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Analysis of Technical Efficiency in Sole Cowpea Production in Ganye Local Government Area of Adamawa State, Nigeria

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Abstract: **This study analysed the technical efficiency of Sole Cowpea Production in Ganye Local Government Area of Adamawa State, Nigeria. The specific objectives were to determine the technical relationship between inputs used and the resultant output and technical efficiency of farmers. Multistage sampling technique was adopted to collect primary data at random from 120 respondents. The data were analysed using the stochastic frontier production function. The result of the analysis shows that the sigma squared was 0.32 and significant at 1% level, indicating goodness of fit and correctness of the distributional form assumed for the composite error term. The variance ratio defined by gamma was 0.82 and significant at 1% level, suggesting that the existence of technical inefficiency among the farmers accounted for 82% variation in the output level of the farmers. Findings of this study indicated that there is scope to increased technical efficiency of sole-cowpea production by 16% in the short run since the mean technical efficiency (TE) of the farmers was estimated 0.84. The coefficient of farm size(X_1), fertilizer (X_2), seed (X_3) and insecticide(X_4) have the expected positive sign, except family labour and hired labour which have negative coefficient. The major constraints facing the farmers include pests and disease infestation, limited access to credit facilities and high cost of inputs. Policy recommendations geared toward farmers' education, access to farm inputs and credit facilities were preferred.**

Keywords: **Cowpea, Sole, Production, Technical Efficiency.**

I. INTRODUCTION

Cowpea (*vigna unguiculata (L) Walp*) is one of the most widely adopted, versatile and nutritious legumes (Ehlers and Halla, 1997). It has been consumed by humans since the earliest practice of agriculture in the developing countries of Africa, Asia and Latin America where it is especially valuable as a source of protein, vitamins and minerals (Singh *et al*., 2003). Cowpea is an herbaceous short-term annual leguminous plant, which is grown in many tropical and subtropical countries (Singh and Sharma, 1996). Cowpea grains contain about 25% protein, and the ability of cowpea plants to tolerate drought and poor soil makes it an important crop in the Savannah regions where these constraints restrict other crops (IITA, 2004). To realize the goal of reducing hunger and malnutrition, the total output of cowpea must be increased. This can be achieved mainly in two ways. The first being the expansion of the area under cultivation. Secondly, the extent to which the cowpea farmers are technically efficient, will determine how much of the cowpea produced will be left for general consumption and other uses. According to Food and Agricultural Organization (FAO) data 2001-2010, Nigeria produces an average of 2.58+/-0.3 million metric tons. Nigeria's cowpea demand deficit is met by import from neighbouring countries like Niger and Burkina Faso. In Nigeria, the greatest production of cowpea comes from the Northern region. The North produces about 1.7 million tonnes from 40 million hectares. This represents over 60% of the total production. With sole cropping system and improved technologies, yield of 1,500 to 2000kg/ha of cowpea can be obtained (FAO, 2011).

According to the FAO (2017), about 81% of the global cowpea production is being produced in West Africa. Similarly, Nigeria is the leading producer of the crop in region contributing about 58.5% of the region's total production. Despite all these, cowpea production has not increased significantly to match the demand and its production has not been fully exploited by most Nigerian farmers. Stephen and Mshelia (2008) attributed to their production systems, use of limited resources, and local varieties. Agwu (2001) stated that cowpea produced in Nigeria is cultivated by small scale farmers who are resource-poor and obtained smaller output from their production. Despite all these, cowpea production has not increase significantly to match the demand and moreover, its production have not been fully exploited by most of the Nigerian farmers. Stephen and Mshelia (2008) attributed to their production systems, use of limited resources and local varieties. Agwu (2001) stated that cowpea produced in Nigeria is cultivated by small scale farmers who are resource poor and obtained smaller output from their production. However, efficiency in the use of resources is a major pivot for a profitable farm enterprise. Inefficiency in the use of resources and wrong choice of enterprise combination constitute the major constraints to increased cowpea production in Nigeria (Omonona *et al.,* 2010). This study therefore, analysed the technical efficiency of sole cowpea production in Ganye Local Government Area of Adamawa State. The specific objectives were to:

i. Determine the technical relationship between inputs used and the resultant output;

ii. Determine the technical efficiency of the farmers.

II. METHODOLOGY

Study area

This study was conducted in Ganye LGA of Adamawa State, Nigeria. Geographically, the area is situated between latitude 8º 45^1 and 8º 26^{1}N and longitude 12º 09^1 and 12º 03^{1}E, covering area of about 14,561,120 km². The area shares international boundary with Cameroun Republic to its South East border. Similarly, Toungo and Jada Local Government Areas are located in Southern parts, while Taraba State is to the West. The climate of the area is the tropical South-Humid type with marked dry and rainy seasons. The rainy season commences in April with the highest rainfall mostly being recorded in September. The area has a good rainfall pattern with some areas having as high as 1,400mm (Adebayo, 1999). And moderately hot temperature estimated at 28ºC which is normally being experienced between March and April. The mean annual temperature of the study area is 26.7^{o}C. The area is well noted for its agricultural potentiality which earned it the name food basket of Adamawa State due to the varieties of food and cash crops being cultivated and marketed in the area. Yam is one of the major cash crops that the area produced. The area is located within the Guinea Savannah vegetation belt and has rich agricultural land suitable for growing all types of crops, vegetables, fruits, cereals, cash crops such as sugarcane, cashew among others. The major economic activities in the area is agriculture, food crops grown in the area are maize, sorghum, cowpea, cassava and potatoes, while cash crops such as groundnuts, rice, yam and sugar cane are produced in large quantities. Major Livestock reared in the zone are cattle, sheep and goats (ADSEED, 2004).

Sampling Method

This study employed multi-stage random sampling technique in the selection of respondents. In the first stage, four out of the ten wards in Ganye Local Government Area of Adamawa State were randomly selected. In the second stage, three villages in each of the selected wards were sampled to give a total of twelve villages. The sampling frame for this study consist of 465 sole cowpea farmers. Finally, a total of 120 sole cowpea farmers were randomly selected proportionate to the size of the sole cowpea farmers in the selected villages.

Analytical Technique

The empirical Stochastic Frontier Production Model used for the study for the analysis of technical efficiency is expressed as follows

$\text{Log } Yi = \beta_o+\beta_1 \text{Log}X_1+\beta_2\text{Log}X_2+\beta_3\text{Log}X_3+\ldots +\beta_6\text{Log}X_6+V_i-U_i$…………………………...(1)

Where;

Y_i = Output of cowpea (in kg)

X_1 = Farm size (in hectares)

X_2 = Quantity of fertilizer (in kg)

X_3 = Quantity of seed planted (in kg)

X_4 = Quantity of insecticide used (in litres/ha)

X_5 = Family labour (Man days/ha)

X_6 = Hired labour (Man days/ha)

V_i = Random errors (White noise) which are N (0, δ^2, V)

U_i = Technical inefficiency effects which are non-negative N (0, δ^2, U)

The technical inefficiency effects U_i will be affected by socio-economic characteristics of the farmers and the model specification is defined as;

$Ui = \delta_o + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 \ldots + \delta_7 Z_7$……………………………………………………. (2)

Where;

U_i = Technical inefficiency effects

Z_1 = Age of the farmers (in years)

Z_2 = Family size

Z_3 = Literacy level (in years)

Z_4 = Farming experience (in years)

Z_5 = Credit accessibility (1= access to credit and 0 otherwise)

Z_6 = Extension visit (1 = Visited, 0 = Not visited)

Z_7 = Membership of cooperatives (Yes = 1, No = 0)

δ_1- δ_7 = Parameters to be estimated

δ_o = Constant or intercept.

The socio-economic variables are included in the model to indicate their possible influence on the technical efficiencies of the farmers. Battese and Coelli (1995) stated that the TE of a farmer is between 0 and 1 and is inversely related to the level of the technical inefficiency. The technical efficiency TE is defined as the ratio of observed output to maximum feasible output. The maximum likelihood estimates of β and γ coefficient were estimated simultaneously using the computer programme FRONTIER 4.1.

III. RESULTS AND DISCUSSION

Technical efficiency

The maximum – likelihood estimates (MLE) of the parameters of the stochastic frontier production function was presented in Table 1. The production estimates indicated the relative importance of factor inputs in sole Cowpea production. From the results, most of the coefficients of the explanatory variable have the expected positive sign, except family labour and hired labour which have negative coefficients. This indicates that more output would be obtained from the use of additional quantities of these inputs ceteris paribus.

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The value of sigma squared (δ^2) is 0.320 and significantly different from zero, indicating goodness of fit and correctness of the distributional form assumed for the composite error term. The variance ratio defined by gamma (γ) is estimated at 0.82 and significantly different from zero, indicating that systematic influence that are unexplained by the production function were the dominant sources of random error. In other words, the existence of technical inefficiency among the farmers accounted for 82% variation in the output level of these farmers. This confirms that in the specified model, there is the presence of one-sided error component. The coefficient of farm size was estimated at 0.19 and statistically significant at 1% level, implying that a 1% increase in the hectares of land put into Cowpea production will bring about increase in output by 0.19%. This is attributed to the relative important of land in crop production. This is in conformity with the work of Taru *et al.* (2011) who reported that the coefficient of farm size is positive and had significant effects on output.

The coefficient of fertilizer was estimated at 0.013 and statistically significant at 5% level, implying that a 1% increase in the amount of fertilizer used in Cowpea farming will bring about increase in output by 0.013%. Fertilizer plays an important role in increasing and improving agricultural output per hectare. Seed has an elasticity coefficient of 0.015 and statistically significant at 5% level, implying that 1% increase in the quantity of seed used will increase output by 0.015%. This implies that higher seed rate would result in high Cowpea population and subsequently higher yield. This is in line with the findings of Maurice *et al.* (2015) who stated that the productivity of seed had significant effect to translate into a more than proportionate increase in output per hectare. Insecticide has a positive coefficient and statistically different from zero at 5%, indicating that a 1% increase in the litres of insecticides applied on sole Cowpea farms would bring about a 0.15% increase in output. The use of insecticide increases the productivity of seed input, which will ultimately increase output. This relate with the findings of Omonona *et al.* (2010) who reported that the use of insecticide has a significant influence on cowpea output.

Family labour and hired labour were statistically insignificant because they have a negative sign. This does not mean that the use of family labour and hired labour for cultivation was not important, but it could be that it has been under-utilized. The inefficiency parameters were specified as those relating to farmers specific socio-economic characteristics and were examined by using the estimated δ coefficients. A negative δ coefficient indicates that the parameters have positive effect on efficiency and vice versa. The result of the inefficient model showed that all the variables used in the model except farming experience have the expected negative sign. The coefficient of family size, farming experience, access to credit and membership of cooperative societies were however not significant. The coefficient of age was negative and significant at 5%, implying that technical efficiency among farmers increase with age. As respondents advance in age, technical inefficiency decreases. This is in conformity with the findings of Jongur *et al.* (2010) who reported that efficiency increase with age until a maximum efficiency is reached. The coefficient of family size was also negative, implying that increase in numbers of adult persons in household reduce inefficiency and increase productivity in sole Cowpea production. This is in tandem with the findings of Offar *et al.* (2015) who reported that number of persons in households is very important in determining family labour availability for farming activities. Formal education had a negative coefficient and significantly different from zero at 5%, implying that as farmers acquire more years of formal schooling, their technical efficiency increases. This agreed with the findings of Jongur *et al.* (2010) who reported that high education attainment reduces technical inefficiency thereby increases productivity. Credit accessibility variable has a negative coefficient implying that access to credit will reduce technical inefficiency. Lack of access to credit facilities affects technical efficiency because quantity and timing of inputs usage also influence farm output. This is in conformity with the findings of Onuk (2017) that access to credit and off- farm income reduces technical inefficiency.

The coefficient of extension visit was negative and significant at 5%, implying that technical efficiency increases among farmers who have contact with the extension agents. Because extension contact has significant relationship with cowpea output. Inadequate contact with extension agents leads to production inefficiency. Membership of association had a negative coefficient, implying that as farmers belongs to associations, technical inefficiency decreases. Cooperative membership enables the farmers to have access to soft loans and productive inputs, thereby increasing their technical inefficiency. This corroborates the findings of Wakili (2013) who reported that education and membership of farm association were the most important factors in increasing efficiency.

Table 1: Maximum – likelihood estimate of parameter of the stochastic frontier Production Function for sole cowpea farmer.

Variables	Parameters	Coefficient	Std. Error	t-ratio
Constant	β_0	4.468	0.081	55.088***
Farm size (X_1)	β_1	0.191	0.047	4.026***
Fertilizer (X_2)	β_2	0.013	0.006	2.134**
Quantity of seed (X_3)	β_3	0.015	0.006	2.311**
Insecticide (X_4)	β_4	0.150	0.073	2.056**
Family labour (X_5)	β_5	0.002	0.012	0.172
Hired labour (X_6)	β_6	0.003	0.012	0 .262
Inefficiency model				
Age of farmer(Z_1)	δ_1	-1.803	0.777	-2.320**
Family size(Z_2)	δ_2	-0.504	0.445	-1.133
Literacy level(Z_3)	δ_3	-0.109	0.053	-2.037**
Farming experience(Z_4)	δ_4	0.383	0.342	1.118
Credit accessibility(Z_5)	δ_5	-0.031	0.107	-0.295
Extension visit(Z_6)	δ_6	-0.528	0.250	-2.110**
Coop membership(Z_7)	δ_7	-0.124	0.152	-0.817
Variance parameters				
Sigma squared	δ^2	0.320	0.085	3.772***
Gamma	γ	0.818	0.289	2.826***
Log likelihood function LLF		56.078		

Source: Field survey, 2018 ***Significant at 1%, ** Significant at 5%

The distribution of farmers technical efficiency indices derived from the analysis of the stochastic frontier production function is presented in Table 2. The technical efficiency of the respondents was less than 1(less than 100%) indicating that all of them were producing below the efficiency frontier. Majority of the farmers (90.83%) had technical efficiency of 0.70 and above, while only 9.13% had technical efficiency of less than 0.70. The technical efficiency is estimated at 0.84 with 0.43 as minimum and 0.97 as the maximum. This implies that on the average, farmers in the study area were 84% technically efficient from a given mix of production inputs. This indicates that in the short run, there is a scope for increasing technical efficiency in sole cowpea production in the area by 0.16 given the current state of technology. The efficiency differential between the technically most efficient farmer and the technically least- efficient farmer is 54% indicating a wide gap. This result is similar to the one obtained by Omonona *et al.* (2010) who obtained mean technical efficiencies of 0.87

Table 2: Distribution of technical efficiency indices of sole cowpea farmers

Efficiency indices	Frequency	Percentage
≤0.49	3	2.50
0.50-0.59	2	1.67
0.60-0.69	6	5.00
0.70-0.79	13	10.83
0.80-0.89	51	42.50
0.90-0.99	45	37.50
Total	120	100
Mean	0.84	
Minimum	0.43	
Maximum	0.97	

Source: Field survey, 2018

IV. SUMMARY CONCLUSION

The study estimated the technical efficiency of sole cowpea farmers in Ganye Local Government Area of Adamawa State using the stochastic frontier production model. The distribution of technical efficiency indices revealed that on the average, the farmers were moderately technically efficient with a mean technical efficiency of 0.84 which implies that there is a scope to increase the technical efficiency of the farmers by 16% (1.00-0.84) in the short-run through efficient utilization of existing inputs given the current state of technology. Based on the findings of this research, the following recommendations are proffered.

(i). Government should promote extension activities by encouraging our extension workers to reach out to the farmers and educate them on insect pests' managements. Alternative methods like integrated pests management Practices (IPM) should be encourage. For example, using neem extract in both fields and stored crops should be encouraged.

(ii). Farmers should have access to credit facilities from banks. Also, policies directed for financial assistance to farmers need to be intensified. This will go a long way to increase their scale of production and to remedy the constraints the face in sole cowpea production.

(iii). Cost of agricultural inputs especially pesticides, herbicides, improve seed and fertilizer should be further subsidized since agricultural sector is the largest employer of labour in the country.

(iv). Farmers have entitlement to small area of farmlands as shown in the cultivated area.

Laws should be promulgated to make land available to farmers who want to farm on large scale.

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