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Technical Efficiency Measurement among Maize Farmers in Kogi State, Nigeria

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Abstract
The study focused on the technical efficiency among maize farmers in Kogi State, Nigeria. The data for the study were collected from 400 maize farmers by a multistage random sampling technique through a questionnaire. The data were analyzed through the use of simple descriptive statistics and Cobb-Douglas stochastic production function. The result of the study showed that majority of maize farmers were males, married with an average household size of nine (9) persons. Their average age was 49 years, having one level of education or the other. They operated on small scale and had more than six (6) years of farming experience. Land, seed, fertilizer and labour were significantly and positively related to maize output while age, education, accessibility to credit facilities, cooperative membership and farming experience were the significant determinant of technical efficiency in the study area. It is suggested that Government, non-governmental organization and community based organization and the farmers themselves should come up with programmes and policies that will facilitate technical efficiency in the study area.
Keywords: Maize, Farmers, Efficiency, Kogi, Nigeria.

1. Introduction

Nigeria is highly resource endowed with both agricultural and non agricultural resources which if effectively and efficiently utilized will yield a great transformation in the agricultural sector and the nation as a whole. Food and Agricultural Organization (2003) pointed out that Nigeria is endowed with a huge expanse of arable land, favorable climate, abundant streams, lakes, forests and grassland, as well as a large, active population that can sustain a highly productive agriculture with a great potential to become the food basket of the West Africa sub-region.

Maize is a cereal crop that is grown widely throughout the world in a range of agro -ecological environments. Specifically, maize is a hot season crop and is grown principally in areas with temperatures range of 21 - 30ºC (70 - 86 F), though seeds germinate best at a lower temperature range of 18 - 21ºC (Sowunmi and Akintola,2010). It is one of the most important cereals in sub-Saharan Africa and among the most important cereal in the world along side with rice and wheat (International Institute of Tropical Agriculture (IITA), 2009). It is a very important staple food in Nigeria and accounts for about 40 percent of daily calories and has per capita consumption of 98 kilograms. Bulk of the maize consumed in Nigeria is produced in the middle and northern belts where sunshine and rainfall is moderate (Obi, 1991; Oyewo and Fabiyi, 2008).

Farrell (1957) cited in Ogundari *et al* (2006) distinguishes between technical and allocative efficiency (or price efficiency) as a measure of production efficiency through the use of a frontier production and cost function respectively. He defined technical efficiency as the ability of a firm to produce a given level of output with a minimum quantity of inputs under certain technology; and allocative efficiency as ability of a firm to choose optimal input levels for a given factor price. In Farrell's framework, economic efficiency (EE) is and overall performance measure and is equal to the product of technical efficiency (TE) and allocative efficiency (AE) (That is EE = TE X AE). There are two basic approaches used in efficiency studies, these are the econometric method and the non-parametric data envelopment analysis (DEA) methods This study intend to use the stochastic frontier production function; also called "composed error model" of Aigner, Lovell, Knox and Schimdt (1977); Meeusen and Broeck (1977) in the efficiency analysis. The modeling estimation and application of stochastic frontier production function assumed prominence in econometrics and applied economic analysis within the last two decades.

In Nigeria, maize is a staple food of great socio-economic sources which in the last two decade has gained economic importance (Oyekale and Idjesa,2009). The demands for maize far exceed its supply. The demand for this commodity has gone beyond direct human consumption to raw materials for breweries, baby foods, livestock feed and other industrial uses (Iken and Amusa, 2004). This short fall in output is due to the fact that bulk of the maize produced is from small holding farmers with rudimentary and inefficient farming systems (Ajibefun, 2002; Oluwatayo *et al* 2008). Due to the economic importance of maize, its local production needs be increased to meet the demand. It is against this background that this study intends to carry out the technical efficiency measurement among maize farmers as well as the factors affecting their efficiencies.

2. Materials and Methods

This study was carried out in Kogi State, Nigeria. It is located between latitude $6^0$30'N & $8^0$48'N and longitude $5^0$23'E & $7^0$48'E and sharing boundaries with Kwara, Ondo, Ekiti, Niger , Benue, Nassarawa, Anambra, Enugu, Edo states as well as the Federal Capital Territory. The total land area of the state is 28, 313, 53 59Km^2. The sample for the study was drawn from a list of registered maize farmers from Kogi Agricultural Development Programme (KADP). A multi-stage random sampling technique was employed in the selection of the sample for this study. The first stage comprised the random selection of two (2) Local Governments from each of the four agricultural zones in the study area. These zones are A,B,C and D. This summed up to eight (8) Local Government Areas. The second stage consist the random selection of two communities from each of the selected Local Government Areas. This gave rise to a total of 16 communities. The third stage involved the random selection of maize farmers from the randomly selected communities. This was followed by the administration of questionnaire to the twenty five (25) randomly selected maize farmers in the selected communities. This gave a total of four hundred (400) respondents. The data from all the 400 respondents were analysed for the study.

2.1 Method of Data Analysis

The study used both descriptive statistics and the stochastic frontier production function approach to achieve the objectives.

2.1.1 Stochastic Frontier Production Function (SFPF)

The study made used of the Cobb-Douglas production functional form of the stochastic frontier production function to analyse the collected data. Battese and Coelli (1995) proposed a Stochastic Frontier Production Function which has firm effects assumed to be distributed as a truncated normal random variable, in which the inefficiency effects are directly influenced by a number of variables. This was achieved by using the Frontier 4.1 statistical package. The stochastic frontier production function is thus expressed as:

$$\ln Yi = \beta_0 + \sum_{j=1}^{5} \beta j Xji + (Vi - Ui)$$

where Y is the quantity of maize harvested for the sampled farmers (in kilograms);
X_1 is the total land area planted to maize (ha);
X_2 is quantity of maize seeds planted(kg);
X_3 is the quantity fertilizer applied (kg);
X_4 is the total quantity of chemical (pesticides and herbicides) used (litres);
X_5 is the total labour (family and non family) used in maize production (man days)
X_6 amount of capital used (~~₦~~)

2.1.2 Technical Inefficiency Model for Maize Farmers

$$\mu i = \delta_0 + \sum_{j=1}^{10} \delta j Mji$$

Where δs are unknown scalar parameters to be estimated;
M_1 = age (years)
M_2 = sex
M_3 = marital status
M_4 = years of schooling (yrs)
M_5 =household size
M_6 = farming experience (yrs)
M_7 = accessibility to credit facilities
M_8 = cooperative membership
M_9 = number of extension visit.

3. Result and Discussions

3.1Socio-Economic Features of Maize Farmers in Kogi State

Majority (91%) of the farmers were within the active working age (21-60 yrs) as shown in Table 1 while only 9.0 percent of the farmers were above the active working population. The average age of the respondents was 49 years. This implies increased potentials for the productivity and technical efficiency among the farmers since majority of them are in the most economically active age group. This agrees with Ibekwe et al, (2012) who found out that cassava farmers in South-East, Nigeria were within the active and productive age group.

The frequency distribution of maize farmers in Kogi State according to the sexes as presented in table 1 also indicated that majority (89.50 percent) were male while only 10.50 percent of the respondent were females. This implies that male farmers were dominated in maize production in Kogi State, thus may be as a result of the

rigorous activities involved in cultivation of maize. This agrees with Ekunwe et al, (2008) who found out that male farmers dominated yam production in Kogi and Edo State.

The result of the marital status of the respondents as presented on Table 1 revealed that majority (97.2 percent) of them were married, this was closely followed by single farmers constituting only 9 percent of the respondent. About 0.2 percent of them were divorced and belong to other categories of marital status. This result is in agreement with the findings of Bamire and Amujoyegbe (2005) who found out that about 98% of farmers in Ekiti State were married. The data of the household size of the respondents as presented on the same table further showed that majority (75.2%) of the respondents had above five (5) persons in their households while only 24.8% had less than five (5) persons in their homes. The mean household size was nine (9) persons. Large household size enhances productivity and technical efficiency by contributing to the availability of family labour which tends to reduce the cost of maize production in the area. According to Villano and Fleming (2004) more adult members in a household translates to the availability of more quality labour for carrying out farming activities thus making the production process more efficient.

In addition Table 1 also revealed that majority (66%) of the farmers had one level of formal education or the other while only about 34.0 percent of them had no formal education. This implies that most of the farmers involved in maize production in the area are educated. This facilitates the ease with which improved technologies and innovations are adopted to increase their technical efficiency. Ekunwe and Emokaro (2009) asserted that education increases the level of technical efficiency among farmers in Nigeria.

The data of the respondents according to their years of farming experience presented on Table 1 revealed that majority (91.8%) of the respondents had six (6) and above years of experience in maize production while only 8.2 percent had between one (1) and five (5) years of experience in maize production. The average years of experience in maize production in the study area is 18 years. More years of experience in maize production translates to increase technical efficiency (Agom et al, 2012).

The frequency distribution according to the farm size of the farmers as presented on Table 1 also indicated that majority (67.9%) of the farmers had between one (1) and four (4) hectare of farmland planted to maize. While 8.8 percent of respondents fall into the categories of those with less than one (1) hectare and five (5) to six (6) hectares respectively, while the remaining 14.8 percent had above six (6) hectares of farmland. The average farm size was 3.6 hectare, this according to Upton (1972) cited in Agom et al, (2012) indicates that farmers in the study area are involved in small scale production of maize.

Table 1: Socioeconomic characteristics of maize farmers in Kogi State

Socioeconomic characteristics	Frequency	Percent	Mean
Age			49.0
21-30	19	4.8	
31-40	91	22.8	
41-50	185	46.2	
51-60	69	17.2	
>60	36	9.0	
Total	400	100.0	
Sex			
Female	42	10.5	
Male	358	89.5	
Total	400	100.0	
Marital status			
Single	9	2.2	
Married	389	97.2	
Divorced	1	.2	
Others	1	.2	
Total	400	100.0	
Household size			
1-5	99	24.8	9.0
6-10	198	49.5	
11-15	83	20.8	
16-20	8	2.0	
21-25	7	1.8	
>26	5	1.2	
Total	400	100.0	
Education			
no education	136	34.0	
primary education	148	37.0	
secondary education	80	20.0	
tertiary education	36	9.0	
Total	400	100.0	

Experience			
1-5	33	8.20	18.0
6-10	82	20.5	
11-15	88	22.0	
16-20	73	18.2	
21-25	38	9.5	
>25	86	21.5	
Total	400	100.0	
Farm size			
<1	35	8.8	3.6
1-2	122	30.5	
3-4	149	37.2	
5-6	35	8.8	
>6	59	14.8	
Total	400	100.0	
Mean			

Source: Field survey 2012

3.2 Effect of Resources Used on the Output of Maize in Kogi State.

The result of the effect of resources used on the output of maize in Kogi State as presented on Table 2 showed that the estimated value of the gamma (γ) was significant at 1% for the maize farmers in Kogi State. This coefficient had a value of 0.998 implying that 99.8 percent variability in maize output was due to technical inefficiency .The coefficient of the land area was significant at 1% and positively related to output . This is in conformity with findings of Sofoluwe and Kareem (2011) that got positive relationship between output and farm size among cowpea farmers in Osun State, Nigeria.

The coefficient of the quantity of maize seed was significant at 5%. The coefficient also had positive relationship with maize output. This is in line with the works of Shehu and Mshella (2007). The coefficient of the quantity of fertilizer had a positive relationship with output and was significant at 5%. This corroborates the findings of Oluwatosin (2011) who establish a positive coefficient for fertilizer use among yam farmers in Osun State.

The coefficient of total quantity of labour was positively related to maize output and statistically significant at 5%. This tally with the findings of Simonyan *et al,* (2011) who established a positive relationship between maize output and labour among female farmers in Essien Udim Local Government Area in Akwa Ibom State, Nigeria. The quantity of chemical and the amount of capital were not significant but had positive and negative relationship with maize output respectively. The coefficient of the returns to scale (RTS) indicated that the farmers were in stage II. The challenge for the farmers here is to know the level of input use and output that will maximize profit.

Table 2: maximum likelihood estimates of Cobb-Douglas Stochastic Frontier production function for Kogi State

Variables	Coefficients
Constant β_0	8.900***
	(25.300)
land area (β_1	0.546***
	(10.700)
quantity of maize seeds β_2	0.062**
	(2.150)
quantity fertilizer β_3	0.022**
	(2.217)
quantity of chemical β_4	0.009
	(0.561)
total quantity of labour β_5	0.085**
	(1.987)
amount of capital β_6	-0.040
	(-1.250)
Sigma squared δ^2	0.280***
	(12.902)
Gamma γ	0.998***
	(8.356)
Log likelihood Function	-308.904
Returns to Scale(RTS)	0.684

*** ,** and * represent significance level @ 1%,5% and 10% respectively .Figures in parenthesis represent t-values Source: field survey 2012

3.3Effect of Socio-Economic Characteristics on the Technical Efficiency of Maize Farmers

Table 3 showed estimates of inefficiency model of the stochastic frontier production function for the factors affecting the technical efficiency of maize farmers in Kogi State. Coefficients with negative sign implies that it increases technical efficiency while positive sign implies that it reduces technical efficiency. The age of the respondents had negative sign and significant at 5% . This corroborates the finding of Amaza *et al*, (2006).

The farmer's year of schooling had a negative and statistically significant at 1%. Education facilitates the increase in technical efficiency since educated individuals can easily adopt new and improved innovations which tend to reduce technical inefficiency. This agrees with the works of Ekunwe and Emokaro (2009) and Abba (2012). Farming experience of the respondents was positive and statistically significant at 1% .

The farmer's accessibility to credit facilities had a negative relationship with their technical efficiency and significant at 1%. This is in line with Ohajianya (2004) who found out that accessibility to credit facilities increases technical efficiency of farmers. The coefficient of cooperative membership was negatively signed and significant at 1% . However, the coefficient of sex of the farmers, marital status, farmer's household size and The number of extension visit were not significant at any level but had positive relationship with technical efficiency of the farmers except that of sex.

Table 3: Estimate of inefficiency model of the stochastic frontier production function for Kogi State.

Variables	Coefficients
Constant δ_0	1.860***
	(3.26)
Age δ_1	-0.339**
	(-2.050)
Sex δ_2	-0.012
	(-0.818)
Marital status δ_3	0.028
	(0.135)
Years of schooling δ_4	-0.026***
	(-3.430)
Household size δ_5	0.111
	(1.550)
Farming experience δ_6	0.130***
	(3.140)
Accessibility to credit facilities δ_7	-0.085***
	(-7.780)
Cooperative membership δ_8	-0.040***
	(-3.540)
Number of extension visit δ_9	0.005
	(0.478)

*** ,** and * represent significance level @ 1%,5% and 10% respectively .
Figures in parenthesis represent t-values Source: field survey 2012

3.4Technical Efficiency Levels of Maize Farmers in Kogi State

The data on the distribution of maize farmers according to their technical efficiency levels in Kogi State as presented on Table 4 indicated that majority (79.75 percent) of the farmers in the State were in the least technically efficient group (less than 40.00 percent) while only 1.00 percent of the respondents were in the most efficient category(>80 percent). About 14.50 percent of the respondents belonged to the efficiency category of 41-60 percent while 4.75 percent were in the technical efficiency group of 61- 80 percent. This result implies that maize farmers in the State were technically inefficient and thus need to improve their technical efficiency level by achieving maximum output from a given level of resources available for maize production. The most efficient farmer in the State had a technical efficiency level of 87.40 percent while the least efficient farmer had 2.41 percent level of efficiency with a mean technical efficiency of 25.10 percent. The mean technical efficiency implies that maize farmers in Kogi State fall short of the maximum possible efficiency level by 74.9 percent.

Table 4: Technical efficiency distribution of maize farmers in Kogi State

Efficiency Level	Frequency	Percentage
<40	319	79.75
41-60	58	14.50
61-80	19	4.75
>80	4	1.00
Total	400	100.00
Mean		25.10
Minimum		2.41
Maximum		87.40

Source: field survey 2012

4. Conclusion

The result of this study revealed that land area, quantity of maize seed, quantity of fertilizer and total quantity of labour were positively and significantly related to maize output in the State. Age, years of education, accessibility to credit facilities and cooperative membership increases the technical efficiency of the farmers while farming experience reduces it. The mean technical efficiency value of the farmers in the study area was 25.10 and this revealed that the farmers were not fully technically efficient and established that there is more room for improvement. Given the importance of maize in Nigeria's economy, it is imperative that the output of the crop should be increased through efficient use of resources. Base on the outcome of this study the following recommendation were made:

(i) Government, non-governmental organization (NGO) and community based organization (CBO) should come up with programmes and policies that will facilitate the efficient utilization of resources among maize farmers in Kogi State. This will lead to increase in the output at a given level of resources and technology.

(ii) Effort should be made at providing subsidies on inputs such as seed, fertilizer, and chemical. Because they have significant influence on maize output in the study area.

(iii) More and effective access to credit facilities and group association should be encouraged among farmers in the study area.

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