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ESTIMATION OF EFFICIENCY DIFFERENTIALS IN HONEY BEE ENTERPRISES: IMPLICATIONS FOR HIGHER PRODUCTIVITY IN KEBBI AND KWARA STATES OF NIGERIA

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Abstract

The total honey produced in Nigeria is usually inadequate, not documented and the country only meets the domestic consumption partly from the public based farm, local farmers and mostly import from other countries.This paper examines the Technical Efficiency (TE) gaps between traditional and modern honey bee enterprise in Kwara and Kebbi States, Nigeria. The multistage sampling technique was employed in randomly selecting 80 beekeepers comprising 30 traditional beekeepers from each State and 20 modern beekeepers from both States. The main tools of analysis were descriptive and inferential statistics. Empirical result showed that the mean TE value for modern production system was about 0.84 compared to traditional unit with 0.59. This is an indication that on the average, the bee farmers were operating TE of 0.16 and 0.41 below the frontier for modern and traditional systems respectively. TE coefficients of number of hives (0.29); adjusted hired labour (0.21) and number of baits (0.08) in modern bee farming and traditional bee farming adjusted family labour and number of baits coefficients (-0.05; 0.43) shown that these variables increased TE. A positive mean difference of about ₦6,752 in income was realized among bee farms that adopt new bee farm equipments. The demand-supply gap of honey products could be bridged and sustainable increased output could be achieved if farmers adopt a new techniques and improved their technically efficiency as ample opportunity still exist to move closer to frontier.

Keywords: Baiting materials, efficiency gaps, honey bee, Kenya top bar.

INTRODUCTION

Malthusian theory of arithmetic and geometric of growth of resources and their users opined that the rate of economic growth is lower than that of population increase. Specifically, the theory stated that while food production move at arithmetic mean, human population grow at geometric mean. Food and Agricultural Organisation (2009) affirmed the theory by projecting that feeding a world population of about 9 billion people in 2050 would require raising overall food production by at least 70%. But, the State of Nigeria agriculture and food production, the future challenges and potential solutions required specific agricultural development pathways and technology that must work towards eradicating poverty, hunger and malnutrition in our generation (Diao *et al*., 2012).Investment in modern honey bee production system, ab initio, is one of the pathways for achievingSustainable Development Goals (SDGs)of complete eradication of hunger, enhances food security and improved nutrition, and promotes sustainable agriculture or otherdevelopment goals and targets as proposed by post 2015 SDGs United Nation General Assembly for developing countries including Nigeria.

In view of these, honey bee practices must become more productive, more profitable, resource efficient, more resilient, and less wasteful particularly for millions of bee farmer households in Nigeria and other developing countries that constitutes the bulk of honey production. It is essential to move towards more sophisticated, more knowledgeable, intensive forms of practices and provide the technologies and incentives that make it viable for bee farmers to adopt and adapt (Oladimeji *et al.,* 2015). However, the most critical issue is to increase production in agricultural practices by closing yield and efficiency gaps and, where possible diversifying the technological practices and reduce loss. There are still significant yield gaps in artisanal bee farming that can be exploited through simple intervention such as improve practices and affordable new technology.

For example, Inoni and Oyaide, (2007); Kareem *et al.* (2013) and Oladimeji *et al.* (2015) observed a gap analysis in analysis of efficiency (differentials) in the motorised and non-motorised segments of the artisanal fisheries sector and indicated that the motorised segment was betterin efficient utilization of resources in the production process among the duo. And also reveal the inefficiency with respect to socio-economic factors in both sectors. Therefore,knowledge of the efficiency level at the firm level and its determinant factors are valuable information for understanding the problems of fisheries subsector of agriculture (Kareem *et al.,*2013) as well as other agricultural practices such as bee production. Technical efficiency can be measured by different techniques (Färell *et al*., 1994), but given the stochastic nature of honey bee production, the stochastic frontier approach has so far been advocated in the literature (Kirkley *et al.,* 1995).

Problem Statement

Given the recent and previous government’s economic policies that aimed at improving farm productivity and market performance of agricultural products with export potential, detailed and systematic empirical studies on the production performance among small scale honey bee farmers in Nigeria is necessary. Moreover, despite the huge production potential due to favourable weather conditions and the availability of unemployed millions of youths and able body, and dire demand at export markets of honey, there is need to stir effort towards exploiting honey bee production to addressed demand-supply gap and improve the standard of living of bee farmers (Ajao, 2012; Oladimeji *et al.,* 2015). Like most developing countries, the total honey produced in Nigeria is usually inadequate, not documented and the country only meets the domestic consumption, of recent, partly from the public farm-based institution, traditional honey bee farmers and mostly import from other countries.

Although, beekeeping is advocated to improve human welfare by alleviating poverty through increasing household income, biodiversity conservation, food and nutritional security, raw material for industries and enhance environmental resilience as enumerated by Ajao *et al*. (2014), there is need to focus on critical areas such as basic information on efficiency differentials, and overall improvement in productivity and environmental performance to close honey yield gaps. The honey yield gaps vary widely worldwide in line with Dobermann and Nelson (2013) who observed that the agricultural productivity gaps are particularly large in Sub-Saharan Africa. Subsistence nature of our rural agricultural system brings into focus low yield and income, thereby making poverty to be prevalence among rural farmers. This paper focuses on achieving a sustainable honey production through estimation of Technical Efficiency (TE) in both traditional and modern honey production patterns. Specifically, to identify socioeconomic characteristics of respondents and provide technical suggestions for enhancing productivity, profitability and sustainability of bee farming practices.

MATERIALS AND METHODS

The study was conducted in Kebbi and Kwara States, Nigeria. Kebbi State lies between latitudes 10°8'N and 13°15'N and longitudes 3°30'E and 6°02'E. The Sate is bounded by Sokoto State to the north and east, Niger State to the south, and Benin Republic to the west.Kebbi State is divided into 21 Local Government Areas (LGAS), four emirate councils (Gwandu, Argungu, Yauri and Zuru), and thirty-five districts (KSG, 1996). The State is also divided into four Agricultural Developmentzones namely; Zone I (Argungu), Zone II, (Bunza), Zone III (Zuru) and Zone IV (Yauri).The State has a total landarea of approximately 36,229 sq. km. Out of this, only an estimated 13,209sq. km is currently being used for cultivation, while 293 sq. km is the built uparea thus far, leaving a large proportion of land still under-utilized (Suleiman, 2007).

Kwara State lies between latitude 8°10' and 19° 50'N and between longitudes 3° 10’ and 6° 05'E. The area falls within the southern limits of the tropical savannah zone of Nigeria with mean annual rainfall ranges from 800mm to 1500mm and annual temperature is between 31.5°C and 35°C (Oladimeji and Abdulsalam, 2013). The State lies in two geo-ecological zones; the derived savanna which is characterized by woodland and the Guinea savanna whichis characterized by tall grasses growing intermixed with deciduous trees. Economic trees found in the study areas includes Citrus sinensi,, Parkia biglobosa, Butyrospermum parkii, Azadiracta indica, Mangifera indica, Acacia species Delonix regia and Anacardium occidentale. These species of trees provide forage for the bees (KWADP, 2008).

Sampling procedure and technique

The cross-sectional data used in the study were collected in 2014 using a multi-stagesampling procedure. The first stage of the sampling selected Kebbi and Kwara States from North West and North Central Nigeria respectively and the second stage randomly selected three LGAseach where both traditional and modern beekeeping are being practiced in both States. The third stage involved random selection of two settlements each from the list of selected LGAs in the two States. Finally, a list of bee-keeping farms wasgenerated for each settlements and a proportionate random sampling resulted in a sample totalling 84 bee farms comprising 30 traditional bee farms from each State and 20 modern bee farms from both States. Primary data were obtained using a structured questionnaires and interview schedule. The selected LGAs include: Kebbi State: Bagudo (Lolo, Bagudo);Koko-Besse (Koko, Besse); Ngaski (Ulaira, Warrah); and Kwara State: Ifelodun (Buhari, Share); Moro (Bode-saadu; Malete); Patigi (Lade, Sunkuso).

Analytical techniques

The approach used to obtain technical efficiency is to estimate a stochastic frontier, where technical inefficiency is measured as the deviation of an individual bee farm/hive production from the best-practice production frontier. In this approach, production is assumed to be stochastic because beekeeping is sensitive to random factors such as weather, resource availability, and environmental influences. The two States virtually share similar and close resource abundance and availability, species composition, ecosystems,weather, and socioeconomic conditions and religious beliefs. However, due to differences in nature of bee practices and socioeconomic factors between the modern and traditional bee farmingsectors, among beekeeping households in both Kebbi and Kwara States, Nigeria, three separate stochastic production frontiers are specified, one for each beekeeping unit and the last for the pooled data for representative of North Central and North western Nigeria. The stochastic model that was used for the analysis obtained by the MLE method using the program FRONTIER version 4.1c (Coelli, 1994) is of the form **equation (1)**

$Y_i = f(Xi, \beta).\ e v_i - u_i$

Where:

Y_i = output observed; $f(X_i , \beta)$ = frontier production function; X_i = vector of inputs; β= vector of parameter to be estimated; TE = technical efficiency; e = stochastic error term; v_i = random error and other factors not under the control of the bee farmers and u_i = stochastic error within the bee farmers control.

To estimate β, the stochastic production frontier model was linearised thus, **equation 2**

$\text{In } Y_i = \beta_o + \beta_1 \text{In } X_1 + \beta_2 \text{In} X_2 + \beta_3 \text{In} X_3 + \beta_4 \text{In} X_4 + \beta_5 \text{ In} X_5 + \beta_6 \text{ In} X_6 + V - U$

Where: The output ($\ln Y_i$);= Quantity of honey produced in season (Litres): $\ln X_1$= Area devoted for bee-keeping (Hectares); $\ln X_2$= Number of hives including the top bar invested (Standardized); $\ln X_3$ = Number of baits used (Standardized);$\text{In}X_4$ = Adjusted hired labour used in production (Labour-days); $\text{In}X_5$ =Adjusted family labour used in production (Labour-days) and $\text{In}X_6$= Number of other material used per season (Standardized)

Also, allocative efficiency was estimated using a Cobb-Douglas cost frontier function and was specified in **equation 3** as:

$\text{Ln}C_i = a_0 + a_1 \ln B_1 + a_2 \log B_2 + a_3 \log B_3 + a_4 \log B_4 + a_5 \log H_5 + a_6 \log B_6 + V_i + U_i$

Where:C_i = total cost of production per season; ln represents the natural logarithm;

B_1 = depreciation cost of land area used for honey farm per season; B_2= depreciation cost of hives used per season; B_3 = cost of baits per season; B_4 =wage rate per labour days of hired labour per season; B_5 = the wage rate per labour days of family labour per season and B_6 = miscellaneous cost such as protective wares, boots, cutlasses etc; a_0 = Intercept; a_1-a_6 = Vector of cost function parameters to be estimated; V_i = random variability in the cost of production that cannot be influenced by the farmer and u_i= the deviation from cost frontier attributable to allocative inefficiency.

The inefficiency of production was modelled in terms of the socio-economic and institutional factors that were assumed to affect the efficiency of production of the bee farmers. The determinants of technical inefficiency, (μ_i), is defined by **equation 4**

$\mu_i = f(Z_i; \omega)$

Where: μ_i = technical inefficiency;

Z_i = vector of bee farmer's specific factors and

ω = vector of parameters to be estimated as shown in **equation 5**

$$u_i = \omega_0 + \omega_1 Z_1 + \omega_2 Z_2 + \omega_3 Z_3 + \omega_4 Z_4 + \omega_5 Z_5$$

Where: U_i= technical inefficiency of the ith bee farmers; ω_1= bee farming experience (years); ω_2= Adjusted household size of bee farmers (number); ω_3= Extension visits during bee farming (number); ω_4=Years of formal education/training and ω_5= years of membership of cooperative in farming.

RESULTS AND DISCUSSION

Socio-economic and technical efficiency data

Summary statistics of the data reported in Table 1 indicate that traditional bee practices are family labour intensive, with mean education index of 1.6 years, and that 65% of the respondents had up to 15 years experience in bee farming, In addition, the bulk (98%) were male; 95% were married with mean age of 56 years and honey bee output of 2.6 L per hive and mean bee income of about ₦45 000 per season. Compared to Modern honey bee which was hired labour intensive, has mean education index of 8.7, possess mainly Kenya top bar, has more honey output of 5.2 L per hive, are more capital intensive, have larger revenue and harbour more honey bees per colony. The findings in modern bee farming is in agreement with studies of Chala *et al.* (2013); Onwubuya *et al.* (2013) and Ojo *et al.* (2016) who noted that majority of modern bee farmers are more educated, had secondary occupations and were below the age of 50 years.

The traditional bee production system relied mostly on artificial baits and source local materials to make their hive, devoted less area to bee practices and their hives also have shorter expected remaining economic lives than the modern Kenya top bar. Furthermore, modern Kenya top bar attract more bee with assorted baits thereby producing more honey than traditional type that source both hives and baits from local sources. Both traditional and modern honey bee production systems, however, have no access to credit from formal institution in line with studies of Ebojei *et al.* (2008); Ajao and Oladimeji, (2013), but have access to ancillary income from arable crop farming with a greater proportion of traditional bee farmers (84%) and only 32% of modern bee farmers relying on arable farming.

Fig. 1: A and B adapted from Ajao (2012)

Figure 1A shows a typical hive used by traditional beekeepers in the study area compare to figure 1B which depict modern Kenya top bar hive used mostly by modern beekeepers in the study area. Other modern hives used are transitional and moveable hives such as Tanzania top bar, Langstroth, Omdurman clay hives and Gufa basket hives. It suffice to note that tradition beekeepers in the studied area have rich indigenous knowledge of beekeeping, a good knowledge of different types of hives,made from whatever materials available locally such as local gourd hives, split log, bark logs, cylindrical log hives,bark, clay pots, grasses woven into mats and rolled up, leaves of the doum palm "tangels" (Ajao, 2012).

Stochastic frontier models

Result in Table 2 shows that sigma squared (σ^2) for all the 3 sectors: traditional, modern and pooled bee systems wereall statistically significant which indicates the correctness of the specified distribution assumption of the composite error term. The gamma (γ) values for the three tiers of bee production systems connote variation resulting from the technical inefficiencies which also suggests that the specified model better fits the data than the average production function model.

Parameter estimates of traditional honey bee production shows that number of baits used (X_3) and adjusted family labour (X_5) had a positive and clearly statistically significant estimated coefficients while number of hives (X_2) also has positive and marginally significant at 10%, but for modern honey bee production, number of hives (X_2); baits used (X_3) and adjusted hired labour (X_4) were all clearly statistically significant estimated coefficients at 1%. A possible explanation for significance of (X_2); (X_3); and (X_4) in modern bee farming is the level of investment committed by this sector and more commitment by the use of hired labour which may be attributed to the fact that the bee farming household head may had acquired the service of be expertise that are knowledgeable and educated in modern bee production system. On the traditional unit, X_3 and X_5 were highly significant largely due to family oriented nature of the enterprise. The studies was in tandem with findings ofInoni and Oyaide, (2007); Kareem *et al.* (2013) and Oladimeji *et al.* (2015) who observed that the motorised fishery segment was betterin efficient utilization of resources in the production process than traditional canoe fishery.

Technical Efficiency Scores

Finding in Table 3 shows that modern operators were more technical efficient than traditional ones. The arithmetic means of the individual technical efficiency scores were 0.84 for the modern unit and 0.59, for traditional unit. This implies that bee farmers could increase honey output if the efficiency of inputs usage is increased by 0.16 and 0.41 for operators in modern and traditional units respectively. Thus, opportunity still exists for increasing honey productivity and income through increased efficiency with the use of existing resources as observed by Kareem *et al.* (2013) and Oladimeji *et al.* (2015) among artisanal fisheries in Ogun and Kwara States respectively. Formal education of the bee farming heads was also find to increase efficiency level in the studied area as nearly 70% household heads with formal secondary training had their efficiency greater than 60% while only 31% of bee farmers without formal training had up to 50% level of efficiency. Squires *et al*. (2002) posited that additional schooling can improve literacy and cognitive skills which may reduce technical inefficiency by increasing the ability of farming household heads to adopt technical innovations.

The results of the stochastic frontier model estimated in Table 4 showed that there are significant differences in the allocative efficiency of both traditional and modern bee farming systems. Wage rate per Labour Day of family labour per season (B_5) was statistically significant at 1% and both depreciation cost of hives (B_2) and of baits used per season ($B_{3)}$ were statistically significant at 5% in traditional method. However, B_3 was significant at 5% in modern bee system; B_2 and wage rate per labour day of hired labour per season (B_4) were also statistically significant at 1% level of probability in modern bee unit.

It is succinct to note that the mean allocative efficiency in modern bee segment was also higher, about 75% than the traditional unit (54%). Thus, a combination of statistically significant socio-economic factors in combination with modern techniques such as Kenya top bar and assorted baits is a strategy that can be use to make beekeeping more economically efficient in their investment decision. Therefore, artisanal bee farming in the study area should adopt improved bee techniques to increase their income which will ultimately improve their well being and reduce the level of poverty in the study area (Oladimeji, 2015).

The factors affecting technical inefficiency was analyzed by algebraic sign and significance of the estimated coefficients in Table 5 depict in equations 4 and 5 respectively. The coefficients of w_1, $w_2$in tradition methods werefound to be statistically significant (at 5% and 1% respectively) and w_1 has a negative sign which indicates a decrease in technical inefficiency or anincrease in technical efficiency. As for modern bee system, both w_3, w_4 carried*a priori*expectations and highly significant at 1% level of probability. One possible explanation for positive coefficient of w_2 is that in the traditional bee farming, the available labour for the work are too many This seems to be consistent with thebelief that many people in developing countries are underemployed (Ladipo *et al.*, 1992).

CONCLUSION AND RECCOMENDATIONS

The study showed that the 2 production systems exhibit a different degree of efficiencies. It also suggests that the factors that contribute to technical and allocative efficiencies differ considerably between the 2 bee production systems. The potential implications from these findings are that traditional bee production system should be educated on the need to imbibe modern bee production system. This would invariably lead to more honey and reduce Nigerian demand-supply gaps and expenditure on honey and its products. It could also aids in documenting honey produced in the country and assists the government in the overall socio-economic and institutional development of the bee production in Nigeria.

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Table 1: Differential Bee Farms Efficiency and Production Data in Kebbi and Kwara States, Nigeria

Description	Traditional method n = 60	Mean	Modern method n =20	Mean
Gender	98% were male	na	73% were male	na
Marital status	95% were married	na	69% were married	na
Age (years)	72% above 50 years	56	54% below 50 years	43
Level of education (yrs)	60% had no primary sch.	1.6	65% had secondary sch.	8.7
Bee F. Experience (yrs)	65% had up to 15 years	21	59% had < 15 years	12
Adj. household size	69% had 5-9 persons	7.3	55% had <5-9 persons	4.0
No. of extension contacts	89% had no contact at all	0.5	51% had contact (s)	2.4
Major occupation	78% engage in farming	na	37% engage in farming	na
Ancillary occupation	84% in arable cropping	na	32% in arable cropping	na
Family labour/season	85% used family labour	45	38% used family labour	26
Hired labour/season	30% used hired labour	14	78% used hired labour	41
Type of hive used	93% used local materials	24*	87% used Kenya T. bar	29
Hive materials life span	76% had < 3 years	1.4	76% had < 3 years	4.5
Bait types	74% used artificial baits	na	62% used assorted baits	na
Area devoted to bee farm	83% had < 1 ha	0.5	56% had < 1 ha	1.3
Access to credit (₦)	95% had no access to Cr.	2500	37% had access to Cr.	45 th
Level of investment (₦)	91% invest<₦ 100, 000	60 th.	79% invest<₦100, 000	180 th
Bee income/season (₦)	78% earn < 80th/season	45th	72% earn >₦ 100th/s.	118th
Off-bee income/yrs (₦)	64% had>₦100,000/year	127th	79% had>₦80,000/yr	105th
Honey B. output/hiv (L)	76% had < 5-6 L/hive	2.6	67% had >5-6 L/hive	5.2
Honey bee/colony (L)	35% had ≈ < 60, 000	na	47% had ≈ >60, 000	na

Source: *Field survey, 2014; Note: ₦ 167 = 1US$ in 2014; th denote thousand; na not available*

Table 2: MLE of the cobb−douglas stochastic frontier model for differential TE

Variable estimates	**Traditional**			**Modern**			**Pooled**		
	β	**SE**	**t-v**	**β**	**SE**	**t-v**	**β**	**SE**	**t-v**
Constant	0.75	0.38	1.97	0.06	0.03	2.04	0.62	0.43	1.45
$Ln\ X_1$	0.29	0.27	1.07	0.73	0.58	1.26	0.008	0.004	1.99
$llnX_2$	0.15	0.09	1.68	0.29	0.04	7.25	0.04	0.02	2.02
$Ln\ X_3$	0.43	0.11	3.87	0.08	0.03	2.67	0.31	0.54	0.57
$Ln\ X_4$	0.37	0.54	0.69	0.21	0.07	3.07	0.93	0.88	1.06
$Ln\ X_5$	-0.05	0.02	2.5	0.04	0.05	0.81	0.06	0.03	1.99
$Ln\ X_6$	0.007	0.008	0.88	0.006	0.005	1.30	0.009	0.13	0.07
		Diagnostic statistics							
σ^2	0.242		2.07	0.390		1.94	0.213		1.90
γ	0.429			0.648			0.372		
LR test	-25.90			76.8			-43.8		
LL	87.9			102.5			74.0		
Sampled	60			20			80		
av. TE	0.59			0.84			0.56		

Field survey, 2014; *t-v denotes t-value; SE = standard error;* β= coefficient; MLE= maximum likelihood estimate

Table 3: Differential Technical Efficiency Scores of bee farming enterprises

				Traditional (T) and Modern (M) bee systems						
TE range	**tss**	**T**	**M**	**Ave. Bee Experience**	**Education 0**	**1^0**	**2^0**	**Age Range**	**TE (%) T**	**M**
≤30	5	5	-	8.7	4	3	-	20-29	54.4	81.1
31-40	7	6	1	10.5	10	4	-	30-39	72.0	93.5
41-50	20	17	3	13.2	11	3	3	40-49	63.2	89.5
51-60	15	12	3	16.9	9	5	1	50-59	56.2	85.4
61-70	13	11	2	14.3	8	3	2	≤60	48.8	70.8
71-80	13	9	4	19.6	4	1	1			
81-90	7	-	7	19.7	2	-	2			
91-100	-	-	-	>20	-	-	4			
Total	80	60	20		48	19	13		X=59	X=84

Field survey, 2014; TE= Technical Efficiency; tss= total sample size; 0 denote no schooling; 1^0& 2^0 = primary and secondary schoolings

Table 4: MLEs of the cobb−douglas stochastic frontier model for allocative efficiency

Variable estimates	**Traditional**			**Modern**			**Pooled**		
	β	**SE**	**t-v**	**β**	**SE**	**t-v**	**β**	**SE**	**t-v**
Constant	0.06	0.04	1.62	2.90	1.41	2.07	0.73	0.47	1.56
$Ln\ B_1$	0.74	0.57	1.30	0.05	0.03	1.58	0.02	0.03	0.75
$Ln\ B_2$	0.32	0.15	2.09	0.08	0.008	9.51	0.52	0.25	2.06
$Ln\ B_3$	0.007	0.004	1.97	0.73	0.36	2.05	0.49	0.30	1.65
$Ln\ B_4$	0.03	0.04	0.85	0.004	0.0008	5.18	0.72	0.25	2.90
$Ln\ B_5$	0.08	0.006	13.2	0.60	0.80	0.75	0.008	0.007	1.19
Diagnostic statistics									
σ^2	0.107			0.279			0.148		
γ	0.324			0.408			0.301		
LR	18.70			-65.6			13.2		
LL	59.5			113.9			61.0		
Sampled	60			20			80		
av. TE	54.0			74.8			47.5		

Field survey, 2014; *Note: cost of Kenya top bar, thermometer & hygrometer were depreciated*

Table 5: Estimated technical inefficiency function

Variable estimates	**Traditional**			**Modern**			**Pooled**		
	β	**SE**	**t-v**	**β**	**SE**	**t-v**	**β**	**SE**	**t-v**
Constant	-0.44	0.67	-0.61	0.92	0.86	1.07	0.20	0.11	1.83
$Ln\ \omega_1$	-0.62	0.30	-2.06	-0.08	0.08	-1.02	-0.75	0.19	-3.96
$Ln\ \omega_2$	0.49	0.10	4.70	0.39	0.25	1.55	-0.04	0.02	-1.99
$Ln\ \omega_3$	-0.62	0.70	-0.89	-0.43	0.15	-2.83	0.32	0.18	1.70
$Ln\ \omega_4$	0.07	0.09	0.76	-0.98	0.07	-15.04	-0.05	0.05	-1.07
$Ln\ \omega_5$	-0.08	0.06	-1.43	0.02	0.03	0.74	0.003	0.002	1.50

field survey, 2014; *t-v denotes t-value;*β= coefficient