

## Resource Use Status and Technical Efficiency of Beekeepers in Oyo State, Nigeria

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### Abstract

The objectives of the study were to determine the status of resources used and the technical efficiency of honey beekeepers in Oyo state of Nigeria. This is because identifying status of resources and technical efficiency of producers is important in policy decisions for factor productivity growth in an economy where technological innovation is lacking. Data were collected on inputs and output of bee honey production and firm specific variables; and were analysed using descriptive and inferential statistics, and Stochastic Frontier Production Function. With the exception of enterprise size (number of beehives), each of all the other resources were used in the rational zone of production (elasticity lying between zero and one) and returns to scale was greater than unity. Productivity will rise with increase in enterprise size alone and in all the resources combined. The estimated technical efficiency varied between 21% and 87%, with a mean of 62.2%, implying the existence of substantial inefficiency for improvement in productivity. The inefficiency effects of beekeepers were positively related to age and gender and negatively to literacy level, experience, and extension contacts. Thus, productivity growth in honey production increases with quantities of inputs, literacy, experience, extension agents' contacts and decreases with age of beekeepers.

**Key words:** Beekeeping, Elasticity, Resource use, Returns to scale, Technical efficiency

### INTRODUCTION

Nigeria is an agrarian economy although earns a lot of income from petroleum. The country is agrarian because it is endowed with natural and human resources that support/depend on agriculture. For an agrarian economy, agriculture is expected to perform certain roles which include increased output of agricultural commodities to meet the needs of increasing population and expanding domestic industrial processing;

expansion of agricultural exports to generate foreign exchange earnings; and generation of employment and income to rural communities. In Nigeria, agriculture has failed woefully in the performance of these roles as there is a widening gap between local supply and demand for food and raw materials for human consumption and agro-allied industries, respectively; increasing unemployment; rising poverty in the rural area and low

and declining foreign exchange earnings from agriculture (Ajakaiye and Akande 1998). The failure has been attributed to lack of agricultural development (Abdullahi, 2001). Agricultural development has as its major component rise in productivity of the various enterprises in agriculture. This is because the overall productivity of an economic system is directly related to the productivity (efficiency) of the components within the system. Productivity of a firm or a decision-making unit is the ratio of the output(s) that it produces to the input(s) it uses. A firm can achieve productivity improvement by using better technology, increasing efficiency and exploiting scale economies. In a developing country like Nigeria where opportunities for new technologies are lacking because of its poor science and technology base, increased productivity can only be achieved through the opportunity of improved efficiency and scale economies. Conducting productivity studies will show whether or not it is possible to raise productivity without technological change.

Beekeeping in Nigeria is either traditional or modern. The traditional beekeeping is concerned with making only hives materials such as pot, basket and straw available and it is largely non-

commercial as against modern beekeeping that involves the use of larger resources and has commercial orientation. Modern beekeeping is a relatively new enterprise in Nigeria. It has been identified as a viable and profitable enterprise to increase farmers' income (Habibullah and Ismail, 1991; Farinde *et al.*, 2005). Alimi (2002) indicated that although beekeeping enterprise was profitable in Oyo state of Nigeria, declining physical productivity was projected. However, the study failed to identify measures to maintain or increase productivity.

The objectives of this study, therefore, were to determine the status of inputs used in production, the determinants of technical efficiency and the nature of scale economies in the beekeeping enterprise in Oyo State, Nigeria. For beekeeping enterprise to flourish and meet the high demand for its major product (honey), and generate high income to the beekeepers in a sustainable manner, knowledge of its present level of productivity is necessary. However, only very little is known about the level of technical efficiency of Nigeria's modern beekeeping industry. Results of this study will assist in policy decisions for increasing productivity in modern beekeeping industry.

## THEORETICAL FRAMEWORK

### Productivity Measurement Methods

There are several methods of measuring productivity of a production unit. The classical approach, otherwise called partial productivity approach measures productivity as the ratio of an output to a single input. Some of the variants of this measure are labor productivity (output per man-day of labour), capital productivity (output per unit of capital) and land productivity (crop yield). This method becomes misleading when production involves more than one output and or input. The dissatisfaction of the economists with the shortcomings of the classical approach led to the development of more rigorous methods that take care of multi inputs-outputs production system. One of these methods is ordinary least squares (OLS) regression and its variants. This produces a line of best fit through the sample data thereby estimating average instead of optimal (maximal) production function. It also assumes that technical inefficiency is absent. Some of the studies in Nigeria that made use of this analytical technique are that by Omotesho *et al* (1993), Ayanwale (1995), Alimi (2000) and Alimi (2001). If in reality that (some) firms exhibit inefficiency in production, then maximal (frontier) function

representing a best-practice technology, against which the efficiency of firms within the industry can be measured, is necessary rather than average function of OLS.

### Production Frontier Models

Production frontier function shows the maximum output obtainable from each level of input or inputs combination. Habibullah and Ismail (1994) noted that there are numerous ways of estimating a production frontier. Surveys on various methods were made by Forsund *et al.* (1980) and Thiry and Tulkens (1989). Generally, there are four methods that can be used to estimate the production frontier. These are: (i) non-parametric frontier as stated by Deprins *et al.* (1984);(ii) deterministic parametric frontier applied by Aigner and Chu (1968); (iii) deterministic parametric frontier applied by Schmidt (1976) and Greene (1980), using maximum likelihood (ML) and corrected ordinary least square (COLS) methods, respectively; and (iv) stochastic parametric frontier popularized by Jondrow *et al.* (1982).

Although a variety of methods are used to measure production frontier, each of these methods has advantages and disadvantages and there is no obvious superior approach among these methods (Aly *et al.*, 1987). This position was supported by

Dawson (1995), Ekanayade and Jayasuria (1987), Bravo-Ureta and Rieger (1990), and Kalaitzandonakes *et al.* (1992). Neff *et al.* (1993) warned against the use of different methods when inferring for policy purposes. The most common method of estimating frontier function is stochastic parametric frontier.

#### Stochastic Parametric Frontier Model

Consider a firm using  $n$  inputs ( $x_1, x_2, \dots, x_n$ ) to produce a single output  $y$ . Efficient transformation of inputs into output is characterized by the production function  $f(x)$ , which indicates the maximum output obtainable from various input vectors. The common production functional forms for the stochastic frontier are Cobb-Douglas, translog (Greene 1980) and the Zellner-Revankar generalized production functions (Kumbhakar *et al.* 1991). The stochastic frontier production function is expressed as

$$y_i = f(x_i; b) \exp(v_i - u_i) \dots \dots \dots (1)$$

Where  $y_i$  is the output of the  $i$ -th farm;  $x_i$  is a vector of inputs;  $b$  is a vector of parameters to be estimated;  $f(x)$  is a suitable functional form;  $v_i$  is a symmetric random error that is assumed to account for measurement error and other factors not under the control of the farmer;  $u_i$  accounts for technical inefficiency in production; "exp" stands for

exponential function and  $i = 1, 2, \dots, N$ . This model is such that the possible production  $Y_i$  is bounded above by the stochastic quantity  $f(x_i; b) \exp(v_i)$ , hence the term stochastic frontier. The random errors  $v_i$  are assumed to be independently and identically distributed as  $N(0, S_v^2)$  random variables independent of the  $u_i$ . Some of the assumed distributional forms of  $u_i$  are half normal, truncated normal, exponential and the two-parameter gamma. The parameter estimates are obtained using either maximum likelihood (ML) method or a variant of corrected ordinary least squares (COLS). Coelli (1995) noted that with the availability of automated ML routines, ML estimator is preferred to COLS estimator.

#### Technical Efficiency of Individual Firms

Efficient firms operate on the frontier while those that operate below the frontier are considered to be inefficient. The amount by which a firm is below its production frontier is considered as the measure of its inefficiency. Technical efficiency of an individual firm is defined in terms of the ratio of the observed output ( $Y_i$ ) to the corresponding frontier output ( $Y_i^*$ ), given the available technology.

$$\text{Technical efficiency (TE)} = Y_i / Y_i^* \\ = f(x_i; b) \exp(v_i - u_i) / f(x_i; b) \exp(v_i)$$

$= \exp(-u_i)$

One of the initial setbacks of the stochastic frontier was difficulty in measuring the technical efficiencies of the individual firms. This is because the error term has two components, a symmetric error to account for noise ( $v_i$ ) and an asymmetric error ( $u_i$ ) to account for technical inefficiency. Thus, the residuals from the estimated function will be a mixture of these two effects (i.e. observed values of  $e_i = (v_i - u_i)$ ). This problem was solved by Jondrow *et al.* (1982) who suggested the use of expectation  $u_i$ , conditional upon  $e_i = v_i - u_i$  to predict  $u_i$  and hence to predict  $TE_i = \exp(-u_i)$ . Some of the studies conducted on technical efficiency of firms are that by Xu and Jeffrey (1998), Tadesse and Krishnamoorthy (1997), Habibullah and Ismail (1994), Son *et al.* (1993). A number of empirical studies have identified the sources of technical inefficiency, in addition to predicting the technical efficiency for the firms. Several of these empirical studies have investigated the sources of technical inefficiency in different industries using two-stage analytical method. However, studies by Kumbhakar *et al.* (1991), Huang and Lui (1994), have questioned the theoretical consistency of this two-stage analytical techniques and have proposed the use of stochastic

frontier specifications which incorporate models for the technical inefficiency effects and simultaneously estimate all the parameters involved (single-stage approach). Some of the studies that had used single stage approach are Coelli and Battese (1996), Ajibefun *et al.* (2002), Ajibefun and Daramola (2003) and Bamire *et al.* (2004).

## RESEARCH METHODOLOGY

### Study Area

The study area was Oyo State of Nigeria. The State is located in the southwestern part of Nigeria and has forest and derived savannah vegetation to its southern and northern parts, respectively. The two vegetation types are suitable for beekeeping.

### Sampling Technique, Data Collection and Analytical Techniques

List of modern beekeepers was obtained from the Beekeepers Association of Nigeria (BAN), Oyo State branch. All the beekeepers totaling 114 were interviewed. Structured questionnaire was administered on the beekeepers and data were collected in January, 2005. The questions asked covered the areas of the beekeeper and the enterprise's socio-economic characteristics and the resource inputs and output of production. Data were analyzed using descriptive and inferential statistics and stochastic

frontier production function.

### Stochastic Frontier Production Model for beekeeping Enterprise

Prior to estimation of a frontier function, the form of the production function has to be specified. Two different functional forms for the stochastic frontier were considered, namely, the translogarithmic and the Cobb-Douglas production functions. These are the two most common functional forms, which have been used, in empirical studies on production including frontier analyses. The interest was in testing if the Cobb-Douglas function is an adequate representation of the data, given the specifications of the translog stochastic frontier, in choosing the function that better described the data between the two functions. However, it should be noted that Cobb-Douglas frontier is the restricted form of the translog frontier, in which the coefficients of the second-order terms are zero. In this study, a typical one output-four inputs beekeeping production function was specified. If the result of the estimated models indicated Cobb-Douglas as a better fit than the translog and was chosen as the lead equation, the non-stochastic production function would be specified as follows:

$$Y = \alpha_0 X_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} X_4^{\beta_4} \dots \dots \dots (2)$$

Where:

Y is the dependent variable and

represents output of honey in litre produced per year.

X<sub>1</sub> is number of beehive boxes

X<sub>2</sub> is labour measured in man-hours

X<sub>3</sub> is the management index.

Management plays an important role in any production system. A farmer with a very good management method is at a vantage position to bring production to its frontier. Studies that included management as input in production are those by Makary and Rees (1981), Dawson and Lingard (1982), Mefford (1986), Dawson and Hubbard (1987), Nyong (1989), Mukhtar and Dawson (1990) and Habibullah and Ismail (1994). In this study, management was measured in term of management practices engaged in by the beekeepers and the degree of involvement. Each of the beekeepers was confronted with a list of management practices that would bring about high honey yield. The management practices considered were site selection, routine inspection, feeding, prevention of swarming, pest control, requeening, equalizing, harvesting, processing, packaging, marketing, record keeping and record analysis. A beekeeper was scored zero for a management practice not implemented, and ranked on a scale of 1 to 3 on the ones implemented depending on the degree of implementation. Manage-

ment index for a beekeeper is considered to be the sum of the scores on all the management practices.

X<sub>4</sub> is the other inputs measured in monetary term (cost) because of their heterogeneity.

Parameters α<sub>0</sub> denotes the technical efficiency level, and β<sub>1</sub>, β<sub>2</sub>, β<sub>3</sub> and β<sub>4</sub> are partial elasticities of the various inputs with respect to output. Since the production function is Cobb-Douglas, the sum of the partial elasticities gives the returns to scale.

The Cobb-Douglas stochastic function is stated as:

$$Y = \alpha_0 X_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} X_4^{\beta_4} e^{V_i - U_i}$$

Which when linearised by finding log of both sides becomes:

$$\ln Y = \ln \alpha_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + V_i - U_i \dots \dots \dots (3)$$

where ln represents the logarithm to base e.

V<sub>i</sub> are assumed to be independent and identically distributed random errors having N(0, σ<sup>2</sup>) distribution.

U<sub>i</sub> are non-negative random variables, called technical inefficiency effects, which are assumed to be independently distributed such that U<sub>i</sub> is defined by the truncation (at zero) of the normal distribution with mean, u<sub>i</sub> and variance, σ<sup>2</sup>, and u<sub>i</sub> is defined by

$$U_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i} \dots \dots \dots (4)$$

Where Z<sub>1</sub> is beekeeper's age measured

in years; Z<sub>2</sub> represents literacy level in number of years of formal education; Z<sub>3</sub> is experience measured in number of years as a beekeeper; Z<sub>4</sub> is number of contacts with the extension agents on beekeeping enterprise; and z<sub>5</sub> is sex which is represented by a dummy variable (D), recorded as 1 for a male beekeeper and 0 for female.

The model for technical inefficiency effects, defined by equation (3) specifies that the technical inefficiency effects in the stochastic frontier (2) are a function of the beekeeper's age, literacy level, and experience in beekeeping, extension agents' visits and sex.

The *a priori* expectations are that:

- i) The older the beekeeper, the higher the inefficiency. This is based on the assumption that older farmers are less adaptable to new technological innovations.
- ii) More years of formal education would result in smaller technical inefficiency values.
- iii) Technical inefficiency value decreases with years of experience in beekeeping.
- iv) Higher contacts with extension agents on beekeeping would reduce technical inefficiency
- v) Male beekeepers would be less technically inefficient than the female. The maximum-likelihood estimates for all the parameters of the stochastic frontier and inefficiency model, defined by

equations (3) and (4), were simultaneously obtained by using the program, FRONTIER 4.1 (Coelli 1995), which estimates the variance parameters in terms of the parameterization.

$$\sigma_s^2 = \sigma^2 + \sigma_v^2 \text{ and } \gamma = \frac{\sigma^2}{\sigma_s^2}$$

where the values of  $\gamma$ - parameter lie between zero and one.

**Hypotheses Testing**

The following null hypotheses were tested at 5% level of significance:

i) the Cobb-Douglas frontier is an adequate representation of the data, given the assumption of translog frontier.

$$H_0: \beta_{jk} = 0, j \leq k = 1,2,3,4$$

This was with the intention of choosing the lead equation between translog and Cobb-Douglas and was conducted at the preliminary analysis stage.

ii) the inefficiency effects are absent from the model.

$$H_0: \gamma = 0$$

This is to indicate if traditional mean response function is an adequate representation of the data.

iii) The coefficients of the explanatory variables in the inefficiency model are simultaneously zero.

$$H_0: \delta_1 = \dots = \delta_5 = 0$$

iv) the beekeepers used each of the resources in the rational zone of production, that is the production

elasticity of each resource input lies between zero and one ( $0 < \beta_i < 1$ ).

v) Comparison of mean efficiency and most efficient (100%) levels.

The efficiency level of each beekeeper and the mean efficiency level of all the beekeepers were computed. The mean efficiency level was compared with efficiency level of 100% to test if the beekeepers were fully efficient and operated at the production frontier by testing the null hypothesis ( $H_0$ ), that the mean efficiency level is equal to unity (100% efficiency) against the alternative hypothesis ( $H_1$ ) that the mean efficiency level is significantly less than unity (equations 5 and 6, respectively) using the test statistic stated in equation (7) and tested at 5% level of significance. This is to find out if an average beekeeper operated at the level of efficiency lower than the most efficient.

$$H_0: \mu = \mu_0 \dots \dots \dots (5)$$

$$H_1: \mu < \mu_0 \dots \dots \dots (6)$$

Where  $\mu$  is the population mean efficiency;  $\mu_0$  is the 100% efficiency level and  $H_1$  is the alternative hypothesis that will be accepted on rejection of the null hypothesis.

$$\text{Teststatistic } (t_c) = \frac{X - \mu_0}{\sigma / \sqrt{n}} \dots (7)$$

Where  $\sigma$  is the population standard deviation,

which is unknown. It is represented by sample standard deviation because of the large sample size, taking the advantage of central limit theorem (Daniel and Terrell 1979).  $\bar{X}$  is the sample mean and  $n$  the sample size.

## RESULTS AND DISCUSSION

### Summary Statistics of Variables

A summary of the values of the variables of beekeeping enterprises used in this study is presented in Table 1. The mean value of output of the beekeepers was 177.6 litres of honey, with the least output being 42.7 litres and highest 249.3litres. The number of bee hive boxes varied between 8 and 56, with a mean of 33.6. The man-hours of labour used ranged between 625 and 19119 with a mean of 12076.4, and most of which are family labour. Significant proportion (78%) of beekeepers took beekeeping as part-time. The mean score on management index was 25.9. A maximum mean score of 39 would be obtained if the beekeepers operated efficient management system. Investment on other inputs excluding beehives varied between ₦9566 and ₦38257 with a mean of ₦ 22180. None of the beekeepers was younger than 22 years and none older than 64. The mean age was 43.2 years. Most of the modern beekeepers (80%) were able to read

and write in Yoruba (local language) and English language. The mean number of years spent in formal schools was 11.3. Experience in beekeeping varied from one to nineteen years with a mean of 12.1 years. About 5% of the beekeepers had no contact at all with extension agents on beekeeping enterprise and the mean number of contacts with extension agents was 9.6 per annum. Only about a quarter of the beekeepers were female.

### Test of Hypotheses

The results of the null hypotheses tested are presented in Table 2. The first null hypothesis,  $H_0: \beta_{jk} = 0, j \leq k = 1,2,3,4$ , which specifies that the Cobb-Douglas frontier is an adequate representation of the data given the assumptions of the translog frontier model was not rejected, as such Cobb-Douglas function rather than translog was chosen as the lead equation and was estimated.

The second null hypothesis that there are no technical inefficiency effects,  $H_0: \gamma = 0$ , was rejected, implying that the average response function was not an adequate representation of the data and that technical inefficiency effects associated with beekeeping enterprise are highly significant.

The third null hypothesis, which states that the coefficients of

the explanatory variables in the inefficiency model are simultaneously zero,  $H_0: \delta_1 = \dots = \delta_5 = 0$ , was rejected.

**Table 1: Summary statistics of socio-economic variables of beekeepers in Oyo State of Nigeria**

Variables	Sample Mean	Standard Deviation	Minimum	Maximum
Output value (litres)	177.6	31.4	42.7	249.3
Number of hives	33.6	10.4	8	56
Labour (man-hours)	12076.4	2598.1	625	19119
Management index	25.9	14.5	14	34
Cost of other inputs (naira)	22180	8122	9566	38257
Beekeepers' age (years)	43.2	20.5	22	64
Literacy level (years)	11.3	5.3	6	18
Experience in beekeeping (years)	12.1	6.2	1	19
Extension agents' contacts	9.6	4.4	0	15
Sex (number): Male	85			
Female	29			

Source: Field survey, 2005

**Table 2 :Generalised likelihood-ratio tests of hypotheses for parameters of the stochastic frontier production function for beekeepers in Oyo State**

Null hypotheses	Log likelihood	$\lambda$	Critical value	Decision
$H_0: \beta_{jk} = 0, j \leq k = 1, 2, 3, 4$	-26.03	11.43	18.31	Accept $H_0$
$H_0: \gamma = 0$	-32.67	39.61	13.96	Reject $H_0$
$H_0: \delta_1 = \dots = \delta_5 = 0$	-43.98	22.67	16.94	Reject $H_0$

Source: Computed from field survey data, 2005

Level of significance ( $\alpha$ ) is 0.05

Hence, all the explanatory variables in the inefficiency model (equation 4) made significant contributions in the explanation of the inefficiency effects associated with the values of output of the beekeepers. The

estimated coefficient for each of the identified inefficiency variables in the inefficiency model of equation 4 conforms to a priori expectation (Table 3). The estimated coefficient for age of beekeepers in the

inefficiency model is positive and significant, which indicates that the older farmers are more technically inefficient. The variable experience carries a negative sign, signifying an inverse relationship between experience and technical inefficiency. The more experienced a beekeeper is the less the technical inefficiency. The coefficient of literacy level for beekeepers is negative which indicates decrease in technical inefficiency with literacy.

**Table 3: Maximum likelihood estimates of parameters of Cobb-Douglas stochastic frontier production function for beekeepers in Oyo State of Nigeria**

Variables	Parameters	Estimates
<b>Frontier function</b>		
Constant	$\beta_0$	5.23 (2.17)
Number of hives ( $X_1$ )	$\beta_1$	1.232 (0.365)
Total labour ( $X_2$ )	$\beta_2$	0.324 (0.111)
Management ( $X_3$ )	$\beta_3$	0.343 (0.098)
Cost of other inputs ( $X_3$ )	$\beta_4$	0.448 (0.203)
<b>Inefficiency model</b>		
Constant	$\delta_0$	3.255 (2.232)
Age( $z_1$ )	$\delta_1$	0.093 (0.041)
Experience( $z_2$ )	$\delta_2$	-0.932 (0.258)
Literacy level( $z_3$ )	$\delta_3$	-0.018 (0.007)
Extension contacts( $z_4$ )	$\delta_4$	-0.098 (0.031)
Sex( $z_5$ )	$\delta_5$	0.196 (0.182)
<b>Variance parameters</b>		
	$\sigma_s^2$	0.0218 (0.0063)
	$\gamma$	0.7916 (0.2119)
<b>Likelihood function</b>		26.578

Source: Field survey, 2005

Level of significance ( $\alpha$ ) is 0.05

The coefficient of extension contacts variable carries a negative sign indicating increase in technical efficiency of beekeepers with involvement of extension advisers. The coefficient of the sex variable in the inefficiency model is positive but not statistically significant. By the sign carried by this variable, male are less technically inefficient than the female.

The fourth null hypothesis which states that the beekeepers used each of the resources in the rational zone of production (the production elasticity of each resource input lies between zero and one,  $H_0 : 0 < \beta_i < 1$ ) was rejected for all the resources except enterprise size.

The elasticity of enterprise size was significantly greater than unity implying that operation was in the irrational zone of the production function (stage one) and increasing the enterprise size in the short run while keeping other resources constant will increase productivity. The other resources were used in the rational zone of production. Identifying if the optimal quantity of each of these resources is used requires further analyses not considered by this study. The returns-to-scale parameter is 2.347 (Table 3) indicating increasing returns to scale, such that increasing all the

inputs by 1% increases output by 2.347%.

#### **Technical Inefficiencies**

The individual technical efficiencies obtained for the beekeepers are presented in Table 4. The predicted technical efficiencies differ greatly, varying between 0.214 and 0.909, with the mean technical efficiency estimated to be 0.622 and standard deviation of 0.154. The null hypothesis that the beekeepers operate at full technical efficiency level (equation 5) is rejected ( $t_c = 26.2$ ) and the alternative hypothesis (equation 6) that they are significantly inefficient is accepted. This implies that there is still an avenue for productivity improvement by improving technical efficiency. In order to give a clearer indication of the distribution of the technical efficiencies, a frequency distribution of the predicted technical efficiencies in decile ranges is presented in Table 5. The sample frequency distribution indicates that three - fifths of the beekeepers have technical efficiencies between 0.50 and 0.70. There appears to be a considerable opportunity for effecting improvements in the technical efficiency of the beekeepers for increased productivity in Oyo State of Nigeria.

**Table 4: Predicted technical efficiencies of beekeepers**

Beekeeper number	Technical efficiency	Beekeeper number	Technical efficiency	Beekeeper number	Technical efficiency
1	0.345	41	0.679	81	.463
2	0.435	42	0.456	82	.364
3	0.736	43	0.653	83	.412
4	0.527	44	0.680	84	.636
5	0.638	45	0.804	85	.327
6	0.686	46	0.714	86	.547
7	0.314	47	0.634	87	.467
8	0.705	48	0.675	88	.431
9	0.725	49	0.762	89	.909
10	0.414	50	0.687	90	.827
11	0.657	51	0.901	91	.713
12	0.532	52	0.874	92	.667
13	0.667	52	0.653	93	.596
14	0.813	54	0.680	94	.624
15	0.654	55	0.734	95	.569
16	0.396	56	0.753	96	.579
17	0.800	57	0.715	97	.653
18	0.692	58	0.634	98	.816
19	0.568	59	0.834	99	.742
20	0.674	60	0.745	100	.654
21	0.598	61	0.563	101	.653
22	0.615	62	0.774	102	.653
23	0.521	63	0.864	103	.777
24	0.743	64	0.863	104	.432
25	0.214	65	.721	105	.702
26	0.645	66	.432	106	.532
27	0.834	67	.653	107	.560
28	0.567	68	.576	108	.268
29	0.503	69	.765	109	.543
30	0.847	70	.563	110	.524
31	0.546	71	.286	111	.579
32	0.653	72	.415	112	.548
33	0.674	73	.615	113	.444
34	0.596	74	.674	114	.287
35	0.842	75	.712		
36	0.756	76	.637	Mean	0.622
37	0.687	77	.752		
38	0.665	78	.642		
39	0.907	79	.373		
40	0.574	80	.294		

Source: Field survey data, 2005

**Table 5: Frequency distribution of technical efficiencies in decile ranges**

Efficiency (E) range	Frequency (%)	Cumulative frequency (%)
$0.20 < E < 0.30$	4.4	4.4
$0.30 \leq E < 0.40$	5.2	9.6
$0.40 \leq E < 0.50$	9.7	19.3
$0.50 \leq E < 0.60$	20.2	39.5
$0.60 \leq E < 0.70$	29.8	69.3
$0.70 \leq E < 0.80$	17.5	86.8
$0.80 \leq E < 0.90$	10.6	97.4
$0.90 \leq E \leq 1.00$	2.6	100.0

Source: Field survey data, 2005

#### SUMMARY AND CONCLUSION

The study determined the resource use status and factors influencing technical efficiency in beekeeping enterprise in Oyo State of Nigeria. All the modern beekeepers of BAN, Oyo State chapter were interviewed. Data collected were on socio-economic characteristics of beekeepers and beekeeping enterprise, which were analysed using descriptive and inferential statistics, and stochastic frontier production model.

Results indicated that only enterprise size (number of beehives) was underutilized and all other resources were used in the rational zone of production. This indicates that increasing the number of beehives boxes (enterprise size) while keeping other resources constant will increase productivity.

The returns to scale were greater than unity, implying higher

proportional increase in output than increase in all the inputs combined together. The inefficiency effects of beekeepers were directly related to age and gender and inversely to literacy level, experience and extension contacts. There was room for increase in productivity without change in technology as mean technical efficiency was only 62.2%. Thus, rise in productivity of bee honey could be achieved with increase in quantity of resource inputs used and beekeeper's literacy, experience and extension agent's visits and involvement of young people in beekeeping industry.

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