

Short Communication

Analyzing the Technical Efficiency of Rubber Tapping in Nigeria

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ABSTRACT

A study was conducted to analyse the technical efficiency of rubber tappers in Nigeria. A structured questionnaire was used to sample randomly 129 (68 permanent & 61 non-permanent) tappers. Data were analyzed using stochastic frontier analysis. The result revealed that the variance of parameters (gamma & sigma squared) of the frontier production function were significant. Wage had positive effect on output. The mean technical efficiency index was 0.72, while the minimum and maximum efficiencies are 0.38 and 0.99, respectively. Adopting an increased wage package, prompt payment of wages, replanting of old plantations and recruitment of young male tappers were recommended to enhance technical efficiency of tappers.

Key Words: Technical efficiency; Rubber; Stochastic frontier analysis; Rubber tappers

INTRODUCTION

Natural rubber (*Hevea. Brasiliensis* Muell Arg) was introduced into Nigeria from Kew gardens, England in 1895 and it has become increasingly important since the beginning of the 20th century (Uraih, 1980). *Hevea* belongs to the family *Euphorbiaceae*. It is a tree that could grow up to 25 m tall with a straight trunk covered with smooth light-grey bark, 6 to 15 cm thick. The trees have deep taproot with lateral roots of 7 to 10 cm long. Slender branches form an open, leafy crown with spirally arranged trifoliate leaves. Most planted rubber is grown between 15°N and 10°S, where the climax vegetation is humid with temperatures ranging from 23 to 45°C and well distributed rainfall of 1800 mm to 2000 mm on a well drained soil (Uraih, 1980; Aigbekaen *et al.*, 2000). Production statistics show that Nigeria has a total of 247,100 of land under rubber cultivation. Of this figure, small scale farmers 200, 100, while the remaining 47,000 are owned by estates (Kpolo, 1999; Aigbekaen *et al.*, 2000; Delabarre & Serier, 2000).

The Nigerian rubber industry has enormous potentials for sustainable growth and development (National Agricultural Research Project NARP, 1998). Williams *et al.* (2001) suggested the use of improved productivity of rubber by introducing clone rubber trees instead of traditional seedlings with low yield potentials. Food and Agriculture Organization (FAO, 1966) reported that unselected or local clones of rubber has yield of 300 to 400 kg ha⁻¹ per year of dry rubber, while remarkable improvements have been made in the breeding of high yielding clones of rubber by the Rubber Research Institute of Nigeria as RRIN adapted (exotic) clones and RRIN developed clones having latex yield of 900 to 1600 kg ha⁻¹ per year of dry rubber and 2000 to 3000 kg ha⁻¹ year⁻¹, respectively (Alika, 1982; Mekako,

1983; Omokhafa & Ugwa, 1997). According to NARP (1998) RRIN developed clones are one of the best yielding clones in the world. The Nigerian rubber industry provides employment opportunity and also serves as foreign exchange earner (Abolagba *et al.*, 2003).

The Nigerian rubber industry is labor-intensive particular for maintenance and tapping. Studies have shown a negative correlation between wages and rubber production in Nigeria (Aigbekaen & Alika, 1984). The bark of the rubber tree is the economic reserve of the farmer; hence efficient exploitation method is crucial in the determination of financial returns of the rubber estates. The high labor wage has forced majority of plantation owners to either abandon or adopt a share cropping system with willing tappers. This system of management fails to give the owner sufficient control over the tapper. This arrangement motivates tappers to “slaughter tap” all in an effort to extract latex resulting in poor bark regeneration and declining productivity of the trees (Mekako, 1983). There has been increased demand for rubber and its products but productivity seems to be inadequate to meet the demand for tyres perhaps due to shortage of labor (Spore, 2004).

Considerable research has been conducted on the natural rubber in the areas of crop improvement and other production innovations (Alika, 1982; Mekako, 1983; Aigbekaen & Alika, 1984; Esekade *et al.*, 1996; Omokhafa & Ugwa, 1997). However, little is known on the rubber tappers who are very crucial in the sustenance of the natural rubber industry. The hypothesis of this study was that the tappers operate at a level of technical efficiency sufficient to justify future survival of the industry. Hence, the objective was to analyze the technical efficiency of rubber tapping in Rubber Research Institute of Nigeria. The specific objectives are to estimate and examine the effects of

tappers' socio- economic characteristics on their efficiency.

MATERIALS AND METHODS

This study was carried out at RRIN main station, Iyanomo, Benin City, Edo State. It falls within Latitude 6 and 7°N of the Equator and Longitude 5 and 6°E of the Greenwich Meridian. It is within the humid rainforest zone with mean annual rainfall of 2000 mm. Rainfall has two peaks in the month of July and September but highest in July and there is drought in August. The soils of this humid forest belts are mainly ultisols with pH range between 4 and 5.5. The soils have been described as the "acid sand belt" derived from un-consolidated grits and stones containing clay beds in varying proportions (Vine, 1956).

Data for this study were obtained from two sources: primary and secondary. The primary data were obtained through the use of structured questionnaires. Natural rubber production output in kg dry rubber and mean prices from 1993 to 2003 is given in Table I. Data on the respondent's salaries was also obtained from the salary unit for analysis. Price of dry rubber per kg was obtained from the Sales Unit of the Institute for the Determination of Revenue from Tapping. 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, but a sample of 129 tappers was eventually used. The tappers provided adequate information required for the study. Data were subjected to stochastic frontier analysis. The Maximum Likelihood Estimates (MLE) for all the parameters of the stochastic frontier production and the inefficiency model defined above and the technical efficiency (TE) were obtained using the program frontier 4.1 (Coelli, 1994; Ajibefun, 1998).

RESULTS AND DISCUSSION

The MLE of the parameters of the stochastic frontier model of rubber tappers showed that estimates of the parameters for the frontier production function, inefficiency model and the variance parameters of the model (Table II). The parameter sigma squared, (δ^2) was 0.011 and different from zero ($P < 0.01$). This indicated a good fit and correctness of the distributional form assumed for the composite error term. Gamma (γ) indicated that systematic influence, which was un-explained by the production function, was the dominant source of random error. The gamma estimate (0.96) shows the amount of variation resulting from the TEs of the tappers. This implied that more than 95% of the variation in tappers output was due to difference in TE. This implied that ordinary least squares (OLS) estimate was not adequate in explaining the inefficiencies on rubber tapping. Therefore, the specification of a stochastic frontier production function was justified.

Typical of the Cobb-Douglas production function, the estimated coefficients for the specified function can be

Table I. Natural Rubber Output in Kilogramme 1993 - 2003

Year	Production (kg)	Mean price ₦ kg ⁻¹
1993	111,863	20.50
1994	108,263	35.15
1995	104,108	39.27
1996	368,229	41.22
1997	877,710	73.28
1998	508,042	60.73
1999	1,291,871	44.01
2000	346,595	58.89
2001	203,559	56.10
2002	194,701	67.10
2003	210,231	88.16

Source: Tapping Division, Rubber Research Institute of Nigeria (RRIN 2006), RRIN Annual Reports (Various issues)

Table II. Maximum Likelihood Estimate of parameters of Cobb – Douglas Stochastic Frontier Production function for Rubber tappers

Variable	Parameter	Coefficient	T. value
Stochastic frontier			
Constant	β_0	1.64***	5.12
No. of trees tapped	β_1	3.22	1.21
Wage (in naira)	β_2	1.09***	8.90
Labour (man days)	β_3	0.03	0.20
Age of plantation	β_4	-4.19*	-1.70
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
Status of tapper	δ_7	0.45***	7.20
Variance parameter			
Sigma squared	δ^2	0.011***	5.43
Gamma	γ	0.96***	33.00
Mean TE		0.72	

Source: Field survey, 2006. Significant at *** $P < 0.01$; * $P < 0.10$

explained as the elasticities of the explanatory variables. Except for age of plantation, the sign of the slope coefficients of the stochastic production frontier were positive. A 72% mean TE of rubber tappers implied that the tappers were not as efficient as the observed output was 28% lesser than the maximum output. Also 52.71% of the tappers had TE-index below the mean value, which indicated that for Nigerian tappers TE was higher than the mean TE (0.59) reported in Vietnamese rubber farms (Tran *et al.*, 1993).

The estimate of the parameters of the stochastic production frontier indicated that elasticity of output with respect to wage was positive and approximately 1.09 ($P < 0.01$). This implied that wage is a profound factor that influences the output of rubber tappers. An increase of 1% in wage will increase the output by 1.09%, depending upon the management of the rubber plantations. A negative (-4.19) production elasticity of age of plantation ($P < 0.01$) showed that output from rubber trees was necessarily a

function of age. Output declines when the trees are too old. Other possible reasons may be the type of clones used, agronomic practices, management and other soil and climatic conditions and incidences of pest and diseases. The coefficients of variables associated with total trees tapped and labour were 0.03 and 3.22, which indicated that total trees tapped were not a critical factor in output if such tappers do not efficiently tap the allocated task. As for labor, tappers may report for work and may not actually tap, thereby reducing output for that day especially among the permanent rubber tappers whose payment was not based on daily output, whilst non-permanent rubber tappers were paid on daily output. Another possible reason may be that of poor supervision.

The TEs provides a good ground to find out the sources of inefficiencies among rubber tappers in the study area. Variations in TE of the tappers may arise from managerial decisions, tappers characteristics and existing technology. Socio-economic variables were considered and estimated in the model (Table II). The signs and coefficients in the inefficiency model were interpreted in the opposite way such that a negative sign indicated the variable increases efficiency and vice versa. Result of inefficiency model showed that coefficients of the efficiency variables with the exception of age, education, training and status of tappers were the expected signs. The coefficients for tapping experience and family size were estimated to be - 0.009 and - 0.03, respectively implying that they meagerly affect efficiency. The estimated coefficient for status of tapper (4.53) was positive to inefficiency ($P < 0.01$). This implied that permanent rubber tappers were inefficient. However, the coefficient for gender variable was negative and ($P > 0.01$). This means that male tappers were more efficient than the females. A plausible reason for this is that female tappers are constrained by socio-cultural factors. On the other hand, female tappers devote most of times in household activities taking care of their children.

CONCLUSION

Less than unity TE of the tappers indicated that the tappers were not fully efficient. Variables of the production coefficients (wage & age of plantation) were significant. To improve the efficiency of the tappers, wages should be increased. Prompt and regular payment of such wages will spur tappers to increase output. Further recruitment policy should favour younger male rubber tappers to increase tapping efficiency. Finally, area of old trees may be replaced with new plants.

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