Efficiency analysis in agricultural enterprises in Turkey: case of Thrace Region

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Abstract

This research was conducted via surveys applied to agricultural enterprises of Edirne, Kırklareli, Tekirdağ provinces in order to determine the efficiency of the agricultural enterprises of the Thrace Region. The enterprises were ranked with respect to their sizes and divided into three strata, including 1-50, 51-200, and 201 decares and above. In accordance with this stratified random sampling method, number of the surveyed enterprises was determined as 169. The average size of the surveyed enterprises was found to be 117.49 decares. The active capital based on the average of enterprises was determined as 621052.29 TL. Vegetative gross output value, animal gross output value, variable costs and fixed costs were found as 32929.42 TL, 23895.80 TL, 30288.35 TL and 20331.77 TL, respectively. Coefficients of technical efficiency, allocative efficiency and economic efficiency were determined and they were found to be higher in the third group enterprises than those for the other groups. Based on the average of the enterprises, technical efficiency, pure technical efficiency, scale efficiency, allocative efficiency and economic efficiency were computed as 0.66, 0.84, 0.78, 0.89, and 0.75 respectively. Based on the results of the Tobit modeling, the education period of the farmers, the size of the family, income from nonagricultural activities, the number of agricultural organizations which they join were determined to have a negative effect on the economic efficiency whereas the land size, the presence of livestock and irrigation amount were evaluated to have a positive effect.

Key words: Agricultural Enterprise, Data Envelopment Analysis, Efficiency

1. Introduction

Agriculture sector contributes to economic development in terms of transferring capital and labor to other sectors and supplying raw materials and crop requirement. Nowadays, increasing of global warming and decreasing of the water sources increases the importance of agriculture sector. Increasing the efficiency and productivity of agriculture sector is very important for existing among the countries which are self-sufficient in international competition and food area.

The main purposes of agricultural production are to strengthen the agricultural enterprises and increase the contributions to national income by increasing the disposable income level of the farmers and to increase the production amount and productivity of the enterprises by providing the efficient and compatible usage of soil, climate, water, plant and human labor sources.

In each production activity, providing the low-priced production factors and usage in optimum level increases the yield and decreases the costs. The producers cannot use the agricultural production factors in optimum level due to the insufficient business capitals and technical lack of information. For this reason, researches which introduce the input usage levels are required (Gundogmus, 1997).

Nowadays, increment of agricultural production has become important in developed countries as well as the reduction of production costs. Therefore, reduction of production costs comes first for the enterprise managers and the policy makers. Obtainment of the effective usage of the production factors and reduction of the costs will contribute the optimum usage of natural resources and increase the sustainability of the enterprises.

For this reason, all agricultural inputs which are efficient in sustainable usage of natural resources and important for the reduction and input and energy costs, must be used efficiently. Considering the substantial external dependence of many agricultural inputs, optimum usage of these inputs becomes more important. Optimum input usage can only be possible by the determination of the efficiency at enterprise level.

Efficiency analysis are especially important in countries like Turkey, where economy is based on agriculture. In Turkey, 23.3% of working population is being employed in the agriculture sector and there are nearly three million agricultural enterprises.

In countries like Turkey where agriculture is an important sector, as studies regarding efficiency enable the existing resources to be used in an optimum way without requiring for production inputs to be increased or for the technology to be improved, they bear significant importance. Especially in the process of full membership in European Union, there are a lot of works to be done with regards to Turkish agriculture. By enabling effective usage of resources in agriculture, agricultural returns could be increased and the sector could become more competitive. (Kacira, 2007).

Thrace Region, which is in European part of Turkey, has a significant agricultural potential. Thrace Region is in the northwest of Turkey within 40^0 and 42^0 north latitudes and 26^0 and 29^0 east longitudes and includes Edirne, Tekirdağ and Kırklareli provinces. It is a significant agriculture region in Turkey due to the reasons such as soil structure and geographic conditions.

The sufficient amount of land for agriculture is 1 002 223 ha and 965 910 ha of this land is planted. The most significant crops in the region are wheat, sunflower and rice and 55-60% of rice production, 60-65% of sunflower production and 10-15% of wheat production in Turkey are obtained in Thrace Region (Erdem, 2012).

This study includes the agricultural enterprises in Thrace region as the efficiency and productivity of many crops are in high level in this region. Whether organizations realize their activities in an effective way or not, the degree of their efficiencies, or the level of efficiency are important particulars to be revealed.

Because, according to the efficiency level and in accordance with its direction, outcomes would be obtained and recommendations could be made. The main purposes of this study are to determine the technical, allocative and economic efficiencies of the enterprises by data envelopment analysis method and to analyze the effective factors on economic efficiency. Besides, some suggestions have been made in consideration of the results.

Various researches were conducted on efficiency analysis in agriculture. Mao and Koo (1997) used data envelopment analysis (DEA) approach to analyze total factor productivity, technology, and efficiency changes in Chinese agricultural production from 1984 to 1993. Technical progress was mostly attributed to Chinese agricultural productivity growth after the rural economic reforms.

Shafiq and Rahman (2000) determined the technical and allocative efficiencies of cotton farms in Punjab State in Pakistan. The use of DEA showed that the technique provided a clear identification of both the extent and the sources of technical and allocative inefficiencies in cotton production. Binam et al (2004) estimated technical efficiency among small holder farmers in the slash and burn agriculture zone of Cameroon and identified sources of inefficiency using detailed survey data obtained from 450 farmers over 15 villages throughout 2001/2002 growing season. The mean levels of technical efficiency were 77%, 73% and 75%, respectively, for groundnut monocrop, maize monocrop and maize–groundnut farming systems.

Dhungana et al (2004) measured the economic inefficiency of Nepalese rice farms using data envelopment analysis. Economic, allocative, technical, pure technical and scale inefficiencies were determined as 0.34, 0.13, 0.24, 0.18 and 0.07 respectively. The significant variations in the level of inefficiency across sample farms are attributed to the variations in the ‘use intensities’ of resources such as seed, labor, fertilizers and mechanical power. Johansson (2005) estimated technical, allocative, and economic input efficiency scores for an unbalanced panel of Swedish dairy farms, using data envelopment analysis (DEA) and the stochastic frontier approach (SFA).

By comparing the results it was concluded that when the entire dairy farm is studied the DEA is more appropriate to use since it does not require any particular parametric form to be chosen. The average DEA technical, allocative and economic efficiency indices were eventually found to be 0.77, 0.57 and 0.43 respectively.

Alemdar and Oren (2006) estimated technical efficiencies of wheat growing farmers in Southeastern Anatolia region of Turkey using both parametric and non-parametric methods. According to the results of the Data Envelopment Analysis (DEA) model, mean efficiencies of wheat growing farmers were estimated to be 0.72 and 0.79 for constant and variable returns to scale (CRS and VRS) assumptions respectively.

Kacira, (2007) determined the technical, allocative and economic efficiencies of corn producers in Şanlıurfa using the parametric Stochastic Frontier Analysis (SFA) technique and nonparametric Data Envelopment Analysis (DEA). The mean technical, allocative and economic efficiencies were determined as 84%, 78% and 64%, respectively, for the parametric approach and 81%, 87% and 77% for DEA. Hazneci (2007) calculated efficiency measures of sample cattle fattening farms and to explore determinants of economic efficiency in Suluova district of Amasya province, Turkey.

The results of the efficiency analysis showed that the average output of farmers in Suluova would increase 8% under prevailing technology. In the research area, the variables of farm size, experience of farm operators and pasture use negatively affected the economic efficiency.

However, schooling, family size, credit use, land allocated to feed crops, fattening period, feeding frequency, the ratio of European breed, keeping record and frequency of contact with extension service showed positive relationship with economic efficiency. Parlakay (2011) estimated the level of technical, economic and allocative efficiency for peanut production in the farms growing peanut in Turkey. Peanut yield, pure nitrogen, pure phosphorus, machinery operating time, labor and cost of pesticide were used in the analysis as variables of efficiency models.

The results revealed that technical efficiency varied between 0.81 and 0.86, economic and allocative efficiencies were around 0.60 and 0.74 respectively. Engindeniz and Cosar (2013) performed the economic analysis of field-crop tomato growing and technical efficiency analysis of input use. Data of this research were collected from 86 farmers with face to face survey method by using proportional sampling method.

According to DEA with input oriented, average technical efficiency (CRS) has been determined to be 0.787 and 0.753 for table and processing tomato producing farms, respectively. Parlakay et al. (2015) estimated the technical efficiency for dairy farms in Hatay province of Turkey.

The data were obtained from 138 dairy farms and analyzed using the Data Envelopment Analysis (DEA) method. Annual milk production quantity, concentrate feed, roughage feed, veterinary costs, and human labor were used in the analysis as variables of efficiency model. The Tobit Regression Model was used to calculate the DEA scores in order to establish the causes of inefficiencies.

According to the results of the DEA model, mean technical efficiency scores estimated for the Constant Return to Scale (CRS) and Variable Return to Scale (VRS) were 0.64 and 0.69, respectively. Bagchi and Zhuang (2016) computed technical and scale efficiency of Chinese litchi farmers. They collected data from 160 farm household spread across the six southern provinces of China during 2014. The result revealed that the mean technical efficiency was 0.804 in study area which suggest that farm households are potential for producing 80% of litchi.

Pereira and Tavares (2017) evaluated the technical and scale efficiency of the regions Northeast, traditional Mid-South and expansion Mid-South, according to the production costs of cane sugar in 2007/2008 to 2011/2012 harvests in Brazil. The results showed that the traditional Center-South region was the most technically efficient, and four of the five harvests obtained maximum efficiency.

2. Efficiency Concept

One of the necessities for the continuity of life is to make innovations in the World. The progressive World confronts the producers with an intensive competition. For this reason, the producers should understand the events which develop beyond their control and work for a more competitive position. More clearly, the limited sources in the production should be used efficiently for providing the continuity of the enterprises. The scientific studies present that the producers sustain inefficient production activities in developing countries.

The performance of the production units are evaluated by the productivity or efficiency of these units. Productivity and efficiency concepts are relevant with one another but quite different indicators. "Productivity" in production is the ratio of output amount to input amount. "Efficiency" is measured by the difference between the optimum input-output amounts.

This can be defined by the ratio between the input amount of the production unit and the maximum output. Efficiency is the indicator of the success to reach the target. Efficiency or inefficiency level is measured by the difference between the targeted and the actual performance.

An important and rapidly growing empirical application of operations research techniques involves the measurement and analysis of the efficiency with which goods are produced and services are provided. The production activities whose efficiency has been the subject of investigation have varied widely, from profit-oriented industrial manufacturing enterprises all the way to public and private service providers operating in a not-for-profit environment.

A similarly wide variety of operations research techniques has been utilized in the measurement and analysis of productive efficiency, ranging from stochastic parametric regression based methods to non-stochastic nonparametric mathematical programming methods (Lovell et al, 1994)

The main principal in either methods is to obtain a production frontier and measure the efficiencies of the production units by comparing with the frontier. The production frontier indicates the maximum output which could be obtained under a certain technology. The production frontier is determined econometrically by parametric methods. In non-parametric methods, a sectional linear production frontier is obtained by utilizing from the observed data and a functional form hypothesis is not required for the production frontier. Non-parametric methods are easily used in efficiency measurement by mathematical programming. Foremost among the non-parametric methods is a family of linear programming models collectively referred to as Data Envelopment Analysis (DEA).

3. Materials and Method

The survey studies with the farmers in Edirne, Kırklareli and Tekirdağ provinces composed the material of the study. Furthermore, the studies that were carried out in our country and in other countries were also investigated.

The name of the districts and the villages and the data concerning the number of the enterprises in the villages were obtained from Edirne, Kırklareli and Tekirdağ Provincial Food Agriculture and Live Stock Directorates. The number of the enterprises were divided into three strata, including 1-50, 51-100 and 101 and above.

In accordance with Neyman method, number of the surveyed villages was determined as 51 with 10% error margin and in 90% confidence interval. Surveys were applied in 18 villages in Edirne province, in 14 villages in Kırklareli province and in 19 villages in Tekirdağ province. In Neyman method, the following formulas were used (Yamane, 1967).

$$n = \frac{(\sum N_h * S_h)^2}{N^2 * D^2 + \sum N_h * (S_h)^2} \qquad n_i = \frac{N_h * S_h}{\sum N_h * S_h} * n \qquad \textbf{(1)}$$

The data of the land sizes of the farmers, registered to farmer registration system, were obtained for the determined villages. The enterprises were ranked with respect to their sizes and divided into three strata, including 1-50 (first group), 51-200 (second group), and 201 decares and above (third group). In accordance with this stratified random sampling method, number of the surveyed enterprises was determined as 169 with 10% error margin and in 95% confidence interval. The selection of the surveyed enterprises was done according to random numbers table.

In stratified random sampling method, the following formulas were used (Cicek and Erkan, 1996).

$$n = \frac{N \sum[N_h (S_h)^2]}{N^2 D^2 + \sum N_h (S_h)^2} \quad n_i = \frac{N_h}{\sum N_h} * n \qquad \textbf{(2)}$$

$D^2 = (d/Z)^2$, d= deviation from average , Z= degree of freedom, N_h = number of the enterprises in the strata, S_h = Standard deviation of the strata, S_h^2 = Variance of the strata, P= population size, n_i = sample number in the strata n= sample size

4. Efficiency Analysis Method

Data envelopment analysis was used in efficiency analysis. This method is commonly used in the literature and the efficiencies of the enterprises, having more than one input and output, can be calculated by this method.

The methods used in data envelopment analysis can be solved as input or output oriented. Input oriented is defined as the examination of the changes in input amounts by fixing the output amounts and output oriented is defined as the examination of the changes in output amounts by fixing the input amounts.

Technical efficiency that shows whether enterprises operate effectively or not is divided into two subgroups as pure technical efficiency and scale efficiency (Coelli et al, 1998).

Pure technical efficiency indicates the efficient usage of the inputs according to variable return to scale assumption. If technical efficiency values for constant return to scale and variable return to scale are different for a specific production unit, this indicates that the production unit has scale inefficiency. Accordingly, scale efficiency could be explained in this way (Zaim, 1999).

Technical efficiency (CRS) = Pure technical efficiency (VRS) x Scale efficiency

In models with constant returns to scale, any increase that can happen in the quantity of input could be seen as increase in the quantity of output with the same ratio, whereas for models with variable returns to scale, any increase in the quantity of input would be seen in different ratios as being reflected on the quantity of output.

In a production process, when the inputs are increased with a certain quantity, if the increase in the level of outputs is more than the increase in inputs, it means there is increasing return to scale if the increase in outputs is less than the increase in inputs, there is reducing return to scale and finally if the quantity of increase in outputs and the quantity of increase in inputs are the same, there is fixed return to scale (Coelli et al, 1998).

Allocative efficiency indicates how the farmer operates technically and economically. In other words, allocative efficiency deals with the usage of the inputs giving the highest yield by the lowest cost. Allocative efficiency is calculated by the following formula.

$$Allocative\ efficiency = \frac{Economic\ efficiency}{Technical\ efficiency} \quad \textbf{(3)}$$

Economic efficiency is the ratio of the minimum cost of a crop to the observed cost of the enterprise. Economic efficiency is defined as the production achievement in minimum cost level. Farrell (1957) divided the economic efficiency as technical efficiency and allocative efficiency.

In the efficiency analysis, enterprises with efficiency coefficient between 0.95 and 1 are considered as effective, those with efficiency coefficient between 0.90 and 0.95 are considered as less effective and those with efficiency coefficient that is less than 0.90 are classified as ineffective enterprises. (Charnes et al, 1978).

As the producers have more tendency to control their inputs than their outputs, efficiency measurements of Farrell (1957) relating with inputs have been used in this study. A model was formed with four inputs and two inputs. Plant gross output value and animal gross output value were accepted as outputs, and variable costs, fixed costs, active capital and total land size were accepted as inputs in the model.

Two-stage approach was used for determining the effects of the variables on efficiency. Efficiency coefficients of the enterprises are obtained in the first stage of this approach. The relation between the efficiency and the effective variables on efficiency is estimated by an appropriate regression model in the second stage (Coelli et al, 1998).

As the efficiency coefficients change between 0 and 1 and classical least squares method estimates the coefficients greater, tobit regression was used in this research.

When number of groups is two and three or more for continuous data, t test and variance analysis were used whether there were differences with regards to the investigated variables or not and χ^2 test was used for discrete data.

5. Results and Discussion

5.1. Efficiency measurement in the enterprises

Plant gross output value and animal gross output value were taken as outputs, and variable costs, fixed costs, active capital and total land size were taken as inputs in the model. An enterprise obtained an average income as 32929.42 TL from plant production and 23895.80 TL from animal production. The average variable costs and fixed costs of the enterprises were determined as 30288.35 TL and 20331.77 TL, respectively. The average capital amount of the enterprises was found as 621052.29 TL and average land size was determined as 117.49 da.

The average, lowest and highest technical efficiency values by enterprise size groups are shown in Table 1.

Table 1: Descriptive statistics of technical efficiency scores

Land size groups	Average	Standard deviation	Minimum	Maximum
1. Group	0.80a	0.17	0.44	1.00
2. Group	0.86b	0.13	0.48	1.00
3. Group	0.91b	0.12	0.69	1.00
Average	0.84	0.15	0.44	1.00

* The averages of the groups with different letters are different in 5% significance level

Technical efficiency values with variable return to scale (VRS) changed between 0.44 and 1 and it was determined as 0.84 on average. This value indicated that the inefficient enterprises could reduce the inputs in the ratio of 16% by not decreasing the outputs. Technical efficiency values differed by enterprise size groups (F=5.811, p=0.021).

It was determined that 49.32% of the enterprises in the first group, 43.75% of the enterprises in the second group and 31.25% of the enterprises in the third group had lower technical efficiency values than the average efficiency value of the enterprises.

Technical efficiency by enterprise size groups are shown in Table 2. Accordingly, it was determined that 28.77% of the enterprises in the first group, 33.75% of the enterprises in the second group and 62.5% of the enterprises in the third group were determined as technically efficient enterprises. The number of the enterprises, which were completely efficient, in other words the technical efficiency values of which were 1, was determined as 47.

Table 2: Technical efficiency by enterprise land size groups

	1. Group		**2. Group**		**3. Group**	
	Number	**%**	**Number**	**%**	**Number**	**%**
Efficient (0.95 ≤ TE ≤ 1)	21	28.77	27	33.75	10	62.50
Less efficient (0.90 ≤ TE ≤ 0.949)	5	6.85	7	8.75	1	6.25
Inefficient (TE ≤ 0.899)	47	64.38	46	57.50	5	31.25
Total	73	100.00	80	100.00	16	100.00

Input oriented technical efficiency values are given in Table 3. Technical efficiency with constant returns to scale, technical efficiency with variable returns to scale and scale efficiency values were determined as 0.66, 0.84 and 0.79, respectively.

Table 3: Distribution of technical efficiency values

Land size groups	**Total technical efficiency**	**Technical efficiency**	**Scale efficiency**
1. Group	0.54	0.80	0.68
2. Group	0.74	0.86	0.86
3. Group	0.84	0.91	0.91
Average	0.66	0.84	0.79

Scale efficiency analysis results are given in Table 4. According to the analysis results, it was determined that 78.08% of the enterprises in the first group, 77.50% of the enterprises in the second group and 50% of the enterprises in the third group had increasing return to scale and 13.70% of the enterprises in the first group, 11.25% of the enterprises in the second group and 37.5% of the enterprises in the third group had constant return to scale. χ^2 Tests results showed that returns to scale changed according to the groups ($\chi^2 = 8.257$, p=0.083).

Table 4: Returns to scale by enterprise land sizes

	1. Group		2. Group		3. Group	
	Number	%	Number	%	Number	%
Increasing returns to scale	57	78.08	62	77.50	8	50.00
Constant returns to scale	10	13.70	9	11.25	5	31.25
Decreasing returns to scale	6	8.22	9	11.25	3	18.75
Total	73	100.00	80	100.00	16	100.00

5.2. Allocative efficiency in the enterprises

The average, lowest and highest allocative efficiency values by enterprise size groups are shown in Table 5.

Table 5: Descriptive statistics of allocative efficiency scores

Land size groups	Average	Standard deviation	Minimum	Maximum
1. Group	0.90a	0.12	0.49	1.00
2. Group	0.87a	0.10	0.65	1.00
3. Group	0.94b	0.07	0.80	1.00
Average	0.89	0.11	0.49	1.00

* The averages of the groups with different letters are different in 5% significance level

Allocative efficiency values changed between 0.49 and 1 and it was determined as 0.89 on average. This showed that some of the enterprises made production with improper input combination. This value indicated that the inefficient enterprises made expenses in the ratio of 11% more than the input combination with minimum costs. Allocative efficiency values differed by enterprise size groups (F=3.424, p=0.035).

It was determined that 28.77% of the enterprises in the first group, 50% of the enterprises in the second group and 25% of the enterprises in the third group had lower allocative efficiency values than the average efficiency value of the enterprises.

According to data envelopment analysis results, allocative efficiency by enterprise size groups are shown in Table 6.

Table 6: Allocative efficiency by enterprise land size groups

	1. Group		2. Group		3. Group	
	Number	**%**	**Number**	**%**	**Number**	**%**
Efficient ($0.95 \leq TE \leq 1$)	27	36.98	23	28.75	10	62.50
Less efficient ($0.90 \leq TE \leq 0.949$)	21	28.77	15	18.75	1	6.25
Inefficient ($TE \leq 0.899$)	25	34.25	42	52.50	5	31.25
Total	73	100.00	80	100.00	16	100.00

It was determined that 36.98% of the enterprises in the first group, 28.75% of the enterprises in the second group and 62.5% of the enterprises in the third group used the resources efficiently.

5.3. Economic efficiency in the enterprises

The average, lowest and highest economic efficiency values by enterprise size groups are shown in Table 7.

Table 7: Descriptive statistics of economic efficiency scores

Land size groups	Average	Standard deviation	Minimum	Maximum
1. Group	0.72a	0.17	0.34	1.00
2. Group	0.75a	0.15	0.43	1.00
3. Group	0.86b	0.13	0.64	1.00
Average	0.75	0.16	0.34	1.00

* The averages of the groups with different letters are different in 5% significance level

Economic efficiency values changed between 0.34 and 1 and it was determined as 0.75 on average. This value indicated that the inefficient enterprises could reduce the operation expenses in the ratio of 25% in order to reach the level of the efficient enterprises. Economic efficiency values differed by enterprise size groups ($F=5.878$, $p=0.029$).

It was determined that 63.01% of the enterprises in the first group, 56.25% of the enterprises in the second group and 18.75% of the enterprises in the third group had lower economic efficiency values than the average efficiency value of the enterprises.

According to data envelopment analysis results, economic efficiency by enterprise size groups are shown in Table 8.

Table 8: Economic efficiency by enterprise land size groups

	1. Group		2. Group		3. Group	
	Number	%	Number	%	Number	%
Efficient ($0.95 \leq TE \leq 1$)	8	10.96	11	13.75	7	43.75
Less efficient ($0.90 \leq TE \leq 0.949$)	7	9.59	3	3.75	0	0.00
Inefficient ($TE \leq 0.899$)	58	79.45	66	82.50	9	56.25
Total	73	100.00	80	100.00	16	100.00

Accordingly, it was determined that 10.96% of the enterprises in the first group, 13.75% of the enterprises in the second group and 43.75% of the enterprises in the third group were determined as economically efficient enterprises.

The number of the enterprises, which were fully economically efficient, in other words the economic efficiency values of which were 1, was determined as 22.

5.4. Effects of some socio economic factors on economic efficiency

Average, minimum and maximum values of the variables used in Tobit model are shown in Table 9.

Education levels of the farmers were determined to be quite low. The mean ages and average family sizes of the farmers were found as 49.92 and 3.46, respectively. The average land size was 117.49 decares and average parcel number was 4.95. The presence of livestock in terms of great cattle unit per enterprise was found as 6.58.

The average incomes from external agricultural activities and nonagricultural activities were determined as 6417.24 TL and 13987.31 TL. Farming is done generally in dry conditions in the region and for this reason, irrigation number was quite low.

Agricultural credit usage in the enterprises was not very high and average credit usage amount was found as 12181.61 TL. All of the farmers joined at least one organization and the average number of the agricultural organizations which they joined was 3.24. Participation to the meetings about agricultural activities was not prevalent and average number of the meetings which they joined was approximately 2.

Table 9: Descriptive statistics of the variables used in Tobit modeling

	Average*	Standard deviation	Minimum	Maximum
Tobit model				
Demographic characteristics				
Age of the farmer (year)	49.92	10.44	26	75
Education period of the farmer (year)	6.58	2.45	5	15
Family size (person)	3.46	1.33	1	7
• General characteristics of the enterprise				
Land size (da)	117.49	170.84	10	1800
Parcel number (number)	4.95	2.70	1	27
Livestock presence (number)	6.58	10.07	0	52
External agricultural income (TL)	6417.24	6299.27	99	29980
Nonagricultural income (TL)	13987.31	14153.31	0	144000
Irrigation number (number)	1.00	2.34	0	15
• Relationship with agricultural organizations				
Credit amount (TL)	12181.61	20861.02	0	135400
Number of the organizations they joined (number)	3.24	1.45	1	8
Number of the agricultural meetings (number)	1.55	1.55	0	5

* Arithmetic mean was used in distance and ratio data as measure of central tendency.

Results of Tobit modeling which was composed in order to determine the effective factors of economic efficiency are shown in Table 10. The signs of the great majority of the included variables were estimated as expected.

Table 10: Tobit analysis results: Factors on economic efficiency

Variables	Coefficient	Standard deviation	p
Age of the farmer	- 0.001078	0.000775	0.1639
Education period of the farmer	- 0.011129**	0.004363	0.0107
Family size	- 0.020971**	0.008237	0.0109
Land size	0.000351**	0.000155	0.0239
Parcel number	- 0.014733	0.009410	0.1174
Livestock presence	0.003988***	0.001326	0.0026
External agricultural income	0.00000251	0.00000252	0.3198
Nonagricultural income	- 0.00000162*	0.000000865	0.0608
Irrigation number	0.005365*	0.005016	0.0954
Credit amount	0.00000105	0.00000581	0.8570
Number of the organizations they joined	- 0.0016828*	0.008846	0.0571
Number of the agricultural meetings	0.002376	0.008022	0.7671
Likelihood ratio	18.31***		

* significant in 10% significance level, ** significant in 5% significance level, *** significant in 1% significance level

The ages of the farmers and number of the parcels were determined to have negative effects and external agricultural income, credit amount, participation to agricultural meetings were determined to have positive effects on economic efficiency. These variables were statistically insignificant ($p>0.10$).

Presence of livestock had a positive effect on economic efficiency ($p=0.026$). This indicated that stock farming increased the income levels of the farmers.

The family size had a negative effect on economic efficiency ($p=0.0109$). Economic efficiency decreased as the family size increased. Similarly, in previous studies, Hazneci (2007) found that the family size had a negative effect on economic efficiency.

The education period of the farmers had a negative effect on economic efficiency ($p=0.0107$). As the educational levels of the farmers increased, they were interested in different activities besides agricultural activities. Moreover, the percentage of the highly trained farmers was low and this caused to be a negative relationship between education level and economic efficiency.

The land size had a positive effect on economic efficiency (p=0.0239). The economic efficiency increased as the land size increased. Similarly, in previous studies, Parlakay (2011) found that the land size had a positive effect on economic efficiency.

The incomes from nonagricultural activities had a negative effect on economic efficiency (p=0.0608). The incomes of the farmers from nonagricultural activities were high and this caused the reduction of the increasing effort of the incomes from agricultural activities.

Irrigation amount had a positive effect on economic efficiency (p=0.0954). This indicated that irrigation increased the yield amount, accordingly the incomes of the farmers. Similarly, in previous studies, Kaçıra (2007) found that the irrigation amount had a positive effect on economic efficiency.

The effect of the number of the agricultural organizations on economic efficiency was examined. As the number of the agricultural organizations increased, economic efficiency decreased (p=0.0571). As the functions of the agricultural organizations were insufficient, the farmers were affected negatively and dealt with different occupations.

5.5. Comparison of efficient and inefficient enterprises

Comparison of the efficient and inefficient enterprises was done and the results are shown in Table 11. The enterprises which were completely economically efficient were compared with the other enterprises.

The average ages of the efficient enterprises were determined to be a bit low according to the inefficient enterprises. The education periods and family sizes of the efficient enterprises were a bit high than the inefficient enterprises.

The land sizes of the efficient enterprises were higher than the inefficient enterprises (t= -2.645, p=0.009). Livestock presence of the efficient enterprises were higher than the inefficient enterprises (t= -4.642, p=0.000). This indicated that the income from stock farming had an important effect on efficiency.

The parcel number of the efficient enterprises were higher according to the inefficient enterprises. This was due to the higher land sizes of the efficient enterprises according to the inefficient enterprises. The average parcel sizes of the efficient enterprises were determined to be higher than the inefficient enterprises.

Table 11: Socio economic characteristics of efficient and inefficient enterprises

Variables	Efficient enterprises (n=22)	Inefficient enterprises (n=147)
Demographic characteristics		
Age of the farmer (year)	47.68 (8.53)	50.26 (10.68)
Education period of the farmer (year)	6.81 (2.86)	6.52 (2.39)
Family size (person)	3.64 (1.36)	3.43 (1.32)
• *General characteristics of the enterprise*		
Land size (da)	205.77 (371.83)***	104.27 (111.12)***
Livestock presence (number)	15.27 (14.91)***	5.28 (8.33)***
Average parcel size (decare)	23.91 (15.79)	19.63 (10.96)
Irrigation number (number)	1.77 (3.70)*	0.88 (2.06)
Second crop farming[1]	0	0
Green manure application[2]	0	0
• *Relationship with agricultural organizations*		
Credit usage (TL)	18309.09 (31011.95)	11264.57 (18865.86)
Having soil analysis[3] (median)	2	2
Number of the organizations they joined (number)	3.27 (1.55)	3.24 (1.44)
Number of the agricultural meetings (number)	1.68 (1.59)	1.53 (1.55)
Capital structure of the enterprise		
Business capital (TL)	163991.73 (148601)***	95148.79(99837.10)***
Own capital (TL)	782023.88 (792886)***	478343.27 (402907)***
Annual activity results of the enterprise		
External agricultural income (TL)	10530 (8996.32)***	5801.72 (5575.71)***
Nonagricultural income (TL)	15694.36 (2495.52)	13731.84 (1196.05)
Agricultural income (TL)	62815.32(50430.59)***	17025.03(22548.50)***

Numbers in brackets indicate standard deviation.
Arithmetic mean was used in distance and ratio data as measure of central tendency, median was used in ordered data and mode was used in classified data.

[1] Enterprises growing and not growing second crops were included to the model with 1 and 0, respectively.
[2] Enterprises applying and not applying green manure were included to the model with 1 and 0, respectively.
[3] Enterprises having, sometimes having and not having soil analysis were included to the model with 1, 2, and 3 respectively.
* The difference between the efficient and inefficient enterprises is statistically significant in 10% significance level.
** The difference between the efficient and inefficient enterprises is statistically significant in 5% significance level. *** The difference between the efficient and inefficient enterprises is statistically significant in 1% significance level.

The efficient enterprises made irrigation in further amounts than the inefficient enterprises. Irrigation has a positive effect on yield and this caused the increment of the income and the efficiency (t= -1.669, p=0.097). Second crop farming and green manure application were rather low in all the enterprises.

The efficient enterprises used more credits than the inefficient enterprises. All the enterprises had sometimes soil analysis and the number of the agricultural organizations which they joined and the number of the agricultural meetings were almost equal. The business capital (t= -2.809, p=0.006) and own capital (t= -2.826, p=0.005) of the efficient enterprises were quite high than the inefficient enterprises.

The agricultural incomes of efficient enterprises from external agricultural activities were quite high according to the inefficient enterprises (t= -7.251, p=0.000). The nonagricultural incomes of the efficient enterprises were even a little high than the inefficient enterprises and the agricultural incomes of the efficient enterprises were quite high when compared with the agricultural incomes of the inefficient enterprises.

6. Conclusion

Technical efficiency was determined to be at good level in the research area. According to the average of the enterprises, technical efficiency was calculated as 0.84. According to this result, it was decided that the inefficient enterprises could reduce the inputs in 16% ratio by not reducing the production amount.

Pure technical efficiency scores were determined to be higher than scale efficiency scores and this indicated that low technical efficiency was based on the inefficiency of input usage rather than the scale inefficiency.

Allocative efficiency scores changed between 0.49 and 1 and average value was determined as 0.89. This value indicated that the inefficient enterprises made expenses in the ratio of 11% more than the input combination with minimum costs. Economic efficiency scores changed between 0.34 and 1 and average value was determined as 0.75.

Technical efficiency scores of the enterprises were found to be higher than economic efficiency scores. This result indicated that the farmers required information about optimum input combination selection on data-price level rather than technical information.

It was determined that the farmers generally made fertilizer and pesticide usage according to the experiences. The amount of the inputs and application time are important in fertilizer and pesticide applications. Publication establishments can be effective on decreasing the wastes in input usage.

Fertilizer usage had the highest ratio among the expense items. The ratio of having soil analysis was low especially in small and medium enterprises. It can be understood that the farmers were not very knowledgeable about soil analysis. The farmers must be informed that the soil analysis provided the data for annual production.

This can be done by agriculture consulting channel ideally. Therefore, free agriculture consulting system must be developed and the applications must be extended. These studies must be supported and controlled by public extension programs.

It was determined that stock farming had positive effect on economic efficiency. However, different training programs can be introduced for increasing the efficiency of the enterprises because these enterprises ignored the agricultural activities except stock farming and this could affect the plant production income negatively.

It was concluded that the organization of the enterprises could increase the efficiency. It was seemed impossible that economic efficiency could be increased by the current situations of the organizations. Studies on the required regulations in order to make the current organizations more efficient could increase the efficiency of the enterprises. On this subject, Ministry of Food, Agriculture and Livestock must provide the cooperation with other ministries and make the essential legal regulations.

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