Determinants of Crop Production Intensification among Maize-Based Farming Households in Southern-Guinea Savanna of Nigeria.

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ABSTRACT

Maize is Nigeria's main staple crop and is therefore of major concern in agricultural policy and the overall development of both the agricultural sector and the economy. Available evidence shows that the Nigerian farming households practice low-external-input agriculture, rather than increasing the productivity of their arable lands through crop production intensification. Concerns are raised over the long-term sustainability of the agriculture systems in Nigeria in addition to the frequent food insecurity situations. Thus, this study analyzed crop production intensification and its determinants among maize-based farming households in southern-guinea savanna of Nigeria. A total of two-hundred and fifty two maize-based farming households were interviewed using structured questionnaire. Data collected were analyzed using crop intensification index and tobit regression model. Analysis revealed that farming households can be grouped into high and low intensity farming households. The high intensity households have higher crop intensity scores than those of low intensity households. The estimated tobit regression model revealed that age of the household head, farm size, household size, extension contact and market distance are the significant variables affecting crop production intensification of farming households in the zone. For sustainability of maize-based crop production in the area, there is the need for a policy option that addresses the provision of qualitative extension education and farming households' access to the market in the study area.

Keywords: Crop production intensification, tobit regression model and maize-based farming households

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INTRODUCTION

In Nigeria, subsistence farmers practice low-external-input agriculture (LEIA) rather than increasing the productivity of their arable lands through crop production intensification which according to Tiffen et al., (1994); is the use of increased average inputs on smallholding for the purpose of increasing the value of output per hectare. LEIA, requires huge amounts of organic matter to substitute for a small amount of inorganic fertilizer, which is increasingly impractical where the density of animals per square mile has been steadily declining in many land-constrained areas of Africa. LEIA has the potential to increase food output by only about 1 percent a year, which falls far short of meeting Africa's 3.0 to 3.5 percent annual growths in food demand (Ruttan and Hayami, 1990). In the faces of demographic and environmental pressures and changes in social and political circumstances, LEIA becomes disrupted. LEIA also depends primarily on expansion of cultivated area. In areas where population is quite high, marginal lands and forest reserves are encroached for crop cultivation. The inherent limitation of this approach is evident in the decline in Nigerian arable land area by 15.4% attributable to land alienation, degradation and loss of about 351 000 hectares annually to desertification (Brown, 2005). Consequently, LEIA is always not sustainable and certainly not economical (Udoh, 2000). Continuous increase in population density and the consequent pressures from competing demands for land over times have the tendency of worsening the Nigerian arable land situation in the foreseeable future, if unaddressed. This study therefore describes the crop production intensification systems and highlights the determinants of crop production intensification in the study area.

METHODOLOGY

Area of the Study:

The study area is the Southern Guinea Savanna ecological zone of Nigeria located at longitude 38° 148° E and latitude 78° and 108° N. The savanna ecology can well be called the Corn Belt of Nigeria. The zone represents a geographical area that is majorly made up of Kwara, Niger, Kogi, Taraba, Plateau and Benue States. The Southern Guinea Savanna of Nigeria has great potential for the expansion of maize production beyond the present level due to its bimodal rainfall pattern, (a short early growing season followed by fairly long late season) high solar radiation and favorable temperature during the growing season. However, the zone is characterized by variable weather, fragile soils with low moisture holding capacity that is prone to drought (Fakorede et al; 2001). The soils are also mainly alfisols that are low in organic matter, especially nitrogen which is one of the most essential units for maize growth and productivity. Thus, the region offers a lot of potential for intensification with a view to bringing about much required growth in the maize sub-sector of the Nigerian economy.

Sampling Procedure and Sample Size: The target population for this study is the farming households involved in maize-based production systems in the Southern Guinea Savannan zone of Nigeria. The zone represents a geographical area that is majorly made up of Kwara, Niger, Kogi, Taraba, Plateau and Benue States. A three-stage sampling technique was used to select sample for the study. The first stage involved a purposive selection of Kwara and Niger States. The two states have the list number of crop farmers in the zone in the year 2007 (NBS, 2008). The ADPs zones are four and three in Kwara and Niger states respectively. The second stage involved the random selection of 4 villages from each of the ADPs zone in each of the states. The upgraded 2001 Agricultural Development Projects (ADPs) village listing served as the sampling frame for the selections in the two states. In each village, 10 farming households were selected among the farming households in the areas to make up a sample size of 280. However, only 252 pieces of questionnaires were retrieved and analyzed.

Analytical Techniques: Descriptive statistics, crop intensity index, and tobit regression model were the analytical tools employed to achieve the research objectives. Following Shriar, (2005) intensification activities such as intercropping, use of legume, use of fertilizer, pesticides use per hectare, use of herbicides, ploughing methods, use of organic fertilizer and improved seeds have been assigned a particular weight based on its contribution to production intensity. These led to weight values ranging from 2 to 3.5 points (Table 1)

Table 1: Scale ranges and weights associated with agricultural intensity index

Intensification activity	**Scale range**	**Weight**	**Max. Points**
Scale of cereal/ legume plots	0-3	3.5	10.5
Scale of improve seeds	0-3	3.0	9.0
Scale of Ploughing	0-3	2.5	7.5
Scale of intercropping	0-3	3.0	9.0
Scale of fertilizer use per ha	0-3	3.0	9.0
Scale of pesticides use per ha (excluding herbicides)	0-3	2.0	6.0
Use of organic fertilization	0-1	3.0	3.0
Scale of herbicides use per ha	0-3	2.0	6.0
Total			**60.0**

Adapted from Shriar, 2005 but modified.

As evident from the Table 3, not all farming activities could be assessed in sufficient detail to justify using a 0-3 scaling and that the maximum points attainable by the household from all the intensification activities is 60. The index is stated as:

$$CI_i = \sum_{J=1}^{8} S_j W_j \qquad i = 1 \ldots N \text{------------}(1)$$

Where

CI is the crop intensification index for the i[th] household; S is the scale range for the agro-technology and strategy employed by the i[th] household and W is the weight of the agro-technology and strategy employed by the i[th] household.

A scale range of 0-1 for the use of organic fertilization implies a yes/No dummy variable. If the household is engaged in the activity he gets 1point and 0 if otherwise. In contrast, a scale range of 0-3 indicates whether the household undertakes the activity and if so, does so at low (1point), medium (2 points), or high (3 points) scale. The multi-level scales (low, medium, high) used in the index are based on the proportion of the total area cropped on which the strategy is practiced except for fertilizer and pesticide scales which are based on the quantities of these items used, calculated on a per hectare basis. Cereal/legume plots received the highest weighting of 3.5, because production values are likely to be more sustainable over time with legume (Shirar, 2005). The scale of cereal/legume plots involves the intercropping of cereal with any leguminous plants .It takes the value of 0, for no, and 1, 2, 3 for low, medium and high levels of activity respectively.

The scale of improved seeds on the other hand, indicates the proportion of the area cropped on which improve seeds are grown. It takes the value of 0, for no, and 1 (if less than 40% is cropped), 2 (if 40-69% is cropped), 3 (if 70% and above is cropped) for low, medium and high levels of activity respectively.

The primary tillage or cultivation implement used in land preparation in the study area represents the Scale of Ploughing. It takes the value of 0, for no, and 1, 2, 3 for use of cutlasses and hoes, animal traction and tractor respectively.

The scale of intercropping entails the intercropping of maize with other crops apart from legumes. It takes the value of 0, for no, and 1 (if less than 40% is intercropped), 2 (if 40-69% is intercropped), 3 (if 70% and above is intercropped) for low, medium and high levels of activity respectively.

Based on the recommended fertilizer input rate by ADPs, (2000), fertilizer application rate per hectare of between 50-100kg, 150- 200kg and

250-300kg is hereby regarded as low, medium and high application rate respectively for scale of fertilizer use per hectare.

The quantities of herbicides such as Altrazin, Gramozone, Primextra etc that are used up in the production processes on per hectare basis represents the scale of herbicide use per hectare. Based on ADP, (2000) recommended rate of 3litres/ hectare, the following classifications are made: 0.1-1.5 litres, 1.6-3.0 litres and 3.1-4.5liters and are thus regarded as low, medium and high application rate respectively.

The scale of pesticides use per hectare (excluding herbicides) involves the quantities of insecticides, fungicides, nematicides etc that are used up in the production processes on per hectare basis. Based on the ADP, (2000) recommended rate of 4 liters/ hectare, the following classifications are made: 0.1-1.5 liters, 1.6-3.0 liters and 3.1-4.5liters and are thus regarded as low, medium and high application rate respectively. The scale of organic fertilization is a dummy variable, if the household is engaged in the use of animal dung's and/or poultry droppings on the farm to raise soil productivity he gets 1point and 0 if otherwise.

Tobit Regression Model: The Tobit model developed by Tobin (1958) described as an extension of the probit model (Gujarati, 2003), used by Adejobi, (2004) and Muhammad-Lawal (2008) was adapted for this study. The linear tobit regression model was used to analyze the effect of certain socio-economic factors on the crop production intensification of farming households. The model was used because the dependent variable crop production intensification scores are censored having values ranging between 0 and 1. The model specification is given as:

$$V_j = \beta z_{ij} + \epsilon \text{ ------------------------------- } 2$$

$$V_j = V_j \text{ if } V_j > 0$$

$$V_j = 0 \text{ if } V_j * \leq 0$$

$$j = 1---411$$

$V_j *$ = Limited or censured dependent variable. It is the measure of severity of household crop production intensification. It is defined as

$$(K - Y_j)/K \text{ -------------------------------- } 3$$

Where K = threshold level; $Y_j =$ j^{th} household's crop intensity; β = Parameter estimates; $z_{ij} =$ Vector of the explanatory variables.

The farming households' decision to intensify crop production intensification may be related to the characteristics and composition of the household, the size of the farm, capital lay out of the household and the level of transaction costs incurred in the process of using the crop intensification strategy. The household composition and characteristics were captured by number of household members, age, farm and market distances and the number of visits by the extension agents'. A negative coefficient implies that the variable is reducing the severity of crop production intensification of farming households and vice versa. The following variables affecting crop production intensification of farming households were fitted into the Tobit model:

Z_1 = Age of the household head (years)

Z_2= Farm size (hectares)

Z_3= Adjusted household size (number)

Z_4 = Extension contact (number)

Z_5= Farm distance (km)

Z_6= Market distance (km)

μ= error term which explains other effects outside the household's control e.g weather, natural disaster, etc.

RESULTS AND DISCUSSION

Socio-economic characteristics of the Household Heads

The age of the farming households' heads ranged between 30 and 75 years with an average of 48.3 year. About 11.5% of household heads are above 60 years. Over 88% of the households' heads in the zone were below 60 years of age. This has implication on the available family labour and productivity of labour (Table 2).

Table: 2 Socio-economic Characteristics of the Household Heads

Variables	Frequency	Percentage
i) Age of the Household Head		
21-40 years	62	24.6
41-60 years	161	63.9
61-80 years	29	11.5
Total	252	100
ii) Sex of the Household Head		
Male	216	85.7
Female	36	14.3
Total	252	100
iii) Marital Status of the Household Head		
Married	198	78.6
Single	44	17.5
Widower/Separated	10	03.9
Total	252	100
iv) Household Size		
1- 5	26	10.3
6- 10	117	46.4
11-15	99	39.3
16-20	10	03.9
Total	252	100
v) Education Status of the Household Head		
No formal Education	46	18.3
Quranic Education	77	30.6
Primary Education	81	32.1
Secondary Education	30	11.9
Tertiary Education	07	02.8
Adult Education	11	04.4
Total	252	100
vi) Primary Occupation of the Household Head		
Farming	192	76.2
Agricultural Trading	19	07.5
Non-Agricultural Trading	24	09.5
Business	15	05.9
Civil Service	06	02.4
Total	252	100
vii) Farming Experience of the Household Head		
1- 10	13	5.20
11-20	55	21.8
21-30	76	30.2
31-40	56	22.2
41-50	52	20.6
Total	252	100
viii) Household Head Introduction to Farming		
Inherited	214	84.9
Farm Friends	22	08.7
Relations	16	06.4
Total	252	100

Source: Field survey 2009/2010

Sex distribution varies appreciably, 14.3% and 85.7% of the household heads were females and males respectively. The higher percentage (85.7%) of the male headed households may be due to cultural and religious belief of the people in the area, which prohibits woman to go out freely and engage in activities such as farming. Women are usually not allowed to own land and where the woman owns a land, they usually delegate its administration to their senior male child or one of their male relations.

The average household size is 11 persons in the zone. Most (69.3%) households are polygamous in nature. Polygamous nature of the people probably explains the large family size recorded in the area. Their availability reduces labour constraints faced during the peak of the farming season.

Majority (76.2%) of the household heads are predominantly farmers, while others were involved in both agricultural and non-agricultural trading, business and civil service as their secondary sources of livelihood. Farming household heads (82%) are literate with most of them having primary education (32.1%) and this is closely followed by Quranic education (30.6%) Those who had tertiary education (2.8%) probably constituted the civil servant who engaged in part-time farming in the area. Given this level of literacy it is expected that information can be disseminated with ease among these households' heads. The farming households head's years of experience ranged between 5 and 45 years with an average of the average of 29.1 years. Farming households' heads experience is expected to have a considerable effect on their productive efficiency. Majority of the household heads (72.6 percent) have inherited farming business as an occupation, while the remaining was introduced to it by either friends or relations.

The crop production intensification strategies in the study area are capital-intensive, labor-intensive and land-intensive, or a combination of these. The capital-intensive strategies commonly used in the study area are the application of inorganic fertilizer, use of improved hybrid maize seed and agro-chemicals. The application rate ha^{-1} of inorganic fertilizer in the area was low (87.5kg) compared to the recommended rates of 600kg (ADP, 2001). Given the low inorganic fertilizer application rate, the farming households were unable to maintain or improve the maize production levels and yield. Most households (89%) used fertilizer mainly for the purpose of direct and immediate supply of needed plant nutrient to growing crops in the study area on an average farm size of 1.89 hectares. This result revealed that fertilizer use was the most prevalent practice among the sampled farming households. The major agro-chemicals used were attracine, karate and Paraquate which are all insecticides. The mean level of application of the insecticides per hectare was 1.03 liters which is lower than the ADP recommended rate of between 3.0liters ha^{-1}. About 43% of the households used applied insecticides on an average farm size of 1.21 hectares. The herbicide application rates was also low (1.24litres) compared to recommended rate. About 26% of the households used improved hybrid maize seed as a capital-intensive strategy on an average farm size of

0.87 hectares. The use of hybrid maize was more pronounced among households with requisite resources. The improved hybrid seed is a crop production intensification strategy used to improve the yields only when all agronomic aspects of planting, weeding and fertilizer application are strictly followed. The improved hybrid maize seed was not accompanied with the appropriate agronomic management practices that raise the yields by households in the study area (Table 3).

Table 3: Land management practice, percentage use and farm size in maize production

Input Use or Management Practice	Percentage of household	Average Farm Size(ha)
Hybrid Maize	26.0	0.87
Tractor Usage	09.0	2.31
Minimum Tillage	87.0	1.05
Cover Cropping	50.0	1.20
Crop Rotation	23.4	0.65
Organic Fertilization	22.0	1.29
Mulching	05.0	0.57
Intercropping	73.0	0.89

Source: field survey 2009/2010

The labor-intensive strategies are most common since households in the study area were cash constrained. The households merely added labour in crop production, allowing him to crop more densely, weed and harvest more intensively. Also due to land constraints, labour/land ratios are rising, and therefore households choose production methods that are as labor-intensive as possible to raise productivity. The households used two or more of the integrated soil management practices on their respective fields. Labour-intensive strategies were mainly soil management practices. These included uses of minimum tillage, crop rotation, cover cropping, animal manure application and mulching.

Minimum tillage was the second most prevalent land management practice after fertilizer use. About 87% of the sampled households practiced minimum tillage on an average farm size of 1.05 hectares. Other households that did not practice minimum tillage used animal traction and tractors to till the soil. Minimum tillage in the study area involved the use of hoes to disturb the soil in the process of constructing mounds or heaps. This practice was more prevalent among low intensity households.

Cover cropping; the third most prevalent land management practices in the area was practiced by about 50% of the households on an average farm size of 1.20 hectares. The practice was more common among high than low intensity households. The major problem with cover cropping practice is the opportunity cost which the households consider to be very high. Crop rotation was the fourth most common land management practices among the sampled farming households. About 23.4 percent of the sampled respondents practiced crop rotation on an average farm size of 0.65 hectares. Organic fertilization was another land management practice used by 22 percent of the sampled households on an average farm size of 1.29 hectares. Animal manure was commonly used in the southern part of Niger State, although most households complained of its bulkiness and high cost of application. A few households left plant residue in the furrows to rot and strengthen the soil after their initial land cleaning operations. In most cases, households who planted cowpeas ploughed the vegetation part into the soil after harvest with the aim of improving soil fertility. Mulching was the least prevalent land management practice among the sampled households. The land-intensive strategies are commonly practiced on increasingly small land sizes in the area. Intercropping was practiced by about 73% of the households on an average farm size of 0.89 hectares. Intercropping has long been recognized as a common practice among subsistence farmers due to the flexibility of labour used and less risk. Mixed cropping has been shown to lead to better utilization of land, labour and capital. It also results in less variability in annual returns compared with mono cropping (Eneh et al; 1997).

Levels of Crop Production Intensification among the Sampled farming households.

The analysis revealed that the crop production intensity scores among the farming households in the zone ranged between 5.5 and 38.50 with a mean score of 23.13. Using this mean value as the threshold value, the households were classified into high and low intensity categories. The high intensity farming households had the maximum and mean crop intensity scores of 38.50 and 27.47 respectively. Majority of the households (74.6%) belong to the low intensity category while the remaining 25.4% are high intensity households (Table 4).

Table 4: Levels of Crop Production Intensification of Households

Category	No of households	Range	Min	Max	Mean	Variance	Kurtosis
High Intensity	064	24.00	14.50	38.50	27.47	16.51	0.461
Low Intensity	188	26.50	5.50	32.00	19.57	26.66	-0.296
All Households	252	33.00	5.50	38.50	23.13	37.36	-0.217

Source: Field Survey, 2009/2010

The Kurtosis value of -0.296 and 0.461 suggests that the variability in crop intensity from one farming household to the next is higher among low intensity households than those of high intensity households. The negative Kurtosis value (-0.296) implies greater level of inter- household variation among low intensity households in terms of the land size and cropping strategy. In contrast, high intensity households are much more homogenous from a socio-economic and farming systems stand point. For a normally distributed variable the kurtosis value equals three.

Determinants of Crop production intensification among Maize-Based Farming Households

The drivers of crop production intensification among maize-based farming households in the zone are presented in Table 5.

Table 5: Maximum Likelihood Estimate (MLE) of the Tobit Regression Analysis of all Farming Households.

Variables	Coefficients	Std Error	t-value	P[|Z|>z]
Constant	0.4358***	0.0709	6.140	0.000
Farm Size (X_1)	-0.0743***	0.0205	-3.630	0.000
Age(X_2)	0.0043**	0.0016	2.660	0.008
Household Size (X_3)	-0.0110*	0.0059	-1.870	0.062
Extension Contact (X_4)	-0.0239*	0.0131	-1.830	0.069
Farm Distance (X_5)	-0.0032	0.0036	-0.880	0.381
Market Distance (X_6)	-0.0083***	0.0025	-3.24	0.001
Sigma	0.2235***	0.0121	18.47	0.000

Source: Data Analysis, 2010. ***parameter significant at 1%, ** parameter significant at 5%, * parameter significant at 10% n =252; Log likelihood = -38.32; Pseudo R= 0.347; LR chi^2 (6) =40.75 Prob>chi^2=0.0000

The coefficient of farm size, age of the household head, household size, extension contact and market access were all found to be significant in explaining the variation in the levels of crop production intensification of households.

Age of household head significantly influenced the crop production intensity at 5% level of probability. As household heads increase in age the crop production intensity on their farms increases. This may be because older household heads have more experiences and are more familiar with the ecosystem than young ones. This result agrees with the findings by Gockowski and Ndoumbe, (2004); Hassan *et al*., (1998) that age is an important factor in adoption of crop intensification strategies

Farm size is positive and significantly related to crop production intensity at 1% level of probability. Farm size is an indication of the level of economic resources available to the household and thus a proxy for wealth this support our apriori expectation. The coefficient of household size is significantly positively related to crop production intensity at 10% level of probability. Households with larger family sizes are more likely to have higher crop production intensity value than households with smaller family sizes in the zone.

Access to the extension services as determined by the number and frequency of visits by the extension agents to the household heads is positive and significantly related to crop production intensity at 10% confidence level. Household heads who received frequent visits from the extension agents had much higher crop production intensity value than household heads without frequent visit from the extension agent. Thus, the number of contact with an extension agent in a year influenced the crop production intensity. The results show that the adoption of crop intensification strategies is influenced by the frequency of the households' contact with extension services. This result agrees with the study by Salasyia *et al*. (2007) that information flow is vital in adoption of agriculture technologies. Both formal and informal channels of information flow could be used for dissemination of agriculture technology.

The coefficient of market access is positive and significantly related to crop production intensity at 1% level of probability. The further the distance of farmhouse to the market, the lower the probability of using the hybrid maize seed in the zone. When households incur high transactions costs in marketing, the total production costs are increased and the product profit margins are reduced. This result agrees with earlier findings by Binswanger and McIntire, (1987); and Reardon *et al*. (2001), that market access is a major driving force of agricultural intensification. Sustainable crop intensification could occur with concomitant development of markets for the agricultural inputs and products.

Improving farmers' access to markets has a potential of improving the household income, increasing agriculture produce demand and triggering sustainable crop production intensification.

CONCLUSION AND RECOMMEDATION

The study showed that the level of crop production intensification in the Southern Guinea Savanna of Nigeria is generally low. The study indicated that age of the household head, household size, farm size, access to extension agents and input/output markets were the major drivers of crop production intensification in the study area. Policy should target at strengthening maize-based farming households to have improved access to input/output markets as well as provides adequately trained and equipped extension workers for disseminating technology information. This has the potential to increase the intensity and the usage of improved maize-based technology in the study area to attain sustainable maize-based production.

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