PROFITABILITY AND CROP PRODUCTION INTENSIFICATION OF MAIZE-BASED CROPPING SYSTEMS IN SOUTHERN-GUINEA SAVANNA OF NIGERIA

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Abstract
Many developing countries face major challenges to achieve food security in a sustainable manner, considering the increasing population, adoption of inappropriate land management practices and limited availability of land and water resources. To meet the profitability goal of the households, efficient crop production intensification strategies or land management practices need to be identified to ensure sustainable agricultural production. Thus, this study aimed at identifying current land management practices its implication on crop production intensification of farming households and consequently on households' profitability. A total of two-hundred and fifty two maize-based farming households were interviewed using structured questionnaire. Data collected were analysed using descriptive statistics, crop intensity index and farm budget analysis. Eight maize-based enterprises were identified in the area. Each of the eight enterprises under consideration yielded positive Gross Margins (GM). Analysis further revealed that farming households can be classified into high and low intensity households and majority (74.6%) of these households belong to the low intensity category. Costs and return structure of farming households indicated that the high intensity maize-based households have a higher estimated Gross Margin (GM/ha) than those of low intensity maize-based farming households. A comparism of the means of high and low intensity households showed that the means are significant at 1% for all enterprises.

Keywords: Land management practices, crop production intensification, maize-based farming households.

Introduction

Agricultural production and land productivity are influenced to a considerable extent by the native soil fertility status of the land and also by the cultural practices adopted as the land husbandry method. The most pressing challenge of Nigerian agriculture, in the new millennium, is how it can meet the food need of an ever-bourgeoning population in the fact of the myriads of social, cultural and economic problems that negates sustainable land management (Chambers and Jiggins, 2000). The need to identify promising land management practices to expand both cash and food crop production is becoming increasingly important for most developing countries mainly due to the rapidly growing population and limited availability of productive land. The world's population is expected to reach 8 billion by the year 2025 and almost all of this increase will be in developing countries (Lal, 2001).

Maize *(Zea mays L.)* s a staple food of great socio-economic importance in Nigeria. Maize is said to be the second most common cereal food crop after rice (IITA 2007). Green fresh maize is cooked or roasted and hawked by women and children, providing a livelihood for many urban poor households. It is also used for

animal feed and in various industries such as flour mills, breweries, and confectioneries. Thus, any attempt to boost maize production will enhance food security, serve as import substitution, and earn foreign exchange for the country through export to neighboring food deficient countries and potentially beyond (IITA 2007).

In maize production, farming households adopt different cropping practices. These practices determine the quality and quantum of gross agricultural production and the crop-mixture grown in an agricultural year. For the individual farming household there is a problem of what combination of crops to grow on limited land area with given quantities of labour, capital, management and other resources in order to maximize returns to maize production? More so, the Nigerian farming households depend heavily on their natural resources and lack access to alternative sources of income. These poor households are usually marginalized to less fertile land with steeper slopes, which are prone to high risk of soil erosion and could not be cultivated sustainably without the use of appropriate conservation measures. Consequently, such households experience poor standard of living. Therefore, this study describes the crop production intensification strategies and examines the profitability of maize-based production systems at different levels of cropping intensification in the study area.

Materials and Methods

Area of the Study

The study area falls within southern guinea savanna agroecological zone of Nigeria, and is located between Latitude 08.33 N and Longitude 08.32 E. The savanna ecology can well be called the Corn Belt of Nigeria. The zone represents a geographical area that covers 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 as favoured by 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. Rainfall usually starts from March-October and the average monthly rainfall figures ranges from 40-350 mm. The months of July and August usually records heavy rainfall. The daily maximum temperature ranges from 20.00-38.5ºC and daily minimum ranges between 18.70-28.2ºC. 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 cropping systems in the SGS zone of Nigeria. The zone represents a geographical area that covers Kwara, Niger, Kogi, Taraba, Plateau, Beneu, Nassarawa States and southern part of Kaduna State.

Kwara and Niger states are purposively selected for this study. The two states have the list number of crop farmers in the zone in the year 2007 (NBS, 2008). The Agricultural Development Projects (ADPs) zones are four and three in Kwara and Niger states respectively. A two-stage sampling technique was used to select sample for the study. The first stage involved the simple random selection of 4 villages from each of the ADPs zone in each of the states. This was done using the ADPs village listing. In the selection of farming households, given the absence of sampling frame, the assistance of key informants was sought in indentifying maize-based households. Ten farming households were randomly selected from each village to make up a sample size of 280. However, 252 pieces of

questionnaires were retrieved and analyzed.

Analytical Techniques

Descriptive statistics, crop intensity index and farm budget analysis were the analytical tools employed to achieve the research objectives. Following Shriar, (2005) intensification activities such as intercropping, use of legume, use of inorganic fertilizer, insecticides 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 inorganic fertilizer use per ha	0-3	3.0	9.0
Scale of insecticides use per ha	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:

$$CI_i = \sum_{j=1}^{8} S_J W_J \quad \text{i = 1…N----------(1)}$$

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 improved 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 Altrazine, 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 3liters/ 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.

Farm Budget Analysis

A farm budgeting is a detailed physical and financial plan for the operation of a farm for a certain period (Olukosi and Erhabor, 1988). The aim of the farm budget is to compare the probability of different kinds of enterprise combinations. The model for estimating the farmers returns to labor and management is outlined thus:
Gross value of output (GVO), which was obtained by adding the revenue from direct sales to revenue from gifts, home consumption and other uses valued at market prices and summed for all maize-based crops produced by the farmer expressed in naira.
Less

Total variable cost (TVC) of production, this comprised of expenses (direct and imputed) on seeds, planting materials, fertilizers, agro-chemicals, hired labor, transportation and marketing and others, but excluding unpaid family labor.
Equals Gross margin (GM)

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. 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, 2010

Sex distribution varies appreciably, 14.3% and 85.7% of the household heads were females and males respectively. 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. 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%). 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 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. Basically, eight crop combinations were popular among the sampled households. Maize intercropped with cowpea had the largest number of occurrence (25%). This may be due to the easy adaptation of maize and cowpea to the environment. Maize-cassava, maize-sorghum, sole maize and maize-millet mixture are the second, third, fourth and fifth widely adopted crop mixtures. Other crop mixtures are maize-sorghum-millet, maize-okro, maize-yam, maize-cassava-yam, and maize-okro-tomatoes.

The Cropping Intensification Strategies in the Study Area

The crop production intensification strategies in the study area can be classified as being land-, capital or labour-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 pesticides. The application rate ha^{-1} of inorganic fertilizer in the area was low (87.5kg per hectare) compared to the recommended rates of 300kg per hectare (ADP, 2001). 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 Altrazine, 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 sowing, 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 Land 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. Labour-intensive strategies were mainly land 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. 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. 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. 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 Maize-based Farming 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.

Profitability of Maize-Based Cropping Systems of Low Intensity Farming Households

The result reveals that the variable costs of production incurred by low intensity households for maize-cassava, maize-cowpea and maize-yam enterprises are ₦87,154, ₦40,404 and ₦72,109 respectively. The cost of hired labour dominated the total variable cost of production. For instance, in maize-cassava enterprise, it accounted for 30.18% of the total variable costs. Thus labour is identified as the single most costly input in the production process. This situation is expected, since most farm operations were accomplished through manual labour.

All the eight maize-based enterprises have impressive return to capital and yielded a positive average gross margin (GM). This implies that all the eight enterprises are profitable. The most prominent cropping system among this category of households is maize-cassava enterprise while the least prominent is maize-okro-tomatoe. The result also indicates that while maize/cassava (E_1) has the highest gross margin (₦104, 169/ha), the least ranked enterprise in terms of gross margin per hectare (₦54, 416/ha) is the sole maize (E_5) enterprise. Thus, maize/cassava enterprise is the most profitable among low intensity maize-based farming households as presented in Table 5.

Table 5: Profitability of Maize-Based Cropping Systems (₦/ha) of Low Intensity Households

ITEM	E_1M/Ca	E_2M/S	E_3M/M_i	E_4M/C	E_5SM	E_6M/Ca/Y	E_7M/O/T	E_8M/Y
Gross Revenue (GR)	191,523	109,265	116,450	126,800	80,608	158,450	94,500	143,800
Less								
Total variable costs (TVC)	87,154	35,443	37,898	40,404	26,191	59,482	33.303	72,109
Seeds/planting materials	17,000	6,777	7,436	8,300	3,100	14,580	4,500	26,800
Fertilizer	8,330	8,231	8,610	4,800	5,889	5,300	8,900	5,400
Pesticides	3,371	3,348	3,600	4,000	3,800	3,500	2,401	3,100
Hired Labour	26,300	13,231	14,500	19,100	10,600	18,500	14,100	16,800
Marketing and Transport costs	32,150	3,783	3,750	4,201	2,800	17,600	3,400	20,008
Equals								
Gross margin (GM)	104,169	73,822	78,552	86,396	54,416	98,968	61,197	71,690

*E_1M/Ca= maize/cassava; E_2M/S= maize/sorghum; E_3M/M_i = maize/millet; E_4M/C= maize/cowpea; E_5SM= sole maize; E_6M/Ca/Y= maize/cassava/yam; E_7M/O/T= maize/okro/tomatoe; E_8M/Y= maize/yam

Profitability of Maize-Based Cropping Systems of High Intensity Farming Households

Table 6 presents the respondents' costs and returns structure to maize-based cropping systems of high intensity households.

Table 6: Profitability of Maize-Based Cropping Systems (₦/ha) of High Intensity Households

ITEM	E_1M/Ca	E_2M/S	E_3M/M_i	E_4M/C	E_5SM	E_6M/Ca/Y	E_7M/O/T	E_8M/Y
i.Gross Revenue (GR)	238,446	126,231	134,300	201,599	96,500	240,446	102,689	195,900
Less								
ii.Total variable costs (TVC)	100,929	39,432	41,062	59,670	34,510	109,211	36,167	105,714
Seeds/planting materials	19,400	8,331	8,560	10,300	5,301	20,900	5,485	42,500
Fertilizer	9,105	10,541	11,300	9,121	9,600	9,400	9,380	9,350
Pesticides	3,488	3,451	3,600	4,586	3,300	3,800	2,400	3,450
Hired Labour	34,333	14,441	15,200	30,462	13,428	26,908	14,666	27,113
Marketing and Transport costs	44,600	2,666	3,400	5,200	3,880	48.200	4,233	23,300
Equals								
Gross margin (GM)	137,517	86,799	92,237	141,928	61,990	131,235	66,522	90,185

*E_1M/Ca= maize/cassava; E_2M/S= maize/sorghum; E_3M/M_i = maize/millet; E_4M/C= maize/cowpea; E_5SM= sole maize; E_6M/Ca/Y= maize/cassava/yam; E_7M/O/T= maize/okro/tomatoe; E_8M/Y= maize/yam

The cost of hired labour dominated the total variable cost of production. For instance, in maize-cassava enterprise a large proportion (34.01%) of the variable costs was attributable to hired labour input. This is

so because all farm operations, including land preparation, planting, weeding and harvesting, were done manually. This result is consistent with other similar studies that have found labour accounting for the largest share of the total cost of small farm holdings production (Ogundari et al; 2006). The costs of seeds, fertilizer, and agrochemical were relatively low. The result shows that all the maize-based enterprises yielded a positive Gross Margin (GM). The most common crop mixture among the high intensity farming households is maize-cowpea enterprise while the least prominent is sole maize. The maize/cowpea (E_4) enterprise has the highest GM (₦141,928/ha), while the maize/okro/tomatoe (E_7) enterprise has the lowest GM (₦66, 522/ha) Thus, maize/cowpea enterprise is the most profitable enterprise among the high intensity farming households. This is probably because of the high value attached to maize and cowpea among urban dwellers who are the major consumers.

The study also reveals that maize-based production systems are more profitable among high intensity households than those of low intensity households. The higher GM among high intensity maize-based farming households could be attributed to their higher level of crop production intensification than those of low intensity households. The implication of this is that, there is need for enhanced crop production intensification in the area, to exploit the full potential of the higher profitability.
The independent samples t-test shows that the means are significant at 1% level for all enterprises as presented in Table 7.

Table 7: A Comparison of Gross Margin of Low and High Intensity Farming Households for all Enterprises

Crop Combination	Mean Difference	Std. Error Difference	t-value
Maize/Cassava			
GM_{hih} Vs GM_{lih}	31783.4	3204.0	9.920
Maize/Sorghum			
GM_{hih} Vs GM_{lih}	14453.8	1593.5	9.070
Maize/Millet			
GM_{hih} Vs GM_{lih}	11941.8	1071.7	11.14
Maize/Cowpea			
GM_{hih} Vs GM_{lih}	56751.7	813.11	69.79
Sole Maize			
GM_{hih} Vs GM_{lih}	8052.8	986.65	8.162
Maize/Cassava/ Yam			
GM_{hih} Vs GM_{lih}	27791.9	2751.6	10.10
Maize/Okro/Tomatoe			
GM_{hih} Vs GM_{lih}	5057.3	542.29	9.326
Maize/Yam			
GM_{hih} Vs GM_{lih}	18675.7	863.04	21.64

Source: Data Analysis, 2010.

Conclusion

Land management practices play a vital role in producing sufficient food for the rapidly expanding population in developing countries. This study aimed at identifying current land management practices its implication on crop production intensification of farming households and consequently on households' profitability. Application of mineral fertilizer was the most widely adopted land management practices for replenishing soils in the study area, however the rate of application was found to be low compared to recommended rate. The results further revealed that high intensity farming households have higher crop intensification scores than

those of low intensity maize-based farming households. The profitability analysis showed that the high intensity households have higher estimated GM/ha than those of low intensity households. These results imply that policies that substantially improve households' access to use and adoption of land management practices will facilitate the process of cropping intensification and consequently enhances households' income. It is therefore recommended that the farming households should raise their level of intensification to earn more returns to maize-based production. Lastly, from the findings of this study, certain crops and crop mixture are more profitable. It is therefore recommended that, a large proportion of land should be devoted to the cultivation of these crops. This is because with appropriate crop mixtures, farming households in the area could increase the present level of their returns without additional inputs.

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