

# Technical Efficiency of Cowpea Production in Osun State, Nigeria

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## Abstract

This study was carried out to analyze the technical efficiency among cowpea farmers in Osun State, Nigeria. Stochastic production frontier function was used to analyze the data obtained from 200 cowpea farmers in the study area. The efficiency analysis indicated that mean technical efficiency level was 66%. It was also found that age, household size and farming experience reduces technical inefficiency, while farmers' gender and educational level increases technical inefficiency. The finding suggests that there is provision for improvement in cowpea farmers' efficiency to further increase output with available inputs and technology.

**Key words:** Cowpea; technical efficiency; inefficiency

## 1. Introduction

The importance of cowpea in bridging the food gap in Nigeria cannot be overemphasized. Every Nigerian eats cowpea and the per capita consumption is about 25kg to 30kg per annum (Falusi 1997). The grain is a good source of protein for human nutrition, while the haulms are valuable source of livestock protein. It is also a source of income for many smallholder farmers in sub-Saharan Africa and contributes to the sustainability of cropping systems and soil fertility improvement in marginal lands through provision of ground cover and plant residue, nitrogen fixation and suppressing weed (Fatokun 2002). Additionally, cowpea is regarded as the cheapest source of protein to the poverty ridden populace of Nigeria. Recently, following the interest of international bodies in reducing hunger, poverty and malnutrition, in developing countries, including Nigeria, the prospects for reducing hunger, malnutrition and food insecurity through increase in cowpea productivity is significant (Coulibaly & Lowenberg-Debbler 2000).

To realise this 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 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.

Farrel (1957) developed the concept to technical efficiency based on the input output relationship. He suggested a method of measuring technical efficiency by estimating the production function of firms. A farm is said to be technically inefficient when actual or observed output from a given input mix is less than the maximum possible output. The efficiency of a farm/firm refers to its success in producing as much output as possible given a set of inputs.

Nigeria has not been able to attain self-sufficiency in food production, despite increasing land area been put into food production annually (Fasasi 2007). One way smallholder farmers can achieve sustainable agricultural development is to raise the productivity of their farm by improving efficiency within the limits of the existing resource base and available technology. Efficient use of various inputs is an important part of sustainability (Harwood 1987) which implies either fewer inputs to produce the same level of output or higher output at the same level of inputs. An increase in efficiency in food crop production could invariably lead to an improvement in the welfare of farmers and consequently a reduction in their poverty level and

food insecurity. This study therefore seeks to estimate technical efficiency among cowpea farmers in Osun State, Nigeria.

## 2. Methodology

The data were collected from a random sample of 200 cowpea farmers in four selected areas of Osun State, southwest Nigeria, for the 2010/2011 agricultural growing seasons. The sample comprised of a random sampling of 50 cowpea farmers from each of the four purposively selected local governments' area notable for cowpea production in the state. The data were collected using structured questionnaires designed to elicit information on input – output cowpea production activities.

The Cobb-Douglas functional form Cobb-Douglas was used to estimate the technical efficiency in the stochastic production frontier. Following Battese & Coelli (1988), the stochastic frontier production function for this study is expressed as follows:

$$Y = f(\beta, \epsilon) e^{u_i} \quad (1)$$

The explicit form of the model is written thus:

$$\ln Y = \beta_0 + \ln \beta_1 X_1 + \ln \beta_2 X_2 \dots + \ln \beta_5 X_5 + V_i - U_i \quad (2)$$

Where Ln = natural logarithm;

i = i th sample smallholder farmer;

Y = value of farm output for farmer

X<sub>1</sub> = farm size (in acres);

X<sub>2</sub> = no of family labour in mandays

X<sub>3</sub> = no of hired labour in mandays

X<sub>4</sub> = seed quantity (kg)

X<sub>5</sub> = pesticide quantity (lt)

β s = input coefficient for the resources used in production;

Where Y, β, X<sub>1</sub>, X<sub>2</sub>, X<sub>3</sub>...X<sub>6</sub> are as defined earlier. The V<sub>is</sub> is assumed to be independent and identically distributed normal random errors having zero mean and unknown variance. U<sub>i</sub>'s are non-negative random variables called technical inefficiency effects which are associated with technical inefficiency of production of the respondent farmers which are assumed to be independent of the V<sub>is</sub> such that U<sub>is</sub> are the non negative truncation (at zero) of the normal distribution with mean, μ and variance, σ<sup>2</sup>. The technical efficiency of the ith farmer is expressed as:

$$Te_i = \exp(-U_i) \quad (3)$$

$$U_i = \sigma_0 - \sigma_1 Z_1 + \sigma_2 Z_2 + \sigma_3 Z_3 \dots + Z_6 \quad (4)$$

Z<sub>1</sub>, Z<sub>2</sub>, and Z<sub>3</sub> ...Z<sub>6</sub> are the age, household size, sex, marital status, educational qualification and farming experience of the ith farmers respectively, and the βs and σs are unknown scalar parameters to be estimated. These variables were included in the model for the technical inefficiency effects to indicate effects of farmer's characteristics on the efficiency of production.

## 3. Results and Discussion

The maximum-likelihood estimates (MLE) for the parameters of the Cobb-Douglas production function are presented are given in Table I. From the results, all but farm size and access to credit variables had the

expected positive signs. This suggests that a percentage increase in any of the production input would lead to a percentage increase in output, *ceteris paribus*.

The co-efficient of both the family and higher labour were positive and statistically significant ( $p < 0.05$ ) with an elasticity of 0.13 and 0.14 respectively. This suggests that a 1 percent increase in family and hired labour will induce an increase of 0.13 and 0.14 percent in the farm gross margin and vice versa respectively. These results agree with previous work by Amaza *et al.* (2000) who found a positive relationship between labour and farm gross margin.

The seed variable had a positive sign, which conforms to *a priori* expectation and statistically significant ( $P < 0.05$ ). This indicated that a percentage increase in the quantity of seed planted would result in an increase in cowpea output. This finding corroborates Shehu *et al.* (2007). The elasticity coefficient of the seed variable equals 0.36 indicating the importance of the input in cowpea production.

The coefficient of pesticide quantity was positive and statistically significant ( $P < 0.05$ ). The result indicates that a percentage increase in the use of pesticide would bring about a proportionate increase in cowpea output. This corroborates body of literatures on high yield reducing effect of pests and disease of cowpea in Nigeria compared to other food crops (Isubikalu *et al.* 2000). Further, the result indicates that farmer's access to a minimum level of credit would enhance the output of cowpea.

The variance ratio ( $\gamma$ ), which was associated with the variance of technical inefficiency effects in the stochastic frontier, is estimated to be 0.98, suggesting that systematic influences that are unexplained by the production function were the dominant sources of random errors. This indicated that 98.85% of the total variability of cowpea output for the farmers was due to differences in technical efficiency.

The results of the inefficiency model are presented in Table II. The variables of the inefficiency model were modeled to explain the determinants of efficiency of production among the cowpea farmers. The sign of the variables in the inefficiency model is very important in explaining the observed level of TE of the farmers. A negative sign implied that the variable had the effect of reducing technical inefficiency, while a positive coefficient indicate that the variable has the effect of increasing inefficiency. The results of the inefficiency model showed that all the included variables except sex, marital status and education qualification had the expected sign. The coefficient of sex, marital status and educational qualification was estimated to be positive, which suggested these variables enhance technical inefficiency of the farmers.

The results of the inefficient estimated function reveals that coefficient of age was negative, which implies that older farmers tend to be less technically inefficient in cowpea production and corroborates the findings of Kareem *et al.* (2008).

The predicted coefficient of household size was negative. The negative coefficient is in agreement with the hypothesized expected sign and implies that as the number of persons (adults) in a household increases, farmers invariably becomes less inefficient. This is because more adult members in a household meant that more quality labour would be available for carrying out farming activities thus making the production process more efficient (Villano & Fleming, 2004).

The estimated coefficient of farming experience variable was negative as expected. This implied that farmers with more years of farming experience tend to be more efficient in cowpea production. The positive contribution of the variable to TE could be that farmers with more years of experience tend to become more efficient through 'learning-by-doing'. This corroborates the findings of Fasasi (2007).

However, the estimated coefficient of education and sex were positive and statistically not significant. This implies that the level of education, sex do not have any impact on the efficiency level of cowpea farmers in the area of study (table 2).

The inefficiency indices in table III show that the technical efficiency of the sampled farmers is less than 1 (less than 100%) implying that all the farmers in the study area are producing below the efficiency frontier. The best farmers have technical efficiency of between 0.84 and 0.88 while the worst farmer has a technical efficiency of 0.02. The mean technical efficiency is 0.661 (66%) implying that on the average, farmers in the study area were able to obtain average of 68 percent of potential output from a given mix of production inputs. From this estimation, maximum technical efficiency is not yet achieved suggesting a need for more

effort at improving efficiency of cowpea farmers. Age, household size and farming experience are the major factors that culminate to influence the magnitude of the farmers' technical efficiency.

#### 4. Conclusion

The study focused on estimation of technical efficiency of farmers using stochastic parametric estimation methods. A Cobb Douglas production frontier was estimated by Maximum Likelihood Estimation method to obtain ML estimates and inefficiency determinants. The distribution of the technical efficiency indices suggested that the state of technology used by the sampled farmers are probably inferior, although farmers on the average, have moderately high level of technical efficiency, given the resources at their disposal (about 52% of the farmers have technical efficiency above 75%). Also the farmers' level of technical efficiency has been shown to be positively and significantly influenced by hired labour, seed quantity and pesticide quantity but negatively influenced by access to more credit. This study concluded that cowpea production is profitable and the mean technical efficiency of 0.66 could be increased by 34 percent through better use of available resources. This study therefore recommend that for an effective improvement in the level of efficiency among the cowpea farmers, provision should be made by governments and other stakeholders in the agricultural sector to provide farmers with access to affordable inputs such as seed, pesticides as well as making provision for alternative source of family labour.

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Table I. Maximum-likelihood estimates for parameters of the Cobb-Douglas stochastic frontier production function for the cowpea farmers during the 2009/2010 cropping season.

Variables	parameter	Co-efficient	Std. Error
Constant	$\beta_0$	4.9747296	0.31653886
Farm size	$\beta_1$	-0.0029316314	0.055408664
Family labour	$\beta_2$	0.12637861	0.096265501
Hired labour	$\beta_3$	0.13940010*	0.052553915
Seed quantity	$\beta_4$	0.36947332*	0.10845277
Pesticide quantity	$\beta_5$	0.35041910*	0.13070950
Access to credit	$\beta_6$	-0.35442432*	0.16007395
Model variance	$\sigma^2$	6.3528773	2.9561235
Variance ratio	$\gamma$	0.98859107	
Log likelihood		-73.457269	
No of observations		100	

\*, means significant at 5%.

Table II. Maximum-likelihood estimates for parameters of the inefficiency model Cobb-Douglas stochastic frontier production function for the cowpea farmers during the 2009/2010 cropping season.

Variable	Parameters	Coefficient	Standard error
Constant	$\delta_0$	6.5435886	4.8312530
Age	$\delta_1$	-5.8481342	3.8517607
Household size	$\delta_2$	-0.089951780	0.84992609
Sex	$\delta_3$	4.0262659	2.7459425
Education	$\delta_4$	2.8292973	2.1981910
Experience	$\delta_5$	-0.60237024	0.84680001

Source; Data Analysis, 2010

Table III. Distribution of technical efficiency indices among farmers in the study area

Efficiency class index	Frequency	Percentage
0.01-0.09	1	1.0
0.19-0.28	2	2.0
0.29-0.37	7	7.0
0.38-0.46	2	2.0
0.47-0.55	12	12.0
0.56-0.64	12	12.0
0.65-0.74	12	12.0
0.75-0.83	28	28.0
0.84+	24	24.0
Total	100	100.0

Mean = 0.661

Maximum value = 0.88

Minimum value = 0.02

Source: Computed from MLE results.

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