TECHNICAL EFFICIENCY OF RATTAN-BASED ENTERPRISES IN SOUTH WESTERN NIGERIA

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Abstract

The study examined the technical efficiency of rattan-based enterprises in South Western Nigeria. Multistage Sampling technique was adopted to select 121 rattan cane processors in Lagos, Ogun and Oyo States and data were collected through administration of structure questionnaire. Stochastic Frontier production function was used to estimate the technical efficiency of rattan-based enterprises. The result of the maximum likelihood estimate of the stochastic Frontier showed that sigma (σ^2 = 0.979) and the gamma (γ = 0.183) were statistically significant at 1% probability level. The estimated gamma value indicated that about 18.3% of the variability in output was not explained by the selected explanatory variables. Findings showed that land area occupied by the enterprise and capital were statistically significant respectively (P<0.05). The technical efficiency indices ranged from 0.67 and 0.98 with a mean of 0.85 implying 85% efficiency level. Education and gender were important determinants of technical efficiency (P<0.05) in rattan-based enterprise. The study recommends the need for upgrading the skills and developing the processing capacity of rattan-based enterprises.

Key Words: Technical efficiency, stochastic frontier model, Rattan, Rattan-based enterprise.

INTRODUCTION

Rattan belongs to the group of non-timber forest products. They are spiny and climbing palms belonging to the family palmae (Aracaceae) and a large sub-family Calamoideae. The rattan plant derives its name from Malaysia word 'raut' which means 'pare'. It has therefore been suggested that the name is a reflection of its preparation method which includes surface peeling; to clean and splitting before being converted to numerous end-products (Dahunsi, 2000). There are about 600 different species of rattan, belonging to 13 genera (Dransfield, 1992). A unique feature of rattan is the abundance and diversity of species, sometimes as many as 30 species occur in one locality in what is apparently rare vegetation. According to Dransfield (1992), of the 13 genera of rattan, three are endemic to Africa. These include *Laccosperma*, *Eremosphata* and *Oncocolamus*. *Calamus* species with about 370-400 species is the largest genus and is distributed throughout the geographic range of rattans (Dransfield and Manokaran, 1993).

Rattan species have enormous economic potentials for rural and urban economies in developed and developing countries. Its socio-economic value in terms of provision of employment, generation of foreign exchange earnings, contribution to Gross Domestic Product (GDP) and local utilization potentials have been greatly exploited in many countries especially Indonesia, China, Philippines, Malaysia, India, Thailand, Lao People's Democratic Republic and Singapore. Unfortunately, the Socio-economic potentials of rattan species are yet to be fully tapped in Africa particularly in Nigeria.

According to an estimate by the International Network for Bamboo and Rattan (INBAR), the global and local usage of rattan is worth US $2.5 billion and external trade of rattan is estimated to generate US $4 billion annually. Wulf and Ian (2000) reported that Seven Hundred Million People worldwide use rattan.

The International trade in rattan is currently US 6.5 billion dollars per annum with the majority of the trade being dominated by the rattan producing countries of South East Asia. Kumar and Sastry (1999) reported that rattan products were responsible for eighty nine percent (89%) of Indonesia's foreign exchange earnings. Indonesia is the highest producer of rattan species in the world. Cadecott (1988) stated that the largest demand for canes is for making furniture, for which they provide both frames and decorative trimmings and facing. Uses of canes include mats, handcrafts and souvenirs. Cane can also be utilized for riot and judicial flogging. Panayotou (1990) asserted that rattan is indisputably one of the most important non-timber forest products in the world. There is therefore a compelling need to explore the potentials of rattan resource for economic and social development in Nigeria.

Efforts aimed at increasing the output of rattan cane products cannot be properly directed unless the current level of technical, economic and allocative efficiencies of the rattan based entrepreneurs are known. Therefore, the challenge of meeting the supply-demand gap of rattan-based products depend on the knowledge of how efficient and effective the utilization of human and material resources of the rattan-based entrepreneurs disposal are. The establishment of technical, economic and allocative efficiencies of different categories of rattan-based entrepreneurs is very useful for trade policy intervention in Nigeria and also to foster enhanced income of the rattan-based entrepreneurs.

Review of literature has shown that up to date, there have being scanty systematic studies on technical, economic and allocative efficiencies in rattan-based enterprises in Nigeria. This study therefore measures technical efficiency and its determinants among rattan based enterprises in Lagos, Oyo and Ogun States in South west Nigeria.

Theoretical Framework

The term efficiency of a firm can be defined as its ability to provide the largest possible quantity of output from a given set of inputs. This is usually based on a given set of technology and economic factors. Efficiency measurement started with Farrell (1957) who drew upon the work of Debreu (1951) and Koopmans (1951) to define a simple measure of a firm efficiency that accommodated for multiple inputs. Farrel (1957) however, classified efficiency into two that is, Technical and Allocative (price) efficiencies and the combination of these two provides a measure of Economic efficiency. These measures of production efficiency have important implications for both economic theory and economic policy (Coelli, 1995). Such measurement enables one to quantify the potential increases in output that might be associated with an increase in efficiency. In essence, the efficient utilization of resources in the production process implies optimal productivity of resources. The fundamental philosophy behind efficiency measurement is the quantity of output per unit input. Technical efficiency can be measured either as input conserving oriented or output expanding orientation which according to Jondrow *et al.* (1982) and Ali (1996), is the ratio of observed to maximum feasible output, conditional on technical and observed input usage.

The most popular approach to measurement of efficiency, the technical efficiency component, is the use of frontier production function (Battese and Coelli, 1995; Sharma 1999; Wadud and White, 2000; Tzouvelekas *et al.*, 2001). Formally, the level of technical efficiency is measured by the distance of a particular firm is from the frontier. The term frontier involves the concept of maximality in which the function sets a limit to the range of possible observations (Forsund *et al.*, 1980). It is therefore possible to observe points below production frontier for firms producing below maximum possible output, but there cannot be any point above the production frontier given available technology. Deviation from the frontier is attributed to inefficiency. Frontier studies are classified according to the method of estimation. Kalaizandonakes *et al.* (1992) grouped these methods into two broad categories-parametric and non-parametric methods, it can be deterministic, programming and stochastic depending on how the frontier model is specified. Schmidt (1976) reported that efficiency measures from deterministic models are affected by statistical noise; hence, the adoption of the stochastic production frontier by many Research Scientists. The Stochastic frontier production function was independently proposed by Aigner *et al.* (1997) and Meeusen and Van den Broeck (1997). The original specification involved production function specified for cross-sectional data which had the disturbance term which is a composite error consisting of two components, one symmetric and the other one-sided. The symmetric component, Vi, captures the random effects due to measurement error, statistical noise and other influences outside the control of the firm and it is assumed to be half normally distributed. The one-sided component of Ui, captured randomness under the control of the firm. It gives the derivation from the frontier attributed to inefficiency. It is assumed to be half-normally distributed or exponential. A stochastic frontier production model can be expressed in the following form (Equation 1):

$Y\grave{\imath}=f(X\grave{\imath}, \beta) \exp (Vi - Ui) \quad i = 1, 2, 3, \ldots N \ldots (1)$

Yì=the output (or the logarithm of the production of the ith firm)

Xì=the corresponding kXi vector of (transformation of the) input quantities of ith firm).

β=Vector of unknown parameters to be estimated

f=An appropriate functional form

Vi=the symmetric error component that accounts for random-effect and exogenous hock (assumed to be iid)

Ui=a one-sided error component that measures technical inefficiency.

METHODOLOGY

The Study Area, Sampling and Data Collection Procedure

The study was conducted in South Western Nigeria which consists of Lagos, Ogun, Oyo, Osun, Ondo and Ekiti States. South Western Nigeria occupies a major position in the Agricultural and Forestry sub-sector economy of the country. The area lies between longitude $2^{0}31^{1}$ and $6^{0}00^{1}$ East and Latitude $6^{0}21^{1}$ and $8^{0}37^{1}$ North (Agboola, 1979). The South Western Nigeria is bounded in the East by Edo and Delta states, in the North by Kwara and Kogi states, in the West by Republic of Benin and in the South by the Gulf of Guinea. The total land area is about 77,818 km^2 with the population of

27,581,992 in 2006 (NPC, 2006). The climate of the study area is tropical in nature and it is characterized by wet and dry seasons. The temperature ranges between 21^0C and 34^0C while the annual rainfall ranges from 150 mm to 3000 mm. The ecology of South Western Nigeria is made up of fresh water swamp and mangrove forest at the belt. The low land forest stretches inland to Ogun and part of Ondo State while secondary forest tends towards the Northern boundary where derived and Sudan Savannah exists (Agboola, 1979). South Western Nigeria consists mainly of the Yoruba ethnic group. There are other ethnic groups and nationals from within and outside Africa living in various parts of South Western Nigeria. People in this part of the country are predominantly small-scale farmers. Other major occupations include trading, teaching, catering, tailoring, bricklaying, establishment and operation of agro-allied and forest-based small scale industries.

Data used for this study are mainly primary and were obtained from the rattan-based cottage entrepreneurs using structured questionnaire. Three states were purposively sampled out of the six states that formed South Western Nigeria because of the prevalence of the target group that is rattan-based cottage entrepreneurs, in such states. These states were Lagos, Ogun and Oyo. Purposive sampling technique was adopted to select the towns where at least five rattan-based enterprises are available. The sampled locations were Lagos comprising Maryland Cane Village, Ikeja, Ojota, Ketu, Agboju, Festac town; Ogun-Abeokuta, Ilaro, Sango and Ibadan in Oyo State. Random Sampling Technique was used to select rattan-based cottage entrepreneurs as indicated thus: Lagos (59), Abeokuta (6), Ilaro (10), Sango (14), and Ibadan (32). The numbers of respondents (sample size) was determined on the basis of the number of rattan-based cottage entrepreneurs available in each purposively sampled town. A total of one hundred and twenty one (121) respondents were selected. Relevant information on socio-economic characteristics of the rattan-based cottage entrepreneurs, input use and output levels were collected and analyzed.

Model Specification

Stochastic Frontier Model

The Stochastic Frontier Production function for the rattan-based cottage enterprise was used to estimate the technical inefficiencies of production. According to Coelli (1995), the stochastic frontier model measured relative efficiency which could account for all factors of production and this can be represented as in equation 2

$$Y_i=f(W_i\, \beta) \exp (V_i - U_i),\ l = 1,2,3, \ldots N \ldots (2)$$

The error terms in the model accounts for both technical inefficiency and measurement errors in the output (Coelli, 1992; Amanza and Olayemi, 2002).

The Empirical Model

In this study, Stochastic frontier translog production function was employed. The model fitted for rattan-based cottage entrepreneurs using the maximum likelihood (ML) method were specified as follows (Equation 3):

$$LnY = \beta_0 + \beta_1 \ln W_1 + \beta_2 \ln W_2 + \beta_3 \ln W_3 + \beta 4 \ln W_4 + 0.5\, \beta_5 \ln W^2{}_1 + 0.5\beta_6 \ln W^2{}_2 + 0.5\beta_7 \ln W^2{}_3 + 0.5\beta_8 \ln W^2{}_4 + \beta_9 \ln W_1 \ln W_2 + \beta_{10} \ln W_1 \ln W_3 + \beta_{11} \ln W_1 \ln W_4 + \beta_{12} \ln W_2 \ln W_3 + \beta_{13} \ln W_2 \ln W_4 + \beta_{14} \ln W_3 \ln W_4 + Vi - Ui \ldots\ldots\ldots (3)$$

Where $\beta 0$ = Constant

β_1-β_{14} = Parameters to be estimated/determined.

V_i =Random errors which are assumed to be independently and identically distributed as $N(0, \sigma^2 V)$

U_i = Non-negative random variable associated with technical inefficiency of production assumed to be independently distributed such that U1 as obtained by truncations at zero of the normal distribution with variance $\sigma\mu^2$

Ln = Natural logarithm to base 10 Y_i = Total output of rattan products of enterprise expressed in monetary term (₦)

B = The parameter to be estimated

W_1 = Land occupied by the enterprise (m^2)

W_2 = Capital (Cost of production ₦)

W_3 = Labour (man days)

W_4 = Quantity of (raw) rattan cane used (kg).

Inefficiency Effects

A unique feature of stochastic frontier is the decomposition of the component error term (Vi – Ui) into mutually exclusive events. The values of the unknown coefficients were estimated using maximum likelihood (ML) method as indicated below (Equation 4):

$U = \sigma_0 + \sigma_1 Z_1 + \sigma_2 Z_2 + \sigma_3 Z_3 \ \sigma_4 Z_4$……….(4)

Where U= Non-negative random variable associated with technical inefficiency of production assumed to be independent and identically distributed.

Ϭ = a vector of unknown parameters to be estimated

Z_i = i = (1,2,3,4,5,6,7) = factors contributing to inefficiency.

Z_1 = Age of respondent

Z_2 = Marital status (married = 1; 0 if otherwise)

Z_3 = Level of education (years)

Z_4 = Household size (No)

Z_5 = Gender (Male = 1:0 if otherwise)

Z_6 = Access to credit (access = 1; 0 if otherwise)

Z_7 = Experience in business (Years)

Result and Discussion

Empirical findings of the maximum likelihood estimates (MLE) of the stochastic frontier translog production and factors inefficiency parameters are presented in table 1. The sigma (σ^2 = 0.979) is quite high and significant at 1% level of probability. The high and significant level of this parameter signifies the goodness of fit and the correctness of the composite error terms distribution. The gamma (γ = 0.183) is significant at 1% level of significance. The estimated gamma value shows that about 18.3% of the variability in output that are unexplained by the MLE of stochastic frontier production function model. Land area occupied by the enterprise appears to be most important resource in production with elasticity of 2.969. The implication of this is that 10% increase in the size of the land occupied by the enterprise will lead to 29.6% increase in the output of rattan-based cottage enterprises. The 2.029 elasticity of capital with respect to output is significant at 5% level of significance. It is another very important factor of production after the size of the enterprise; this implies that 10% increase in the capital input to rattan enterprises will stimulate a 20% increase in output. Labour and the number of raw rattan bundles used by the enterprises were not statistically significant.

Sources of Inefficiency

The estimated coefficient of the specified inefficiency model provides an insight into the relative technical efficiency levels among individual rattan-based enterprise. The inefficiency variables had appropriate signs except credit. However, only educational status and gender are statistically significant at 5% probability level. This tends to suggest that the higher the level of educational status of the rattan-based entrepreneur, the lower the inefficiency and technical efficiency increases. Age, marital status, household size and access to credit had negative coefficient and are not statistically significant.

Table 2 shows the frequency distribution of individual enterprise efficiency indices. The efficiency indices ranges from 0.67 to 0.98 with a mean production efficiency index ranging between 0.61 and 0.90 while only 3.31% had efficiency of about 85.5%. About 96.6% of the rattan enterprises had production efficiency index greater than 91%. This result shows that the mean efficiency of the rattan-based enterprises was high. There exists a narrow gap between the least efficient and most efficient enterprise.

Conclusion and Recommendation

The study examined the technical efficiency and its determinants using stochastic parametric estimation techniques. The parameters of the ML estimates and inefficiency determinants obtained using stochastic frontier translog production function were asymptotically efficient, unbiased and consistent. Land area occupied by the enterprise as well as capital were important factors in rattan product processing. The distribution of rattan-based enterprise-specific technical efficiency shows that rattan-based entrepreneurs in South Western Nigeria were operating below the frontier threshold, although the mean (85.5%) efficiency of the rattan-based enterprises was high. However, within the context of efficient production, the output of rattan-based enterprise can still be increased by 14.5% using available input and technology. Policy interventions aimed at encouraging the cultivation, development, management, sustainability, processing and maximum utilization of the rattan resource should be formulated and the enabling environment for implementation of such policy provided. There is therefore the need for government intervention which can lead to promotion of rattan business in South Western Nigeria. Strategies needs to be put in place for rattan-based entrepreneurs to improve on production practices and reduce inefficiencies as this may lead to entrance of new investors, reduce unemployment, contribute to poverty reduction, increase family income, enhance the contribution of forestry sub-sector to the national economic growth and overall development of Nigeria.

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Table 1: Parameter estimates of Translog Stochastic Frontier Production Function.

Production factors		Parameters	Estimated coefficient	t-value
Constant		β_0	-2.688**	-2.605
Land area (W_1)		$\beta 1$	2.969**	2.953
Capital (W_2)		$\beta 2$	2.029**	2.527
Labour (W_3)		$\beta 3$	0.001	-0.001
Rattan raw material (W_4)		$\beta 4$	0.137	0.169
$0.5\ln(W_1)^2$		β_5	0.310	1.506
$0.5\ln(W_2)^2$		β_6	-0.244	1.216
$0.5\ln(W_3)^2$		β_7	1.071**	3.168
$0.5\ln(W_4)^2$		β_8	0.324**	3.285
lnLand area x ln capital input		β_9	-0.096	-0.374
lnIn area x lnLabour		β_{10}	-0.012	-2.229
lnLand area x ln rattan raw material		β_{11}	0.161	0.955
lnCapital x lnLabour		β_{12}	-0.021	-1.011
lnCapital area x ln rattan raw material		β_{13}	-0.021	0.151
lnLabour xln raw material		β_{14}	-0.428*	1.987
<u>Efficiency Model</u>				
Constant		σ_0	0.305	0.671
Age		σ_1	-0.333	-0.327
Marital Status		σ_2	-0.123	-0.798
Education		σ_3	0.042**	3.31
Household Size		σ_4	-0.009	-0.231
Gender		σ_5	0.004**	2.487
Access to Credit		σ_6	-0.125	-0.468
Years of Experience		σ_7	0.002	0.319
<u>Variance Parameter</u>				
Sigma-Squared			0.979***	5.519
gamma (Total variance)			0.183***	2.816
Loglikehood function	-218.0			
LR Test	30.282			

*, ** and *** implies significant at 10%, 5% and 1% respectively

Source (Field Survey, 2009)

Table 2: Distribution of production frontier efficiency (technical efficiency) for rattan-based enterprises

Efficiency class		**Frequency**	**Percentage**
<0.5		2	1.65
0.5-0.6		5	4.13
0.61-0.7		3	2.48
0.71-0.8		2	1.65
0.81-0.9		105	86.78
>0.91		4	3.31
Total		**121**	**100**
Maximum	0.984		
Minimum	0.670		
Mean	0.855		

Source (Field Survey, 2009)