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EFFECT OF CROP DIVERSIFICATION ON FOOD SECURITY STATUS AMONG ARABLE CROP FARMERS IN IKWUANO LOCAL GOVERNMENT AREA, ABIA STATE, NIGERIA

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Abstract
The study was carried out to analyze the effect of crop diversification on food security status among arable crop farmers in Ikwuano L.G.A of Abia State. A two-stage sampling technique was used to select 80 arable crop farmers. The data collected were analyzed with the use of descriptive and inferential statistics. The results showed that the farmers were about 44years, 57.5% males and 77.5% married with about 11years spent in school. The average household size was 5persons, and farming experience of about 9.41 years. Majority (60%) were members of cooperative societies, while 65% and 85% had no extension contact and access to credit respectively. Also, average farm size was 1.53ha with crop diversification index of 0.71. Education, off-farm income, farm size, land ownership and crop yield significantly influenced crop diversification, while crop yield, education, household size, crop diversification and off-farm income significantly influenced the food security status of the farmers in the study area. The study therefore, recommends that extension agents should create more awareness on the importance of crop diversification on the food security of the farmers in the study area. Provision of affordable or free education will enable farmers' access and process information on innovations that will enhance crop diversification for improved income and food security status. There is also need for land reform policies to enable farmers' access more land for increased crop diversification in the study area.

Keywords: Diversification, Farmers, Food Security, Herfindahl Index

Introduction

There is an emerging concern about the viability of small-scale agricultural enterprises, particularly in the context of the on-going process of globalization. Agricultural based economy like Nigerias' is dominated by small and marginal farmers. Their small operational base makes it impossible to improve the incomes of their households merely by raising the existing crop yields (Ojo *et al.,* 2014). Crop diversification is one method of reducing farm income variability. It is a strategy to maximize the use of land, water and other resources and for the overall agricultural development in the country. It provides the farmers with viable options to grow different crops on their land (Saraswati *et al*., 2011). Viability of small farms can be improved through diversification of agriculture into higher-value crops, and those whose consumer demand is high (Joshi *et al.,* 2006). It is also perceived to augment total income levels as farmers adopt different cropping patterns to achieve better incomes, improved standard of living and food security. The diversification in agriculture is also practised with a view to avoid risk and uncertainty due to vagaries of climatic and environment (Saraswati *et al*., 2011).

Diversification has been analysed as a rational response by households to lack of opportunities for specialization and was initially considered not the most desirable option. However, recent studies indicate that rather than promoting specialization within existing portfolios, upgrading them to augment income could be more realistic and relevant for poverty reduction and food security (Ellis and Freeman, 2005). Studies that have analyzed the food and nutrition security outcomes of crop diversification have found varying effects on nutrition (Immink and Alarcon, 1991; Torheim *et al.,* 2004; Kankwamba *et al.,* 2012; Jones *et al.,* 2014). Immink and Alarcon (1991) in their study on household food security, nutrition, and crop diversification among smallholder farmers in the highlands of Guatemala, found that crop diversification is associated with higher incomes but no significant nutritional changes at the individual or household level.

Despite the growing importance of crop diversification, very little is known about the role it plays in improving the food security status of households who diversify (Ibekwe *et al.,* 2010). The tendency for rural households to engage in multiple cropping systems is often

noticeable, but few attempts have been made to link this behaviour in a systematic way to rural poverty reduction and food security policies. Also, less emphasis has been given to household level choices and especially to the explanation of difference in strategies among households in terms of income-source diversification.

One of the most established characteristics of rural communities is that they obtain their incomes from many different sources (Reardon 1997; Davis *et al*., 2009). Household crop diversification is the norm in rural societies, and specialization as a single activity is the exception. The failure of many food security interventions in Nigeria has been because they ignored the great diversity and heterogeneity in assets and income portfolios across the rural households and the range of crop mix in which they engage to generate income. It thus becomes important for policymakers to understand cropping systems that rural households engage in to generate incomes and how these cropping systems affect their food security status.

Methodology

The study was carried out in Ikwuano Local Government Area (LGA) Area of Abia State, Nigeria. The local government lies between longitudes 7.34°and 7.56°E and Latitudes 5.26° and 5.43°N in the tropical rainforest area of South East Nigeria, and 122 metres above sea level. The Local government has an area of 281km^2 and a population of 180, 600 (NPC, 2016). It is made up of 4 clans and about 28 communities. The people of Ikwuano engage mainly in farming, accounting for about 85% of the entire population while petty trading and transport business occupies the minor sector. Ikwuano has a vast area of arable land; her soil is very rich and good for agriculture. Major crop cultivated are cassava, rice, melon plantain, banana, cocoa and palm fruits etc., while livestock such sheep, goat and poultry are reared in the area. A two-stage sampling technique was employed in selecting the sample from the 4 clans in the study area. The first stage involved the random selection of two autonomous communities from each of the clans. The second stage involved the random selection of 10 farmers from the list of arable crop farmers in each of the selected autonomous communities making a total of 80 respondents for the study. Primary data were obtained through the use of well-structured questionnaire. Data were analyzed using descriptive statistics, herfindahl index, Foster Greer and Thorbecke (FGT) model, ordinary least square and logit regression models. This study employs Herfindahl index because it is widely used in the literature on agricultural diversification. Besides, the index is easy to compute. Herfindahl Index (Swades and Shyamal, 2012) is computed by taking sum of squares of acreage proportion of each crop in the total cropped area. Mathematically, the index is given thus:

$$HI = \beta_0 + \beta_1 Edu + \beta_2 Inco + \beta_3 Exp + \beta_4 Ext + \beta_5 Age + \beta_6 FSiz + \beta_7 HSiz + \beta_8 Lan + \beta_9 FDIS + \beta_{10} Cyd + e ...(2)$$

Where;
HI = Herfindahl Index (Crop diversification index)
EDU = Education (years spent in formal school)
INCO = Off farm income in Naira
EXP = Years of farming experience
EXT = Number of extension contacts during the 2017/2018 farming season
AGE = Age of the farmer (years)
FSIZ = Farm size (hectare)
HSIZ = Number of people in household involved in farm work
LAN = Land ownership (1 if direct ownership; 0 otherwise)
FDIS = Farm Distance from home (km)
CYD = Crop yield (tonnes) (crop yields aggregated using Grain Equivalent Table)
e = Error term
β_0 = Intercept
$\beta_1 - \beta_{10}$ = Coefficients to be estimated

The Cost-of-Calories (COC)

Oluyole *et al.* (2009), examined the food security status among cocoa farming households of Ondo State, Nigeria and employed Cost-of Calorie (COC) function proposed by Greer and Thorbecke (1986). This method was also used in similar studies (Ojogho, 2010; Adenegan and Adewusi, 2007). The function is stated thus:

$$\ln X = a + bC ..... (3)$$

Where; X = adult equivalent food expenditure (in Naira) and C = actual calorie consumption per adult equivalent of a household (in kilocal). The calorie content of the recommended minimum daily nutrients level (L) 2260Kcal was used to determine the food security line Z. From the COC function, the Cost of minimum recommended energy level, Z was calculated as:

$$Z = e^{(a+BL)} .....(4)$$

Where;
Z= Cost of minimum recommended energy level (N) (Food security line for the study area);
L= FAO recommended minimum daily energy (calorie) level (2260kcal) following FAO (2012)
a= Intercept;
B= Coefficient of the calorie consumption;
e= A mathematical constant (2.71828).

Based on the estimation, a household whose average cost of daily calorie consumption is equal to or more than Z is said to be food secure, while a household with average cost of daily calorie consumption lower than Z is considered food insecure. To establish food security status of farming households in the study area, the study constructed Food Security Index (Z_i) and determined the food security status of each household based on the food security line using the Recommended Daily Calorie Required approach as used by Babatunde *et al.* (2007). Households whose Daily Calorie Intake were equal or higher than Recommended Daily Calorie Required were considered food secure households and those whose Daily Calorie Intake were below the Recommended Daily Calorie Required were considered as food insecure households. The Food Security Index is

given as:

$$Z = \frac{\text{Household's daily per capita calorie supply}}{\text{Recommended daily per capita calorie requirement}} \quad \text{.....(5)}$$

Based on the food security index (Z), Logit regression model was employed to estimate the effect of crop diversification on food security of arable crop farmers in the study area. The functional form of logit model is specified following Gujarati (2003):

$$Pi = E\left(Y = \frac{1}{Xi}\right) = \frac{1}{1+e^{-(\alpha+\beta Xi)}} = \frac{1}{1+e^{-(Zi)}} \quad \text{.....(6)}$$

For ease of exposition, the logit becomes a linear function of different explanatory variables:

$$L_i = \ln\left(\frac{p_i}{1-p_i}\right) P_i = Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_{2.....+} \beta_7 X_7 \quad \text{.....(7)}$$

Where;
Y is the food security status of the household
Pi is the probability of been food secure
1 – Pi is the probability of been food insecure
Li is the logit,
Xi is a vector of explanatory variables (X1.....X10) such as: age(years), herfindahl index, crop yield (kg), education(years), household size (number), off-farm income (N), Farm size (Ha)

Results and Discussion

Socioeconomic Characteristics of Arable Crop Farmers

The socioeconomic characteristics of the arable crop farmers are presented in Table 1.

Table 1: Socioeconomic Characteristics of Arable Crop Farmers in the Study Area

Variables	Frequency	Percentage	Mean	Deviation
Age Group			44.38	4.18
26-35	12	15		
36-45	32	40		
46-55	20	25		
56-65	10	12.5		
66-75	6	7.5		
Sex				
Male	46	57.5		
Female	34	42.5		
Education			10.75	3.11
1-6	22	27.5		
7-12	42	52.5		
13-18	16	20		
Household Size			5.35	2.73
1-3	16	20		
4-6	36	45		
7-9	18	22.5		
10-12	10	12.5		
Marital Status				
Single	8	10		
Married	62	77.5		
Divorced	2	2.5		
Widow	8	10		
Farming Experience			9.41	6.38
1-5	18	22.5		
6-10	22	27.5		
11-15	25	31.25		
16-20	15	18.75		
Cooperative Membership				
Member	48	60		
Non-Member	32	40		
Extension Contact				
Contact	28	35		
No Contact	52	65		
Credit Access				
Access	12	15		
No Access	68	85		
Farm Size			1.53	0.92
0.1-1	46	57.5		
1.1-2	19	23.75		
2.1-3	15	18.75		

Source: Field Data, 2019

The distribution of the respondents based on their age group as presented in Table 1 showed that majority (55%) of the respondents were below 45 years, 25%, 12.5%, and 7.5% were between 46-55, 56-65 and 66-75 years respectively. The mean age of the respondents was 44.38 with a deviation of 4.18 years. This implies that majority of the arable crop farmers are still in their active age and hence still energetic to diversify their cropping pattern away from mono-cropping system. The distribution of the respondents based on gender showed that majority (57.5%) were male, while 42.5% were female. This result is not unconnected with the cultural and religious inclinations that confers household headship to males and most important, the responsibility of sustaining the household economy. The distribution of the respondents based on their level of education showed that majority (52.5%) of the arable crop farmers had spent 7-12 years in school, 27.5% spent 1-6 years, while 20% at least 13 years in school. The mean years spent in school was 10.75 years with a deviation of 3.11. From the result it can be shown that all the respondents in the study area are literate with at least primary education. Educational level of the respondents is an additional factor which is thought to influence the food security status of households. Ahmed *et al.* (2015) stated that awareness of food groups necessary for human growth and wellbeing may be dependent upon the level of education of the household head. The knowledge of these food groups ultimately influenced nutritional decisions that enhanced quality food intake. Results show that 45% of the arable crop farmers had a household size of less than 6 persons, while 55.5% had between 7-12 persons. The mean household size was about 5 persons with a deviation of 2.73. Increasing household size could exert more pressure on the level of consumption since food requirements tend to increase with the number and composition of persons in the households which can affect crop diversification and food security. This implies that as the household size increases, the probability of food security decreases. Majority (77.5%) were married while 22.5% were single, widowed or divorced. Marriage comes with increasing responsibility in the form of more number of mouths to feed which may reduce the food security status of the arable crop farmers except he/she diversifies his/her cropping pattern. About 50% of the arable crop farmers had less than 10 years of farming experience, while 31.25% and 18.25% had between 11-15 years and 16-20 years of farming experience respectively. The mean farming experience of the arable crop farmers was 9.41 years with a deviation of 6.38. Increase in farming experience predisposes farmers to acquisition of skills and better farming practices which will enhance their food production and reduce incidence of food insecurity. Majority (60%) of the arable crop farmers were members of cooperative society, while 40% were non members. It is believed that cooperative membership offers members access to agricultural inputs, modern technologies and food items at affordable rates. This suggests that the high level of education of the arable crop farmers could possibly have affected the level of awareness and need for functional cooperative membership in the study area.

Majority (65%) of the arable crop farmers had no extension contact, while 35% had extension contact. This implies that traditional farming methods were still widely practiced in the study area. This could affect productivity in quality and quantity of output, income of farmers and ultimately the food security status of households. Ibrahim *et al.* (2009) noted that access to extension services by farming households' accords households the knowledge of improved inputs and adoption of new farming techniques and marketing. Also, Mango *et al.* (2018), indicated that lack of extension contact significantly affected the adoption of crop diversification in Malawi. Majority (85%) of the arable crop farmers had no access to credit, while 15% had access. This implies that agricultural loans were not easily accessible in the study area. The low access to credit by the arable farmers may be due to lack of collateral and the high level of risk associated with agricultural production. It is expected that low access to agricultural loans will adversely affect domestic food production and other agro-processing enterprises resulting in food insufficiency, decreased income, and lack of sustainable rural household food security and reduced quality of life. Majority (57.5%) of the arable crop farmers had farm size of between 0.1-1ha, while 23.75% and 18.75% had between 1.1-2 and 2.1-3ha respectively, with an average farm size of 1.53ha and deviation of 0.92. It is expected that increase in farm size will enhance crop diversification that will result in increased food production and household food security.

Level of Crop Diversification among Arable Crop Farmers

The level of crop diversification of the arable crop farmers is presented in Table 2.

Table 2 Level of Crop Diversification among Arable Farmers in the Study Area

Level	No of Crop	Frequency	Percentage
Low	1-4	16	20.00
Moderate	5-8	42	52.50
High	9-12	22	27.50
Total	12	80	100.00

Source: Field Data, 2019, Herfindahl Index=0.71

Results show 20% low crop diversification, 52.50% had moderate crop diversification, while 27.50% had high crop diversification in the study area. This implies that majority (52.50%) of the arable crop farmers cultivate between 5-8 crops in their farms in a planting season. The Herfindahl index value of 0.71 implies that arable crop farmers in Ikwuano LGA of Abia State diversified in their cropping pattern. This result is in line with the findings of Ogundari (2013) who reported that food crop farmers in the South-western part of Nigeria were more

diversified in their cropping pattern and contrary to Ojo *et al.* (2014) who stated that variation in weather conditions of zones led to specialization on the growth of crops that thrive well in the prevailing weather condition in the North central zone of Nigeria.

Food Security of Arable Crop Farmers in Relation to Crop Diversification

The food security status of the arable crop farmers in relation to crop diversification is presented in Table 3.

Table 3: Food security Status of Arable Crop Farmers in Relation to Crop Diversification in the Study Area

Food Security Status	**Food Secure**		**Food Insecure**	
Crop Diversification	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Low	6	7.5	10	12.5
Moderate	28	35	14	17.5
High	19	23.75	3	3.75
Total	**53**	**66.25**	**27**	**33.75**

Source: Field Data, 2019

About 66.25% of the arable crop farmers were food secure, while 33.75% were food insecure. Out of the 66.25% of the food secure arable crop farmers, 7.5% had low crop diversification, 35% had moderate crop diversification, while 23.75% had high crop diversification. Of the 33.75% of the food insecure arable crop farmers, 12.5%, 17.5% and 3.75% had low, moderate and high diversification respectively. The high level of diversification of food secure arable crop farmers implies that crop diversification increases food security of the diversifying farmers than a non-diversifier. This is because crop diversifying households with high output resulting from different crop combinations on his/her farm are faced with arrays of nutritional diversity that is capable of improving his/her food security status. Ajimoti and Kwadzo, (2018) noted that household access to food depends largely on her production and crop diversification which provides farmers with the different crops that they cannot access either because of the cost or poor infrastructure constraints (physical access).

Determinants of Crop Diversification among Arable Crop Farmers

The determinants of crop diversification among arable crop farmers are presented in Table 4.

Table 4: Regression estimate of the determinants of crop diversification

Variable	**Coefficient**	**Standard Error**	**t-ratio**
Constant	0.0065	0.0034	1.91*
Education	-2.0845	0.6205	-3.36***
Off-farm income	-0.0087	0.0038	-2.39**
Experience	0.0453	0.0488	0.93
Extension contacts	0.1098	0.1103	0.99
Age	-12.9071	11.3332	-1.14
Farm size	0.0123	0.0042	2.93***
Household size	0.9807	0.9431	1.04
Land ownership	-0.0017	0.0007	-2.43**
Distance	-0.3301	0.5111	-0.65
Crop Yield	-3.5641	1.8432	-1.93*
R^2	0.8826		
F-Ratio	86.52		

Source: Field Data, 2019, Note *, ** and *** denote significance at 10%, 5% and 1% probability levels, respectively

The coefficient of education was negative and significant at 1% level. This implies that educated people tend to specialize than diversify their cropping pattern. In other words, the more educated one gets the more he/she masters his/her area of specialty and as a result concentrate more on the crop he/she has a comparative advantage in terms of technical know-how. Previous findings by Ibrahim *et al.* (2009) and Sichoongwe *et al.* (2014) indicated a positive relationship between educational level and crop diversification. The coefficient of off-farm income was negative and significant at 5% level. This implies that the greater the income from off-farm sources, the less likely the attention to farming and hence diversification. The coefficient of farm size was positive and significant at 1% level. This implies that the larger the farm sizes, the higher the probability of crop diversification among the farmers. In other words, the more the farm size of a farmer, the more he/she is able to diversify. The amount of land a farmer has available plays a crucial role in determining how many crops a farmer can produce. Previous findings show that crop diversification is associated with larger farms (Benin *et al.,* 2004). The coefficient of land ownership was negative and significant at 5% level. This implies that non land owners tend to diversify their cropping pattern to avoid risk associated with crop failure. Also their diversification is to supplement crop income and increase land productivity, thereby increasing aggregate output of the farmer. Also, diversification will help non land owners to derive more income to be able to meet obligations of settling land rent and other contractual

arrangements he/she may have with the land owner. The coefficient of crop yield was negative and significant at 10% level. This implies that with high crop yield, the farmer tend to concentrate on that particular crop that gave him/her high output per unit of input and forgo those ones that yield less output per unit of input. This emphasizes that diversification is a risk mitigation strategy employed by farmers to supplement income and as a strategy against total crop failure.

Effect of Crop Diversification on the Food Security of Arable Crop Farmers

The effect of crop diversification on the food security of arable crop farmers is presented in Table 5. The coefficient of crop diversification was positive and significant at 1% level. This implies that as the farmer diversifies more into different crops, his/her food security increases; that is, people that farm more crops in a piece of land are likely to be food secure than those that specialized in one or few crops in a piece of land. In other words, crop diversification reduces the severity of food insecurity in the study area. This result agreed with the findings of Saraswati *et al*. (2011); Ojo *et al.* (2014) and Makate *et al.* (2016) who indicated that crop diversification had positive and direct effect on crop output and income stability among arable crop farmers since increase crop output will improve the food security of the diversifying farmer. The coefficient of crop yield was positive and significant at 10% level. This is in line with *a priori* expectation that increased crop yield will improve quantity of food available for the farm households, thus improving their food security status. The coefficient of education was positive and significant at 10% level. This implies that as the educational level of household head increases, the food security of the household tends to increase. In other words, the level of formal education of the household head could impact positively on the household diversification and nutrition decision, thereby reducing food insecurity.. This is consistent with the study of Ahmed *et al.* (2015) and Mango *et al*. (2018) who noted that as the level of education of the household head increases, their food security status increases. The coefficient of household size was negative and significant at 5% level. This is in line with *a priori* expectation that as household size increases without a corresponding increase in quantity and quality of food that can be accessed by the households, food security decreases. This corresponds with the finding of Ahmed *et al.* (2015) who stated that increase in family size necessitates increase in household food expenditure, especially, in a situation where many of the other household members could not generate any income but only depend on the household head; the probability that food security would reduce as household size increased is slim. The coefficient of off-farm income was positive and significant at 5% level. This implies that as the farmer diversifies his sources of income to off-farm, his food security improves. This finding follows that of Omotesho *et al.* (2006); Babatunde *et al.* (2007) and Ahmed *et al.* (2015) who indicated that increase in household income would lead to a corresponding increase in access to food and mitigation of food insecurity.

Table 5: Logistic Regression Estimates of the Effect of Crop Diversification on Food Security of Arable Crop Farmers

Variable	Coefficient	Standard Error	t-ratio
Constant	-9.8401	3.5112	2.80***
Age	11.3893	8.6433	1.32
Herfindahl index	0.0349	0.0084	4.16***
Crop Yield	0.4745	0.2213	2.14*
Education	3.0178	1.5568	1.94*
Household size	-0.0922	0.0413	2.23**
Off-farm income	0.0008	0.0003	2.67**
Farm size	0.0649	0.0814	0.79
Log Likelihood	-182.17		
R^2	0.7248		

Source: Field Data, 2019, Note *, ** and *** denote significance at 10%, 5% and 1% probability levels respectively

Conclusion

The study revealed that arable crop farmers that diversified their cropping pattern were mostly food secure and that the drivers of crop diversification were farm size, crop yield, land ownership, education and off-farm income. Extension contact and access to credit of the arable crop farmers were low which affected their awareness of the importance of crop diversification to food security. Also, crop yield, education, household size, and off-farm income significantly influenced the food security of the arable crop farmers in the study area. Based on the findings, it is therefore recommended that extension agents should create more awareness on the importance of crop diversification on the output of the farmers in the study area. This will further encourage the farmers to improve on the right selection and cultivation of different crop types on their farms which will eventually lead to increase in crop output and food security. There is need for policies that will improve farmers' access to and control over land. Since smallholder farmers are the ones who produce the bulk of the food, improved access to more land will enable farmers to grow more crops, thereby enhancing food and nutrition security status and poverty mitigation. Off-farm income was also identified to have a significant effect on food security status of households especially

during lean periods. It is therefore important that improving wage earning capacity and exploring income diversification opportunities are crucial in enhancing food security status of households. Households should be encouraged to intensify combination of enterprises and off-farm activities that could generate more income for the households and also help to improve their asset base.

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