296 = 0.971 and exponent of -0.0041=0.996 for food availability, food accessibility, food stability and food utilization respectively. The calculation of these odds ratios could also be done automatically using the Stata software but to conserve space, this approach was employed since same results are obtained.

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utilization (model 3 of table 3) is statistically significant at 1 percent level while the remaining three pillars of food security are not significant at the conventional levels. Since sex is a dummy variable which takes the value of 1 for female and 0 for male, the result shows that female respondents are more likely to be food insecure in terms of the availability of food and accessibility to food but once they have access to available food, they are more likely to become food stable and maximize nutritional intake (food utilization). In fact, the coefficient on sex is strongly significant for the food utilization (model 3 of table 3) indicating that increase in sex (from 0 to 1) by one unit, is expected to increase the log odds of food utilization by 0.8410, holding other variables in the model constant. In other words, for a one-unit increase in sex (from 0 to 1), the odds of being strongly agree versus the combined strongly disagree and disagree are 0.9319, 0.9415 lower for food availability and accessibility but 1.1245 and 2.319 greater for food stability and food utilization, respectively. This suggests that there is high likelihood of maintaining greater nutrition by female compared to male in the sample states. The insignificant coefficients on the sex variable for the remaining three pillars of food security (model 1, model 2 and model 4 of table 3) suggests that there is no evidence of significant relationship between sex and these three food security pillars in the study area.

The results in table 3 also show that there is no evidence of a significant relationship between marital status and the pillars of food security except for food utilization which is only weakly significant at 10 percent level. This shows that increase in marital status (from single to married)[7] by one, is expected to increase the log odds of food utilization by 0.5354, holding other variables in the model constant. Hence, increase in marital status is associated with increase in nutritional intake. This is in conformity with Apriori expectation.

The coefficients on educational level appear to be positive and statistically significant for all the four pillars of food security in the four models in table 3, suggesting a direct relationship between educational level and food security. This shows that for every level[8] increase in education of the respondent, the log odds of food security increase by 0.2586 for food availability, 0.1187 for food accessibility, 0.2838 and 0.1362 for food stability and food utilization, respectively, holding other variables in the models constant. Putting it differently, for every one

[7] The categories of marital status have been collapsed to single versus married and has been converted to a dummy variable where single takes the value of 0 and married takes the value of 1. A divorcee is also considered as single during the estimation under this study.

[8] Increase from one level to another means increase from primary to junior secondary level, to secondary level, and so on.

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level increase in education, the odds of being strongly agree versus the combined strongly disagree and disagree are 1.2951, 1.1260. 1.3282 and 1.1459 greater for food availability, accessibility, stability and utilization, respectively, keeping other variables constant. This particular result indicates the importance of education in addressing food challenges because educational level of individuals that participated in this study is directly linked to food security, suggesting that increasing the educational level of people, especially in the rural communities is directly related to increased food security. This can be connected to the fact that people with higher level of education are more likely to secure quality jobs, engage in good business management practices and in the case of farmers, engage in good agronomic practices and employ modern farming techniques because they can read and write and understand instructions easily. This has the tendency of increasing their productivity and enhancing food security.

Likewise, the estimated coefficients on household size of the respondents have all been reported to be positive and statistically significant at 1 percent level for all the pillars of food security, suggesting strong evidence of a direct relationship between the household size and food security in the three sample states combined. This implies that increase in household size by one member is associated with increase in the log odds of food security by 0.0353 for food availability, 0.0477 for food accessibility, 0.0397 for food stability and 0.0253 for food utilization, holding other variables in the models constant. In other words, for every one-member increase in household size, the odds of being strongly agree versus the combined strongly disagree and disagree are 1.0359, 1.0449 ,1.0405 and 1.0256 greater for food availability, food accessibility, stability and utilization, respectively, holding other variables constant. This direct relationship between household size and food security can be explained with the fact that majority of the people in the study area make use of family labour on their farms to facilitate production of food thereby increasing their output and contributing to food security. Meaning, increase in household size is instrumental in increasing food production, and as a result, improving household food security status in the study area.

The joint test of significance of the parameter estimates for all the models of the food security shows that based on the Wald Chi-Square (Chi^2) statistics and their probability values (less than 0.01), all the regressors are simultaneously/jointly statistically significant at influencing food security in the sample states. Hence, the hypothesis that the effects of socio-economic characteristics of households on

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food security based on age, gender, marital status, educational level and household size are jointly equal to 0 can be rejected[9] at the 1 percent level.

Regression results for Borno state

The regression results for Borno state as presented in appendix 1 provide similar findings to that of the aggregated/combined results in table 3. The result shows a very impressive outcome whereby all the explanatory variables (age, sex, educational level, and household size) except marital status are statistically significant in explaining the level of food availability within the state. Although age and sex are negatively correlated with food availability as an indicator of food security, education and household size have consistently been positively correlated with food availability. The age of the respondents has a negative and statistically significant effect on all the pillars of food security except for food utilization which appears to be statistically insignificant. Like the previous results, this result also indicates that increase in the age of the respondents is associated with declining food security. That is, as individuals get older, they tend to become more food insecure, holding other factors constant.

Similarly, the relationship between sex and food security in Borno state is negative except for food utilization which is positive and statistically significant at the 5 percent level. In this case, for an increase in sex (from 0 to 1), the log odds of food security are expected to decrease by 0.5085, 0.1916 and 0.0434 for food availability, accessibility and stability respectively while the log odds of food utilization are expected to increase by 0.4748, holding other variables in the models constant. In other words, for one-unit increase in sex (from 0 to 1), the odds of being strongly agree versus the combined strongly disagree and disagree are 0.6014, 0.8256, and 0.9575 lower for food availability, accessibility and stability but 1.6077 greater for food utilization, all things being equal.

The coefficients on marital status for Borno state are not statistically significant for all the pillars of food security except also for food utilization which again is positive and strongly significant at 1 percent level of significance. This shows that there is no evidence of significant relationship between food security and marital status in Borno state except for food utilization which has a direct relationship, suggesting that increase in marital status (from single to married) is associated

[9] The degree of freedom used for the Wald Chi-Square is 5 for all the four models and the pillars of food security and the Wald statistics are reported in table 3 with the log pseudo likelihood obviously indicating the rejection of null hypotheses in all the cases.

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with increase in nutritional intake (food utilization). Again, consistent with Apriori expectation.

The educational level of respondents appears to have a positive and statistically significant effect on all the pillars of food security, except in this case, the coefficient on educational level for food utilization is not significant at the conventional level. This implies that for every one level increase in education, the log odds increase by 0.3910, 0.1990, 0.4370 and 0.0164 for food availability, accessibility, stability and utilization respectively, holding other variables in the models constant. Also, in terms of odds ratios, for if educational level increases by one, on the average, the odds of being strongly agree versus the combined strongly disagree and disagree are 1.4785 greater for food availability, 1.2202 greater for food accessibility, and 1.5481 and 1.0165 greater for food stability and food utilization, respectively, holding other variables constant. Again, this explains the important role of education in ensuring food security, especially in the sample states.

In the same vein, the household size has a consistently positive and statistically significant impact on all the pillars of food security in Borno state. As shown in appendix 1, for every one-member additional increase in household size, on the average, the log odds are expected to increase by 0.0349, 0.0491, 0.0459 and 0.0293 for food availability, accessibility, stability and utilization, respectively, keeping other variables constant. This result is similar to what was obtained from the aggregated analysis and it is consistent with the importance attached to family labour as a source of farm labour in the study communities. Large household size means large labour size which immensely contribute during the farming season towards increased agricultural output.

Regression results for Katsina state

In all the four models in appendix 1, the independent variables have been found to be jointly statistically significant in influencing food security in Borno state. This suggests that although some components of the socio-economic characteristics of households are individually not significant determinants of food security, all the socio-economic variables used in this analysis are jointly[10] statistically significant determinants of food security in Borno state.

[10] The Wald Chi-square statistics and their probability values as well as the log pseudo likelihood ratio in appendix 1 provide a good indicator that the explanatory variables are all jointly significant at 1 percent level of significance.

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The results of the regression for Katsina state which are presented in appendix 2 is somewhat less robust compared to that of Borno state. While the effect of age on food security remains negative which is consistent with the results in table 3 and appendix 1, only the coefficient for the model of food accessibility is statistically significant at 5 percent level. This suggests that in the case of Katsina, age has influence on only one out of the four pillars of food security and the relationship shows that increase in the age of the respondent is expected to result in decline in food access in the sample communities. In the case of gender effect for Katsina, the coefficients on sex for all the pillars of food security are statistically significant at 1 percent level except for food utilization which is not significant at that conventional level. However, while the direction of the relationship between sex and food security is negative in the case of Borno state, it is positive for all the pillars in the case of Katsina state. The magnitudes of the coefficients are also higher in the case of Katsina than Borno and the combined results. The results in appendix 2 therefore shows that for one unit increase in sex (from 0 to 1)[11], the log odds of food security are expected to increase by 2.5210, 16.8955, 2.5254 and 0.5382 for food availability, accessibility, stability and utilization, respectively, holding other variables constant. This finding speaks to the fact that women play a significant role along the entire agricultural value chain, contributing as producers, distributors, processors, and marketers, as well as, being responsible for feeding their families. It therefore reinforces the assertion that, closing the gender gap in agriculture, as opined by the United Nations Food and Agriculture Organization, could increase yields on farms by 20 – 30 percent, raise total agricultural output in developing countries by 2.5 – 4 percent, and reduce the number of hungry people in the world by 12 – 17 percent.

The effect of marital status remains negative even in the case of Katsina except for food utilization which is positive and statistically insignificant. The effect of marital status on food accessibility and stability is also not significant, but weakly significant at 10 percent in the case of food availability. Unlike the case of Borno state where the coefficients on educational level are significant for virtually all the pillars of food security, it is only statistically significant for food utilization in the case of Katsina state. Although the direction of the relationship appears to be positive for all the pillars of food security, such relationship is only statistically significant in one out of four pillars. For the food utilization, it implies that for every increase in the level of education, the log odds of nutritional intake (food

[11] Increase in sex from male to female, i.e., increase in female gender.

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utilization) are expected to increase by 0.5525, holding other variables in the model constant. Furthermore, the coefficients on household size are positive for all the pillars of food security with the exception of food utilization which is negative. These coefficients appear to be statistically significant only for food accessibility and food utilization. This shows that increasing household size by one member is expected to increase the log odds by 0.0383, 0.0816 and 0.0257 for food availability, accessibility and stability respectively but decreases log odds by 0.0445 for food utilization in the case of Katsina state.

The joint test shows that all the independent variables in model 1 and model 2 of appendix 2 (food availability and food accessibility) are statistically significant at influencing food security. However, the independent variables in model 3 and model 4 of appendix 2 (food utilization and stability) are not jointly statistically significant. This is evident from the higher probability values for the model 3 and model 4 (p-values = 0.2533 and 0.1566) representing the model of food utilization and stability respectively; suggesting that the null hypothesis that the explanatory variables are not jointly significant, and cannot be rejected at the 5 percent and even at 10 percent level of significance.

Regression results for Sokoto State

The results of the effect of socio-economic characteristics of household on food security for Sokoto also produced divergent findings as presented in appendix 3. First and foremost, the sex variable was automatically dropped from the regression models for all the pillars of food security due to the problem of perfect multicollinearity[12] among the regressors. The age of the respondents appear to have a statistically significant effect on all the pillars of food security except for food utilization but the direction of the effect is consistently negative in all the models. The result shows that increase in age by one year is associated with decrease in log odds by 0.0416 for food availability, 0.0370 for food accessibility, 0.0335 for food stability and 0.0066 for food utilization, holding other variables in the models constant. The effect of marital status is also negative on all the pillars of food security except for food availability which is positive but statistically insignificant. Only the effect of marital status on food utilization is strongly significant at 1 percent level and the magnitude of the negative coefficient is greater than that of Borno and Katsina States as well as the combined results. This

[12]Stata 15 automatically drops any independent variable that is perfectly collinear with another independent variable in the estimation model making it easier to address the issue of perfect multicollinearity in the estimation.

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result shows that for one-unit increase in marital status, the log odds of food utilization are expected to increase by 13.8063, holding other variables in the model constant.

On the other hand, the effect of educational level is positive on food availability and accessibility but negative on food stability and food utilization. However, only the relationship between marital status and food availability is significant at 5 percent level. It shows that for every one level increase in education, the log odds of food availability are expected to increase by 0.2460, holding other variables constant. The effect of household size is also not significant for all the pillars of food security in Sokoto unlike the other two sample states. The joint test of Wald chi-square shows that all the explanatory variables for the models are statistically significant suggesting that the socio-economic characteristics of households in Sokoto jointly have influence on all the pillars of food security.

Conclusion and policy recommendations

The socio-economic characteristics of households in the study area and its significance to advances in climate change and food security parameters was described for greater understanding. The study indicates strong evidence of a direct relationship between the household size and food security in the three sample states combined. The average household size of approximately 10 persons/household is consistent with ‘’The Malthusian theory of exponential population and arithmetic food supply growth”, which if not backed with commensurate economic opportunities and climate smart farming technologies, will pose a significant threat to food security in the short and long term.

There is inverse relationship between food security and age of the respondents. This implies that the older the individuals, the more food insecure they become and vice versa, holding other factors constant. In other words, an increase in the years of an individual is associated with decrease in food availability, accessibility, stability and declining nutritional intake (decrease in food utilization). There is no evidence of a significant relationship between marital status and the pillars of food security except for food utilization which is only weakly significant at 10 percent level. Hence, increase in marital status is associated with increase in nutritional intake. This is in conformity with Apriori expectation.

The coefficients on educational level appear to be positive and statistically significant for all the four pillars of food security in the four models, suggesting a direct relationship between educational level and food security. This further suggests that increasing the educational level of people, especially in the rural

communities is directly related to increased food security. In conclusion, all the regressors, including sex, are jointly statistically significant at influencing food security in the sample states. Hence, the hypothesis that the effects of socio-economic characteristics of households on food security based on age, gender, marital status, educational level and household size are jointly equal to 0 can be rejected[13] at the 1 percent level.

The study therefore recommends that efforts should be focussed on making the population less vulnerable to food shocks through:

1. Strategic, culture-friendly, and effective family planning programme (by government and non-governmental organizations) to address the monster of unsustainable household sizes that easily plunge families into poverty and food insecurity.
2. The promotion of strategic investments in existing viable enterprises in the agricultural value chain (by government). This may become cheaper than direct cash transfer in the long term.
3. Conscious and systematic use of social protection but market driven schemes (by government, private and non-government actors) to build capacity of vulnerable households enabling them to crawl out of poverty.
4. Strengthening and expansion of the coverage of adaptive socioeconomic safety net program. Safety nets (by policy makers) against food price volatility, and other forms of food shocks for vulnerable households which can be made revolving without hiccups (easy to access by poor households), and
5. Given that the estimated coefficients on household size and educational level appear to be positive and statistically significant for all the four pillars of food security in the four models, suggesting a direct relationship between household size, educational level and food security, and indicating the importance of education in addressing food challenges, government may have to pay more attention to social parameters like massive access to quality education in the study area, as a double edged sword.

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[13] The degree of freedom used for the Wald Chi-Square is 5 for all the four models and the pillars of food security and the Wald statistics are reported in table 3 with the log pseudo likelihood obviously indicating the rejection of null hypotheses in all the cases.

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendices

Appendix 1: **Regression results of the effect of socio-economic characteristics of households on food security in Borno State**

Dependent variables:	Food Availability Model 1	Food Accessibility Model 2	Food Utilization Model 3	Food Stability Model 4
Independent variables:				
Age	-0.0257^{***} (0.0087)	-0.0415^{***} (0.0086)	-0.0036 (0.0086)	-0.0294^{***} (0.0078)
Sex	-0.5085^{**} (0.2534)	-0.1916^{**} (0.0825)	0.4748^{**} (0.2367)	-0.0434 (0.0834)
Marital status	0.5483 (0.3511)	-0.3326 (0.2495)	0.8230^{***} (0.3245)	-0.5515 (0.3486)
Educational level	0.3910^{***} (0.0894)	0.1990^{**} (0.0871)	0.0164 (0.0951)	0.4370^{***} (0.0878)
Household size	0.0349^{***} (0.0089)	0.0491^{***} (0.0084)	0.0293^{***} (0.0107)	0.0459^{***} (0.0087)
/cut 1	-0.8254 (0.5137)	-3.9883 (0.4832)	-2.0351 (0.5589)	-2.5052 (0.5050)
/cut 2	0.2693 (0.5094)	-1.8001 (0.4286)	-1.2122 (0.5292)	-0.5868 (0.4796)
/cut 3	0.9706 (0.5127)	-0.6131 (0.4192)	1.2945 (0.5431)	0.0602 (0.4773)
/cut 4	2.0710 (0.5096)	0.9618 (0.4308)	5.0923 (0.7194)	1.7444^{***} (0.4825)
Number of Observations	384	384	384	384
Pseudo R^2	0.0641	0.0638	0.0392	0.0768
Log pseudo likelihood	-547.54205	-539.68933	-402.5499	-534.4914
Wald Chi²	59.03 [0.0000]	78.49 [0.0000]	27.48 [0.0000]	82.82 [0.0000]

Note: *, **, and *** denotes statistical significance at 10%, 5% and 1% levels respectively. Robust standard errors in () and probability values in [ ]. Low value of Pseudo R^2 is not a concern in this type of estimation. Cut 1, cut2, cut3 and cut4 are cutpoints and their interpretation are of no use.
Source: Author's Field Survey, 2019

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Appendix 2**: Regression results of the effect of socio-economic characteristics of households on food security in Katsina State**

Dependent variables:	Food Availability Model 1	Food Accessibility Model 2	Food Utilization Model 3	Food Stability Model 4
Independent variables:				
Age	−0.0233 (0.0180)	−0.0396** (0.0187)	−0.0013 (0.0258)	−0.0184 (0.0191)
Sex	2.5210** (1.1337)	16.8955*** (0.6461)	0.5382 (1.0217)	2.5254** (1.0481)
Marital status	−1.2578* (0.6611)	−1.0553 (0.7223)	1.1591 (0.8585)	−0.3602 (0.6585)
Educational level	0.1272 (0.1699)	0.2462 (0.1782)	0.5525** (0.2418)	0.1692 (0.1679)
Household size	0.0383 (0.0425)	0.0816** (0.0407)	−0.0445*** (0.0433)	0.0257 (0.0459)
/cut 1	−0.8123 (1.2965)	13.1785 (0.9449)	0.5535 (1.4276)	0.1294 (1.2839)
/cut 2	04241 (1.2527)	14.6157 (0.9246)		1.3912 (1.2555)
/cut 3	3.4071 (1.2550)	18.9001 (1.0624)		3.9529 (1.2734)
Number of Observations	100	100	100	100
Pseudo R^2	0.0579	0.1050	0.0581	0.0348
Log pseudo likelihood	−114.6208	−98.4167	−53.9748	−120.9594
Wald Chi²	12.27 [0.0312]	782.89 [0.0000]	6.59 [0.2533]	7.99 [0.1566]

Note: *, **, and *** denotes statistical significance at 10%, 5% and 1% levels respectively. Robust standard errors in () and probability values in []. Low value of Pseudo R^2 is not a concern in this type of estimation. Cut 1, cut2, cut3 and cut4 are cutpoints and their interpretation are of no use.
Source: Author's Field Survey, 2019

Appendix 3**: Regression results of the effect of socio-economic characteristics of households on food security in Sokoto State**

Dependent variables:	Food Availability Model 1	Food Accessibility Model 2	Food Utilization Model 3	Food Stability Model 4
Independent variables:				
Age	−0.0416*** (0.0140)	−0.0370*** (0.0140)	−0.0066 (0.0236)	−0.0335*** (0.0133)
Sex				
Marital status	0.0276 (0.6407)	−0.0165 (0.5557)	−13.8063*** (0.6720)	−0.5427 (0.9642)
Educational level	0.2460** (0.1206)	0.1999 (0.1261)	−0.0191 (0.1593)	−0.1352 (0.1247)
Household size	0.0346 (0.0372)	0.0191 (0.0340)	0.0125 (0.0444)	−0.0130 (0.0336)
/cut 1	−5.8467 (0.9441)	−61496 (1.0641)	−15.5594 (0.7120)	−3.1658 (0.9418)
/cut 2	−2.6983 (0.6733)	−2.5306 (0.6598)		−2.4401 (0.9517
/cut 3	−1.7531 (0.6775)	−1.7801 (0.6616)		0.6511 (0.9490)
/cut 4	0.2839 (0.6950)	0.3112 (0.6612)		

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Number of Observations	141	142	142	142
Pseudo R^2	0.0315	0.0264	0.0183	0.0341
Log pseudo likelihood	−189.342	−186.1551	−63.3314	−182.0099
Wald Chi²	14.96 [0.0048]	11.32 [0.0232]	883.75 [0.0000]	14.98 [0.0047]

Note: *, **, and *** denotes statistical significance at 10%, 5% and 1% levels respectively. Robust standard errors in () and probability values in [ ]. Low value of Pseudo R^2 is not a concern in this type of estimation. Cut 1, cut2, cut3 and cut4 are cutpoints and their interpretation are of no use.
Source: Author's Field Survey, 2019

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