# A STOCHASTIC FRONTIER APPROACH TO MEASUREMENT OF COST EFFICIENCY IN SMALL SCALE CASSAVA PRODUCTION IN KOGI STATE, NIGERIA

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**Abstract**

The study was carried out in Kogi State of Nigeria in 2011. A multistage random sampling was used to select 360 small scale cassava farmers in the study. The survey instrument was a structured questionnaire. Information was collected on their socioeconomic characteristics and inputs used in cassava production and their prices. The data were analyzed with the use of stochastic frontier Cobb- Douglas cost function. The parameters of the function were estimated by the maximum likelihood method using the computer program frontier version 4.1. Results indicated that all the cost elements included in the cost function positively influenced the total cost of cassava production and the influence of each was statistically significant at the 1 percent level of probability. Age of the farmers, educational attainment of the farmers, household size, farming experience, extended visit, access to credit and membership of farmers association were significant determinants of cost efficiency at different levels of probability. Recommendations made to enhance cost efficient cassava production to include provision of farm inputs to the farmers at cheap prices, provision of transport facilities for easy transportation of farm inputs and outputs and encouraging youths to stay in the rural areas to provide labor for cassava production.

**Keywords:** Cassava, Cost efficiency, Measurement, Stochastic frontier

## Introduction

The cost of farm production are payments made to inputs employed on the farm. The farmers pay wages to labourers, rent for land, interest for borrowed capital, prices for seeds, herbicides, feeds, fertilizers and other farm inputs. All these payments are included in his cost of production. These direct payments to the factors of production are called explicit cost of production (Pindyck and Rubinfield, 2005). The farmer invests a certain amount of his own money on his farm. If this money is invested elsewhere, it would earn a certain amount of dividends or interest (Reddy and Ram, 2004). Moreover, the farmer devotes his time to his farm business and contributes his entrepreneurial and managerial skill to it. If the farmer has not been operating his farm, he would have sold his services to others for money. Therefore, the cost of farm production includes the normal return to the farmer's money in his farm business and the wages the farmer would have earned if he had sold his services to others. This cost is referred to as implicit cost and is included in the cost of production like explicit cost. Therefore, implicit cost refers to the value of the inputs owned by the farm which is used by the farm in its own production processes (Salvatore, 2005). Explicit and implicit costs of farm production constitute private cost (Olayemi, 2004). Farmers take private cost into consideration while making decisions with respect to prices and outputs of their enterprises.

Explicit costs are categorized into variable and fixed costs depending on the durability of the inputs on which the costs are incurred. Variable costs are those which are incurred in the employment of variable factors such as fuel, seeds, fertilizers and feeds. The amount of the variable costs can be altered in the short run and they are incurred only if the farmer engages in production. Fixed costs are those costs which are incurred on fixed inputs such as farm buildings, borehole, tractor and salary of permanent workers. These costs are fixed amount which must be incurred by a farmer in the short – run. Even if a farm is closed down temporarily in the short – run but remain in business, fixed costs have to be borne by it. In the long-run fixed cost becomes variable. The total cost of production is the sum of total variable cost and total fixed cost (McGuigan *et al*., 2005). All other costs are derived from these two cost concepts.

Efficiency study has assumed important dimension in agricultural production because scarce resources are combined to produce outputs. The success of any farm business depends on the ability of the farmer to combine the scarce resources in the right proportion. The ability of a farmer to produce the maximum level of output possible with a minimum quantity of inputs under a given technology is known as his technical efficiency while his allocative efficiency measures the degree of success in obtaining the best combination of inputs in producing a specified level of output having regard to the relative prices of the inputs. (Adeoti, 2006). Cost efficiency is the ability of a farmer to produce the maximum level of output possible at a minimum cost outlay under a given technology. Cost efficiency results from technical efficiency and allocative efficiency (Anyaegbunam, et al., 2009). A cost efficient operation results in large profit for the farmer. This is why the study was carried out to shed light on cost management by the farmers. The specific objectives of the study were to isolate factors that significantly influence the cost of producing cassava and determine the sources of the cost efficiency of the cassava farmers.

**Materials and method**

The study was carried out in Kogi State of Nigeria between June and November, 2011. The State is located between latitude $6^0$30'N, and $8^0$50'N and Longitude $5^0$51'E and $8^0$.00'E (KOSEEDS, 2004). It shares common boundaries with Niger and Nasarawa States and the Federal Capital sTerritory to the North and Benue State to the East. To the West, it is bounded by Kwara, Ekiti and Ondo States and to the South by Enugu, Anambra, and Edo States.

A multistage random sampling was used to select the respondents for the study. In stage one, three Agricultural Zones were purposefully selected for the study because cassava production was dominant in the areas. In stage two, two Local Government Areas were selected from each agricultural zone. In stage three, four settlements that were well known in cassava production were selected from each Local Government Area making eight settlements from each Agricultural Zone. In stage four, a sample of 15 cassava farmers were selected from each settlement and interviewed. Therefore, the sample was made up of 120 cassava farmers from each Agricultural Zone and a total of 360 cassava farmers in the State.

A well structured questionnaire was used to collect the primary data that were used for the study. Information collected was on the socioeconomic characteristics of the farmers such as age, sex, marital status, household size, years spent in schools, cassava farming experience, sources of finance, extension visits, membership of farmers association, farm size and method of acquisition of cassava farmlands, quantity and cost of variable and fixed inputs such as family labour, hired labour, fertilizers, herbicides, cassava stems, transportation, tractor services, hoes, cutlasses, wheel barrows and sacks and Output of cassava root tubers and revenue generated from the sale of the root tubers and stems Audu, (2012) Stochastic frontier Cobb-Douglas cost function and the technical inefficiency model were used to analyse the data. The stochastic frontier Cobb-Douglas cost function was specified as follows:

$$\text{Ln } C = \text{Ln}\,\beta 0 + \beta_1 \text{LnP}_1 + \beta_2 \text{LnP}_2 + \beta_3 \text{LnP}_3 + \beta_4 \text{LnP}_4 + \beta_5 \text{LnP}_5 + \beta_6 \text{LnP}_6 + V_i + U_i$$

Where:

C = Total cost (naira)

$P_1$ = Cost of labor (naira)

$P_2$ = depreciation of farm tools (naira)

$P_3$ = cost of fertilizers (naira)

$P_4$ = cost of herbicides (naira)

$P_5$ = cost of cassava stems (naira)

$P_6$ = cost of transportation (naira)

Ln = natural logarithm

$\beta_0$ = constant

$\beta_1 - \beta_6$ = estimated coefficients

Vi=random error due to statistical noise, weather, diseases etc. which are outside the control of the farmers.

Ui= randomness (technical inefficiency) due to farmers' socioeconomic characteristics such as age, years spent in schools, farm size etc.

In the stochastic frontier cost function, error components have a positive sign because inefficiency increases cost of production (Coelli *et al.*; 1998).

The technical inefficiency model was specified as follows:

$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7$

Where:

$U_i$ = randomness (technical inefficiency) due to farmers' socioeconomic characteristics such as age, years spent in schools, farm size, etc.

$Z_1$ = age of farmers in years

$Z_2$ = years spent in schools

$Z_3$ = household size (number of persons in the households)

$Z_4$ = years of cassava farming experience

$Z_5$ = number of extension visits in the previous year

$Z_6$ = access to credit

$Z_7$ = membership of farmer' association

$\delta_0$ = constant

$\delta_1 - \delta_7$ = estimated parameters

The stochastic frontier Cobb-Douglas cost function and technical inefficiency model were jointly estimated in a single stage estimation procedure by the maximum likelihood method using the computer software frontier version 4.1 (Coelli, 1996).

## Results and discussion

### Factors influencing the cost of cassava production

The estimated coefficients of the stochastic frontier cost function and the diagnostic statistics are presented in Table 1. The estimated sigma squared ($\partial^2$) which was 0.278 was statistically significant at the 1 percent level of risk thereby confirming the model to be a good fit. The gamma coefficient (0.961) was also significant at 1 percent. The implication of the value of gamma is that 96 percent of the cost of production incurred by the farmers was due to differences in their cost inefficiency.

The constant term which was 1.2931 was significant at the 1 percent level of risk. This is in agreement with the findings of Ogundari and Ojo (2006) who obtained a coefficient of 3.565 for the constant term in their study of cassava farmers in Osun State. This is because the expenses on fixed factors of production such as land, farm machineries and tools, buildings, farm roads and other permanent structures would keep running whether or not production takes place. The coefficients of all the factors included in the function were positive implying that increase in the use of any of the factors will increase the total cost of production, all things being equal. Specifically, the coefficients of the cost of labor (0.6410), depreciation of farm tools (0.0304), fertilizers (0.0112), herbicides (0.0024), cassava stems (0.1960) and transportation (0.1132) were positive and each was significant at the 1 percent level of risk. In a similar study carried out by Anyaegbunam *et al.*, (2009), the coefficients obtained for wage rate, land rent, price of cassava bundles were positive and each was statistically significant at the 1 percent level of probability. The findings are also sign agreement with Ogundari and Ojo (2006) in their study of cassava farmers in Osun State where they obtained positive coefficients for the price of labor, price of planting materials, price of Agrochemicals and the price of farm tools each of which was statistically significant at the 1 percent level of probability.

### Sources of cost efficiency among the farmers

The socioeconomic factors included in the inefficiency model were age, education, household size, farming experience, extended visit, access to credit and membership of the farmers' association. The result of the maximum likelihood estimate of the parameters of the function is presented in Table 2.

Age of the farmers was positively related to the farmers' cost efficiency with coefficient of 1.47 which was statistically significant at the 1 percent level of probability. The older a farmer becomes, the more the ability to combine resources in an optimal manner given the available technology (Idiong, 2005).

Education was positively related to the farmers' cost efficiency with a coefficient of 0.0298. The coefficient was significant at the 1 percent level of risk. Education gives a farmer the knowledge of how to combine farm resources in an optimal way.

Household size had a negative relationship with cost efficiency with coefficient of -0.1973 which was significant at the 5 percent level of probability. The implication is that the more the number of people in the household the less the cost efficiency. This is because more household members mean more expenditure on housing, food, clothing and medication and less money available for farm inputs procurement.

Farming experience had coefficient of 0.4088 which was significant at the 1 percent level of risk. As farmers spend more years in farming, their expertise in combing resources increase and so they can curtail wastage in the use of resources. This will increase cost efficiency of the farmers.

Extension visit had coefficient of 0.0419 which was statistically significant at the 1 percent level of probability. The positive coefficient of extension visit means an increase in cost efficiency. Extension visit increases farmers' awareness about innovation and facilitate the rate of adoption. This enables the farmers to combine inputs more efficiently.

Access to credit had a positive coefficient of 0.0199 which was significant at the 5 percent level of risk. Credit empowers the farmers to buy farm inputs and improved technologies which can make them produce at optimal capacity and at minimum cost thereby boosting their cost efficiency.

Membership of the farmers' association was positively related to the farmers' cost efficiency with coefficient of 0.0689 which was significant at the 1 percent level of probability. Membership of the farmers' association increases farmers' interaction with fellow farmers, non-farmers and extension agents. All these improve farmers' methods of production and prevent irrational utilization of resources.

**Conclusion**

Prices of labor, fertilizer, herbicide, cassava stems, transportation and depreciation of farm tools exercised positive influence on the cost of cassava production. The farmers operated in the stage of decreasing return to scale and so they were fairly efficient in cost management. The interplay of these factors and the farmers' socioeconomic factors such as age, education, household size, extended visit, access to credit and membership of the farmers' association determine the degree of farmers' cost efficiency at different probability levels.

**Recommendations**

The following recommendations are made in the light of the findings of this study to enhance cost efficient cassava production in the area.

Farm inputs such as fertilizers, herbicides, cassava stems and farm machineries should be made available to the farmers at cheap prices. This gesture will reduce their cost of operations.

Transport facilities should be provided by the government for easy transportation of inputs and outputs.

Youth should be encouraged to stay in rural areas so as to provide labor for cassava production. The encouragement can come in form of establishing projects such as schools, electricity, and pipe bone water which can make life more bearable.

Provision of efficiency enhancing factors such as extension services, credit facilities, education and formation of cooperative societies among farmers should be embarked upon by governments at all levels.

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**Table 1:** Maximum likelihood estimates of the stochastic frontier Cobb-Douglas cost function

| **variables** | **coefficients** | **standard error** | **t-ratios** |
|---|---|---|---|
| Constant $\beta_0$ | 1.2931* | 0.1300 | 9.9470 |
| Cost of labour $\beta_1$ | 0.6410* | 0.0151 | 42.4503 |
| Depreciation of farm tools $\beta_2$ | 0.0304* | 0.0118 | 2.5600 |
| Cost of fertilizers $\beta_3$ | 0.0112* | 0.0009 | 13.0043 |
| Cost of herbicides $\beta_4$ | 0.0024* | 0.0010 | 2.5633 |
| Cost of cassava stems $\beta_5$ | 0.1960* | 0.0136 | 14.3849 |
| Cost of transportation $\beta_6$ | 0.1132* | 0.0130 | 8.6858 |
| Sigma squared ($\delta^2$) | 0.2780* | 0.0429 | 6.4780 |
| Gamma ($\gamma$) | 0.9621* | 0.0090 | 107.1146 |
| Log likelihood function | 171.1014 | | |
| LR test of one sided error | 239.962 | | |

*Significant at 1%

Source; Field survey data, 2011

**Table 2:** Maximum likelihood estimates of the parameters of the inefficiency model

| **variables** | **coefficients** | **standard error** | **t-ratios** |
|---|---|---|---|
| Constant $\delta_0$ | -8.1129* | 0.5073 | -15.9935 |
| Age of farmers $\delta_1$ | 1.4700* | 0.1810 | 8.1194 |
| Education $\delta_2$ | 0.0298* | 0.0061 | 4.9223 |
| Household size $\delta_3$ | -0.1973** | 0.0891 | -2.2139 |
| Farming experience $\delta_4$ | 0.4088* | 0.0549 | 7.4520 |
| No. of extension visits $\delta_5$ | 0.04187* | 0.0064 | 6.5617 |
| Access to credit $\delta_6$ | 0.0199** | 0.0084 | 2.3596 |
| Farmers' association $\delta_7$ | 0.0689* | s0.0061 | 11.2695 |

* Significant at 1%

** Significant at 5 %

Source: Field survey data, 2011