An analysis of technical performance in Turkish beekeeping farms using Translog Production Function

Recebimento dos originais: 16/12/2020
Aceitação para publicação: 14/06/2021

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Abstract

This paper investigates technical efficiencies of beekeeping farms and their determinants, using stochastic production frontier function in Malatya Province of Turkey. Data used in the study were collected from randomly selected 58 beekeepers. For the estimation of farm level technical efficiency coefficients, Stochastic Frontier Analysis method was performed. Translog production function was used in the analysis. Research results showed that the technical efficiency scores of beekeeping farms in Malatya varied from 0.261 to 0.998 with mean of 0.728. It revealed that beekeeping farms would have produced same output with the decreased of inputs by 27.2%. Results of the Stochastic Frontier Analysis model showed that inefficiencies of beekeeping farms were mostly due to non-random factors such as age, education, experience and migratory beekeeping condition. In order to achieve the rationale input use, training and extension studies consistent with the good farm management and adaptation of new production methods should be applied.

Keywords: Beekeeping. Elasticity. Stochastic Frontier Analysis.

1. Introduction

Beekeeping is one of the few human economic activities that are not only environmentally friendly but also contributes to the rational management of natural resources (Thrasyvoulou, 1998). The most important product of beekeeping is honey, followed by beeswax, pollen, propolis, royal jelly and bee poison. In addition to meet today's increasing consumption needs and it becomes increasingly important to produce in line with the preferences of consumers. Turkey has a geography where suitable locations for beekeeping can be found. Turkey's has to the rich flora, shows the potential of increase the honey yield. This potential can be activated by studies that will help beekeepers to choose the appropriate apiary for beehive production and the suitable location to the nutrition. Thus, it is possible to increase revenue of the beekeepers in Turkey (Fıratlı et al., 2010; Kosoğlu et al., 2017). In Turkey, 109,330 tons of honey, and 3,971 tons of wax were produced. The average yield of honey in Turkey was 13.55 kg per hive, well below than the world average of 20,10 kg. Despite the low yield, Turkey is the world's most honey producing country following China (FAOSTAT, 2019). Malatya Province is one of the most suitable regions for beekeeping in Turkey. However traditional production mode still dominates the sector which negatively affects the total production and productivity. When the Malatya province is evaluated in terms of the 1176 of beekeeping farm numbers, ranks 25th in Turkey. In terms of honey production, it meets 0.5% of the total production amount with 529 and 1.1% of the production amount with 43 tons in wax production (TURKSTAT, 2020). These results show that it is necessary to increase production and make the current production more efficient. Therefore, it is needed to give attention to beekeeping and efficiency of the beekeeping with techniques for estimating efficiency components of beekeepers.

Beekeepers carried out the production process using traditional methods. Since far away from technology and innovation, they cannot make the desired contribution to the national economy (Oren et al., 2010). Despite the much advantages, lower level than the average yield of the world indicated that technical efficiency problems in beekeeping in Turkey It is known that, the main source of the yield problem is input use inefficiency in the agricultural production as well as beekeeping farms. Providing sustainability and productivity in farms is solely possible with the efficient use of inputs in production. Though the input use in beekeeping less than in other agricultural production process, the rational use of the inputs will increase the efficiency level.

It can be determined by efficiency searches whether inputs are used at optimum level or not. Using the results of efficiency analyses, some precautions may be taken by determining the source of inefficiency and so, more efficient production can be provided, costs can be declined and profits can be maximized (Gunduz et al. 2011)

Therefore, the main aim of the study was to estimate the technical efficiency of beekeeping farms in Malatya Province using Stochastic Frontier Analysis (hereafter SFA) and to determine the factors which influence technical inefficiency in honey production. Output elasticity was also calculated to determine the returns to scale (hereafter RTS) of input use. Through the estimated model and technical efficiency estimates, some policy implications are suggested to improve on beekeeping farms.

2. Literature Review

The application of frontier models to investigate farm technical efficiency in agriculture has received considerable attention from researchers around the world (Battese, 1992; Bravo-Ureta et al., 2007; Latruffe et al., 2016). Since it can readily incorporate the technical efficiency component, a stochastic frontier function is preferred mostly. The stochastic production frontier gives the maximum level of output producible given inputs, the technology, and the production environment (Kumbhakar, 1987).

Some studies have conducted technical efficiency analyses to investigate how to maximize production output using the available resources (Farrell, 1957). Measuring technical efficiency is popular in the agricultural production economics literature; such analyses have been applied to vegetables in China (Xu et al., 2018), fish cage culture in Malaysia (Islam et al., 2016), pineapples in Colombia (Trujillo and Iglesias, 2013), rice in Vietnam (Khai and Yabe, 2011), dry apricot farms in Turkey (Gunduz et al., 2011), wheat in Turkey (Alemdar and Oren, 2006), and crop and livestock farms in Poland (Latruffe et al., 2004). Technical efficiency is important for small farmers with small incomes, such as beekeepers.

In terms of studies in beekeeping, conducted technical efficiency Malik and Mohammed (2012) used a number of hives, the total number of top bars, labor and extension service for efficiency model, and age, education, marital status, main occupation, membership of social group and experience for inefficiency model. Makri et al., (2015), used gross return for output, and fixed capital, variable capital and labor wages for input in their study. Kuboja et al., (2017), used labor costs, transport cost, costs of other materials, and number of beehives for efficiency model, and age, sex, experience, number of a household member, number of visits in beekeeping, access to practices for inefficiency model. Gurer and Akyol (2018) used feed, medicine, costs of other materials, labor, and fixed costs for efficiency model, and the number of hives, subsidy rate, and bee species for inefficiency model. Alropy et al., (2019) determined economic indicators in producing with average honey production, average total return, average total cost, and average net return. Aydin et al. (2020), who one of the limited number of studies from Turkey, used Data Envelopment Analysis method to estimate the technical efficiency. They used the tobit model for estimate the effects of inefficiency determinants such as age, education and experience. In this study, to estimate the efficiency, the number of hives, honeycomb amount, feeding cost and labor use were used. Also, age, education, experience, migration condition and off-farm income variables were used to estimate the factor affecting the inefficiency. It was seen that the there were limited number of studies carried out related beekeeping farms efficiency in Turkey.

3. Materials and Methods

3.1. Analytical methodology

In the research, Stochastic Frontier Analysis (SFA) approach was used to estimate the technical efficiency of honey production. SFA approach establishes a functional relationship between dependent variables such as cost, profit and production, and explanatory variables such as input and environmental variables (Berger and Humprey, 1997). It also includes an error term in the model. Stochastic efficiency frontier approach, a parametric method, was developed by Aigner et al., (1977), Meeusen and Broeck (1977) and Battese and Corra (1977) to estimate production efficiency using $Y_i = x_j\beta + \varepsilon_i$ production function. Aigner et al., (1977) and Meeusen and Broeck (1977) stated that error term (ε_i) of the production function consisted of two independent elements and formulized the production function as follows:

$$Y_i = x_j\beta + v_i - u_i \quad (i = 1,2, \ldots, n) \qquad (1)$$

$$v_i - u_i = \varepsilon_i \qquad (2)$$

Y_i, Production function of i^{th} farm; x_i, input vector of i^{th} farm; β, coefficient. v_i, random variable that cannot be controlled, has normal distribution $N\left(0, \sigma_v^2\right)$ and is independent of u_i.

u_i is independent random variable which is non-negative, can partially be controlled and hence lead to technical inefficiency. u_i can have semi-normal, truncated normal or exponential distribution depending upon the function used. Battese and Coelli (1995) developed following model to explain changes in u_i which represents technical inefficiency.

$$u_i = z_i \delta \quad (3)$$

In the Eq.3, z_i represents specific features affecting technical inefficiency (such as education level, age, administrative approach), while represents coefficients. With stochastic efficiency frontier approach, the efficiency of a firm could be determined as the ratio of observed output to expected output using Eq. 1 (Coelli et al. 2005). Thus, technical efficiency can be formulated as follows:

$$TE_i = e^{x_i\beta + v_i - u_i} / e^{x_i\beta + v_i} = e^{-u_i} \quad (4)$$

where TE_i has a value ranged from 0 to 1, and if $u_i = 0$, means i^{th} the farm is full technically efficient. Coelli (1995) reported that the maximum likelihood method is more suitable for the estimation of production functions than the least-squares method.

In the present study, the efficiency of beekeepers was calculated using Translog production function by the maximum likelihood method. Translog production function is a kind of variable elasticity production function that is easy to estimate and has strong tolerance (Christensen et al, 1973). The translog functional can be formulated as follows:

$$nY = \beta_0 + \sum_j \beta_j lnX_{ij} {}_1 + \frac{1}{2}\sum_j \sum_k \beta_{jk} lnX_{ij} \, lnX_{ik} {}_2 + v_i - u_i \quad (5)$$

where, Ln is the natural logarithm, Y_i is output if i^{th} farm, x_i's are input variables presented in Table 1 and β's are estimated parameters

For the model specification, diagnostic tests were estimated using likelihood ratio test (LR) and variance parameters *Gamma* $(\gamma = \sigma_u^2 / (\sigma_v^2 + \sigma_u^2))$, and *sigma square*$(\sigma^2 = \sigma_v^2 + \sigma_u^2)$. If the value of γ is equal to zero, the difference between actual quantity and the estimated quantity is entirely due to statistical noise. On the other hand, γ value closer to 1 shows technical inefficiency (Coelli et al., 2005).

In the research, to calculate the efficiency of beekeeping farms, one output and four input variables were used. In the model, Output (Y_i) was total honey production, and inputs (x_i) were the number of hives (H_i), honeycomb amount (HC_i), feeding cost (FC_i), and labor use (L_i).

Thus, the translog function was formed as follows.

$$LNY = \beta_0 + \beta_1 lnH_i + \beta_2 lnHC_i + \beta_3 lnFC_i + \beta_4 lnL_i + ½\, \beta_5 lnH_i^2 + ½\, \beta_6 lnHC_i^2 + ½\, \beta_7 lnFC_i^2 + ½\, \beta_8 lnL_i^2 + \beta_9 lnH_i lnHC_i + \beta_{10} lnH_i lnFC_i + \beta_{11} lnH_i lnL_i + \beta_{12} lnHC_i lnFC_i + \beta_{13} lnHC_i lnL_i + \beta_{14} lnFC_i lnL_i + V_i - U_i \quad (6)$$

The total output elasticity (RTS) is $eH_i + eHC_i + eFC_i + eL_i$ (Yang et al 2020). Where, e shows elasticity term. It was seen that elasticity of each input (x_i) needs to be calculated, separately. To calculate each elasticity (RTS), following formulas were used (Yang et al. 2020).

Output elasticity of hive was shown to be an example below;

$$eH_i = \frac{dY_i / Y_i}{dH_i / H_i} = \partial lnY_i / \partial lnH_i = \beta_1 + \beta_5 lnH_i + \beta_9 lnHC_i + \beta_{10} lnFC_i + \beta_{11} lnL_i \quad (7)$$

Considering the formula, elasticity of the other inputs can be calculated. The elasticity of inputs refers to how many percentage points the output will increase when an input increases by 1% under the condition that other inputs remain unchanged in the same period.
In the research, to determinants of inefficiency effects, six non-random variables were used.

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 \quad (8)$$

Variables used to explain technical inefficiency (u_i), on the other hand, were the age of beekeepers, education level, experience, cooperative membership status, off-farm income, and migratory beekeeping condition. Descriptive statistics of the variables used in the model were given in Table 1.

Stochastic efficiency frontier estimations were performed using FRONTIER 4.1. developed by Coelli (2007).

Technically efficient and inefficient farms were compared statistically by “independent t-test”.

3.2. Research data

The present study was conducted in Malatya province of Turkey. Data used in the research were collected from randomly selected 58 beekeepers using questionnaires and the data belongs to the 2018-2019 production year. Sample size was calculated using following formula;

$$n = \frac{N * s^2 * t^2}{(N-1) * d^2 + s^2 + t^2} \qquad (9)$$

where n: sample size, N: Total number of farms, s: standard deviation of number of beehives, t: value at 95% confidence level (1.96), d: precision (5%). Thus, the sample size was calculated as 58.

4. Findings and Discussion

Descriptive statistics of the variables used in the model established to estimate the efficiency of beekeepers in the study were given in Table 1.

Average honey production was 884.76 kg and ranged from 100 kilograms to 2,000 kilograms. The large variability indicated that the beekeepers used inputs in different ways, which tended to affect their production levels.

Honey yield was 9.96 kg/hive in the beekeeping of Malatya. This finding lower than Turkey’s average yield which was 13.55 kg/hive. (TURKSTAT, 2020). To obtain the output, farms used 88.79 hives, 61.72 kg honeycomb, 3,047.79 TRY feeding cost and 857.05 hours labor per farm. There was a high variation in the number of inputs used per farm. They show that the inputs were not used rationally. The average age of farm head was 50.50 years, had an average of 8.62 years of education, and 21.86 years of experience. In light of these findings, it is possible to say that beekeepers are relatively young, their education level is sufficient and they have enough experience in beekeeping. On the other hand, it has determined that low rate of cooperative membership (0.34), and a large part of the beekeepers have off-farm income (0.69), and conducting migratory beekeeping (0.88).

Table 1: Descriptive statistics of the variables used in the SFA model

Code	Variables	Units	Mean	Std. Dev.	Min.	Max.
Y_i	Honey production	Kgs	884.76	529.92	100.00	2,000.00
H_i	Number of hives	piece	88.79	41.29	30.00	150.00
HC_i	Honeycomb amount	Kgs	61.72	43.17	10.00	195.00
FC_i	Feeding cost	TRY	3,047.79	2,254.96	400.00	9,450.00
L_i	Labor use	hours	857.05	665.49	77.00	2,972.00
Z_1	Age of beekeepers	years	50.50	12.13	26.00	87.00
Z_2	Education of beekeepers	years	8.62	3.61	4.00	17.00
Z_3	Experience of beekeepers	years	21.86	10.94	3.00	60.00
Z_4	Cooperative membership	If yes 1; others 0	0..34	0.48	0.00	1.00
Z_5	Off-farm income	If yes 1; others 0	0.69	0.47	0.00	1.00
Z_6	Migratory beekeeping	If yes 1; others 0	0.88	0.33	0.00	1.00

Kgs; kilogram, TRY; Turkish Liras which is Turkish Money Unit;

The estimated results of the stochastic frontier model using Translog production function was given in Table 2. Likelihood ratio test (LR) was applied to test the null hypothesis (H_0) that the Translog stochastic frontier production function was not suitable for estimation of technical efficiency in the beekeeping farms. The chi-square distribution of LR test was statistically significant at 0.01 level. So, the H_0 hypothesis was rejected. The γ (gamma) parameter associated with variances in the stochastic production frontier was estimated to be close to 1 and statistically significant. It means that major level of the variance in the beekeeping production process were mainly due to the inefficiency

Estimated parameter coefficients of input variables by SFA model in the research showed the effect of input use on honey production. Statistically insignificant coefficients were not interpreted and discussed.

According to the results, majority of the estimated parameters satisfy the monotonicity and diminishing marginal returns properties. Total elasticity result calculated as 1.183, which revealed that beekeeping farms had increasing return to the scale.

Number of hives, one of the explanatory variables of the output in the model, devoted to beekeeping affected honey production positively, and the coefficient was significant. The coefficient of lnH_i (β_1) was 3.461, and the values of β_5, β_9, β_{10}, *and* β_{11} were -0.566, 0.380, 1.310 and -1.875, respectively. According to Eq. (7), we could calculate that the output elasticity eH_i of hive was 0.478, which indicated that the honey production could be increased by 0.48% when the hive was increased by 1%. This result has consistent with the finding by Walle (2020) that a 1% increase in the number of beehives significantly increases honey yield by 0.39%.

As expected, there was a statistically significant correlation between honeycomb quantity and honey production output. Considering the output elasticity of HC input calculated as 0.380, it can be said that if an increasing of 1% in honeycomb quantity, honey production will increase 0.380%. Since, no study was found in which the number of honeycombs was used as an input variable, this finding could not be discussed,

The feeding of bees is directly related to honey production. When bees that are fed adequately provide a higher level of efficiency. Contrary to many studies (Gurer and Akyol, 2018; Walle, 2020) it was determined that the increase in the cost of bee feed affects the production negatively in the study. According to the elasticity result, an increase by 1% in the feed cost will cause a 0.015% decrease in the production.

Estimated coefficient of labor use, which one of the important input in the honey production, was statistically significant. Output elasticity level calculated as 0.340 showed that labor use input has majority contributed to the output. Output elasticity showed that the increasing by one percent on labor use could raise the honey production by 0.34%. This finding conformed to study of Gurer and Akyol (2018), but not Walle's (2020).

The quadratic coefficient of the inputs were calculated as negative, except labor use, which indicated that the each input had an "inverse U" shape relationship with production. This result showed that "law of diminishing marginal returns" is valid in beekeeping farms. It shows that due to the diminishing marginal law the increase in inputs will cause a decrease in honey output.

The results of determinants of inefficiency effects in honey production were given in Table 3. Variables of age of the beekeepers, his/her level of education, years of experience, and migration in beekeeping were significant, while cooperative membership status, and off-farm income variables were not.

Table 2: Results of the SFA model for beekeeping farms

Variables	Parameter	Coefficient	Std. error	t-value
Stochastic Production Efficiency Model				
Constant	β_0	-14.160	1.230	-11.508***

lnX_1	β_1	3.461	0.950	3.644***
lnX_2	β_2	-2.587	1.060	-2.441**
lnX_3	β_3	2.734	0.699	3.912***
lnX_4	β_4	1.590	0.803	1.979**
lnX_1^2	β_5	-0.566	0.490	-1.156
lnX_2^2	β_6	-0.085	0.358	-0.239
lnX_3^2	β_7	-0.044	0.342	-0.128
lnX_4^2	β_8	1.306	0.256	5.110***
$lnX_1\ lnX_2$	β_9	0.380	0.282	1.349
$lnX_1\ lnX_3$	β_{10}	1.310	0.506	2.589***
$lnX_1\ lnX_4$	β_{11}	-1.875	0.559	-3.356***
$lnX_2\ nX_3$	β_{12}	-0.784	0.425	-1.844*
$lnX_2\ lnX_4$	β_{13}	1.192	0.429	2.777***
$lnX_3\ lnX_4$	β_{14}	-0.789	0.153	-5.143***
Elasticity				
eH_i		0.478		
eHC_i		0.380		
eFC_i		-0.015		
eL_i		0.340		
Total output elasticity (RTS)		1,183		
Technical Inefficiency Model				
Constant	δ_0	1.920	0.784	2.450**
Z_1	δ_1	0.055	0.018	3.029***
Z_2	δ_2	-0.080	0.031	-2.556***
Z_3	δ_3	-0.043	0.018	-2.350**
Z_4	δ_4	0.327	0.258	1.264
Z_5	δ_5	0.343	0.246	1.397
Z_6	δ_6	-0.868	0.371	-2.336**
Variance parameters				
Sigma squared	σ^2	0.144	0.045	3.217***
Gamma, $(\sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$	γ	0.999	0.000	4,949.847***
LR test		35.553***		
Mean technical efficiency		0.728	0.178	

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

Age of the household head showed a statistically significant positive effect at 1% level on technical inefficiency of beekeeping farms. The results revealed that an increase in the farmer's age by one year increases the level of technical inefficiency by 0.06%. This means that older farmers were less technical efficient in honey production. This finding was consistent with findings by Gurer and Akyol (2018) and Walle (2020). The finding also attributed to the fact that older beekeepers in the study area were relatively more reluctant to take up better technologies instead they prefer to hold traditional methods.

As expected, the effect of education level of household head variable on inefficiency was negative and statistically significant at 1%. It can be argued that farmers with better level of education are indicated to have less inefficiency. There have been reached same findings in the many researches on efficiency in beekeeping (Ceyhan, 2017; Gurer and Akyol, 2018; Aydin et al, 2020; Walle, 2020).

As also expected that the experience variable of household head was negatively and statistically significant affected on the inefficiency. This result showed that when a one year increase the experience, technical inefficiency decreases by 0.04%. It was indicated that more experienced farmers about beekeeping are used the inputs efficiently.

There have many reasons of beekeepers to migration by different zone such as a) increasing honey production by reach to rich flora, b) keeping bee colonies from intensive pesticide applied agricultural areas and c) saving different climate conditions. The reasons are affected the input use efficiency (Sharma and Bhatia, 2001). In the research, it was found that the migrant beekeeping activity affected positively and significantly to the technical efficiency more than non-immigrants. Efficiency scores in beekeeping farms estimated by Ceyhan (2017), Gurer and Akyol (2018) and Aydin et al. (2020) close to the results. They estimated that migrant beekeeping positively affected technical efficiency (or negatively affected inefficiency).

Because cooperative membership status and off-farm income variables were statistically insignificant, parameters coefficient of these were not interpreted.

Estimated technical efficiency scores of beekeeping farms using SFA approach were given in Table 3. Results indicated efficiencies varied between 0.261 and 0.998 with a mean 0.728. It could be stated that achieving production efficiency would lower input use. This suggests that it is possible to achieve current output in the short run by decrease 27.2 % of input use.

Malik and Mohammed (2012) estimated technical efficiency as 66% for beekeepers of Ghana. Also, Makri et al., (2015) calculated 86% of production efficiency for Greek beekeeping farms.

In the last years, studies related efficiency analysis of beekeeping carried in Turkey shows similar results with the present study. In the researches carried by Ceyhan (2017), Gurer and Akyol (2018), and Aydin et al. (2020) technical efficiency were estimated as 0.84%, 43%, and 74%, respectively.

Table 3: Descriptive statistics of technical efficiency of the beekeeping farms

	Coefficient
Mean technical efficiency	0.728 (73%)
Standard deviation	0.207 (21%)
Minimum	0.261
Maximum	0.998

As seen from the fig.1, 15 beekeepers had efficiency levels over 90%, and were considered efficient. Gurer and Akyol (2018) was determined that the ratio of the efficiency score higher than 0.90 of beekeeping farm in Turkey was 11%. Investigating results of the remaining farms, 17% had efficiencies lower than 50%, while 14% had efficiencies varied from 50 to 60%, 14% had efficiencies varied from 60 to 70%, 12% had efficiencies varied from 70 to 80%, and 17% had efficiencies varied from 80 to 90%.

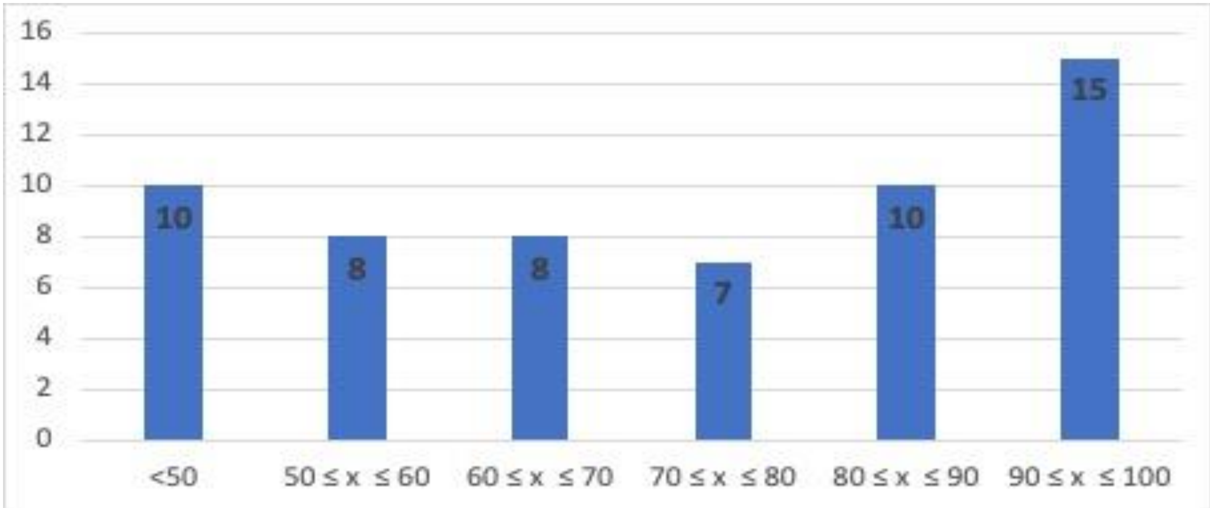

Figure 1: Distribution of the technical efficiency scores

Characteristic differences between efficient and inefficient beekeeping farms were calculated and results were given in Table 4. As can be seen in the table, there was little difference between efficient and inefficient beekeepers, except age variable. In terms of age variable there was a statistically significant ($p<0.05$) difference between efficient an inefficient farm. Comparing with inefficient farms, beekeepers were young in the efficient farms.

Table 4: The differences between technically efficient and inefficient beekeeping farms

Variables	Inefficient beekeepers (n=43)	Efficient beekeepers (n=15)
Honey production (kgs)**	818.74	1074.00
Number of hives (pieces)	88.18	90.53
Honeycomb amount (kgs)	65.00	52.33
Feeding cost (TRY)	3,073.67	3,038.77
Labor used in production (hours)	865.69	832.27
Age of beekeepers (years)**	55.60	48.73
Education of beekeepers (years)	8.33	8.72
Experience of beekeepers (years)	21.16	23.87

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

5. Conclusion

The aim of the present study was determining the efficiency of beekeeping farms in Malatya Province with stochastic frontier production function. In this context, the research aspired to help beekeepers improve the way they operate, increase their efficiency and consequently improve their economic results.

As far as farm efficiency is concerned, results show that farms inputs' reorganization can induce significant improvements in the beekeeping sector. Findings of the present study showed that average hive size 89 and average honey production is 884.76 kg in the region. In terms of yield per hive is lower than Turkey's average. Production efficiency of beekeepers in the experimental area was 73%. Only 26% of the beekeepers achieved production efficiency and the remaining 74% were inefficient. Results from the model for the inefficiency effects in the production frontier help better understand the determinants of efficiency in beekeeping farms. It is possible to have a sufficient number of beehives to increase production efficiency, to avoid excessive use of honeycomb, to be careful about feeding and to use sufficient labor. The age, education level and experience of the beekeeper, as well as migratory beekeeping condition, are among the important factors when examined with the factor affecting the inefficiency.

Estimated technical efficiency of beekeeping farmers and also identified the socio-economic factors that determine the level of estimated technical efficiency of the sampled respondents. The results indicate that the mean technical efficiency of the sampled respondents was not too far from the frontier. This implies that there is a significant potential for the beekeepers to sustainably increase output using the available inputs and existing technology.

Some results of this study are quite surprising. Being a member of a cooperative is not significant for efficiency. However, the said cooperatives are very important in learning new production methods and marketing honey and other bee products.

Consequently, off-farm income did not any effect on efficiency. The structure is mostly due to small-scale beekeeping operations in Turkey. More professional beekeepers need additional income to use their resources more effectively.

Among the most important problems that beekeepers face is the marketing of honey and other bee products, struggling with diseases, providing suitable accommodation areas and transportation. In order to solve the problems in the beekeeping farms, beekeepers 'associations should contribute more to the solution of their members' marketing and accommodation problems. Besides, training and extension studies should be carried out to reduce disease and wintering losses. Also increasing of education level of farmer was found as one of the important determinants of efficiency due to access to information, good farm management and adaptation of new production methods.

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