Technical Efficiency and Cost of Production among Gum Arabic Farmers in Jigawa State, Nigeria

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Abstract: The paper investigated the cost of gum arabic production with a view to understanding the functional relationship between cost of production and technical efficiency of gum arabic farmers as well as some socio-economic variables. The study covered some selected local government areas of Jigawa State. Stochastic and cost functions were fitted to the data. The results showed that the variance parameters (sigma squared (σ^2) and gamma(γ) are statistically different form zero at 1 percent. The coefficients for farm size and hired labour are statistically significant. Farmers were efficient in the use of resources with greater reduction in cost which can be achieved through efficiency improvement. It is therefore recommended that improvements in the efficiency levels of farmers by training them at minimal cost would sustain gum arabic production. [Report and Opinion. 2010;2(1):52-57]. (ISSN: 1553-9873).

Keyword: cost function, stochastic frontier, gum arabic, Jigawa, Nigeria

1. Introduction

Agricultural production in Nigeria is dominated by small scale farmers and is known to produce more than 90% of the food consumed in the country. The agricultural sector has been major export earner for the country prior to the discovery of crude oil. Gum arabic (*Acacia* species) a leguminous tree crop belongs to the family of *Mimosaceae* and is reported to have over three thousand species. They are widely cultivated in the Sudano – Sahelian zone of the country. The use of gum arabic has been widely reported in industrial application (food and beverages, pharmaceuticals,cosmetics, textiles).Other uses include provision of pods for livestock feed, shelter belt planting to control desertification and provision of timber. It is an important revenue earner for the country and employer of labour for rural people who are engaged in production and gum collection. Gum arabic production in Nigeria has been low arising from lack of capital to boost production, use of improved planting materials amongst other factors. To harness the current potentials for gum arabic production and export, its production must be improved. Production must shift from the traditional form to the use of cultivation in organized plantation with intercrop based combination for maximum economic benefit.

The role efficiency in increasing agricultural output has been widely recognized in both developed and the developing countries of the world (Tran *et al*, 1993; Tadesse and Krishnamoorthy 1997; Ojo and Imoudu 2000; Amaza *et al*., 2001; Maurice *et al.,* 2005; Shehu and Mshelia 2007; Shehu *et al.,* 2007; Giroh and Adebayo 2007; Ojo, 2008; Giroh and Adebayo, 2009). Many of these studies have not considered the predicted technical efficiencies for inclusion as a variable in a cost function. An efficiency level of the farmers has direct bearing on cost of production which consequently translates to more profit to the farmers. If the farmers are efficient in the allocation of inputs, this would lead to minimization of cost resulting maximization of profit and encourage them to produce leading to food security. The study was therefore conducted to examine the relationship between production cost and technical efficiency. The specific objectives were to estimate technical efficiency of gum arabic production, determine cost and returns in gum arabic production and examine factors influencing the cost of gum arabic production. A study of this nature will provide gum arabic farmers and policy makers with insights into key factors for improving production.

2. Methodology

2.1 Study area, data collection and sampling procedure

The study was conducted in selected local government areas of Jigawa State. The area fall within the Sudano – Sahelian zone suitable for gum arabic production in Nigeria.

Data used for this study were collected from field survey in the area. Information on farm size, farm production, cost of inputs, prices of inputs and output, sources of labour and other socio- economic variables were collected through the use of structured questionnaires. The data were collected in 2006.The survey covered four local government areas .A purposive sampling procedure was employed in selecting four local government areas of Jigawa state

namely (Gumel, Malam Madori, Kazaure and Ringim) . From this, three villages each were chosen from the local government areas constituting the second stage of sampling. Within the identified village, 10 gum arabic farmers
were randomly selected at the third stage of sampling. One hundred and twenty questionnaires were administered out and 90 used for data analysis.

2.2 Stochastic frontier production function

The use of the stochastic frontier production function has some conceptual advantage in that it allows for the decomposition of the error term into random error and inefficiency effects rather than attributing all errors to random effects (Xu and Jeffrey, 1998, Ojo, 2008)

It is specified as:

$Y_a = f(X_a: \beta) + (V_- U)$ (Battese, *et al.,* 1993) (1)

Where:

Y_a = Production of the ith firm

X_a = Vector of input quantities of the ith firm

β = Vectors of unknown parameters

V = Assumed to account for random factors such as weather, risk and measurement error. It has zero mean, constant variance, normally distributed and independent of U. It covers random effects on production outside the control of the decision unit.

U = is non negative error term having zero mean, and constant variance (Xu and Jeffrey,1998). It measures the technical inefficiency effects that fall within (because the errors could be controlled with effective and adequate managerial control of the firm), the control of the decision unit (Apezteguia and Garate, 1997).

The production technology of the farms would be assumed to be specified by the Cobb- Douglas functional form. Ojo (2008) reported that the stochastic frontier models are better estimated using either the Cobb-Douglas or Translog functional form.

2.2.1 The empirical stochastic frontier production model

The stochastic frontier production model used is specified as follows:

$$\text{Log}Y_1=\beta_o+\beta_1 \log X_1+\beta_2 \log X_2+\beta_3 \log X_3+ (v_i-u_i) \quad (2)$$

The budgetary technique used for cost and return analysis is the gross margin. The gross margin per hectare, which is the difference between total revenue

Where:Y_1 = Output (kg of gum arabic) of the ith farmer,X_1 =Farm size(hectare), X_2 = Family labour (man days), X_3 = Hired labour (in man days), v and as previously defined. The technical efficiency of gum arabic production for the ith farmer, defined by the ratio of observed production to the corresponding frontier production associated with no technical inefficiency, is expressed by $TE = \exp(-u_i)$ so that $0 \leq TE\ 0 \leq 1$.

Variance parameter are: $\sigma^2 = \sigma^2_v + \sigma^2_u$ and $\gamma = \sigma^2_u / \sigma^2$ (3)
so that $0 \leq \gamma\ 0 \leq 1$.

The inefficiency model is defined by:

$$U_i = \delta_0 +\delta_1 Z_1+\delta_2 Z_2+\delta_3 Z_3+\delta_4 Z_4 +\delta_5 Z_5+\delta_6 Z_6 +\delta_7 Z_7 \quad (4)$$

Where: U_i = Inefficiency effect, Z_1 = Age of farmer (in years), Z_2 = Status of cultivation (dummy variable, 1 cultivated otherwise zero) Z_3 = Family size (total number of persons in household), Z_4= Education (measured by years spent in school) and Z_5 = Farming experience (years). σ^2, δ, γ, βs are unknown parameters that would be estimated. The Maximum Likelihood Estimates (MLE) for all the parameters of the stochastic frontier production function was obtained using the computer program frontier 4.1 (Ajibefun, 1998).

To achieve the objective of explaining the inter farm variation in production costs, the relationship between gum arabic output, some socio-economic characteristics and technical efficiency and production costs. Costs are estimated using empirical cost equation. Because the effect of output in production cost are non linear, the variables is specified in quadratic form. The equation model is specified as:

$$COP = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + E \quad (5)$$

Where: COP = Cost of production,X_1 = Output in kg of gum arabic, X_2 = Technical efficiency index of the ith farmer, X_3 = Age (years), X_4 = Family size, X_5 = Education, X_6 = Experience (years), E = Error term, β_o = a constant, β = parameters to be estimated.

per hectare and total variable costs per hectare, is expressed by:

Gross profit (π) $= P_y.Y$ (6)

$GM = \sum P_y.Y - \sum Px.X$ (7)

Thus,

$GM = GR - TVC$ (8)

Where: GR = gross return (Naira/ha), TVC = total variable cost (Naira/ha).

Where Y = output (kg/ha); P_y = unit price of the output (N), $P_y.Y$ = total or gross revenue derived per hectare, X = quantity of the ith input/ ha, Px = price per unit of the ith input/ ha, $Px_{..}$ X = total cost associated with ith input /ha and $\sum$= summation sign.

3. Results and Discussion

The result in Table 1 indicated that the mean age of gum arabic farmers was 49 years old. This implies that the farmers are relatively older based on World Health Organization (Awotide and Adejobi,2006) life expectancy of 49 years for Nigeria. This could have serious implication for gum arabic production (declining productivity as the farmers get older with reduction in hectares of land cultivated) in the study area. It can also be depicted from the table that hired labour was mainly used in gum arabic production. Gum arabic production was mainly on small scale basis and farmers are experienced.

Table 1. Summary statistics of the descriptive statistics of some the socio-economic characteristics

Variable	Mean	Standard deviation	Minimum	Maximum
Age	49	7.86	22	61
Family size	5	2.79	1	21
Family labour (man day)	14	3.27	39	52
Hired labour (man day)	42	8.35	47	69
Farm size	2.56	1.25	1	7
Farm experience	8	2.60	6	11

3.1Technical Efficiency Estimates

The maximum likelihood estimates of the Cobb- Douglas stochastic production model is presented in Table 2.The estimate of sigma squared (σ^2)and gamma(γ) are statistically different form zero at 1 percent. These indicate a good fit and the correctness of the specified distribution assumptions for the decomposed error term. The coefficients for farm size and hired labour are significant.

The frequency distribution of the predicted technical efficiency of the farmers is presented in Table 3 revealing substantial variations in the estimated efficiencies. The mean technical efficiency for the sampled farmers is 79% with a gap of 21% to get to the efficiency frontier. This implies that output could be improved without increasing the resources used.

The estimated coefficients in the inefficiency model of the stochastic frontier also revealed that status of cultivation and education increase technical efficiency of the gum arabic farmers (Table 4).Education has been reported to be a catalyst in the efficiency of farmers. Gum arabic production in established plantation rather than cultivation in the wild offers the farmers the opportunity for husbandry practices with increased yields from the plantation.

3.2 Cost and returns to gum arabic production

Profitability of gum arabic production among farmers was measured as the gross margin as seen in Table 5.The rate of return (ROR) is the ratio of total revenue to total cost of production. It is similar or identical to the discounted benefit/ cost ratio of a project. This indicates that for ₦1 invested gum arabic production, ₦1.59 is made as revenue.

The rate of return per capital invested indicates what is earned by the business per capital outlay. It is the ratio of profit to the total cost of production. The RORCI in this study it is ₦0.59 which is higher than the prime- lending rate in many commercial banks in Nigeria. This shows that gum arabic production is a profitable venture. The result of this study is line with earlier studies conducted in the gum arabic belt of Nigeria and Sudan that gum arabic production and collection enhances rural income of collectors and farmers (Giroh *et al.*, 2005).

Table 2. Maximum likelihood and ordinary least square estimators of gum arabic production frontier

Variable	MLE	OLS
Constant	0.75110(0.89327)	0.72866(0.76721)
Farm size	1.25718(0.44667)**	0.87427(0.93399)
Family labour	0.64155(0.85707)	0.64172(0.70796)
Hired labour	-0.77354(0.28380)***	0.77324(0.90828)
σ^2	0.50935(0.57446)***	0.45436
γ	0.96292(0.90375)***	-
Log likelihood	0.14898266	0.13456667

Source: Computer print out. Figures in parentheses are standard errors

Table 3. Estimated coefficients in the inefficiency model of the stochastic frontier

Variable	Coefficient	Standard error	T.value
Constant	-0.26975	0.89974	- 0.299
Age	-0.32054	0.67125	-0.471
Status of cultivation	-0.23419	0.12823	-1.830**
Family size	0.44474	0.14545	3.057***
Education	-0.91525	0.21181	-4.680***
Farming experience	-0.23348	0.96202	0.240

Source: Data analysis, 2009.****,*****indicate significance at 5 and1percent

3.3 Cost function

Output and technical efficiency on production of gum arabic are critical factors that are significant, while experience (though) not significant has a possibility in the reduction of cost of production (Table 6). This implies that as farmers get experienced, they are better off in the management of farm enterprises.

Finally, the table shows that improvement in technical efficiency reduces cost. For 100 % increase in efficiency would cause a reduction or fall in cost of production by ₦1630.90. This result is in agreement with earlier works conducted by Awotide and Adejobi (2006) who reported reduction in costs as a result of increase in the technical efficiency of farmers.

4. Conclusion

Results of this study show greater reduction in the cost of gum arabic can be achieved through efficiency improvement. The results of this study suggested that sampled farmers could increase output and income from gum arabic production through increasing land and cultivation in established plantation. Gains in output resulting from improved productivity is not only important to the farmers but the country in the area of foreign exchange earning.

The study contains implication for the future of gum arabic farmers. Improvements in the efficiency levels of farmers will entail improving their managerial level by training them and it is recommended that policies that improve the productivity of the farmers at minimal cost would sustain gum arabic production in Jigawa State.

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Table 4. Technical efficiency distribution of respondents

TE range	Number	Percentage
≤ 0. 55	1	1.11
0.56 – 0.80	88	97.78
0.81 – 1.00	1	1.11
Total	90	100.00

Source: Data analysis 2009

Table 5. Cost and returns in gum arabic production

Variables	Value
Per hectare analysis	
Total revenue (TR)	₦4, 853.28
Total variable cost (TVC)	₦ 305.12
GM (TR - TVC)	₦4,548.16
ROR (rate of return)	159%
RORCI	59%

Source: Data analysis,2009.

Table 6. Cost function for gum arabic production

Variable	Coefficient	Standard error	T.value
Constant	5.459	0.933	5.852***
Output	2.959	0.760	3.893***
Technical efficiency	-16.309	8.913	-1.820*
Age	0.179	0.196	0.913
Family size	5.793E- 02	0.061	0.954
Education	0.228	0.187	1.219
Experience	- 4.479E-02	0.089	-0.504
R^2 adjusted 0.754			
F value 15.073***			

Source: Data analysis, 2009. ***, ***** indicate significance at 10 and 1 percent

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