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Cropping Intensification and Technical Inefficiency of Maize-Based Farming Households in Southern-Guinea Savanna (SGS) of Nigeria.

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ABSTRACT: Maize is a main staple food in Nigeria, high productivity and efficiency in its production are critical to food security and poverty alleviation in the country. Thus, this paper estimates cropping intensification, the levels of technical efficiency of 252 maize–based farming households in southern-guinea savannah (SGS) of Nigeria and provides an empirical analysis of the determinants of technical inefficiency. Results show that the crop production intensity scores among the farming households ranged between 5.5 and 38.50 with a mean score of 23.13. Technical efficiencies of smallholder maize-based farming households ranged from 0.183 to 0.926 with a mean of 0.478. This result indicated the possibility of improving the efficiency of the sampled farming households by 51.3% with the existing resources and technology. The result of the inefficiency model shows that cropping intensification, farming experience and household size are the significant variables determining technical efficiency of maize-based households. Favourable inputs and output prices of agricultural produce as well as other policies that could facilitate households' access to agricultural inputs are hereby suggested. Policies aimed at reducing household size should also be vigorously pursued.

Keywords: Maize-based farming households, productivity and technical efficiency.

Introduction

The attainment of food self sufficiency is a prominent development agenda facing most nations of Sub-Saharan Africa (SSA). Nigeria as the most populous nation in the region is in no way facing lesser challenges as regards reducing the country's dependence on food importation through improvement in food self sufficiency ratio which is in turn pivoted on increased domestic food production. Maize, one of the major staples in Nigeria, is one of the vital concerns to agricultural policy decisions. Current maize production is about 8 million tonnes and its average yield is 1.5 tonnes per hectare. The average yield is lower compared to the world average of 4.3 tonnes/ha and to that from other African countries such as South Africa with 2.5 tonnes/ha (FAO 2009). There has been a growing gap between the demand for maize and its supply. The stronger force of demand for maize relative to supply is evidenced in frequent rise in price of maize and therefore, has great implication for the food security status and economic development of the Nigerian economy. It is reported that among other causes of the food crisis, gross underinvestment in agricultural production and technology in the developing world with donors and developing countries has contributed to static productivity, weak markets, and underdeveloped rural infrastructure (CSIS 2008).

The total land area planted to maize in 2003 was about 4.7 million hectares with an estimated output of about 5.2 million metric tonnes. The output increased by 14.5 percent to 5.9 million metric tonnes in 2005 (FAO 2006). This increase in maize production was attributed mainly to expansion in cultivated land areas rather than 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. In an attempt at meeting the goal of increased domestic maize production, it has been observed that these households do not take cognizance of the effectiveness of resource use in production. This is attributable to ignorance on the part of the households of the appropriate combination of inputs that gives the maximum output. Studies have shown that technical efficiency measures for Nigerian agriculture are low (Ajibefun and Daramola 2003, Rahji 2005, Oluwatayo et al. 2008, Oyewo et al. 2009). One of the reasons often attributed to decline in productivity is depletion in soil fertility primarily resulting from poor production practices characterized by low use of modern inputs. In order to avoid over generalization which often leads to ineffectiveness in government policies, there is the need to assess the current levels of technical efficiency of maize-based households and to identify the factors that affect the levels in the zone.

METHODOLOGY

Area of the Study: The study area is the Southern Guinea Savanna ecological zone of Nigeria located at longitude 38^o 148^o E and latitude 78^o and 108^o 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 questionnaires were retrieved and analyzed.

Analytical Techniques: Descriptive and inferential statistics, crop intensity index, and multiple regression analyses involving the stochastic frontier production function 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 i)

Table i: 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 ADP (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.

A Cobb–Douglas stochastic production frontier approach was used to estimate the production function and the determinants of technical efficiency among smallholder maize-based farming household. Given the potential estimation biases of the two-step procedure for estimating technical efficiency scores and analysing their determinants, the one-stage procedure is adopted following Battese and Coelli (1995). Although this approach has its own limitations, it remains one of the popular production functions in production frontier studies. The following model is estimated on the basis of the Battese and Coelli (1995) procedure:

$Yi = Xi\beta + (Vi – Ui)$, $i = 1, N$,---(2)

Where Y_i is the output of maize crop in grain equivalent. Xi is a k x 1 vector of input quantities of the $_i$th household (land is measured as the total plot area cultivated in hectares; and labour is estimated as man-days worked; fertilizer is the amount of fertilizer used on the plot in kilogram; seed is the quantity of seed in kilograms, regardless of the type of maize and agrochemicals is the quantity of chemicals used in liters). β is a vector of unknown parameters to be estimated: Where Vi are random variables, two-sided ($- \infty < vi < \infty$) normally distributed random error $N \sim (0,\delta v2)$, which are assumed to be independent of the Ui that captures the stochastic effects outside the farmer's control (e.g., weather, natural disasters, and luck, measurement errors in production, and other statistical noise).

The two components v and u are also assumed to be independent of each other. Thus, to estimate a Cobb-Douglas production functions, we must log all the input and output data before the data is analyzed (Coelli 1995). The estimating equation for the stochastic function is given as:

$$\ln Y = \beta 0 + \beta 1 \ln X1 + \beta 2 \ln X2 + \beta 3 \ln X3 + \beta 4 \ln X4 + \beta 5 \ln X5 + Vi - Ui \text{ -----(3)}$$

The maximum likelihood estimation of equation yields consistent estimators for β, the variance parameters; gamma (γ), lambda (λ) and Sigma squared (δ^2).

Determinants of Technical Inefficiency

U_i =Inefficiency component of error term. It is assumed that the inefficiency effects are independently distributed and Ui truncation (at zero) of the normal distribution with means 0 and variance σ^2u where Ui is specified as:

$$U_i = \delta o + \delta i Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i} + \delta_6 Z_{6i} + \delta_7 Z_{7i} \text{----------------------(4)}$$

Where

U_i=Technical inefficiency of maize-based farming household.

$Z_{1=}$ Farm size was measured in hectares

$Z_{2=}$ Farming Experience in years

$Z_{3=}$Household size was based on the number of direct and dependants of the household and was adjusted to adult equivalent.

$Z_{4=}$ Extension contact was based on the number of visits by the extension agent.

$Z_{5=}$ Crop Production Intensification which was measured using Shriar (2005) index.

$Z_{6=}$Credit Access measured by a dummy. 1 if the household head has access and 0 if otherwise.

Results and Discussion

Socio-economic characteristics of Farming Households

The age of the farming households' heads ranged between 30 and 75 years with an average of 48.3 year (Table ii). Sex distribution varies appreciably, 14.3% and 85.7% of the household heads were females and males respectively. This 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. 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. Family size is used as a proxy for labour because individual in the household is a potential source of labour. 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. This result has effect on the cropping practices adopted and also enhances the intensity with which agricultural land is used.

The farming households head's years of experience ranged between 5 and 45 years with an average of the average of 29.1 years. This indicates that most of the household' heads have been practicing farming for long. The accumulated years of experience may help farming households' heads in crop selection and enable them to evolve the farming practices that are most suitable to their fragile environment. 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. Eighty-two percent (82%) of the household heads 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. Education and literacy are indispensable means of imparting information or knowledge. Basically, the levels of education of households' heads have significant impact on productivities, income earning opportunities and ability of farming households heads to effectively adopt better management practices.

Table: **ii Socio-economic characteristics of maize-based 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

Crop Production Intensification Strategies in Maize-Based Production Systems.

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 300kg (ADP 2000). 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 iii).

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

Input Use or Management Practice	Percentage of household use in maize-based production	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 of Maize-Based 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. This study therefore used the mean crop production intensity scores as the threshold value and as a basis for classifying the farming households 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, which were higher than those of the low intensity households (Table iv).

Table iv:Levels of crop production intensification of farming households.

Category	No of households	Range	Min	Max	Mean	Varian	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 number of households that fall within each of the intensity category provides additional data with which to compare the farming households. Majority (74.6%) of the households belong to the low intensity category while the remaining 25.4% are high intensity households.

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.

Maximum Likelihood Estimates (MLE) of Maize-Based Farming Households in SGS

Diagnostic Statistics

The estimate of the sigma-square (δ^2) is 0.3287. This is large and statistically significant at 1 percent. Lambda (λ) estimated at 1.8767 which is greater than 1 indicates a good fit and the correctness of the specified distributional assumption of the composite error term. (Tradesse and Krishmamooorthy (1997) (Table v).

Table v: Maximum Likelihood Estimates of the Stochastic Frontier Function of Farming Households

Variables	**Parameters**	**Coefficient**	**t-values**
Physical inputs			
Constant	β_0	0.4196	0.4669
Land (ha) (X_1)	β_1	-0.4183*	-1.9521
Labour (man-days) (X_2)	β_2	0.2126	0.1127
Seeds (Kg) (X_3)	β_3	-0.0840	-0.1006
Fertilizer (kg) (X_4)	β_4	0.8492***	12.025
Agrochemical(litres) (X_5)	β_5	-0.1235**	-2.3236
Inefficiency model			
Constant term Farm size (Z_1)	δ_0 δ_2	0.1791 0.0492	0.4246 0.4380
Farming Experience (Z_2)	δ_2	-0.0213**	-2.2706
Household size (Z_3)	δ_3	0.0535*	1.6754
Extension contact (Z_4)	δ_4	-0.3592	-0.5524
Crop intensification (Z_5)	δ_5	-0.6277***	-3.3689
Credit Access (Z_6)	δ_6	-0.5295	-0.1489
Diagnostic statistics			
Sigma square (δ^2)	($\delta u^2 + \delta v^2$)	0.3287***	3.9528
Gamma (γ)	($\delta u^2 / \delta^2$)	0.7789***	7.9756
Lambda	($\delta u / \delta v$)	1.8767	
Log-likelihood function			-0.6356
δu^2	0.2560		
δv^2	0.0727		
δu	0.5059		
δv	0.2696		

Sample size (n)	**252**		

Source: Data analysis, 2009/20101 *** significant at 1%, ** significant at 5%, * significant at 10%.

The variance ratio represented by gamma (γ) is estimated as 77.89%. This suggests that systematic influences that are unexplained by the production function are the dominant sources of random error. That implies that the presence of technical inefficiency among the sampled maize based farming households heads explains about 80 percent variation in error observed in the estimated stochastic production frontier. The generalized likelihood ratio is significant at 1 percent level suggesting the presence of the one sided error component. This implies that technical inefficiency is significant and a classical regression model of production function based on Ordinary Least Square (OLS) estimation techniques would be inadequate representation of the data. Thus, the results of the diagnostic stochastic confirm the relevance of the stochastic parametric production frontier and maximum likelihood estimator for this work.

The coefficient of fertilizer is positive and statistically significant at 1% level of probability. This implies that as the respondents increase the use of fertilizer, ceteris paribus, maize-based output increases. This implies that availability of fertilizer at affordable price generally determines the increase in land under maize production in any particular year in the zone. Thus areas cultivated to maize decrease as fertilizer subsidies are withdrawn. Similar results were obtained by Oluwatayo et al. (2008) and Oyewo et al. (2009); among Ekiti and Oyo states maize-based farming households respectively. Also, the coefficient of agro-chemical and land though negative, are statistically significant at 5% and 10% level of probability respectively. This suggests a situation of inappropriate (and hence, inefficient) use of this input in maize- based production systems in the study area. In some cases, agro-chemical was used on larger areas than the technical specifications and in other cases the instructions may be conflicted with traditional farming systems. The coefficient of the three physical inputs: quantity of fertilizers, land and agro-chemical are all significant. These are the major factors influencing maize-based production systems in the study area. On the other hand, the coefficient of labour and seeds are not significant in explaining the variation in output among maize-based farming households in the study area.

Determinants of Technical inefficiency of Maize-Based Farming Households

The coefficient of farming experience is negative and statistically significant at 5% level of probability (Table v). This is expected because as household heads gain more experience in maize production, it is expected that their efficiency level will increase. Oyekale and Idesa (2009) reported similar findings among maize-based farming households in Rivers state, Nigeria. On the other hand, Oyewo et al. (2009) reported a positive and significant relationship between farming experience and technical inefficiency. This implies that farmers with more years of experience are relatively less technically efficient or more inefficient among Ogbomosho maize farmers. The coefficient of crop production intensification is negative and statistically significant 1% level of confidence. This implies that household's level of technical inefficiency tends to decrease with increased maize production intensification. This is expected because with increased maize intensification households used more of fertilizers, hybrid seeds and land management practices which in turn enhance their technical efficiency.

The coefficient of household size is positive on the other hand but significant at 10% level of probability. This indicates that household's level of technical efficiency increases with reduced household sizes. This finding agrees with the work of Ebong et al. (2009) but is inconsistent with the findings of Ebong (2005) and Onyenweaku et al. (2005), which identified a positive relationship between household size and technical efficiency among crop farmers. Farm size has a positive coefficient, indicating that that the level of technical inefficiency of the maize-based farming households tends to increase for the larger farms. However, this variable and other variables are not significant in influencing the level of technical efficiency.

Technical Efficiency Ranges of Maize-Based Farming Households.

The technical efficiencies differ substantially among the sampled maize-based farming households ranging between 0.183 and 0.926 with a mean technical efficiency index of 0.487. This leaves inefficiency gap of 0.513. This is expected since the technical inefficiency effect in the estimated model is significant. This suggests that reasonable marketable output is sacrificed as there are resource wastages. The result implies that about 33 percent higher production could be achieved without additional resources or inputs could be reduced by 33 percent to achieve the same level of output. The mean levels of efficiency are low but comparable to those from other Sub-Saharan African countries. For example Weir and Knight (2000) find mean efficiency levels of about 55% among Ethiopia cereal crop producers. On the other hand, Ephraim (2007), find average technical efficiency of 46% among small holder maize farming households in Southern Malawi. This indicates a need for specific (area, crop) policy formulation in addressing low technical efficiency especially in the developing countries. The distribution of the technical efficiencies is presented in Table vii.

Table vii: Distribution of Farm Specific Technical Efficiency Indices of all Households

Class interval of efficiency indices	**Frequency**	**Percentage**
0.11 - 0.20	02	00.08
0.21 – 0.30	15	05.95
0.31 – 0.40	21	08.33
0.41 – 0.50	18	07.54
0.51 – 0.60	19	13.88
0.61 – 0.70	39	15.47
0.71 – 080	50	19.84
0.81 – 0.90	82	32.53
0.91 – 1.00	06	02.38
Total	252	100.00

Source: Summarized from MLE result frontier 4.1.

The indices in table vii showed that the technical efficiency of the sampled farming households was less than one (less than 100%), implying that all the maize based farming households in the study area were producing below the maximum efficiency frontier. Although, there is a wide range between the maximum and minimum values of technical efficiencies the estimated technical efficiencies clustered around 0.8 and 0.9 ranges, with reasonable spread among the range. About 35 percent of the farming households have technical efficiency value of 0.80 and above while 65 percent have technical efficiency value of less than 0.80. Given the wide variation in the level of technical efficiency, there appears to be considerable room for improvements in the technical efficiency of the sampled maize based farming households. The distribution of the efficiency estimates over a wide range agrees with previous works carried out in other parts of Nigeria (Udoh (2000), Fatoba (2007)

Conclusion

Within the limitation of the data availability, we have been able to measure crop production intensification, estimate technical efficiency as well as identify the factors determining technical efficiency among maize-based farming households in the SGS ecological zone of Nigeria. Technical efficiency index computed shows that sampled households under study are highly technical inefficient, with a mean efficiency ratio of 0.487. Therefore, our result indicates that great potential exist for the maize-based farming households to further increase output using the available inputs and technology. Among those factors that have significant impacts on technical efficiency are household size, crop production intensification and farming experience. This outcome thus suggests that household size, farming experience and cropping intensification of households are vital variables to be considered when policy-makers deliberate on ways to reduce in-efficiency among maize-based farming households in the zone.

Recommendations

Environmental sustainability is the central paradigm of the 21st Century. Consequently, the paradigms of agricultural production need to be changed. Given that maize is the main staple food in Nigeria, food production efficiency, food security and sustainability can be enhanced through policies that increase the utilization of the existing small holdings by promoting adoption of high yielding maize varieties and by promoting the use of soil conservation practices among farming households. Policy aimed at reducing household size should also be vigorously pursued.

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