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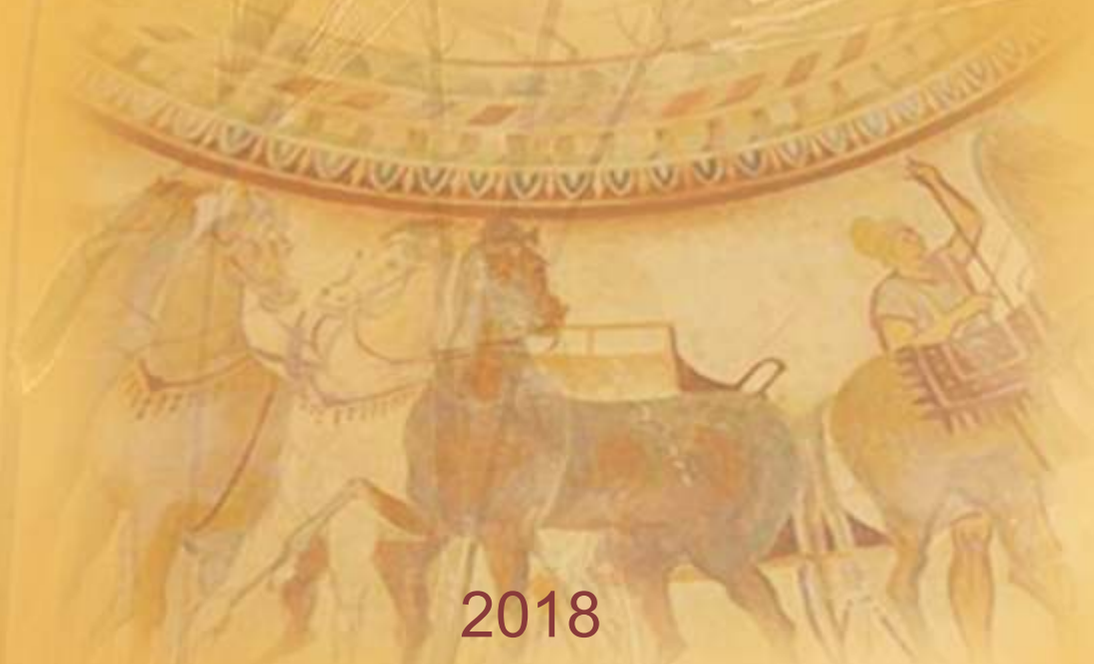

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Technical efficiency of cowpea farmers in Mubi south local government area of Adamawa state, Nigeria

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Abstract. *The study analyzed the technical efficiency among cowpea farmers in Mubi South Local Government Area of Adamawa State, Nigeria. Data were collected from 100 respondents randomly selected cowpea farmers using multi-stage, purposive and simple random sampling process. The result of the stochastic frontier production function shows that sigma squared was 0.656 and significant at 1% level, indicating good fit and correctness of the distributional form assumed for the composite error term. The value of gamma was 0.522 and significant at 1% level, suggesting that 52% of the variability in the output of farmers was due to differences in their technical efficiency. The coefficients of farm size, seed, fertilizer, agro-chemicals and labor were positive and significant at varying levels indicating direct relationship with output of cowpea production. The analysis of the inefficiency variables revealed that education, farming experience and extension contact decreases technical inefficiency of the farmers. Mean technical efficiency (TE) was 0.78 with the minimum and maximum values of efficiency as 0.53 and 0.97, indicating that farmers have the potential to increase their TE by 21.2% in the short run given the current state of technology. To achieve this, policies by the government and nongovernmental agencies should be geared towards encouraging farmers' education on farm management practices so that they would be able to allocate production resources more efficiently especially fertilizer and herbicide for optimum yield.*

Keywords: farmers, cowpea, production, technical efficiency

Introduction

Cowpea (*Vigna unguiculata*) is a food and animal feed crop grown in the semi-arid tropics covering Africa, Asia, Europe, United States and South and Central America. It is originated and was domesticated in Southern Africa and was later moved to East and West Africa and Asia. The grains contain 25% protein, 64% carbohydrate and several vitamins and minerals (IITA, 2010). It is also of vital importance to the livelihoods of millions of people in the semi-arid regions of West and Central Africa. It is the most important grain legume crop in sub-Saharan Africa (Ishikawa and Boukar, 2013). Cowpea is a protein-rich grain that complements staple cereal and starchy tuber crops. It also provides fodder for livestock, improves the soil by fixing nitrogen, and benefits households by bringing in cash and diversifying sources of income. The sale of cowpea stems and leaves for animal feed during the dry season provides vital household income (Erkut and Congiz, 2004).

Nigeria is the world leading cowpea (*Vigna unguiculata*) producing country, producing over 2.91 million tons of dry grain in 2008, 61% of production in Africa and 58% worldwide in 2010 (Food and Agricultural Organization Statistics, 2011). Countries in Africa such as Niger (1.57 million tons), Ghana, Burkina Faso, Senegal and Cameroon are also significant producers. Outside Africa, the major production areas are Asia, North and South America. Cowpea has wide soil type adaptability and is considered more drought tolerant than groundnut in Niger (Fery, 2002). Tolerance to drought reduces the use of irrigation and subsequently the cost of production.

The concept of efficiency is concerned with the relative performance of the process used in transferring given input into output. The crucial rule of efficiency in increasing agricultural output has been widely recognized by researcher and policy makers. The Nigerian Government in 2003 made a policy on exportation of food crops (Omononaet al., 2010). For the past 15 years, food crop production growth in Nigeria has been driven completely by increase in area planted rather than by increasing productivity per hectare through innovations and development of high yielding varieties of arable crops (Report of the Vision, 2020). The gap between potential and actual crop yields obtained by farmers suggests abundant opportunity for enhancing productivity. Growth targets thus should be productivity driven instead of determining productivity by acreage expansion as is the existing practice in Nigeria (Diao et al., 2009). The productivity growth may be achieved through either technological progress or efficiency improvement (Coelli, 1995). Several studies indicated that the existing low levels of technical efficiency hinder efforts to achieve progress in production (Beleteet al., 1991; Seyoum et al., 1997). Despite the significant growth in cowpea production, there is huge inefficiency in the production, hence the study examines technical efficiency of farmers in cowpea production.

Material and methods

Study area

The study was conducted in Mubi South Local Government Area (LGA) of Adamawa State, Nigeria. The LGA is located in North eastern part of Adamawa State and lies on latitude l0°00' North and longitude 13°30' East on the altitude of 731.4m. The wet season commences as early as May/June and attains its peak in July/August before it declines in September and the average rainfall in the area is about l00 mm/annum. The annual temperature ranges between 25°C-30°C (Adebayo and Tukur, 1999). It shares common

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border with the Republic of Cameroon and Maiha LGA of Adamawa State to the South. It also shares common border with Mubi north LGA to the north and with Hong LGA to the west (Adamawa State Government Dairy, 1999). Mubi south LGA has a population of 128937 people (NPC, 2007). Farming is the major occupation of the people of the area with cowpea as the most cultivated crop. Other crops cultivated in the area included maize, rice, millet, sweet potatoes, cassava, cowpea and cotton which is the major cash crop cultivated.

Sampling procedure

Multistage, purposive and random sampling techniques were adopted for the study. The first stage involved purposive selection of Mubi South LGA. Second stage was purposive selection of five notable cowpea producing wards out of the eleven wards of the local government area. Thirdly, two villages were randomly selected from each ward, and finally simple random sampling technique was used in the selection of one hundred cowpea farmers in proportion to the size of cowpea farmers in the selected villages. One hundred respondents were eventually used for the study.

Analytical techniques

Descriptive and inferential statistics were the analytical tools adopted for the study. The descriptive statistics used include mean, frequency distribution and percentages these were used in the analysis of constraints faced by cowpea producers. Inferential statistics used include Stochastic Frontier Production Function (SFPF), which was used in the estimation of technical efficiency of the cowpea farmers.

The model specified output (Y) as a function of inputs (X) and a disturbance term (μ) can be write as:

$$Yi = f(Xi;\beta) + (Vi-Ui), \quad (1)$$

Where:

Y_i is Output by i^{th} farmer;

X_j = Input quantities of the j^{th} firm;

β = Vectors of unknown parameters;

Vi = Assumed to account for random factors such as weather, risk and measurement error;

Ui = due to technical inefficiency.

The explicit form of the Cobb-Douglas production function is stated thus:

$$\text{Log}Y_1 = a_o + a_1\text{log}X_1 + a_2\text{log}X_2 + a_3\text{log}X_3 \ldots\ldots\ldots a_5\text{log}X_5 + V_i\text{-}U_i, \quad (2)$$

Where:

Y is Output of cowpea, kg;

X_1 = Cultivated land area for cowpea in hectares;

X_2 = Quantity of cowpea seed planted, kg;

X_3 = Quantity of fertilizer, kg;

X_4= Quantity of agro-chemicals used, Liters;

X_5 = Sum of labor used (man days);

V_i = random error term with normal distribution N (O, σ^2,v);

U_i = a non-negative random variable called technical efficiency effects associated with technical inefficiency of production of farmers involved;

Log = the natural logarithm (i.e. to base e);

$a_o - a_5$ = parameters to be estimated.

The technical efficiency of cowpea production for farmer, defined by the ratio of observed product as to the corresponding frontier production associated with no technical inefficiency (Y*/Y) was calculated as follow:

$$TE = \text{Exp}(-U_1) \text{ so that } 0 \leq Te \leq 1, \quad (3)$$

$$\text{Variance parameters are: } \sigma^2 = \sigma^2 v + \sigma^2 u \text{ and } \gamma = \sigma^2 u / \sigma^2, \quad (4)$$

Then $0 \leq \gamma \leq 1$

$$\text{The inefficiency is defined as: } \mu_1 = \delta_o + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5, \quad (5)$$

Where: μ_i is inefficiency effects;

Z_1 = Literacy level (in year);

Z_2 = Faming experience (in year);

Z_3 = Extension contact (1 contact, 0 contact);

Z_4 = Access to formal credit (1 access to credit and 0 no access to credit);

Z_5 = Family size; s^2, $\delta_o, \gamma, \delta_s$ are unknown parameters that were estimated.

Equations (3) to (5) will be simultaneously estimated using FRONTIER 4.1 Program Software.

Results and discussion

Technical efficiency

The maximum-likelihood estimates (MLE) of the parameters of the stochastic frontier production function are presented in Table 1. The production estimates indicated the relative importance of factor

Table 1. Maximum likelihood estimate of parameters of the Cobb-Douglas stochastic frontier production function of cowpea production in Mubi South LGA, Adamawa State

Production	Parameters	Coefficient	T. ratio
Constant	β0	1.782	12.963
Farm size	β1	0.903	6.364**
Seeds	β2	0.403	3.444**
Fertilizer	β3	0.192	2.156*
Agro chemical	β4	0.707	6.756**
Labor	β5	0.315	4.497**
Inefficiency variables			
Constant	δ0-	-2.379	-7.089
Education	δ1-	-0.294	-3.906**
Farming experience	δ2	0.909	-2.996
Extension contact	δ3	0.171	-4.089**
Access to credit	δ4	0.388	1.241
Family size	δ5	4.151	4.944**
Variance parameter			
Sigma squared	δ2	0.656	4.571**
Gamma	Υ	0.5221	3.092**
Long likelihoods function		25.198	
Generalized likelihood ratio		7.936	

Source: Field survey, 2013

* indicate significant level at 5%; ** indicate significant level at 1%

inputs in cowpea production. From the results, all the coefficients of the explanatory variables have the expected positive sign, indicating that more output would be obtained from the use of additional quantities of these inputs *ceteris paribus.*

The value of sigma squared (δ^2) is 0.656 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 (Y) is estimated at 0.522 and significantly different from zero indicating that systematic influences 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 52% variation in the output levels of these farmers. This confirms that in the specified model, there is the presence of one sided error component.

The distribution of farmers' technical efficiency indices derived from the analysis of the stochastic production function is presented in Table 2, which ranges from 0.5-1.00. 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 (82%) had technical efficiency of 0.70 and above, while only 38% had technical efficiency of less than 0.70. The mean technical efficiency was 0.78 (78%) with minimum and maximum as 0.53 and 0.97. This implies that the average farmers produced about 78% of maximum attainable output for a given input levels in the study area. Although the farmers were relatively (not fully) efficient. Therefore, there is still room to increase the technical efficiency in their cowpea farming activities. This means that, if the average farmers were to achieve the TE level of his or her most efficient counterpart in Mubi South LGA of Adamawa State. He or she would realize 21.2% [i.e. (1-78/99) x 100] more productive. This result is similar to the ones obtained by Shamsudeenet al. (2011), Maurice et al. (2015) and Bathon and Maurice (2015) who obtained mean technical efficiencies of 0.70, of 0.66 and of 0.74 respectively.

Table 2. Docile range of technical efficiency levels for the cowpea farmers in Mubi South LGA, Adamawa State

Efficiency level	Frequency	%
0.50 – 0.59	17	17
0.60 – 0.69	21	21
0.70 – 0.79	15	15
0.80 – 0.89	12	12
0.90 – 1.00	35	35
Total	100	100
Min	0.53	
Max	0.97	
Mean	0.78	

Source: Field survey, 2013

The result of inefficiency variables revealed that education had a negative coefficient and significantly different from zero at 1% implying that as farmers acquire more years of education, their technical efficiency increases. This agrees with the findings of Amazaet al. (2006) and Uaiene and Arndt (2009) who asserted that more years of formal education is imperative for better understanding and adoption of new technology by farmers which would move them closer to the frontier. The coefficient of farming experience was negative, implying that technical efficiency among farmers increases with more years of experience in farming and vice versa. This corroborates the finding of Fassasi (2007) who reported that increase in farming experience reduces technical inefficiency. Extension contact is also negatively at 1% related with technical inefficiency.

Constraint faced by cowpea producers

Table 3 revealed the problems affecting cowpea production in the study area which includes; 15.52% pest and disease infection, 13.6% lack of storage facilities, 10.4% low cowpea prices, 10.08% inadequate rainfall, 9.76% inadequate research and extension service, 9.44% inadequate capita, 9.28% inadequate credit facilities, 7.52% land tenure system, 7.36% shortage of labor and also 7.04% inaccessibility to cheap farm inputs. Therefore, the study indicated that pest and disease infection and inadequate storage facilities were the most prominent problems faced by farmers in the study area. It also shows that majority of respondents in the study area are small scale farmers (subsistence farmers) that have little or no access to financial resources and extension services that could be utilized in cowpea production that is targeted at a giving high yield. This study is in line with the study of Ya'aishe et al. (2010) and Jimjel et al. (2014).

Table 3. Distribution of the respondents by constraints faced by cowpea producers

Production constraints	Frequency	%
Inadequate rainfall	63	10.08
Low cowpea price	65	10.4
Pest and disease infestation	97	15.52
Inadequate credit facilities	58	9.28
Inadequate capita	59	9.44
Inadequate research and ext. service	61	9.76
Inaccessibility to cheap from inputs	44	7.04
Land tenure system	47	7.52
Shortage of labor	46	7.36
Lack of storage facilities	85	13.6
Total	625*	100

Source: Field survey, 2013
*Multiple Responses

Conclusion

The study estimated the technical efficiency of cowpea farmers in Mubi South Local Government Area of Adamawa State, Nigeria using the stochastic frontier production model. The distribution of technical efficiency indices revealed that on the average, the farmers were moderately technically efficient (74%) in their cowpea output given the resources at their disposal and the existing technology. There is still room to increase the technical efficiency of the farmers by 21.2% 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 were made:

· Policies by the government and non-governmental agencies should be geared towards encouraging farmers' education on farm management practices so that they would be able to allocate production resources more efficiently especially fertilizer and herbicide for optimum yield;

· Cost of agricultural inputs especially fertilizer and herbicides should be subsidized since agricultural sector is the largest single employer of labor within the country;

· Farm mechanization be provided and be made affordable and accessible to farmers, so that they can increase the area under cowpea production so as to obtain higher yield. This will reduce the overdependence on primitive tools which is associated with the limitations in agricultural production.

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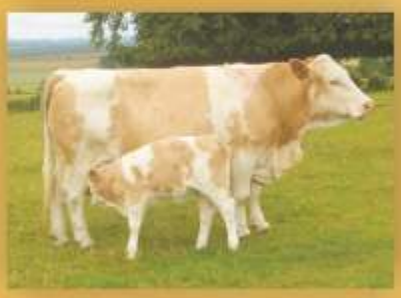

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