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Determinants of Crop Diversification among Small – Scale Food Crop Farmers In North Central, Nigeria.

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Abstract

This study examines the determinants of crop diversification in among small-scale food crop farmers in North Central, Nigeria. Data used for the study were obtained from primary source using a multi-stage sampling technique with structured questionnaires administered to 300 randomly selected food crop farmers from the study area. The study uses herfindahl index to measure extent of crop diversification among the farmers in the study area while ordinary least square (OLS) regression analysis was used to determine the factors affecting crop diversification and effect of crop diversification on crop production in the study area. The study revealed the mean computed Herfindahl index values of 0.72, and 0.64 for Niger and Kogi States respectively. This implies that Kogi State food crop farmers shifted towards more diversification cropping patterns than their counterparts in Niger State. However, the overall result in the two States combined in this study shows a mean Herfindahl index of 0.68 which implies that the food crop farmers in the study area were not too diversified in their cropping pattern. The study further revealed that farming experience, extension contact, farm size and land ownership positively and significantly affected diversification among the farmers in the study area. The results of the regression model of the effect of crop diversification on food crop production revealed that crop diversification had positive and significant effect on food crop outputs in the study area. The study 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 outputs and food security

Keywords: *Crop diversification, herfindahl index and food crop production*

Introduction

Agriculture is a risky business because it deals with uncertain factors such as weather and market conditions. These uncertainties affect various decisions that farmers make in a particular season. The agricultural based economy like Nigeria is dominated by small and marginal farmers. Their small operational base makes it impossible to improve the incomes of these households merely by raising the existing crop yields and difficult for the farmer with meagre resources to sustain himself and his family also to make investment on the farm. Crop diversification is one method of reducing farm income variability.

Crop diversification 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. The diversification in agriculture is also practised with a view to avoid risk and uncertainty due to climatic and biological vagaries (Saraswati *et al.*, 2011). To improve the incomes, to provide gainful employment and to stabilize the income flow, diversification of crops emerges as a major strategy. Besides in several circumstances diversification is needed to restore the degraded natural resource base or to enhance the value of natural resources. In several instances cropping systems have been diversified or new cropping systems have been introduced to retain or to enhance the value of natural resources principally land and water. There is also the claim that diversification tends to stabilise farm income at a higher and higher level. This happens when the pattern of diversification is such as to accommodate more and more rewarding crops. This is particularly important for the small farmers who strive to make their farms viable (Saleth, 1995).

However, agricultural production involves risks and farmers have to adapt or adjust their farming practices so as to avoid loss since poor management of risks can result in crop failures leading to low production and unstable income. To deal with this problem, diversification into production of other crops and livestock by farmers has been recognized as a means to ensure stable income (Ali, 2004). Intercropping cassava with other food crops such as cocoyam, yam, maize etc as mean of diversification can also ensure food security and income stability (Aneani *et al.*, 2007). Diversification affects the choice made by farmers in term of enterprise combination on their farms. Different farmers may have different attitudes towards the enterprise chosen. Sometimes farmers who have good attitudes also may not plant certain crops due to some factors that affect their decisions. Farmers who plant food crops cultivate them as sole or mixed crops together. The specific objectives of this paper were to: (i) analyze the nature and extent of crop diversification among food crop farms in the study area, (ii) study the factors affecting crop diversification and (iii) assess the effect of crop diversification on farmers' output in the study area.

Concept of crop diversification

The concept of diversification conveys different meaning to different people at different levels. According to Ellis (2000), the diversification of activities is defined as the process by which rural households build a growing portfolio of activities and various assets to survive and improve their standard of living. Based on this definition, Niehof (2004) envisages diversification as an important strategy which makes it possible to reduce vulnerability. Two forms of diversification are identified: farm diversification (or crop diversification) and farm income diversification (or diversification of activities)

(Emrys and Ngau, 1991). The difference between both diversifications is based on the nature of the activities. According to Ilbery (1991), whereas farm diversification is located within the farm and implies primarily activities in the agricultural sphere, diversification of activities refers to income diversification coming from activities undertaken inside and outside the farm.

Crop diversification means raising of a variety of crops involving intensity of competition amongst field crops for arable or cultivable land. According to Swades and Shyamal (2012), Crop diversification in the developing Countries is a pungent applied concept to remove the plight of subsistence agricultural economy and to ensure diversified nutrition status of the poor countrymen. Crop diversification is intended to give a wider choice in the production of a variety of crops in a given area so as to expand production related activities on various crops and also to lessen risk. Crop diversification is generally viewed as a shift from traditionally grown less remunerative crops to more remunerative crops. Crop diversification and also the growing of large number of crops are practiced in rain fed lands to reduce the risk factor of crop failures due to drought or less rains. Diversification of crops can be an effective tool to help farmers deal with several types of risk, such as price risk. (the farmer can use what he knows about the means and variances of the prices for each crop to choose a mix of crops that have a low correlation of profitability) (Coyle, 1992). The farmer can use diversification and choose an optimal portfolio of crops to help insure against drops in profit or utility that occur if the price for one crop is lower than average in a given year. Farmers can also use diversification in response to output risks or input market risks; by choosing crops with different characteristics (i.e. crops that are more or less drought-resistant, or crops that are harvested in different seasons).

The farmer can use diversification and choose an optimal portfolio of crops to help insure against drops in profit or utility that occur if the price for one crop is lower than average in a given year (Bromley and Chavas 1989). Farmers can also use diversification in response to output risks or input market risks; by choosing crops with different characteristics (i.e. crops that are more or less drought-resistant, or crops that are harvested in different seasons. Farmers can also diversify in response to biological, physical, or economic constraints that affect the farming system or input availability. These types of constraints can take the form of limited availability of inputs, limited water or nutrient availability, public and private payments for ecosystem services and consumer demand for quality-differentiated products or products with environmental attributes (such as organic or pesticide-free varieties).

Measurement of Crop Diversification: There are different approaches for crop diversification which indicate the extent of dispersion and concentration of activities in a given time and space by a single quantitative indicator. The extent of crop diversification at a given point in time may be examined by using several indices namely: Bhatia's Method, Jashbir Singh's Method, Herfindahl Index (HI), Transformed Herfindahl Index (THI), Ogive Index (OI), Entropy Index (EI), Modified Entropy Index (MEI), Composite Entropy Index (CEI), Gini Coefficient (Gi) and Simpson Index(SI). This study employs Herfindahl index because it is widely used in the literature of agricultural diversification. Besides, the index is easy to compute.

Herfindahl Index (HI): Herfindahl Index (Swades and Shyamal (2012) given below is computed by taking sum of squares of acreage proportion of each crop in the total cropped area. Mathematically, the index is given as below.

$$HI = \sum_{i=1}^N P_i^2$$

Where N is the total number of crops and P_i represents area proportion of the i -th crop in total cropped area. With the increase in diversification, the Herfindahl Index would decrease. This index takes a value one when there is complete concentration and approaches zero when diversification is 'perfect'. Thus the Herfindahl Index is bounded by zero and one.

Methodology

Study Area: This study was conducted in the North Central Nigeria. The zone comprises of Benue, Kogi, Kwara, Niger, Nasarawa and Plateau States, including the Federal Capital Territory (FCT), Abuja. The zone occupies a total land area of 296,898 km² representing about 32% of the land area of the country. It is located between latitude 6° 30' to 11° 20' North equator and longitude 2° 30' to 10° 30' East Greenwich meridian (Shuaib *et al*, 1997). More than 77% of the people in the region are rural dwellers and are mostly engaged in one form of agricultural activities or the other (Shuaib *et al*, 1997)

According to Tologbonse (2004), the zone has two main seasons' namely dry and wet seasons, with the wet season beginning towards the end of the March and end at the end of October, while the dry season is from November to March. The rainfall per annual ranges from 1000 to 1500mm with the average of 187 to 220 rainy days with average monthly temperature ranges from 21°C and 37°C. The vegetation of the zone consists of the forest Savannah Mosaic, Southern Guinea Savannah and the Northern Guinea

Savannah. Geographically the zone is characterized by varying landforms such as extensive and swampy feature which are common in the lowland areas which occur in the areas along the valleys of Niger and Benue rivers, deep valleys large hills, mountains and plateaus. The vegetation, soil and weather patterns are favourable for the production of a wide spectrum of agricultural food, industrial and cash crops of various types. The major crops grown in the North Central Nigeria include rice, maize, cowpea, millet sorghum, yam and cassava.

Sampling technique and sample size

Primary data were collected using multi-stage sampling procedure . The first stage involved random selection of Niger and Kogi States in the North Central Zone of the country. This was followed by random selection of 3 Local Government Areas (LGAs) in each State making 6 LGAs altogether. The LGAs selected in Niger State are Shiroro, Lapai and Gurara while Mopamuro, Kabba/Bunu and Ijumu LGAs were selected in Kogi State. The third stage involved a simple random selection of 155 farmers in Niger State with 54, 50 and 46 food crop farmers in Shiroro, Lapai and Gurara LGAs respectively while in Kogi State, 53, 47 and 50 food crop farmers were selected in Mopamuro, Kabba/Bunu and Ijumu LGAs respectively making a total of 300 sampled farmers for this study.

Method of data collection

A limited cost-route approach method was used in data collection for this study. The data were collected with the use of structured questionnaire designed in line with the objectives of the study with the assistance of trained enumerators in the State's Agricultural Development Project (ADP). Data collected included total crop output produced per annum in kilogram or tonnes (rice, maize, cowpea, millet sorghum, yam and cassava), while the inputs included the size of farm land in hectare, quantity of seeds as planting materials in kg; quantity of fertilizer used in kg; quantity of herbicides used in litres and total labour in man-days which include family and hired labour utilised pre and post planting operations and harvesting; prices of yam and cassava in naira; total production cost per year; average wage rate per man days of labour, price per kg of planting materials, average price of agrochemicals, average price of fertilizer and average price of farm tools. Also, data collected include the farmer's socio-economic variables such as farmer's age, years of schooling, household size, number of contact with extension agents, accessibility to credit etc.

Analytical techniques

To determine the effect of different factors on diversification a multiple regression model was used. The values of Herfindahl Index (HI) computed for measuring crop

diversification were taken as dependent variable and different factors affecting diversification were taken as independent variables.

$$HI = \beta_0 + \beta_1 EDU + \beta_2 INCO + \beta_3 EXP + \beta_4 EXT + \beta_5 AGE + \beta_6 FSIZ + \beta_7 HSIZ + \beta_8 LAN + \beta_9 FDIS + \beta_{10} CYD + \beta_{11} FERT + \varepsilon$$

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 2010/2011 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)

FERT = Fertilizer use (kg)

ε = Error term

β_0 = Intercept

$\beta_1 - \beta_4$ = Coefficients to be estimated

To assess the effect of crop diversification on the farmer's output, a simple regression analysis was specified and estimated.

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, U_i) \quad (5)$$

Where Y = Crop output (tonnes) (crop outputs aggregated using Grain Equivalent Table)

X_1 = Farm Size (ha)

X_2 = Quantity of Seeds (Kg)

X_3 = Quantity of fertilizer (Kg)

X_4 = Labour Input (Manday)

X_5 = Agrochemical (Naira)

X_6 = Herfindahl Index (Crop diversification index)

Results and Discussion

The summary statistics of the computed Herfindahl Index showing the trend of crop diversification by LGAs and States are shown in Table1. The survey result revealed that the sampled farmers planted different food crops with a maximum of seven enterprises.

These enterprises include; rice, maize, cowpea, millet sorghum, yam and cassava. These crops were either solely cropped or mixed by the farmers. The results in Table1 shows the mean computed Herfindahl index values of 0.72, and 0.64 for Niger and Kogi States respectively. This shows that Kogi State food crop farmers shifted towards more diversification cropping patterns than their counterparts in Niger State. However, the overall result in the two States combined in this study shows a mean Herfindahl index of 0.68 which indicates that the food crop farmers in the study area were not too diversified in their cropping pattern. This result is at variance 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. This might have been due to variation in weather conditions of the two zones which atimes might have led to specialization on the growth of crops that thrive well in the prevailing weather condition in the North-central zone Nigeria.

Table1: Trends in crop diversification by LGAs and States

States	LGAs	Mean	Standard Deviation	Minimum	Maximum	Count
Niger	Gurara	0.66	0.25	0.27	1.00	46
	Lapai	0.77	0.21	0.48	1.00	50
	Shiroro	0.74	0.24	0.31	1.00	54
	Niger (pooled)	0.72	0.24	0.27	1.00	150
Kogi	Mopamuro	0.60	0.21	0.33	1.00	53
	Kabba/bunu	0.56	0.18	0.36	1.00	47
	Ijumu	0.76	0.23	0.39	1.00	50
	Kogi (pooled)	0.64	0.23	0.33	1.00	150
Niger & Kogi	Pooled	0.68	0.23	0.27	1.00	300

Source: Field survey, 2012

The results of the regression model of the factors affecting diversification among small scale food crop farmers are presented in Table 2 (Double log regression as the lead equation). The value of coefficient of determinations (R^2) indicated that 57.45% of the variation in crop diversification was explained by the variables included in the regression model. The F-ratio 10.80 is significant at ($P < 0.01$) percent, implying that the variables significantly explained variations in the crop diversification among the food crop farmers in the study area. The results revealed that farming experience, extension contact, farm size and land ownership positively and significantly affected diversification among the farmers in the study area. This implies that increased these variables led to increase in diversification in food crop production. This result is consistent with the findings of Muhammad et al., (2008) who reported that

diversification is common among farmers with much year of farming experience and large farm holdings. It was further revealed in the result that off farm income, age and fertilizer negatively and significantly affected diversification in the study area. This implies that crop diversification reduced with increased in off farm income, age and the quantity of fertilizer used. This agrees with the findings of (Katchova, 2005) who reported that better and high off farm income opportunities made farm operators pay less attention to farming and diversification ultimately. Bandara and Thiruchelvam (2008) also reported that farmer’s risk bearing ability reduces as his/her age increases.

Table 2. Estimated regression function for the determinants of crop diversification in the study area

Factors	Coefficients	t-Statistics
Constant	0.0044	0.14
Education (X ₁)	-0.0009	-0.82
Off farm income (X ₂)	-0.0284	-2.83***
Farming experience (X ₃)	0.0014	2.38**
Extension contact (X ₄)	0.0114	2.34**
Age (X ₅)	-0.0021	-2.50**
Farm size (X ₆)	0.0245	4.23***
Household size (X ₇)	-0.013	-1.10
Land ownership (X ₈)	0.0388	3.36***
Farm distance (X ₉)	0.0013	0.84
Crop yield (X ₁₀)	0.0045	0.63
Fertilizer (X ₁₁)	-0.0002	-3.11***

R² = 0.5745, F-value = 10.80***, and ** denote significance at 1% and 5 % probability levels, respectively
 Source: Field Survey, 2012

The results of the regression model of the effect of crop diversification on food crop production are shown in Table3. The results in Table 3 show that farm size, labour, planting material, agrochemical, fertilizer and capital inputs positively and significantly affected the output of food crop farmers in the study area. This indicated that a unit increased in these inputs led to increase in the gross output of food crop in the study area. The coefficients of farm size, labour, planting material, agrochemical, and capital were significant at 1% level of probability while the coefficient of fertilizer was significant at 10% level of probability. The coefficient of crop diversification on food crop output was positive and significant at 0.01 probability level. This implies that one unit increase in the Herfindahl Index of these crops led to increase in the production of food crop by 0.98. This result agreed with the findings of Saraswati *et al.*, (2011) who reported that crop diversification had positive and direct effect on crop outputs among arable crop farmers.

Table 3. Estimated regression function for the effect of diversification on food crop production in the Study Area

Variables	Coefficients	T-values
Constant	-10.4222	-13.81***
Farm Size (ha)	0.0472	2.6338***
Labour (man-day)	0.9007	10.2824***
Planting material (kg)	0.301	8.2831***
Agrochemical (N)	0.0985	1.8322*
Fertilizer (kg)	0.0844	1.7648*
Capital Inputs (N)	0.4745	6.1445***
Herfindahl Index (HI)	0.9856	(2.82)***

Number of Observation = 300 ; R2 = 0.5725 ; Adjusted R2 = 0.5638; F-Ratio = 65.41***

*** = Significant at 1% level of probability, * = Significant at 10% level of probability,

Source: Field Data Analysis, 2012

Conclusion and Recommendations

This study examined the determinants of crop diversification among small-scale food crop farmers in North Central, Nigeria. The study revealed the mean computed Herfindahl index values of 0.72, and 0.64 for Niger and Kogi States respectively. This shows that Kogi State food crop farmers shifted towards more diversification cropping patterns than their counterparts in Niger State. However, the overall result in the two States combined in this study shows a mean Herfindahl index of 0.68 which indicates that the food crop farmers in the study area were not too diversified in their cropping pattern. The study further revealed that farming experience, extension contact, and farm size and land ownership positively and significantly affected diversification among the farmers in the study area. The results of the regression model of the effect of crop diversification on food crop production revealed that crop diversification had positive and significant effect on food crop outputs in the study area.

Therefore, it is 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 outputs and food security

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