Efficiency analysis in organic cattle fattening enterprises in Turkey: case of Ayvacık District of Çanakkale Province

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Abstract

The aim of this study was to calculate the efficiency measurements of the enterprises affiliated to Organic Red Meat Producers Union in Ayvacık district of Çanakkale province where the organic cattle fattening activity is performed intensively and reveal the factors affecting the economic efficiency. The data were obtained from total of 31 producers affiliated to Organic Red Meat Producers Union in Ayvacık district of Çanakkale province in 2018. Data envelopment analysis was used in order to measure the efficiency in organic cattle fattening enterprises in the study. Carcass yields were found as 51.08% and 53.43% in native and cross breeds, respectively and it was found as 51.61% according to the average of the enterprises. In the research area, technical efficiency (CRS), pure technical efficiency, scale efficiency, allocative efficiency and economic efficiency were found as 0.918, 0.949, 0.968, 0.916 and 0.868, respectively. It was determined that 22.58%, 51.51% and 25.81% of the enterprises had decreasing return to scale, increasing return to scale and constant return to scale, respectively According to the variance analysis results, it was concluded that carcass amount, forage amount labor cost changed but fattening period and live weight gain did not change according to the return to scale groups. It was determined that the enterprises should decrease the forage amount, labor cost and fattening period in the ratios of 30.63%, 19.28% and 18.68%, respectively and increase the live weight gain in the ratio of %1.75 in order to be economically efficient. According to Tobit model results, it was determined that the fattening experience of the producer, daily live weight gain, forage plant land size, having training on fattening affected the economic efficiency positively whereas the land size of the producer affected the economic efficiency negatively.

Keywords: Data envelopment analysis, Efficiency, Organic cattle fattening

1. Introduction

Livestock farming, which is one of the two significant branches of agriculture, has been one of the oldest agricultural occupations and livelihoods of the human and retains this status today. Livestock farming, which has a significant role in the adequate and balanced nutrition, has some significant economic and social functions such as providing raw materials to meat, milk, textile, cosmetic and medicine industry branches and contributing to balanced development, decreasing and preventing open and concealed unemployment in rural area, basing the development and industrialization finance upon the own funds, increasing the foreign exchange earnings by exporting, decreasing and preventing the immigrations and the social boredoms due to the immigrations (Özüdoğru, 2012).

Animal food stuffs have a significant role in human nutrition. Animal food stuffs production should be increased both qualitatively and quantitatively in parallel with the population increase. During the increase of animal production, the environment conditions in living and sheltering habitats of the animals should be improved and brought to optimum level besides the increment of the yield potentials of the animals by feeding and genetic improvements. The environmental factors in the habitats of the animals can be physical, chemical, social and microbiological and these environmental factors should be well evaluated in the planning of the shelters. Because, the environmental conditions can be effective on the structural characteristics and costs of the shelters besides the health and the yields of the animals (Kocaman and Yüksel, 2002).

In recent years, although some significant developments have been provided towards the increase of the performances of the livestock and decrease of the production costs by the production increase in conventional livestock farming, uncontrolled use of the medicines aimed at the vegetative production and the animals in order to obtain more animal foods, leads to many health problems (Çukur and Saner, 2005). A great majority of the organic foods do not include pesticide residual (94-100%), organic vegetables include considerably less nitrate and organic cereals include comparable mitotoxin level according to the conventional kinds (Lairon, 2010). Considering in terms of meat products, organic meat production is a type of production which does not include growth hormone components and antibiotics and in which chemical drug is not used and organic meat production can be accepted as a production type which can satisfy the food security concerns of the consumers.

Conventional livestock farming is defined as a production type which aims the highest yield with more inputs and animals. The animal number is fewer in organic livestock farming and by this production type, in proper feeding and shelter conditions, qualified crops with proper production and marketing method can be obtained and they can reach to high prices. The main differences separating the organic livestock farming from conventional livestock farming are animal welfare, natural environment, healthy products and sustainable sources (Çukur and Saner, 2005). In organic production, performed in proper shelter conditions by considering the health and welfare of the animals, breeding and race selection should be done accurately and the animals should be fed with organic forages. Generally, organic livestock farming have some purposes such as developing the sustainable livestock farming, protecting the animal health, performing organic animal production towards the demands of the consumers and increasing the income level of the produces.

Fattening is significant in terms of executing the interregional balanced development and encountering the demands of qualified beef which have fattened carcass weights (Akçay, 2006). Fattening is defined as feeding the animals intensively in order to obtain the carcass as soon as possible and economically by considering the requirements and requests of the consumer.

Organic meat production and consumption gradually become popular in the World as a result of the taking the health factor to forefront. Organic meat is stated as richer in terms of omega 3 fatty acids and conjugate linoleic acid (CLA) and waterier, crispier and more aromatic according to conventional meat. Balanced rate of the essential fatty acids is stated as interrelating with lower cancer, heart diseases, diabetes, obesity and mental disorders (Tekeli, 2005).

Organic meat industry has developed as a result of the increase of the demands of the consumers to organic meat products in the World and many organic food products have been available in sufficient amounts in the markets (Wong and Aini, 2017). Nevertheless, organic meat production is relatively a new sector in comparison with traditional red meat industry. The number of the animals, reared organically, increase in many countries. France, Austrian, Italy, Czech Republic and Spain are the primary countries which have the maximum number of animals (Demirkol and Azabağaoğlu, 2018).

Kars, Çanakkale and Erzurum provinces come to the forefront in organic cattle farming whereas Van, Çanakkale and Kars provinces come to the forefront in organic sheep and goat farming in Turkey. In organic chicken breeding, İzmir, Elazığ and Bilecik provinces are in good state in broiler production and Elazığ, Samsun, Manisa, Konya and İzmir provinces are in good state in egg poultry production. Organic beekeeping is more common in Artvin, Sakarya, Erzurum, Van and Trabzon (Aygün and Akbulak, 2017).

As the producers, performing both vegetative and animal production, cannot interfere the input prices, they restrict the amounts and the varieties of the inputs and this causes yield loss. However, the purpose of each producer is to increase the output amount as a result of the production which is carried out by current resources. Each producer, realizing this purpose, will be able to use the resources more efficient. The efficiency studies enables the inter-enterprise comparison. Besides, some precautions can be taken by determining the source of the inefficiency and by this way, a more efficient production can be performed (Kaçıra, 2007). Determining the inefficient enterprises and developing a policy aimed at preventing the common causes which reveal the inefficiency, can be effective on enhancing the incomes of the enterprises (Parlakay, 2011).

The aim of this study was to calculate the efficiency measurements of the enterprises affiliated to Organic Red Meat Producers Union in Ayvacık district of Çanakkale province where the organic cattle fattening activity is performed intensively and reveal the factors affecting the economic efficiency. Besides, economically efficient and inefficient enterprises were compared in the study. Various factors which could be effective in organic cattle fattening activity, were determined and the current structure of the enterprises was presented and by utilizing from the obtained data, it is expected that recognition of the current state will be favorable in terms of the determination of the regional advantages and shaping the future of organic cattle fattening.

2. Literature Review

Various studies were conducted on efficiency analysis of dairy cattle and conventional cattle fattening but it was not seen any studies on determination of the efficiency of organic cattle fattening.

Johansson (2005) calculated the technical, economic and allocative efficiencies of the dairies in Sweden by data envelopment analysis. Technical, allocative and economic efficiency values were found as 0.77, 0.57 and 0.43, respectively. Besides, the relationship between the efficiency values of the enterprises and the enterprise size was found positively and statistically significant.

Hazneci (2007) determined the efficiencies of the cattle fattening enterprises in Suluova district of Amasya province. According to the average of the enterprises, technical, pure technical, scale, allocative and economic efficiency values were found as 0.868, 0.915, 0.949, 0.900 and 0.822, respectively. It was determined that the ratio of culture livestock, fattening period, number of feeding, record keeping, frequency of contact with extension service and credit use had positive effects on economic efficiency.

Gündüz (2011) measured the technical efficiency of sample dairy farms and subsequently explored the determinants of technical inefficiency in the Bafra District of Samsun province, Turkey. Stochastic Frontier Analysis was used to measure technical efficiency in the study. The mean technical efficiency of the sample farms was found as 0.89. The variables of education level, experience and milking method negatively affected technical inefficiency and these variables were statistically significant. However, household size showed a positive relationship with inefficiency and it was significant.

Kelly et al. (2012) determined the levels of technical efficiency on a sample of Irish dairy farms utilizing Data Envelopment Analysis (DEA). The average technical efficiency score was 0.785 under CRS and 0.833 under VRS.

Gözener (2013) determined the efficiencies of the cattle fattening enterprises in TR83 Region. The analyses revealed that average efficiency of the first group farms was 89% based on VRS-DEA, while it was 83% for the second group farms. Based on Stochastic Frontier Analyses (SSA), the average efficiency of the first group farms was 87% while it was 93% for the second group farms and the results of VRS-DEA and SSA were similar to each other. According to the results of SSA, education, number of feeding, the ratio of forage crops cultivated land area to the total land and the use of credit situations were statistically important for the first group farms. The fattening period, number of feeding, the ratio of forage crops cultivated land area to the total land and the use of credit situations were significant for the second group farms. The results of Tobit analyses showed that fattening period, number of feeding and the use of credit situations were significant for the first group of farms, while experience, fattening period and the use of credit situations were significant for the second group of farms.

Kumbar (2015) determined the efficiencies of the cattle farming enterprises in Thrace Region. According to the average of the enterprises, pure technical efficiency, technical efficiency, scale efficiency, allocative and economic efficiency were found as 0.62, 0.49, 0.80, 0.68 and 0.42, respectively. It was determined that education level, experience, the scale of the enterprise in terms of animal unit and the number of agricultural organizations have positive effect on economic efficiency.

Aydemir et al. (2020) determined the technical efficiency of dairy cattle farms in Artvin province of Turkey. Total technical efficiency, technical efficiency and scale efficiency were found as 0.544, 0.65 and 0.86, respectively. According to the Tobit regression analysis results, it was determined that inefficiency scores increased with increasing herd sizes.

3. Material and Method

The survey studies obtained from organic cattle fattening producers in Ayvacık district of Çanakkale composed the material of the study. Besides, it was utilized from the literature related with the subject of the study and statistics.

The data were obtained from total of 31 producers affiliated to Organic Red Meat Producers Union in Ayvacık district of Çanakkale province in 2018.

During the analyses of the data, it was utilized from main descriptive statistics such as average, standard deviation and percentages. 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.

Data envelopment analysis was used in order to measure the efficiency in organic cattle fattening enterprises in the study.

Data envelopment analysis is used in order to evaluate the relative efficiencies of the decision points which are responsible for presenting output or outputs by using similar inputs and can be defined as a linear programming based method. The main characteristic, separating data envelopment analysis from the other similar methods, is to provide an evaluation in case of many inputs and outputs are present. At the end of the analysis information is obtained about the efficiency value for each decision point, about how ineffective decision making units could improve their efficiencies with which ratio of inputs and outputs and information regarding decision making units which could be used as reference (Anonymous, 2020).

Efficiency measurements are examined as input oriented and output oriented (Coelli et al. 1998). The aim of input oriented measurements is to calculate how much the quantity of input could be reduced without changing the quantity of output. The aim of output oriented measurements is to calculate how much quantity of output could be increased without changing the quantity of input. The input and output oriented efficiency analysis are performed under constant return to scale and variable return to scale assumptions.

The first data envelopment model was put forward by Charnes, Cooper and Rhodes (1978) and mentioned as CCR referring to the authors. This model is based on constant return to scale assumption. Banker, Charnes and Cooper (1984) developed the data envelopment model based on constant return to scale assumption by considering the variable return to scale and this model is known as BCC. According to BCC model, supposing that all the production units do not operate in optimal scale, the use of constant return to scale definition ends up with a technical efficiency measurement stirred with scale efficiencies. For this reason, the use of variable return to scale definition provides a technical efficiency calculation adjusted from scale efficiency. The efficiency obtained from BCC model is named as pure efficiency. The pure efficiency value is equal to or more than the technical efficiency value obtained from CCR model. Potential improvement analyses are done by means of data envelopment model estimations. In this analysis, the output values are determined in order to bring the inefficient units to the level of the efficient units and potential improvement ratios are calculated according to these values.

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

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

Constant return to scale model is valid if only the enterprises perform in optimum scale (Coelli et al. 1998). As the cattle fattening enterprises are subordinate to imperfect competition conditions, the model was converted to variable return to scale model by adding a limiter to constant return to scale model providing the convexity. Adding this limiter to the model prevents the calculation of scale efficiency and consequently, the scale efficiency is found by dividing the minimum cost in CRS conditions to the minimum cost in VRS conditions (Banker et al. 1984).

Technical efficiency is defined as the achievement of the enterprise on producing the maximum output by using the input combination properly. This definition is output oriented technical efficiency definition. Input oriented technical efficiency is the achievement of the enterprise on producing the current output level by using the least resource usage (Bakırcı, 2006). The achievement in realizing production activity with the most convenient scale is defined as scale efficiency. Economic efficiency is defined as both minimizing the costs and providing the optimum input components of the enterprise resources. Allocative efficiency deals with the use of more effective input combination and achieve this with minimum cost during production. Allocative efficiency is calculated by the following formula.

$$Allocative\ efficiency = \frac{Economic\ efficiency}{Technical\ efficiency}$$

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 were used in this study. A model was formed with four inputs and one output. The carcass amount value was accepted as output. The forage amount, labor cost, fattening period and live weight gain were accepted as inputs in the model. While estimating the efficiency measurements, DEAP 2.1 package program that was developed by Coelli (1996) was used.

Two-stage approach was used for determining the effects of the variables on efficiency. Two-stage approach is suggested as it can be used with more than one continuous and discrete variables and does not require an assumption about the effects of the variables. In the first stage of this approach, efficiency coefficients for each enterprise are obtained. 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 changed between 0 and 1, Tobit regression was used in this study as classical least squares method would estimate the coefficients more than adequate.

Tobit model is an econometric model, introduced by James Tobin, in order to define the relationship between nonnegative dependent variable and independent variable or vector. Tobit regression model is frequently used by the economists in order to analyze the restricted or in other words dependent variables subjected to an upper or lower restraint. Tobit model is used as a different estimation method if all the observation value of the dependent variable cannot be accurately obtained or all the values of the dependent variable can be observed but defined at certain intervals (Henningsen, 2013). It is known as censored sample model in which the information of the dependent variable is found only for some observations. It is the nonparametric alternative of least squares regression (Liao, 1994). Therefore, Tobit model is named as censored or discrete regression model.

The dependent variable was economic inefficiency in Tobit model. The independent variables in the model were taken as producer's age, education period, fattening experience, land size, daily live weight gain, forage plant land size, nonagricultural activity and having training on fattening.

4. Results and Discussion

Some technical characteristics of organic cattle fattening activity are given in Table 1. Total of 56.21 heads of native breed and 42.86 heads of cross breed livestock were present in the enterprises. In native breed livestock, live weight at the turn of fattening, live weight at the end of fattening and live weight gain were found as 154.17 kg/head, 272.92 kg/head and 118.75 kg/head, respectively. In cross breed livestock, live weight at the turn of fattening, live weight at the end of fattening and live weight gain were determined as 155.72 kg/head, 302.86 kg/head and 147.14 kg/head, respectively. It was seen that live weight gain obtained from cross breed livestock were higher than native breed livestock. According to the average of the enterprises, live weight at the turn of fattening, live weight at the end of fattening and live weight gain of the livestock were found as 154.52 kg/head, 279.68 kg/head and 125.16 kg/head, respectively.

Average fattening periods for native and cross breed livestock were 145 and 154.29 days, respectively and it was found as 147.10 days according to the average of the enterprises. Daily live weight gain for native and cross breed livestock were determined as 860.19 g/head and 957.14 g/head, respectively and it was found as 882.08 g/head according to the average of the enterprises. It was concluded that daily live weight gain obtained from cross breed livestock were higher than native breed livestock

In previous studies which were carried out on conventional cattle fattening, daily live weight gains per animal were found as 454 g in native and 623 g in cross breed livestock (Kılıç, 1994), 908.45 g in native and 994.04 g in cross breed livestock (Hazneci, 2007), 707.25 g in native and 849.73 g in cross breed livestock (Gözener, 2013), 1342.33 g in native and 1096.73 g in cross breed livestock (Gözener and Sayılı, 2015), 691.23 g in native and 824.82 g in cross breed livestock (Işık, 2018).

Carcass yields were found as 51.08% and 53.43% in native and cross breeds, respectively and it was found as 51.61% according to the average of the enterprises. Carcass amounts per native and cross breed livestock were found as 139.31 kg/head and 161.81 kg/head, respectively and it was determined as 144.47 kg/head according to the average of the enterprises. In previous studies, carcass yields were found as 52.72% in native and 55.52% in cross breed livestock (Hazneci, 2007), 47.34% in native and 53.61% in cross breed livestock

(Gözener, 2013), 44.28% in native and 50.08% in cross breed livestock (Gözener and Sayılı, 2015), 49.09% in native and 54.14% in cross breed livestock (Işık, 2018).

Table 1: Technical parameters related to organic cattle fattening activity

Technical parameters	Native	Cross	Average
Number of fatten animals (head)	56.21	42.86	53.20
Number of the sold animals at the end of the fattening (head)	43.92	37.00	42.36
Live weight at the turn of fattening (kg/head)	154.17	155.72	154.52
Live weight at the end of fattening (kg/head)	272.92	302.86	279.68
Live weight gain (kg/head)	118.75	147.14	125.16
Fattening period (day)	145.00	154.29	147.10
Daily live weight gain (g/head)	860.19	957.14	882.08
Carcass amount (kg/head)	139.41	161.81	144.47
Carcass yield (%)	51.08	53.43	51.61

Descriptive statistics of the variables used in efficiency analysis are given in Table 2. Some technical parameters of organic fattening activity were given by races but the enterprises were evaluated totally in efficiency analysis. In the research area, it was determined that an enterprise obtained 144.47 kg carcass per animal. The enterprises used 836.60 kg forage in order to reach to this production level and live weight gain and fattening period were found as 125.16 kg and 147.10 days, respectively. Besides, it was determined that the enterprises made 113.96 $ labor cost per animal on average.

Table 2: Descriptive statistics of the variables used in efficiency analysis

Variables	**Average**	**Standard deviation**	**Minimum**	**Maximum**
Carcass amount (kg/head)	144.47	15.34	125.00	192.50
Forage amount (kg/head)	836.60	467.43	117.19	1923.08
Labor cost ($/head)	113.96	71.06	27.51	311.20
Fattening period (day)	147.10	41.98	120.00	360.00
Live weight gain (kg/head)	125.16	25.13	90.00	200.00

Technical efficiency with variable return to scale changed between 0.80 and 1 and it was found as 0.949 on average. This value indicated that the inefficient enterprises could decrease the inputs in the ratio of 5.1% by not decreasing the outputs. It was determined that 35.48% of the enterprises had lower values than average technical efficiency value.

Technical efficiency with constant return to scale and scale efficiency were found as 0.918 and 0.968, respectively. Scale efficiency indicates whether the enterprises are in optimum scale or not. In the research area, it was determined that 45.16% of the enterprises had lower values than average scale efficiency value.

In the study which was carried out in Amasya province by Hazneci (2007), average technical efficiency, pure technical efficiency and scale efficiency in cattle fattening were found as 0.868, 0.195 and 0.949, respectively. In the study carried out in TR83 Region, average technical efficiency were found as 0.83 and 0.89 in the enterprises in the first and second groups, respectively (Gözener, 2013). Kumbar (2015) found pure technical efficiency, technical efficiency and scale efficiency as 0.62, 0.49 and 0.80 in cattle farming enterprises in Thrace Region. In the study conducted by Aydemir et al. (2020) in Artvin, technical efficiency, pure technical efficiency and scale efficiency in dairy farming enterprises were found as 0.544, 0.65 and 0.86, respectively.

Allocative efficiency changed between 0.36 and 1 and it was found as 0.916 on average. This value indicated that the enterprises made more expenses in the ratio of 8.4% than minimum costly input combination. It was determined that 41.94% of the enterprises had lower values than average allocative efficiency value.

It was determined that the economic efficiency changed between 0.36 and 1 and was found as 0.868 on average. This value indicated that the economic ineffective enterprises should decrease the operating expenses in the ratio of 13.2% in order to reach to the level of the economically efficient enterprises (Table 3).

In the study which was carried out in Amasya province in cattle fattening enterprises by Hazneci (2007), average allocative efficiency and economic efficiency were found as 0.900 and 0.822, respectively. In the study carried out by Kumbar (2015) in cattle farming enterprises in Thrace Region, average allocative efficiency and economic efficiency were found as 0.68 and 0.42, respectively.

Table 3:. Descriptive statistics of the efficiency scores

Efficiency measurements	Average	Standard deviation	Minimum	Maximum
Technical efficiency (CRS)	0.918	0.07	0.77	1.00
Pure technical efficiency (VRS)	0.949	0.07	0.80	1.00
Scale efficiency	0.968	0.03	0.89	1.00
Allocative efficiency	0.916	0.13	0.36	1.00
Economic efficiency	0.868	0.13	0.36	1.00

The frequency distribution of the efficiency scored is given in Table 4. It was determined that the efficiency scores of the enterprises were frequently between 0.800-0.899in terms of technical efficiency and more than half of the enterprises (58.06%) were fully efficient in terms of pure technical efficiency. It was observed that the scale efficiency scores were substantially between 0.950 and 0.99 and great majority of the enterprises reached to appropriate scale level.

It was determined that the efficiency scores of the enterprises were mainly between 0.950-0.999 in terms of allocative efficiency and the efficiency scores in terms of economic efficiency were mostly between 0.800-0.899. There was only one enterprise the allocative and economic efficiency score of which was lower than 0.50. There were 18 technical and 4 economic fully efficient enterprises. Besides, there were 4 fully efficient enterprises in terms of allocative efficiency and 8 enterprises which operated in optimal scale (Table 4).

Table 4: Frequency distribution of the efficiency scores

Efficiency level	Technical efficiency (CRS)		Pure technical efficiency (VRS)		Scale efficiency		Allocative efficiency		Economic efficiency	
	N	%	N	%	N	%	N	%	N	%
0.000-0.499	0	0.00	0	0.00	0	0.00	1	3.23	1	3.23
0.500-0.599	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
0.600-0.699	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
0.700-0.799	2	6.45	0	0.00	0	0.00	1	3.23	5	16.13
0.800-0.899	10	32.26	8	25.81	1	3.23	10	32.26	13	41.94
0.900-0.949	7	22.58	3	9.68	8	25.81	2	6.45	0	0.00
0.950-0.999	5	16.13	2	6.45	14	45.16	13	41.94	8	25.81
1.000	7	22.58	18	58.06	8	25.81	4	12.90	4	12.90
Total	31	100.00	31	100.00	31	100.00	31	100.00	31	100.00

It was determined that 22.58%, 51.51% and 25.81% of the enterprises had decreasing return to scale, increasing return to scale and constant return to scale, respectively (Table 5). It was stated that the carcass amount and live weight gain of the enterprises which had increasing return to scale were lower than the enterprises which had increasing return to scale and constant return to scale. Besides, it was determined that the forage amount and labor cost of the enterprises which had constant return to scale were lower than the enterprises which had increasing return to scale and decreasing return to scale and the fattening period did not differ in all the groups. According to the variance analysis results, it was concluded that carcass amount (F=7.136, p=0.003), forage amount (F=3.614, p=0.040), labor cost (F=3.140, p=0.059) changed but fattening period and live weight gain did not change according to the return to scale groups.

In the study carried out by Hazneci (2007), it was determined that 74.07% of cattle fattening enterprises had increasing return to scale and 25.93% of the enterprises had constant return to scale.

Table 5: Scale efficiency analysis results

Return to scale	Number	%	Carcass amount (kg/head)	Forage amount (kg/head)	Labor cost ($/head)	Fattening period (day)	Live weight gain (kg/head)
Constant return to scale	8	25.81	152.69a	477.64a	63.86a	172.50	126.25
Decreasing return to scale	7	22.58	154.57a	966.31b	118.73b	150.00	140.00
Increasing return to scale	16	51.61	135.78b	959.34b	136.93b	133.13	118.13

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

Classification of the enterprises according to technical efficiency is given in Table 6. It was determined that 58.06% of the enterprises operated fully efficient in terms of technical efficiency. Besides, it was determined that 6.45% of the enterprises operated efficient, 9.68% of the enterprises operated less efficient and 25.81% of the enterprises were not efficient in terms of technical efficiency.

In the study carried out by Hazneci (2007), it was concluded that 33.33% of the cattle fattening enterprises were not technically efficient and 7.41%, 24.07% and 35.19% of the enterprises were less efficient, efficient and fully efficient in terms of technical efficiency, respectively.

It was determined that 25.81% of the enterprises operated in optimal scale, in other words the scale efficiency scores were equal to 1. Besides, it was concluded that 45.16% of the enterprises operated close to optimal scale.

Table 6: Classification of the enterprises according to technical efficiency

Efficiency status	Technical efficiency (CRS)		Pure technical efficiency (VRS)		Scale efficiency	
	Number	%	Number	%	Number	%
Fully efficient (TE=1)	7	22.58	18	58.06	8	25.81
Efficient (0.95 ≤ TE<1)	5	16.13	2	6.45	14	45.16
Less efficient (0.90 ≤ TE ≤ 0.949)	7	22.58	3	9.68	8	25.81
Inefficient (TE ≤ 0.899)	12	38.71	8	25.81	1	3.23
Total	31	100.00	31	100.00	31	100.00

Classification of the enterprises according to allocative efficiency is given in Table 7. According to the results, it was determined that 12.90%, 41.94% and 6.45% of the enterprises were fully efficient, efficient and less efficient in terms of resource distribution, respectively. It was concluded that 38.71% of the enterprises did not distribute the resources efficiently, in other words made production by improper input combination when the current input prices were taken into consideration in current technology level.

In the study which was carried out by Hazneci (2007), it was determined that 17% of the cattle fattening enterprises and in the study carried out by Kumbar (2015), 3.6% of cattle farming enterprises were efficient in terms of resource distribution.

Table 7: Classification of the enterprises according to allocative efficiency

Efficiency status	Allocative efficiency	
	Number	%
Fully efficient (AE=1)	4	12.90
Efficient (0.95 ≤ AE<1)	13	41.94
Less efficient (0.90 ≤ AE<0.949)	2	6.45
Inefficient (AE ≤ 0.899)	12	38.71
Total	31	100.00

The classification of the enterprises in terms of economic efficiency was done (Table 8). In the research area, it was determined that 12.90% of the enterprises were economically fully efficient, in other words sustained the production with minimum costly input combination. It was determined that 25.81% of the enterprises were economically efficient whereas 61.29% of the enterprises were inefficient.

In the study which was carried out by Hazneci (2007), it was determined that 5.56 of the cattle fattening enterprises and in the study carried out by Kumbar (2015), 3.6% of cattle farming enterprises were economically efficient.

Table 8: Classification of the enterprises according to economic efficiency

Efficiency status	Economic efficiency	
	Number	%
Fully efficient (EE=1)	4	12.90
Efficient (0.95≤EE<1)	8	25.81
Less efficient (0.90≤EE<0.949)	0	0.00
Inefficient (EE≤0.899)	19	61.29
Total	31	100,00

Average realized and optimum input levels of the economically inefficient enterprises and the improvement ratios were determined (Table 9). According to the results, it was determined that the enterprises should decrease the forage amount, labor cost and fattening period in the ratios of 30.63%, 19.28% and 18.68%, respectively and increase the live weight gain in the ratio of %1.75 in order to be economically efficient.

Table 9: Potential improvement ratios of the realized and optimum input levels of economically inefficient enterprises

Variables	Realized	Optimum	Difference	PI (%)
Forage amount (kg/head)	873.05	605.59	-267.46	-30.63
Labor cost ($/head)	116.98	94.43	-22.55	-19.28
Fattening period (day)	150.00	121.99	-28.01	-18.68
Live weight gain (kg/head)	123.70	125.87	2.17	1.75

PI: Potential improvement ratio

The descriptive statistics of the variables used in Tobit model are given in Table 10. It was determined that the producers were generally in 36-45 age interval and average education period and fattening experience of the producer were 7.58 and 29.52 years, respectively. Total land size and forage plant land size of the producers were found as 305.87 da and 37.65 da, respectively. The daily live weight gain was determined as 882.08 g. It was determined that 12.90% of the producers had a nonagricultural activity, in other words a great majority of the producers were not occupied with nonagricultural activity. Besides, it was determined that 45.16%, in other words, more than half of the producers did not have training on fattening.

Table 10: Descriptive statistics of the variables used in Tobit model

Tobit model	Average	Standard deviation	Minimum	Maximum
Producer's age[1]	3.00			
Education period (year)	7.58	3.01	5.00	15.00
Fattening experience (year)	29.52	12.48	8.00	60.00
Land size (da)	305.87	188.79	48.00	824.00
Daily live weight gain (g)	882.08	190.97	277.78	1333.33
Forage plant land size (da)	37.65	101.42	0.00	575.00
Nonagricultural activity[2]	0.00			
Having training on fattening[3]	0.00			

* Arithmetic mean was used in distance and ratio data as measure of central tendency, median was used in ordinal data and mode was used is classified data.
[1] 15-25: 1, 26-35: 2, 36-45: 3, 46-55: 4, 56 and above: 5; [2] No: 0, Yes: 1; [3] No: 0, Yes: 1

The dependent variable was economic inefficiency in Tobit model. The independent variables in the model were taken as producer's age, education period, fattening experience, land size, daily live weight gain, forage plant land size, nonagricultural activity and having training on fattening.

The Tobit model results are given in Table 11. The signs of the great majority of the variables in the model were found as expected and the age of the producer affected the economic efficiency negatively and education period and nonagricultural activity affected the economic efficiency positively. These variables were statistically insignificant ($p>0.10$).

The fattening experience of the producer affected the economic efficiency positively ($p=0.0514$). The economic efficiency increased as the fattening experience increased. This indicated that the experienced producers could obtain more yields by using their experiences. The experienced producers could take more accurately decisions on input usage level and applying production techniques according to the other producers.

The land size of the producer affected the economic efficiency negatively. Economic efficiency decreased as the land size increased ($p=0.0063$). This state could be interpreted as the producers who had more land were mostly interested in vegetative production activities and could not spare enough time to the livestock activities.

Daily live weight gain affected the economic efficiency positively ($p=0.0006$). As the daily live weight gain increased, the cattle fattening activity was more productive and the yield amount, consequently the economic efficiency increased. Forage plant land size affected the economic efficiency positively (p=0.0824). This meant that as the forage plant production increased, the forage expenses of the producers decreased and consequently, the economic efficiency increased. Having training on fattening affected the economic efficiency positively (p=0.0269). This indicated that having training on fattening increased the experiences of the producers and consequently, this increased the economic efficiency.

Table 11: Tobit analysis results: Factors affecting the economic efficiency

Variable	Coefficient	Standard error	P
Producer's age	-0.01526	0.01489	0.3053
Education period (year)	0.00712	0.00644	0.2691
Fattening experience (year)	0.0025*	0.00128	0.0514
Land size (da)	-0.00025***	0.00009	0.0063
Daily live weight gain (g)	0.00030***	0.00008	0.0006
Forage plant land size (da)	0.00030*	0.00017	0.0824
Nonagricultural activity	0.01419	0.04668	0.7612
Having training on fattening	0.09339**	0.04220	0.0269
Likelihood ratio	35.216***		

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

The results of the comparison of the economically full efficient and inefficient enterprises are given in Table 12.

The efficient and inefficient producers were frequently between 36-45 age interval. The fattening experience of the efficient producers was a little higher than the inefficient producers. It was determined that 25% of the efficient producers had a nonagricultural activity and this ratio was 11.11% in the inefficient enterprises. The land size of the efficient producers was lower than the inefficient producers whereas the forage plant land size of the efficient producers was higher than the inefficient producers. The number of the fatten animals, forage amount, labor cost, number of the animals sold at the end of the fattening of the efficient enterprises were lower than the inefficient enterprises. Live weight of the animals at the turn of fattening of the efficient enterprises was lower whereas the live weight of the animals at the end of fattening and live weight gain were higher than the inefficient enterprises. The carcass amount and carcass yield of the efficient enterprises were a little higher than the inefficient enterprises. These variables were statistically insignificant (p>0.10).

The education period of the efficient enterprises was considerably higher than the inefficient enterprises (t=-2.088, p=0.079). This indicated that the education level had an important role on efficiency. The fattening period of the inefficient enterprises was higher than the efficient enterprises (t=1.969, p=0.070).

All of the efficient enterprises but approximately one third of the inefficient enterprises had training on fattening (t=-6.648, p=0.000). The annual production capacity (t=-1.780, p=0.086) and daily live weight gain (t=-1.829, p=0.78) of the efficient enterprises were higher than the efficient enterprises.

Table 12: Socio-economic characteristics of the economical efficient and inefficient enterprises

Variables	Efficient enterprises[1]	Inefficient enterprises[1]
General characteristics of the producer		
Producer's age	3.00	3.00
Education period (year)	9.50 (1.73)*	7.30 (3.14)*
Fattening experience (year)	31.25 (16.52)	29.26 (12.39)
Nonagricultural activity (%)	25.00	11.11
Having training on fattening (%)	100.00***	37.04***
General characteristics of the enterprise		
Land size (da)	221.50 (125,89)	318.37 (198,52)
Forage plant land size (da)	41.00 (33.88)	37.15 (110,14)
Number of fatten animals (head)	44.50 (23.81)	54.48 (38.83)
Annual production capacity (kg)	7000.00 (4708.15)*	4544.44 (2199.53)*
4 *Technical characteristics of organic cattle fattening activity*		
Forage amount (kg/head)	590.58 (319.10)	873.05 (487.92)
Labor cost ($/head)	93.60 (36.28)	116.98 (76.13)
Fattening period (day)	127.50 (15.00)*	150.00 (44.81)*
Number of the sold animals at the end of the fattening (head)	36.00 (24.91)	43.30 (33.94)
Live weight at the turn of fattening (kg/head)	152.50 (5.00)	154.81 (10.51)
Live weight at the end of fattening (kg/head)	287.50 (47.87)	278.52 (22.82)
Live weight gain (kg/head)	135.00 (50.66)	123.70 (20.97)
Daily live weight gain (g/head)	1041.67 (292.66)*	858.44 (170.59)*
Carcass amount (kg/head)	151.25 (29.33)	143.37 (13.15)
Carcass yield (%)	52.50 (2.89)	51.48 (2.21)

[1] The numbers in brackets indicate the standard error.
* The difference between the efficient and inefficient enterprises is statistically significant at 10% significance level.

** The difference between the efficient and inefficient enterprises is statistically significant at 5% significance level.
*** The difference between the efficient and inefficient enterprises is statistically significant at 1% significance level.

5. Conclusion

According to the results of the study, technical efficiency was found as 0.949 and it was seen that technical efficiency was considerably at good level. Lower scores of pure technical efficiency than scale efficiency scores indicated that technical inefficiency was based on scale inefficiency rather than the inefficiency at input usage.

Allocative efficiency was found as 0.916 for the enterprises. This indicated that a certain part of the enterprises made production by improper input combination when the current input prices were taken into consideration in current technology level. These enterprises made more expenses in the ratio of 8.4% than the minimum costly input combination.

Average economic efficiency was found as 0.868. This indicated that the economic ineffective enterprises should decrease the operating expenses in the ratio of 13.2% in order to reach to the level of the economically efficient enterprises.

Technical efficiency scores were found higher than the economic efficiency scores. This result indicated the producers required some information on the subject of selecting appropriate input combination on data price level rather than technical information.

Comparatively analysis results revealed that the efficient enterprises were more successful than the inefficient enterprises. It should be easy for the enterprises to reach to the information sources by well-arranged publishing studies in order to increase the efficiency and raise the efficiency of the inefficient enterprises to the level of efficient enterprises. More efficient performances and concentration on the technical aspect of fattening, especially on fattening period and feeding, of the institutions and organizations publishing conducting extension services could contribute to the increment of the efficiency.

The research area is a very significant region in terms of organic fattening potential. As a result of the study, it was seen that a great majority of the inefficient enterprises did not have training on fattening activity. It was observed that this could affect the profitability in organic fattening activity. For this reason, it is estimated that the agricultural publishing programs which will be applied in the cooperation of government with private sector, will produce successful results in organic fattening activity.

In case of the actualization of the price depending on the meat quality, the increase of the quality of the produced meats will be provided and existing of a competition environment which could affect the organic meat production, will be provided.

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