Technical Efficiency and Costs of Production among Small holder Rubber Farmers in Edo State, Nigeria

Dengle Yuniyus Giroh[1] , Joyce Daudu Moses [2] and F.S. Yustus[1]

1. Research Out reach Department, Rubber Research Institute of Nigeria, P.M.B 1049, Benin City, Nigeria
2. Department of Agricultural Economics and Extension, Adamawa State University P.M.B 25, Mubi, Nigeria.

girohdengle@yahoo.com

Abstract: This study investigated the cost of latex exploitation with a view to understanding the functional relationship between cost of production and technical efficiency of rubber farmers as well as some socio- economic variables. The study covered some selected local government areas of Edo State. Data collected were analyzed using descriptive statistics, budgetary technique, stochastic frontier production function and cost function analysis. The result of the gross margin analysis shows total revenue (TR) and gross margin (GM) ha^{-1} of $990.62(₦148, 592.50) and $686.36 (₦102, 953.58). The result of the stochastic frontier analysis also revealed that the variance of parameters (gamma and sigma squared) of the frontier production function were both significant at $p<0.01$. Wage has positive and significant effect on output at $p<0.01$. 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 to sustain rubber production.

[Dengle Yuniyus Giroh , Joyce Daudu Moses, F.S. Yustus. Technical Efficiency and Costs of Production among Small holder Rubber Farmers in Edo State, Nigeria. World Rural Observations 2011;3(3):22-27]; ISSN: 1944-6543 (Print); ISSN: 1944-6551 (Online). http://www.sciencepub.net/rural.

Keywords: Technical efficiency, stochastic frontier, budgetary technique, latex production, Nigeria.

1. Introduction

Rubber trees are usually tapped for latex by making a spiral cut through the bark of the tree on alternate days. The milky sap or latex which oozes out when the tree is wounded (tapped) can be processed into solid rubber or liquid rubber (known as latex concentrate). Rubber tapping is one of the major employers of labour in many rubber-producing countries of the world. Once begun, tapping is normally continued for 10 – 20 years, depending on how quickly the accessible bark is consumed. A task is normally 500 – 600 trees which takes 3 – 4 hours. Younger trees are simpler to tap. The same person then returns to collect the still - liquid latex cups emptying it into a bigger container. There is then a residual flow of latex which coagulates on the cut and in the cup; this is secured at the next tapping as scrap and cup lump (Giroh and Adebayo 2009). The dearth of qualified tappers and high cost of labour has been the bane of rubber industry in Nigeria. The Nigerian rubber belt corresponds with the oil-producing belt of Nigeria and competes with scarce labour with the oil sector characterized by shortage and high cost of labour. The bark of the rubber tree is the economic reserve of the farmer. Majority of plantation owners either abandon or adopt a share cropping system with willing tappers as a consequence of high cost of labour thereby resulting to the owners without sufficient control over the tapper and destructive tapping characterized by poor bark regeneration, bark bursting, declining productivity and eventual death of the trees (Giroh and Adebayo, 2007).

The role efficiency in increasing agricultural output has been widely recognized in Nigerian agriculture (Adebayo 2006; 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 and technical efficiencies regressed against socioeconomic variables. An efficiency level of the tappers has direct bearing on cost of production which consequently translates to more profit to the plantation owners. Efficiency in the allocation of inputs 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 cost and rubber tapping and the influence of socio-economic variables on the efficiency of rubber tapping among small holder rubber farmers in Edo State, Nigeria. A study of this nature will provide rubber plantation owners or 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 Edo State. Edo State lies between Latitudes 5° 44´´ and 7° 34´´ N of the equator and between Longitudes 5° 04´´ and 6 ° 43´´ E of the Greenwich Meridian. It shares boundary to the south by Delta State, in the West by Ondo State and in the East by Kogi and Anambra States. The state covers a land area of about 17,902 km^2 with a population of 2,159,848. Edo State is divided into 18 Local Government Areas. The State is characterized by a tropical climate which ranges from humid to sub humid at different parts of the year. Three distinct vegetation identified in the State are mangrove forest, fresh swamp and Savannah vegetations. The mean annual rainfall in the northern part is 127cm to 152 cm while the southern part of the State receives about 252 cm to 254 cm respectively. Mean temperature in the state ranges from a minimum of 24 ^{0}C to a maximum of 33^0 C .The people of the state are mostly farmers growing a varieties of crops such as cassava, rice, yam, plantain, pineapple and tree crops such as rubber, oil palm and cocoa. Other occupations of the state include small and medium scale businesses and jobs done by artisans and civil servants who engage in farming on part time basis (Emokaro and Erhabor, 2006).

Data for this study was obtained from primary source obtained through the use of structured questionnaires which were distributed to the respondents. Random sampling technique was adopted in eliciting information from respondents for the study. Information on the population of tappers was obtained from tapping division of the Institute. A total of 150 respondents were served with the structured questionnaires. However, a sample of 129 rubber farmers was eventually used for the study. These were the farmers who provided adequate information required for the study. Data collected were subjected to cost function and linear regression.

2.2 Model specification: To achieve the objective of explaining the inter farm variation in tapping costs, the relationship between rubber 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:

$$COT = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + E \quad (1)$$

Where: COT = Cost of tapping measured in naira ,X_1 = Technical efficiency index of the ith plantation X_2 = Age (years), X_3 = Family size, X_4 = Farming experience (years), X_5 = Output (kg dry) of rubber of the ith plantation, X_6 = tree density/task (number), X_7 = Education(measured in years spent in school), E = Error term, β_o = a constant, β = parameters to be estimated.

2.3 Budgeting technique: Budgeting technique was used to estimate income generated from rubber tapping for the respondents. The specific type of budgeting technique used was the gross margin analysis. Gross margin is the difference between the gross income and the total cost of production.

The model used for the estimation of the Gross margin was explicitly stated thus:

Gross margin (GM) = GI – TVC (2)

Where: GM = Gross Margin, GI = Gross Income and TVC = Total variable cost

2.4 The Stochastic Frontier Production Model: The stochastic frontier production function was independently proposed by Aigner *et al.,* (1977) and Meeusen and van den Broeck (1977). It differs from the traditional production function in that its disturbance term has two components: One to account for technical inefficiency and the other to permit random events that affects production.

It is specified as:

$$Y_i = f(X_i: \beta) \exp(V_i - U_i) \quad i = 1, 2.., N \quad (3)$$

Where: Y_i = Production of the ith firm,X_i = Vector of input quantities of the ith firm, β = Vectors of unknown parameters,V_i = Assumed to account for random factors such as weather, risk and measurement error and U_i = due to technical inefficiency

The production technology of the farms was assumed to be specified by the Cobb- Douglas functional form.

2.5 The Empirical Stochastic Frontier Production Model

The stochastic frontier production model used was specified as follows:

$$\text{Log } Y_1 = \beta_o + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 + \beta_4 \log X_4 + V_i - U_i \quad (4)$$

Where: Y_1 = Output (kg of dry rubber) of the ith farmer, X_1 = Tapping tasks (No. of trees tapped) X_2 = Wage (in naira) X_3 = Labour use (in man days) X_4 = Age of plantation (in years) V_i = Random noise (white noise) which are N (0, σ^2_v) U_i = are inefficiency effects which are non negative, half normal distribution N $(0,\sigma^2_u)$.

The inefficiency model is defined by:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 \quad (5)$$

Where: U_i = Inefficiency effect, Z_1 = Age of farmer (in years), Z_2 = Literacy level (in years), Z_3 = Tapping experience (in years), Z_4 = Training (1 for those trained, 0 for no training), Z_5 = Gender of tapper (1 for male, 0 for female) and Z_6 = Family size (total number of persons in household). σ^2, δ, γ, βs are unknown parameters that were estimated. The Maximum Likelihood Estimates (MLE) for all the parameters of the stochastic frontier production function and the inefficiency model defined above and the technical efficiency were obtained using the program frontier 4.1 (Coelli, 1994; Ajibefun, 1998).

3.0 Results and Discussion

3.1 Summary statistics: The summary statistics of some selected variables used in the stochastic frontier production function and cost analysis is presented in Table 1. The table revealed that the mean cost of rubber tapping is ₦93,232/ hectare with a standard deviation of ₦50,327.The variability shows that rubber farmers operated at different levels of cost of rubber tapping. The mean total man-days of labour used was 214 with a standard deviation of 148.35. This is an indication that rubber tapping is labour intensive considering the large variability recorded. The mean tree tapped was also 384 with a standard deviation of 171. 13. The variation could be attributed to different management practices adopted by plantation owners like different spacing at the establishment of rubber plantation and incidences of pests, diseases and wind damages to the plantation.

Table 1. Summary statistics of some selected variables

Variable	Mean	Standard deviation	Minimum	Maximum
Age	33	5.38	23	44
Family size	5	2.56	1	12
Man days of labour	214	148.35	45	338
No. of trees tapped	384	171.13	286	450
Technical efficiency	72	22.20	0.38	0.99
Farm experience	7	2.50	2	16
Total cost of tapping	93,232	50,327	15,000	136,100

Source: Data analysis 2009.

3.2 Productivity and technical efficiency analysis: The Maximum Likelihood Estimate of parameters of Cobb- Douglas Stochastic Frontier Production function for Rubber farmers presented in Table 2 shows that all the coefficients except age of plantation carried the expected sign. Wage was significant at one percent while age of plantation has a significant and inversely related. The variance parameters were both significant thereby giving a model fit for the data. The rate of return to scale (RTS) is 2.99 showing an increasing return to scale. Any additional increase in input will lead to more than proportionate change in output. This shows that rubber farmers are in stage 1 (irrational zone) of the production frontier. The inefficiency model also indicated that gender is a critical factor that increases efficiency. The coefficients for training and family size affected efficiency but not significant. The mean technical efficiency is 0.72(72%) implying that farmers operated 28% below the efficiency frontier. In Table 3, about 49% of the respondents technical efficiency fall ≤ 0. 60 while those in the range of 0.90 – 0.99 and was represented by about 46%.

Table 2. Maximum Likelihood Estimate of parameters of Cobb- Douglas Stochastic Frontier Production function for Rubber farmers

Variable	Parameter	Coefficient	T.value
Stochastic frontier			
Constant	β_o	0.54***	3.52
No of trees tapped	β_1	3.22	1.21
Wage(naira)	β_2	0.09***	7.90
Labour(SMD)	β_3	0.03	0.20
Age of plantation	β_4	- 0.35*	- 1.97
Inefficiency model			
Constant	δ_0	0.49	1.20
Age	δ_1	4.23	0.16
Education	δ_2	0.16	1.50
Tapping experience	δ_3	- 0.009	- 0.24
Training	δ_4	0.001	0.001
Gender	δ_5	- 5.75**	- 2.97
Family size	δ_6	-0.03	-0.51
Variance parameters			
Sigma squared	δ^2	0.011***	5.43
Gamma	Γ	0.96***	33.00
Mean TE	0.72		

Source: Computer Print Out *** Significant at 1 percent ** Significant at 5 Percent * Significant at 10 Percent

Table 3. Deciles range of frequency distribution of technical efficiency of farmers

TE range	Number	Percentage
≤ 0. 60	63	48.83
0.61 – 0.70	5	3.88
0.71 – 0.79	0	0.00
0.80 – 0.89	2	1.55
0.90 – 0.99	59	45.74
Total	129	100.00

Source: Data analysis 2009

3.3 Cost function: Technical efficiency, output and education on production of rubber are critical factors that are significant, while experience (though) not significant has a possibility in the reduction of cost of production (Table 4). 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 ₦4,095 *ceteris paribus*. This result is in agreement with earlier works conducted by Awotide and Adejobi (2006) and Giroh *et al.,* (2010) who reported reduction in costs as a result of increase in the technical efficiency of farmers.

3.4 Cost and returns to rubber latex exploitation: Profitability of latex production among farmers was measured as the gross margin (Table 5). The average variable cost/ha was ₦45,638.92($304.26) with labour cost accounting for about forty two percent of the total tapping cost. This result is in line with earlier studies conducted which showed that labour was scarce and costly in rubber production in Nigeria. This is as a result of the fact that the Nigerian rubber belt corresponds with the oil belt of Nigeria attracting able bodied youth to the industry leaving the older population as a source of labour for the natural rubber industry (Abolagba and Giroh, 2006). The attendant consequences may be declining productivity and plantation owners may resort to share tapping arrangement for latex production. It was also found out that this arrangement do not give the plantation owners firm grip of production. The willing tappers may slaughter tap, and this may result to detrimental effects such as destruction of cambium cells thereby retarding regenerative ability and eventual death of the trees. The total revenue (TR) and Gross margin (GM) per hectare were ₦148, 592.50($990.62) and ₦102,953.58($686.36).This shows that latex production is a profitable venture.

Table 4. Cost function for rubber tapping

Variable	Coefficient	Standard error	T.value
Constant	113.02	12.62	8.96***
Technical efficiency	- 40.95	20.66	1.98*
Age	0.628	0.618	1.01
Family size	0.318	0.476	0.67
Experience	0.841	0.544	1.55
Output	0.387	0.126	3.08***
Tree density/task	0.169	0.118	1.43
Education	0.384	0.149	2.57**
R^2 0.778			
R^2 adjusted 0.762			
F value 46.16***			

Source: Data analysis, 2009. ***, **, ***** indicate significance at 10, 5& 1 percent

Table 5. Average cost and return of rubber farmers per hectare

Cost item	Value	Percentage of cost
Safety kits	₦ 3,938.00 ($26.25)	8.63
Tapping inputs	₦ 7,500.00 ($50.00)	16.43
Transportation	₦ 14,850.00 ($99.00)	32.54
Labour cost	₦19,350.92 ($129.01)	42.40
Total variable cost	₦ 45,638.92($304.26)	100
Total output	1,981.23 kg	
Price	₦75($0.50)	
Total revenue	₦148,592.50($990.62)	
GM(TR- TVC)	₦ 102,953.58($686.36)	

Source: Field survey, 2009.1US Dollar = ₦ 150.00

4. Conclusion: Results of this study show greater reduction in the cost of rubber production can be achieved through efficiency improvement. The results of this study suggested that sampled farmers could increase output and income from rubber production through increasing land and cultivation in established plantation. Gains in output resulting from improved productivity are not only important to the farmers but the country in the area of foreign exchange earning. The study contains implication for the future of rubber 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 rubber production in Edo State.

Correspondence to:
Dengle Yuniyus Giroh

Research Outreach Department
Rubber Research Institute of Nigeria
P.M.B 1049, Benin city, Edo State, Nigeria
girohydengle@yahoo.com

References

1. Giroh, D.Y. and Adebayo, E.F. Analysis of the Technical inefficiency of Rubber Tapping in Rubber Research Institute of Nigeria. Journal of Human Ecology 2009; 27(3): 171 – 174.
2. Giroh, D.Y and Adebayo, E.F. Comparative Productivity Analysis of permanent and non permanent rubber tappers in State Rubber farms of Nigeria. Journal of Agriculture and Social Sciences 2007; 3(4): 107 – 111.
3. Adebayo, E.F. Resource Use efficiency and multiple objectives of Dairy Pastoralists in Adamawa State, Nigeria. Unpublished Ph.D thesis, 2006, Department of Agricultural Economics, University of Ibadan.
4. Shehu,J.F.andMshelia,S.I.Productivity and Technical Efficiency of Small scale Rice farmers in Adamawa State. Journal of Agriculture and SocialSciences2007;3(4): 117 – 120.

5. Shehu, J.F., Mshelia, S. Iand Tashikalma, A.K. Analysis of the Technical Efficiency of Small scale Rain – fed Upland Rice farmers in the North West Agricultural Zone of Adamawa State. Journal of Agriculture and Social Sciences 2007;3(4):133 – 136.
6. Ojo, S.O. Effects of land acquisition for large scale farming on the performance of small scale farming in Nigeria. Journal of Human Ecology 2008; 24(1):35- 40.
7. Emokaro, C.O and Erhabor, P.O. A comparative Analysis of Input use and Profitability among Cassava farmers in the three Agro ecological Zones of Edo State, Nigeria. Journal of Sustainable Tropical Agricultural Research 2006; 19: 15- 22.
8. Aigner, D., Lovell, C.A.K and Schmidt, P. Formulation and Estimation of Stochastic Frontier Production Model. Journal of Econometrics 1977; 6:21-27.
9. Meeusen, W and van den Broeck, J. Efficiency Estimation from Cobb – Douglas Production function with composed Error. International Economic Review 1977; 18: 435- 444.
10. Coelli, T.J. A guide to Frontier Version 4.1. A Computer Program for Stochastic Frontier Production and Cost Function Estimation. Department of Econometrics, University of New England,1994. Armidale, NSW2351. Australia.
11. Ajibefun, I.A. Investigation of Technical inefficiency of production of farms under the National Directorate of Employment in Ondo State. Applied Tropical Agriculture1998; 3:15- 28.
12. Awotide, D.O and Adejobi, A.O.: Technical Efficiency and Cost of production of Plantain farmers in Oyo State, Nigeria. Moor Journal of Agricultural Research 2006; 7(2):107 -113.
13. Giroh, D.Y, Waizah Y and H.Y. Umar. Technical Efficiency and Cost of Production among Gum Arabic Farmers in Jigawa State, Nigeria. Report and Opinion 2010:2(1):52– 57.
14. Abolagba, E.O. and Giroh, D.Y. Pathways to sustainable Development of the Nigerian Rubber Industry (A Case Study of Delta State). Moor Journal of Agricultural Research 2006; 7(1): 42 – 48.

12/5/2011