Analysis of factors affecting the beef cattle production cost: case study in Sivas Central District

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Abstract

The livestock breeding is important for the sustainability of human beings. Economic efficiency in production is one of the important factors for the sustainability of livestock farming. The purpose of this study was to determine the factors that affect the economic production values of livestock. For this, a face-to-face questionnaire was conducted with 150 livestock breeders, whose average age was 42 years, had 20 years of experience in farming and had 10 years of education. Average variable cost was calculated as $498.04, gross production value was $1,008.18 and gross margin per livestock animal in a production period was $510.14. The economic values affecting the production value in beef cattle were determined by a multivariate regression model. The results of model showed that the production value was affected by the availability of forage crop incentive, live weight increase and number of animals in a farm. The presence of animals is important for high feed prices and profitability. The findings revealed that new policies should be developed to reduce feed prices or to provide animal purchase support.

Keywords: Fattening. Production cost. Gross margin. Regression.

1. Introduction

Animal breeding is one of the economic activities known throughout the existence of human beings (Doğanay and Coşkun, 2015). In the definition, animal breeding, defined as raising pets (Esen, 2017), is an important branch of economic activity due to the products obtained. The livestock sector is known as one of the important economic activity for all countries regardless of development level (Tıknazoğlu, 2010). The most developed countries of the world are also at the forefront of animal production and consumption, and this indicates that the livestock sector will never lose its importance as an economic activity.

Rural economic development in any country of the world is not possible without developing the livestock sector (Esen, 2017; Mundan, 2017). Crop production and animal husbandry are important for economic life in Turkey. The animal breeding is also extremely important to ensure that financing is based on own resources, especially in rural development.

Turkey has extremely favorable opportunities for animal husbandry due to the geographical location. The existence of high quality and wide meadows and pastures supports both cattle and sheep farming. Although there is an important potential for cattle and sheep breeding in Turkey, the number of animals and the yield levels show that the potential of the country is not used sufficiently. Most of animal breeding farms in Turkey are small scale, low in efficiency, have insufficient input supply, product marketing and opportunities. Animal breeding in small scale farms is mostly carried out for subsistence. Therefore, the producers receive a low share from the market price, and especially the fluctuations in market prices negatively affects the income of farmers (Ertuğrul et al., 2017). For this reason, short, medium and long-term plans should be prepared and necessary measures should be taken urgently in order to eliminate the deficiencies and negativities in cattle and ruminant breeding in Turkey (Şeker and Köseman, 2015).

Average carcass weight per livestock in the world is 2105 hg/An, 2424 hg/An in America, 2647 hg/An in Europe and 1614 hg/An in Asia. The average carcass weight in Turkey, which connects Europe and Asia, is 2960 hg/An that is higher than the world average.

Beef meat production in the world is 68313894 tons, and 18.08% of meat is produced by United States of America, 14.93% by Brazil, 8.70% by China and 4.59% by Argentina. Turkey produces 1.57% of meat and ranks 12th in the world. A total of 324518029 head cattle were slaughtered in the world according to the 2019 data of FAO. The report indicated that 42.03% of slaughtered cattle was in America, 28.74% was in Asia, 12.84% wax in Africa, 12.32% was in Europe and 4.07% was in Oceania. The top five countries were China (12.50%), United States of America (10.56%), Brazil (10.00%), Canada (8.96%) and Argentina (4.29%). The share of Turkey was 1.12% ranked 15th in the world. Total number of cattle in 2019 in 192 countries of the world was 1511021075 (FAO, 2021). The top five countries are Brazil (214659840), India (193462871), United States of America (9480470), China (63542332) and Ethiopia (63284177), respectively. Turkey ranks 21st with 17042506 cattle and has a share of 1.13% in total number of cattle.

Turkey has an important place in animal husbandry of the world. The province of Sivas, which is the scope of this study, has 414.361 cattle, which corresponds to 2.43% of the total number of cattle in Turkey. In addition to the number of cattle, economic dimension of the production is important for healthier and more sustainable livestock breeding. Therefore, gross margin per livestock was calculated by considering the gross production values of livestock and variable costs in production. In this way, the factors affecting the economic

production in livestock breeding have been determined and recommendations have been provided for the sustainability of livestock breeding.

2. Literature Review

Livestock is a source of nutrition and livelihood, thus, has an important place in human life. Therefore, the livestock breeding was important in the past and will be important in the future. Due to the importance of livestock breeding, researchers carry out studies in different parts of the world. Many studies have been carried out and reports have been published on beef cattle breeding.

There are studies examining the economic structure of beef cattle breeding (operating costs, production costs, profit, etc.) (Başer and Bozoğlu, 2021; Silva et al., 2020; Eroğlu and Bozoğlu, 2019; Ekowati et al., 2018; Köknaroğlu et al., 2017; Leal et al., 2017; Moi et al., 2017; Costa et al., 2019; Ramsey et al., 2005). Wilcznski (2018) examined the studies comparing the costs and profits of beef production in the European Union. Dill et al (2015) determined the factors affecting the adoption of innovations by beef cattle farms using a probit model. Kamali et al. (2016) determined the relationship between cattle nutrition and economic performance with sensitivity analysis. Gözener and Sayılı (2015) analyzed cattle live weight increase by regression analysis. Several studies have been conducted to determine the factors affecting the profitability of cattle farms.

The factors affecting profitability have been determined by using cobb-Douglas model (Kalangia et al., 2016), regression model (Elfadl et al., 2015), and multiple regression analysis (Sarma et al., 2014; Sugiarto et al., 2019). Bahta and Baker (2015) demonstrated the effectiveness of cattle farms with the stochastic profit frontier model. Sarma and Ahmed (2011) determined the factors affecting the profitability of cattle farms by multiple regression analysis. Similar to this research, there are also studies examining the factors affecting gross profit in cattle farms (Tosun, 2016; Aksoy et al., 2017).

However, the lack of research carried on the study area increases the importance of the current study. The previous reports on the economic aspects and profitability of cattle farms provide a valuable opportunity to discuss the findings and offer recommendations.

3. Material and Methods

3.1. Study area and sample size

The material of the study is the data obtained by the face-to-face questionnaires carried out in September, 2020. Proportional sampling method was used to determine the sample size representing the main mass (Newbold, 1995). Stratified sampling technique was applied, and the equation proposed (Eq. 1) by Yamane (2001) was used to determine the final sample size. The methodology used in this study has been applied by Boz (2015), ul Haq and Boz (2019) and ul Haq et al. (2020).

$$n = \frac{Np(1-p)}{(N-1)\sigma_p^2 + p(1-p)} \qquad \text{Eq 1.}$$

In the equation; n represents the sample size, N represents the population size, p represents the estimation rate (sample size 0.5 maximum), and σ_p^2 represents variances ratio. Table value should have confidence interval of 95%, with 1.96 and 10% margin of error to obtain the maximum sample size. Since the characteristics of the farms which formed the main mass, were not identified at the beginning, p was considered as 0.5 to maximize the sample size. The number of sample size was calculated as 150 producers.

3.2. Production cost

The gross margin (profit), calculated by subtracting the variable costs from the gross production value in the beef cattle farms, was determined (Huyen et al., 2010). Variable costs that vary depending on the production volume were calculated in the study. Roughage cost, feed costs, veterinary medicine and vaccine costs, water, electricity, fuel, marketing, salt and other costs were used as the variable costs for a fattening period (Saner and Çukur, 2006; Uğurtaş, 2008; Huyen et al., 2010). Gross production value was calculated by adding the animal sales income, fertilizer income and beef cattle incentive payment, which is obtained by multiplying the amount of product obtained and the sales price of the product.

The cattle unit (CU) was taken as the basis when examining the animal entity. The number of bulls was multiplied by 1.40, heifer and male calf by 0.70, and calf by 0.50 and converted to CU (Güneş, 2004; Keskin and Dellal, 2011; Tosun, 2016). Male labor force unit (MLFU) was used to analyze the labor force. When calculating the MLFU unit in farms, men aged between 16 and 49 were multiplied by 1.0 and women were converted to MLFU by multiplying by 0.75 (Tosun, 2016).

3.3. Identification of the factors affecting the production

This study was aimed to determine the factors that economically affect the production in beef cattle farms. The estimation method used in the regression model created for this purpose was the Least Squares method. The gross margin was considered as the dependent variable in determining the factors affecting the beef cattle production. Linear, quadratic and logarithmic forms were tested to analyze the model, and the linear model was determined as the most suitable model.

The general form of the model is as follows:

$$Y=\alpha_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7+\beta_8X_8+\beta_9X_9+\beta_{10}X_{10}+\beta_{11}X_{11} \quad \text{Eq. 2}$$

In equation 2,

Y = Gross margin per unit of beef cattle ($),

X_i = vector of qualitative variables.

X1 = age of a farmer (year),

X2 = duration of education (year),

X3 = The number of individuals in a family (number),

X4 = branch of production (1 for only livestock, otherwise 0)

X5 = experience in the profession (farming),

X6 = forage crop cultivation area (da),

X_7 = the status of forage crops incentive (1 if receiving, 0 if not),

X_8 = Pasture use status (1, if using; otherwise, 0),

X_9 = Live weight increase during fattening period (kg),

X_{10} = Number of male animals

X_{11}= duration for fattening period (days)

4. Results and Discussion

4.1. General socio-economic characteristics of the farms

The information on socio-economic structure of the producers is important to analyze the structure of farms. General socio-economic characteristics of the producers were given in Table 1. The average age of the producers was 42 and the experience was 20 years. The results revealed that 35.13% of the producers had secondary and high school degrees. The average training period of the producers was 10 years. Some studies reported similar age and years of experience for the farmers. Sarma et al. (2014) determined that 36.7% of beef cattle

farmers in Bangladesh were between the ages of 41-50 and 43.3% had 5 to 10 years of experience in the profession.

The results revealed that 26.67% of the producers make their living only from beef cattle production, while 73.33% of them work in various insured jobs along with agricultural production. The yearly average income of the producers from agricultural activities was 4,967.00 $ and the non-agricultural income was 2,997.10 $. Average of 6 individuals live in a household of the beef cattle farms, and 2 people are actively working. The results showed that 30% of the beef cattle farmers only deal with animal husbandry, while 70% of them also grow field crops along with animal husbandry.

The farmers have an average of 139.09 da of fodder crop cultivation area (Table 1). Forty four percent of the farms benefited from annual forage crop incentive. Sixty six percent of the farms use pasture to graze their animals. The average number of beef cattle in a farm is 25.67 and the average fattening period is 179.02 days. Studies conducted in Bangladesh reported similar fattening periods for beef cattle. Sarma et al. (2014) reported that 62.2% of beef cattle breeders keep the animals for 4-6 months for fattening and Sarma and Ahmed (2011) reported that average fattening period of the farms was 4.5 months.

Table 1: Some Socio-Economic Characteristics of The Farms

		Frequency	Percent (%)	Mean
Age				41.95
Educational Status of the Farmers	Primary School	9	6.00	
	Secondary School	51	34.00	
	High School	56	37.33	
	Associate degree	29	19.33	
	University	5	3.33	
Duration of education (year)				10.14
Non-agricultural work	No (only producers)	40	26.67	
	Yes	110	73.33	
Branch of production	Only livestock	45	30.00	
	Livestock and crop production	105	70.00	
Forage crop cultivation area (da)				139.09
Incentive status for forage crops	The number of farms who benefits from incentives	66	44.00	
	The number of farms who don't benefit from incentives	84	56.00	
Coverage area for pasture use	Farm uses	99	66.00	
	Farm don't use			
Pasture use statue		51	34.00	
Income (Gross) ($/year)	Income from Agricultural Activities			4,967.00
	Non-Agricultural Income (all salaries and other income in a family)			2,997.10
Experience (years)				19.72
Number of individuals in a family				5.99
Number of working individuals in a family				1.75

1 $ equals to 5.75 TL in September, 2019 (CBRT, 2019)

4.2. Gross production value, variable costs and gross margin

The gross margin is the difference between the gross production values of the production branches and their variable expenses (Tosun, 2016). The gross production value was calculated by adding the production value of the meat obtained by beef cattle production activity, the fertilizer income and the incentive payment per beef cattle.

The gross production value of beef cattle was calculated as $1,008.18 per beef cattle, while the variable cost was $498.04 per beef cattle (Table 1). Sugiarto et al (2019) calculated the gross profit as $1.33 per beef animal in Indonesia. Net profit per beef cattle in Bangladesh has been reported between $172.23 (Satman et al., 2014) and $78.94 (Sarman and Ahmed (2011). The net profit value in Samsun province of Turkey was calculated as $6,035.24 per beef cattle (Eroğlu and Bozoğlu 2019). Although the years are different, high profit per beef cattle has been confirmed by other research results. The highest share among variable costs belongs to feed cost (250.81 $), followed by animal purchase (121.91 $) (Table 2).

The results reported in the literature also indicated that the highest share of the variable cost items in the beef cattle farms is the cost of feed and animal purchase. Similarly, Sarma et al. (2014) indicated that 73.90% of the variable cost in Bangladesh was animal purchase and 15.37% was feed cost. Sugiarto et al. (2019) calculated the variable cost in Indonesia as $0.25 and reported that 60.2% of the variable cost was the feed cost. Florindo et al. (2017) reported that feed costs constitute a large part of the production cost in Brazil. Moi et al. (2017) stated that feed cost has the highest ratio in variable costs. The feed cost (46.45%) had the highest share among the variable costs of the breeders in Grobogan (Ekowati et al., 2018). Sarman et at. (2014) stated that the most important problem in beef cattle breeding in Bangladesh is feed cost. Eroğlu and Bozoğlu (2019) emphasized that the cost of animal and feed is higher than other costs in the variable cost.

Table 2: Gross Margin ($/Head) in Beef Cattle Farms

Cost Items		Cost per unit beef cattle ($/year)	Share in production cost (%)
Fattening material cost		121.91	24.48
Feed cost	Concentrated Feed Cost	168.76	67.29
	Forage crop cost	82.05	32.71
Total feed cost		250.81	50.36
Water cost		1.78	0.36
Salt cost		1.35	0.27
Foreign labor		34.70	6.97
Veterinary medical expenses		26.60	5.34
Interest for the credit		17.88	3.59
Care (disinfectant, vitamin)		23.41	4.70

Marketing expense	1.06	0.21
Other costs	18.54	3.72
Variable Cost Total (A)	498.04	100.00
Gross production value	1,008.18	
Gross Margin	510.14	

1 $ equals to 5.75 TL in September, 2019 (CBRT, 2019)

4.3. Economic factors affecting production in beef livestock farms

In this section, the economic factors affecting production of beef cattle farms were determined and multivariate regression analysis was used for to determine the economic factors. The gross margin per animal was used as the dependent variable to determine the economic factors.

Twelve variables related to farmers, farm characteristics and livestock incentives were considered as independent variables in the model developed to determine the factors affecting the gross margin per animal fattened. The explanations of the variables were given in Table 3.

Table 3: Variables Used in Model Constructed to Determine The Factors Affecting Gross Margin Per Fattening Animal

Variables	Explanation	Variable type
Age	Age of the farm owner (year)	Continuous
Education status	Education status of farm owners (year)	Continuous
Number of people in a family	Number of individuals in a family (person)	Continuous
Branch of production	Farm type (0: only for cattle fattening, 1: cattle for milk and fattening)	Dummy
Experience in production	Experience of a farmer in livestock sector (year)	Continuous
Coverage area of forage crops	Coverage area of forage crops in a farm (da)	Continuous
Incentive for forage crops	Benefit status for annual forage crops incentive (0: no, 1: yes)	Dummy
Pasture usage	Pasture usage status (0: not using, 1: using)	Dummy
Live weight increase	The amount of weight increase for the fattening animal during a fattening period (kg)	Continuous
Number of animals	Number of male animals in a farm (heifer, calf, bull converted to CU)	Continuous
Fattening period	Fattening period (day)	Continuous

The proportion of the variation in the dependent variable that is predictable with the independent variables is indicated by R^2. In this study, the R^2 is 0.779 which indicates that 77.9% of the variation in the dependent variable is explained by the independent variables included in the model. The rest of the variation (22.1%) is explained by the variables that are not included in the model by means of the error term. The adequacy for the number of independent variables in the model was determined by the adjusted R^2 value. In this study, the

adjusted R^2 value was 57.2%, which indicates that if the independent variables that were not included in the model, are included in the model, the explanatory power of the model will decrease. The autocorrelation in the model was determined by the Durbin-Watson test. A Durbin-Watson (2.03) test value between 1.5 and 2.5 indicates no autocorrelation. The ANOVA test explains the significance of the model. An F value of 176.15 means that the model as a whole is significant at all levels.

The parameter values obtained by the estimation of the model and their t values are given in Table 4. The significance of each variable (at 1% and 5% significance level) included in the model from the t-statistical values of the parameters is examined.

The live weight increase of the beef cattle and the number of male animals in a farm will have a positive effect on the gross margin per animal, while, the incentive for forage crops will have a negative effect on the gross margin. One unit increase in the live weight of the livestock will cause a 24% increase in the gross margin.

The increase in live weight will increase the income of the producer and hence increase the gross margin. The result indicates the accuracy of the results. One-unit increase in the number of male livestock in the beef cattle farm is expected to 41% increase in the gross margin. This is a correct hypothesis according to the economic data. The increase in the number of beef cattle in a farm means more animal sales, which indicates an increase in the income of the farmer. Similar positive correlations between beef cattle breeding profitability and live weight increase have been reported in Egypt (Elfadl et al., 2015), Northern Australia (Bowen et al., 2016) and Bangladesh (Sarman et al., 2014). Positive correlations have been reported between the beef cattle profitability and the number of animals from studies conducted in Brazil (Dill et al., 2015), Turkey (Unakıtan and Kumbar, 2018), Indonesia (Sugiarto et al., 2019; Achmad et al., 2019).

One unit increase in forage crop cultivation area of a farmer decreases the gross margin per beef cattle by 56%. The result reveals the possibility of lack of specialization. In the model, there are some results that are not statistically significant and will reveal the importance of specialization. For example, receiving feed incentive, using pastureland and engaging not only beef cattle breeding (dairy and beef cattle breeding) have negative effects on beef cattle gross margin. The results show that the interest in alternative branches for income risk, instead of specializing only by feed cattle breeding, has a negative effect on the gross margin. Kamali et al. (2019) reported that the lowest yield was obtained with grazing on natural pasture and crop residues in Southern Brazil. Ramsbottom et al. (2015) reported an inverse relationship between milk yield and pasture use of dairy cows in Ireland. Bahta and

Baker (2015) determined a negative relationship between beef cattle profitability and crop income in Botswana.

A statistically insignificant positive relationship was found between the age of the farmer, the experience of a farmer in breeding and the gross margin. Similarly, some studies included the age and experience of the breeder among the factors affecting beef profit (Dill et al., 2015; Bahta and Baker, 2015; Unakıtan and Kumbar, 2018; Sugiarto et al., 2019).

A statistically insignificant positive relationship was found between the fattening period of the livestock and the gross profit. However, even if it is not significant, this relationship should be explained in order to eliminate the lack of basic information such as early slaughter and malnutrition. The results suggested that the fattening period should not be less than 6 months to increase the gross profit, which is the economic value of the producers engaged in beef cattle breeding. A positive relationship was reported between beef price and fattening period in a study conducted in Bali (Rusdianto et al., 2015).

Table 4: Model Outputs on Factors Affecting Gross Margin Per Fattening Animal

	β	Std. Error	t Stat	p-value (Sig.)
Constant	-3481.820	1449.486	-2.402	0.018**
Age	3.901	12.794	0.305	0.761
Education Status	-20.969	33.866	-0.619	0.537
Number of people in a family	-29.697	32.803	-0.905	0.367
Branch of production	33.040	183.745	0.180	0.858
Experience in production	10.745	14.883	0.722	0.472
Coverage area of forage crops	-0.548	0.974	-0.563	0.574
Incentive for forage crops	-55.675	17.920	-0.164	0.002*
Pasture Usage	-63.278	164.839	-0.384	0.702
Live Weight Increase	24.391	2.208	11.049	0.000*
Number of animals	41.489	5.726	7.246	0.000*
Fattening period	2.746	6.775	0.405	0.686

Note: *, **==> Significant at 1%, 5% level

5. Conclusion

Animal husbandry has maintained its importance throughout the history in Turkey, which is an agricultural country. The population in the rural area, which makes a living from the livestock sector, is dense. This study aimed to determine the economic factors affecting the production by calculating the gross margin in beef cattle breeding. Following conclusions can be drawn as follows;

✓ The farmers in the study area are in the active working age range and have been engaged in beef cattle breeding for a long time. Although the education level of the breeders is not very low, they have an average of 10 years of education.

✓ Thirty percent of the breeders engage only beef cattle breeding. The result indicates that specialization in beef cattle breeding is pretty low. Dealing with other agricultural branches instead of specializing in a single branch can be attributed to the desire to provide income guarantee due to the high risk and uncertainty in agriculture. Therefore, about 74% of farmers have non-farm income. Another reason is the desire to reduce the cost of feed by growing their own forage crops due to the high feed prices in Turkey. The results of study also showed that feed costs constitute a large part of the variable costs.

✓ The results revealed that the farms in the study area are mostly small-scale enterprises.

✓ The variable costs in a production period were calculated before determining the factors affecting production for the cattle breeding farms. The average variable cost per livestock was calculated as $498.04.

✓ The gross income per livestock of beef cattle breeders was subtracted from the variable cost, and the average gross margin per livestock of the farm was calculated. Gross margin is a profit indicator that provides important information about the status and profitability of the farms in livestock breeding. The gross profit per livestock in the study area was calculated as $510.14.

✓ The calculated gross margin value was used as a dependent variable in determining the factors that economically affect the production of feed cattle breeders. In this study, the factors that determine the production profitability of feed cattle farms were determined. The gross margin of the farms was calculated and the variables that could affect this value were included in the model as independent variables. The most significant model was interpreted.

✓ Multivariate regression model showed that forage crop incentive, live weight increase and number of animals affect the profitability.

The results indicated that the small scale of the farms in Turkey as well as in the study area is one of the factors affecting the profitability. Therefore, increasing the size of the farms is important to overcome the problem. Long-term livestock and support policies that will encourage small producers to increase the size of their farms are needed. Small-scale farms in Turley should not quit the agricultural production, because, the abandonment of production may bring along socio-economic problems. The development of beef cattle breeding in Turkey is important not only to provide the food needed for the consumers or the raw material needed by the industry, but also to prevent migration from rural to urban areas and to improve living standards by providing additional income to producers in rural areas.

The profitability in beef production and, accordingly, continuity in production, can only be ensured by reducing production costs, especially feed. The regression models established to

determine the technical and economic factors affecting the production revealed that the increase in the forage crops production area and the use of forage crops production incentives increased the gross margin and average carcass weight per fattening animal. Although the incentives given for forage crops were increased, forage crop production is not sufficient. Continuity in supporting forage crop production is important, however, small-scale farms need assistance in technical issues related to forage crop production. In addition, fattening male cattle support is also as important as the incentive of forage crops.

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