ANALYSIS OF EFFICIENCY OF HONEY PRODUCTION IN NIGERIA

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ABSTRACT

This study analysed the efficiency of honey production in the Niger-Delta area of Nigeria. Primary data were collected using a set of structured validated questionnaire with interview schedule from one hundred and fifty (150) beekeepers that were selected using multi stage sampling techniques in three states (Delta, Edo and Ondo) of the Niger-Delta area. The Technical Efficiencies (TE) of the bee farms ranged between 0.340 and 0.999 with a mean of 0.613 and standard deviation of 0.14849. The implication of the findings above is that given the production resources at the disposal of the beekeepers, most especially with TE of 61.32%, one could conclude that the beekeepers are averagely efficient in the use of their resources. The structure of production revealed that the returns to scale were 1.100. This was irrational zone of production. The estimated gamma parameter was 0.9991 and highly significant at 5% of significance. The result suggests systematic influences that are unexplained by the production function as the dominant sources of random errors. Put differently, the presence of technical inefficiency among beekeepers explains about 99.9 percent variation in the output level of apiary.

The Fixed cost, Operating expenses and Credit taken having elasticities of production between zero and unity (that is, **0** < **ЄP < 1**) indicate decreasing positive returns to each of the variable. Such variables were therefore efficiently utilized and their use was in stage II of the production function. This study further observed that labour negatively affected technical efficiency. This study concluded that the output and technical efficiency of the honey production could be increased by practicing modern technology which would prevent swarming/absconding thereby stimulate growing colony age. This in turn would move the honey production from stage I of production function to stage II thereby maximizing profit with its attendant effect on poverty reduction.

KEYWORDS: Technical, Efficiency, Beekeeper, Honey, Production

INTRODUCTION

"Beekeeping is an applied science of rearing honeybees for man's economic benefits [1]. The common African honeybee (*Apis mellifera adansonni*),live throughout the year in colonies consisting of a queen or mother bee, which is a fertile egg-laying female, 10,000 to 200,000 worker bees, which are infertile females and the male bees called drones that may be present in the colony only during the reproductive season [2]. Honeybees naturally build their nests in a hole of a tree, inside a cave and under the roof of buildings, but traditionally, people also keep bee colonies. Beekeeping has been in practice in many part of the world where the honey has been used for many purposes. Apart from direct consumption of the honey, it is used for dressing of wounds, as anti-diarrhea drug, in alcoholic drink, tobacco curing, bakery and confectionery and in manufacturing of cosmetics. In addition, other honey products like bee wax, propolis, bee venom, and royal jelly are foreign exchange earning commodities for some countries while the crop pollinating role of the bees is of tremendous importance [3]."

Successful beekeeping starts with the right choice of apiary. The following elements are critical for locating apiaries:

(a) Abundant food resources for the bees, that is, nectar and pollen. With the evergreen forest and diverse indigenous fruit trees, the bees could easily forage throughout the year.

(b) Nearby source of water all the year round.

(c) Abundant vegetation to provide shade for the hives.

In view of this and couple with the Shell Petroleum Development Company's effort at supporting agricultural production especially beekeeping technology in the Niger Delta area, the enterprise has been accepted with great enthusiasm.

Beekeeping generally is a complementary enterprise to virtually all farming enterprises in the study area. This provides insurance against risk and uncertainty that could result due to inclement weather and pest attacks. For honey production to increase in a sustainable manner, the present level of technical efficiency and productivity must be improved upon. However, only little is known about level of technical efficiency of honey production in the Niger Delta Area (NDA) of Nigeria. Technical efficiency implies ability to produce maximum output from a given set of inputs, given the available technology. This paper seeks to examine the factors which influence the level of efficiency in honey production in Niger Delta Area of Nigeria and estimate the technical efficiency of production.

The broad objective of this study is to determine the technical efficiency of honey production in the NDA of Nigeria. While the specific objectives are: to examine the socio-economic characteristics of bee keepers, the resource use efficiency of variables involved in honey production and carry out the technical efficiency analysis of honey production in the study area..

MATERIALS AND METHODS

Study Area

The study was conducted in three states within the NDA. The states are Delta, Edo and Ondo. Delta is made-up of 25 local Government Area (LGAs) with Asaba as its capital and has a population of 4.1 million. While Edo state is made-up of 18 LGAs, with Benin City as its capital has a population of 3.2 million. Ondo State also has 18 LGAs with Akure as its capital has a population of 3.4 million [4]. The area lies between latitudes 5^0N and 7^0N of the equator and approximately between 3^0E and 6^0E longitude. The area has three distinct ecological zones. The mangrove forest to the south, the rain forest in the middle and the savanna to the north. The area is an agrarian one but melliferous flora are common in the area under study and these are weeds, climbers and ornamentals which are plants visited by honeybees.

Sampling Techniques and Data collection

Non-probability and probability sampling techniques were used in selecting the samples. The non-probability method used was the purposive sampling which for the purpose of accurate and detailed comparative analysis selected those towns and villages where apiaries are located. The probability sampling method used was the multi-stage method which based the selection of the sample on a combination of two or more sampling methods. The first stage was a purposive selection of three states namely Delta, Edo and Ondo on the basis of

- The vegetation cover spanned across Mangrove, Rainforest, and Guinea savanna ecological zones
- Modern beekeepers are located in the area.
- There is tradition of beekeeping and honey hunting in the area.

In line with Agricultural Development Programme (ADP) delineation there are 2 ADP zones in each state while each Zone has 2 ADP Areas. One area was purposively selected from each zone.

The second stage was a stratified sampling method. The beekeepers were stratified on the basis of technology used, that is: modern and traditional beekeepers. The

stratification of beekeepers was necessary because variables such as hive types and harvesting/processing equipment have important contribution in honey output. The third stage of the multistage sampling method was a random sampling of the respondents using the lottery method. 25 beekeepers were randomly sampled in each ADP Area by lottery method. In all 150 beekeepers were sampled.

Structured questionnaire supplemented with interview schedule was used to elicit information from the beekeepers regarding their honey production and socio-economic variables with the help of trained enumerators under close supervision.

Data analysis

Data collected were analyzed using descriptive statistics and stochastic frontier production function {SFPF}. The SFPF is a specialized econometric technique for estimating the parameters of the regression model of the production function. In the SFPF the error term of an ordinary regression model is assumed to have two component parts V and U. The V covers the random effects (random error) on the production and they are outside the control of decision unit while the U measures the technical inefficiency effects which are behaviour factors that come under the control of the decision unit, that is they are controllable errors if efficient management is put in place. The SFPF approach is generally preferred for agricultural research for the following reasons:

- The inherent variability of agricultural productions due to interplay of weather, soil, pests, diseases and environmental failures.
- Many firms are small family-owned enterprises where keeping of accurate records is not always a priority, hence, available data on production are subject to measurement errors.

The modeling, estimation and application of SFPF to economic analysis assumed prominence in econometrics and applied economic analysis during the last two decades, but is still a new methodology in bee keeping production.

The stochastic frontier production function was specified by the Cobb-Douglas functional form but linearised in the double log for ease of data fitting.

$\ln Y_i = \beta_0+\beta_1 \ln X_1+\beta_2 \ln X_2+\beta_3 \ln X_3+\beta_4 \ln X_4 +V_i – U_i$ …….equation1

Or,

Implicitly as;

$Y_i = f\{X_j\beta\} + V_i - U_i$ ……equation2

Where; i = 1 to 150 respondents

Y_i = Total value of output per beekeeper (₦)

X_1 = Total quantity of labour (Man days)

X_2 = Fixed cost (₦)

X_3 = Operating expenses (₦)

X_4 = Credit taken (₦)

V_i = is a random error term that are independently and identically distributed (having a normal distribution with mean zero and constant variance σ_v^2, intended to capture events beyond the control of farmers. It is independent of U.

The U_i is a non – negative random variable called technical inefficiency effects associated with the technical efficiency of production of farmers involved.

In = is the natural logarithm.

The Technical Efficiency {TE} of an individual bee keeper is defined in terms of the observed output {Yi} to the corresponding frontier output {Yi*}. The frontier output is the maximum achievable output given the existing technology and assuming 100 percent efficiency. It is denoted as

$Yi^* = f\{X_j\beta\} + V_i$

That is: $TE = \frac{f\{X_j\beta\} + V_i - U_i}{f\{X_j\beta\} + V_i}$ ……. equation 3

And that $0 \leq TE \leq 1$

THE INEFFICIENCY MODEL

It was assumed that the technical inefficiency is a function of socio – economic factors as given in the equation below:

$U_i = \partial_0 + \partial_1 Z_{1i} + \partial_2 Z_{2i} + \partial_3 Z_{3i} + \partial_4 Z_{4i} + \partial_5 Z_{5i} + \partial_6 Z_{6i} + \partial_7 Z_{7i} + \partial_8 Z_{8i}$ …….equation4

Where:

U_i = Technical inefficiency of the ith beekeeper and jth observation of the beekeeper.

Z_1= Number of colonized hives

Z_2= Years of beekeeping experience

Z_3 = Years of formal education

Z_4= Household size

Z_5= Gender of Beekeepers (dummied as one denotes male, zero for female).

Z_6 = Technology (Modern vs. Traditional)

Z_7= Age of colonies (year)

Z_8= Age of beekeepers (years)

The βs and ∂s coefficients are unknown scalar parameters to be estimated by the method of Maximum Likelihood Estimation, using the Computer programme **FRONTIER Version 4.1.** [5].

RESULTS

Table 1: **Socio-economic characteristics of the respondents**

Socio-economic characteristics	Means	Standard Deviation
Household size	7	3.77
Years of experience	3.4years	3.23
Total cost	₦19,575.39	33,408.66
Total value of output	₦ 51,556.67	106,412.46
Profit	₦ 31,981.29	73,452.55
Gender	87% male, 13% female	
Marital status	86% married, 14% single	
Technology	78% modern, 22% traditional	
Literacy level	60% with secondary education & above	

Table 2a: **Summary statistics of variables for estimation of frontier models of honey production (means values per beekeeper)**

Variables	**Mean Value**	**Standard deviation**	**Minimum**	**Maximum**
Total value of output (Naira/year)	51,556.67	106,412.46	5,060.00	1,175,000.00
Labour (Man days)	17.41	23.68	3.00	250.00
Fixed cost i.e. depreciation(Naira)	4,530.89	10,009.43	265.00	108,750.00
Operating expenses (Naira)	15,044.49	23,588.98	2,487.00	248,700.00
Credit taken (Naira)	45,576.00	98,059.20	1,500.00	795,000.00

Source: Computed from field data, 2004

Table 2b: **Technical Efficiency Statistics**

	N	Minimum	Maximum	Mean	Standard Deviation
Delta	50	0.3399	0.9717	0.6199	0.17988
Edo	50	0.3725	0.9991	0.5982	0.11870
Ondo	50	0.3479	0.9794	0.6214	0.14234
Total	150	0.3399	0.9991	0.6132	0.14849

Source: Computed from field Data, 2004

Table 3: ML Estimates from SFP Parameters of Honey Production

Variable	Model 1		Model 2	
FRONTIER MODEL:				
Constant	-2.379	(-3.894)	-0.564	(-0.540)
Labour	-0.243	(-2.814)	-0.196	(-1.959)
Fixed cost	0.112	(1.983)	0.180	(2.661)
Operating Expenses	1.048	(10.928)	0.942	(7.528)
Credit taken	0.269	(6.803)	0.174	(3.345)
INEFFICIENCY EFFECTS:				
Constant	0		-0.759	(-2.787)
Colonized hive number	0		0.003	(0.824)
Experience	0		-0.011	(-0.668)
Education	0		-0.468	(-0.559)
Household	0		0.011	(1.063)
Gender	0		-0.010	(-0.096)
Technology	0		-0.235	(-2.6213)
Colony age	0		-0.054	(-1.302)
Age of Beekeepers	0		0.001	(0.261)
VARIANCE PARAMETERS:				
Sigma-squared (v) σ^2	0.056		0.053	(3.798)
Gamma (γ)	0		0.999	(23,466)
Log-likelihood function	6.383		21.703	
Mean TE			0.613	

Figures in parentheses are t-ratios corrected to 2 decimal figures.

Table 4: **Elasticity of Estimate**

Variables	Elasticity of Production (εp)
Labour	-0.196
Fixed cost	0.180
Operating expenses	0.942
Credit taken	0.174
Returns to scale (RTS)	1.100

Source: Computed from Field Data, 2004

DISCUSSION

The result of the socio-economic characteristics analysis showed that men participated more in beekeeping and honey production in the study area than women (Table 1). This might be partly due to psychological fear exhibited by women towards the profession and coupled with periods of major activities, which are either late evening or early morning hours, which are not convenient for women due to essential domestic chores. The study showed that the level of education of the respondents was higher when compared to national adult illiteracy level of 30% and 48% for male and female respectively [6]. The higher level of education with 60% having secondary school education and above will enable respondents to access relevant information that will stimulate honey production.

The respondent's large household size with average of seven is relevant to honey production because family constituted the bulk of labour supply in this enterprise in Nigeria. The average total cost of production was ₦19, 575.39 out which 76.8% were operating expenses. The annual average profit of ₦ 31,981.29 ($290.29) was slightly higher than per capita income of $280.00 in Nigeria [7] in spite of the fact that this enterprise in the study area was a recent innovation with years of experience of respondents' average at 3.4. Aptitude which is one of the factors of successful beekeeping is directly related to experience. Modern beekeeping technology was gradually gaining ground in the study area with 78% adopting one aspect or the other of modern beekeeping as evidence with the use of moveable combs hives, protective dress and processing equipment of static honey press. Nevertheless, the level of innovation adoption among the beekeepers is still low because of low contact with extension agents who are skillful in the field [8], coupled with non-availability of adequate credit to procure modern beekeeping equipment.

According to Table 2a, the dependent variable represents the value in Naira (₦) of mean output per beekeeper per annum which was ₦ 51,556.67. The variability as measured by standard deviation which was ₦106,412.46. The values of the variables varied among the beekeepers as depicted by the large standard deviation.

The aggregate inputs, included as variables of the production function were also described in Table 2a and the analysis was conducted with respect to four production inputs.

Signs and Significance of the MLE Estimate

The signs and significance of the coefficients of the estimated parameters of the explanatory variables are reviewed in this section and summarized in Table 3. From Table 4, the Fixed cost, Operating expenses and Credit taken having elasticities of production between zero and unity (that is, **0** < **ЄP < 1**) indicate decreasing positive returns to each of the variable. Such variables were therefore efficiently utilized and their use was in stage II of the production function.

Also a T-ratio test of significance at 5% showed that only three variables such as fixed cost, Operating expenses and credit taken were significantly different from zero & greater two, thus important determinants in honey production in the study area. These determinants are discussed as thus:

i) Fixed cost: This resource was significant at 5% level and its coefficient was positive. This implies that increased fixed cost would lead to increase in honey output.

ii) Operating expenses: The coefficient of operating expenses was positive which conformed to apriori expectation and this resource was significant at 5% level. This implies that increased operating expenses would lead to increase in honey output.

iii) Credit taken: The coefficient of credit taken was positive which conformed to apriori expectation and this resource was significant at 5% level.

The study revealed that the RTS was 1.100 as presented in Table 4. This indicates an increasing returns-to-scale and thus beekeeping was in the irrational zone of production; that is, stage I of the production function. Beekeeping output could be increased by scale expansion, that is, by increasing the use of the variable inputs with positive elasticity of production involved in the beekeeping in the study area.

Technical Efficiency Analysis

The Technical Efficiencies (TE) of the bee farms ranged between 0.340 and 0.999 with a mean of 0.613 and standard deviation of 0.14849 (Table 55). The implication of the findings above is that given the production resources at the disposal of the beekeepers, most especially with TE of 61.32%, one could conclude that the beekeepers are averagely efficient in the use of their resources. This is close to the 62.5% reported [9] for beekeepers in Malaysia. Although, a lot of improvement can still be employed to increase the TE over time. Since in this study, TE scores were calculated as output-oriented measures, beekeepers would be able to increase output by 38.68 % with the present state of technology, using their disposable resources more effectively.

The technical efficiency analysis on state basis as shown in Table 2b revealed that Ondo state had the highest mean technical efficiency of 0.621, followed by Delta with TE of 0.620 while Edo state had the lowest value of 0.598. The implication of the findings above is that given the production resources at the disposal of the beekeepers, most especially in Ondo state, one could conclude that the beekeepers are relatively efficient in the use of their resources than their counterparts in Delta and Edo states.

Inefficiency Model

The summary of the estimated parameters of the inefficiency model in the stochastic frontier production function model of the bee farms is presented in Table 3. In this model, the signs of inefficiency variables were of economic importance since no parameter was significant at 5% degree of freedom.

Colonized hives: The colonized hives referred to the number of hives occupied by the bees during the honey – flow period where harvesting of ripe honeycombs took place. The estimated coefficient for colonized hives was positive implying that technical efficiency decreases with increased number of hives. The

reason is not far fetched since worker bees from increasing colonized hives would compete for the same foraging plants in the neighbourhood of apiaries.

Beekeeping experience: The estimated coefficient for years of experience was negative. This indicates that the years of beekeeping experience decreases technical inefficiency of beekeepers, hence, its effect on the technical efficiency is such that technical efficiency increases with more years in beekeeping. Results are corroborated by the findings [10, 11] that with increased years of experience people become more specialized.

Education: The estimated coefficient of education was negative. This indicates that the literacy level of beekeepers in the art of beekeeping and honey production decreases the technical inefficiency of beekeepers. This is in conformity with the Schumpterian theory of economic development which suggests that technical efficiency is influenced by technical knowledge and understanding in addition to other socio-economic environment within which the farmers must make decision [12].

Household: The estimated coefficient for household size was positive. This indicates that the household size increases technical inefficiency of beekeepers, hence, it decreases the technical efficiency of the beekeepers.

Gender: The estimated coefficient for gender was negative. This indicates that the issue of gender decreases technical inefficiency of beekeepers, hence, its effect on the technical efficiency was that it increases technical efficiency.

Technology: The estimated coefficient for technology was negative and complied with apriori expectation. This implies that as beekeepers move from traditional to modern their technical inefficiency decreases and technical efficiency increases.

Colony age: The estimated coefficient for colony age was negative. This indicates that the colony age experience decreases technical inefficiency of beekeepers, hence, it increases technical efficiency. The mean age of colonies in the study area was 2.32 years. The older the colony the stronger the colony, due to increasing worker bee's population which made the four periods of beekeeping management more easy for beekeepers.

Beekeepers' age: The estimated coefficient for Beekeepers' age was positive and complied with apriori expectation. This indicates that the beekeepers' age increases technical inefficiency of beekeepers, hence, it decreases the technical efficiency of the beekeepers.

The mean age of beekeepers was 45.26 years for the period under study. Since beekeeping is energy sapping venture, the older the beekeepers the less the vigour with attendant effect on technical efficiency.

CONCLUSION:

This study concluded that the output and technical efficiency of honey production could be increased, provided modern beekeeping technology is being practiced by all and sundry. Without doubt, beekeeping is profitable, sustainable and is of low risk as an enterprise. Engaging in it by farmers in the study area would bring about poverty reduction, and consequent improvement in the standard of living (quality of life) of the people.

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