Research/Araştırma

Factors affecting milk production cost in dairy cattle farms

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ABSTRACT

The aim of this study was to determine factors affecting milk production cost in dairy cattle farms. The main material of the study was formed by using the data obtained from the surveys which were conducted at a total of 175 dairy cattle farms chosen by the stratified random sampling method in Biga district of Çanakkale province from January to December of 2015. The data were analyzed by using the multiple regression method. The results of this study indicated that 41.7% of the farms had the lowest number of cattle (5-10 head), the prominent age group of farmers' ranged from 36-46 years (45.1%) in the farms and 12.5% of the farmers had the highest income ($\geq$ 24000 TL). According to the results of the multiple regression model, it was determined that some factors such as the time spent in dairy cattle farm, farmers' dairy farming experience, farmers' educational level, farmers' feed procurement, livestock diseases and maize silage production in the farms had significant effects on milk production costs. In conclusion, these factors were explained to have important impacts on decreasing farmers' milk production costs.

Keywords:
Çanakkale
Dairy cattle
Milk production
Regression model

Süt sığırcılığı işletmelerinde süt üretim maliyetini etkileyen faktörler

ÖZET

Bu çalışmanın amacı, süt sığırcılığı işletmelerinde süt üretim maliyetini etkileyen faktörlerin belirlenmesidir. Çalışmanın ana materyalini, 2015 Ocak ve 2015 Aralık dönemleri arasında Çanakkale'nin Biga ilçesindeki süt sırğırcılığı işletmelerinden tesadüfi tabakalı örnekleme yöntemiyle seçilen 175 işletmeden elde edilen veriler oluşturmaktadır. Verilerin analizinde, çoklu regresyon metodu kullanılmıştır. Araştırma sonuçları, işletmelerin %41.7'sinin en düşük süt sığırı sayısına (5-10 baş) sahip olduğunu, işletmelerdeki en göze çarpan yaş aralığının 36-46 yaş (%45.1) olduğunu ve çiftçilerin %12.5'nin en yüksek gelire sahip olduğunu göstermektedir. Çoklu regresyon model sonuçlarına göre, süt sığırcılığı işletmelerinde harcanan zamanın, işletmecilerin süt sığırcılık deneyimlerinin, çiftçilerin eğitim düzeyinin, çiftçilerin yem temininin, hayvan hastalıklarının ve işletmelerde slajlık mısır üretimi gibi faktörlerin süt üretim maliyetleri üzerindeki etkilerinin önemli olduğu belirlenmiştir. Sonuç olarak, bu faktörlerin süt üretim maliyetlerinin azaltılmasında önemli etkilerinin olduğu açıklanmıştır.

Anahtar Sözcükler:
Çanakkale
Süt sığırı
Süt üretimi
Regresyon modeli

1. Introduction

The livestock activity in Turkey has considerable potential as an important part of agricultural sector and economy. Although this sector is ranked second after crop production, its share in the agricultural activity is rather important (Tutkun et al., 2014; Tümer and Birinci, 2011). According to FAO's statistical data, the share of the livestock in total agricultural production in Turkey is about 46% (Aktürk et al., 2010).

Dairy farming, one of the main branch of the livestock sector, have become an important employment opportunity as a core business or a second job for the household living in rural area (Jabir, 2007). The dairy farming activities have a great role on farm management as regards the use of labour and feed resources more effectively and providing an equilibrium cash flow (Schaik et al., 1996; Shamsuddin et al., 2006).

One of the important factors in this sector is to control milk production cost of farms and increase their

profit margin. Cost in agricultural farms plays an important role in explaining economic structure of the dairy cattle farms (Gunlu et al., 2003; Mean and Jain, 2012; Iype et al., 1993).

Dairy farming activity is over the country average in terms of technology being used and yield in Biga Discrit which is one of the most rapidly developing districts of Çanakkale province. Biga Discrit has about 31% of the animals milked and about 32% of the total number of bovine animals (cattle and buffalo) of Çanakkale province in terms of dairy farming activity. Nearly all of the bovine animals in Biga district consist of culture breed and dairy cattle farms that are usually in the form of family enterprises (Aktürk et al., 2010). The number of culture-breed dairy cattle, which is important in terms of its sustainability as well as its effect on yield and quality, is becoming widespread in Biga district.

There are significant effects of optimum resource usage and cost on ensuring sustainable production regarding this activity field of farmers' showing considerable effort into developing the dairy farming in Biga district. Because, optimum utilization of available resources and the control of cost, which are primarily considered for profitability and productivity, are the sign of success or failure in dairy cattle farms (Çiçek et al., 2007). Furthermore, milk production in dairy cattle farms have a crucial importance because of the following reasons; being an activity-field that can be converted into cash in a very short term, providing employment opportunities to certain segment of the population and opportunity to switch production in a short term with less investment compared to other business areas and providing contribution to human nutrition. For this reason, this study was aimed to determine factors affecting milk production costs of the dairy cattle farms in Biga district.

2. Material and Methods

The data of this study was obtained by means of surveys at the dairy cattle farms in Biga district of Çanakkale province by using face-to-face interview technique from January to December of 2015. The dairy cattle farms were selected based on the stratified random sampling method. The size of each sample was determined using in the following equation derived from Neyman method (Yamane, 1967). The sample size was calculated as:

$$n = \frac{(\sum N_h S_h)^2}{N^2 D^2 + \sum N_h S_h^2},$$

where, n is the required sample size; N is the number of dairy cattle farm in population; Nh is the number of dairy cattle farm in the h stratum; Sh is the standard deviation of the h stratum, S_h^2 is the variance of h stratum; d is desired absolute precision; z is desired confidence level (1.96 equates to the 95% confidence interval); D is acceptable error limit in population mean; $D^2 = d^2 / z^2$.

According to this method, the sample size was established with the farms which were selected at random from these strata by dividing into four strata with respect to the number of cattle in dairy cattle farms in Biga district of Çanakkale province. Thus, farms were categorized as 5 to $\leq$ 10 cattle, 11 to $\leq$ 20 cattle, 21 to $\leq$ 50, equal 51 and >51 cattle. According to these four strata, the sample size was determined as 175 dairy cattle farms for Biga district of Çanakkale province in this study (Table 1).

Table 1. The number of farms in the sample

Farm size (head) (number of dairy cattle)	Sample size (n) (number of farms)	Share of farms (%)
5- 10	73	41.7
11- 20	37	21.1
21- 50	54	30.9
$\geq$ 51	11	6.3
Total	175	100.0

The regression method is one of the widely used tools in many studies. This method measures the degree of influence of the independent variables on dependent variable. The regression with two or more independent variables is called a multiple regression. This analysis is a linear statistical technique that is beneficial for predicting the best relationship between dependent variable and independent variables. The model can be formulated as the following equation (Agha et al., 2012; Anas et al., 2013; Akan et al., 2015).

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon$$

where,

Y is dependent variable, X represents the independent variables tested (0, 1, 2,....), βn are the regression coefficients and ε is the error term. This equation can also be written in the following form:

$$Y = f(\beta_1, \beta_2, \ldots, \beta_n)$$

Based on these explanations, multiple regression analysis was used to determine the quantity of the relationship between average milk production cost per cattle and factors affecting milk production cost in this study. This regression model was estimated using SPSS

statistical analysis programme. Factors that constitute the cost of the dairy farming were determined for these farms and average milk production cost per cattle was calculated by using the annual production data. The functional form of the regression model estimating the factors which are effective on this matter is as follows:

$$Y= f (X_1, X_2, X_3, X_4, X_5, X_6)$$

Y: Average milk production cost (Turkish Liras-TL/Liter-L/per cattle)

X_1: The time that is spent in dairy cattle farm; Does the producer do full time farming?(1=yes, 0=no)

X_2: Farmers' educational level (1=primary school, 0=higher than primary school)

X_3: Farmers' feed procurement (1=own production, 0= purchased)

X_4: Livestock diseases; Does the occurrence of epidemics in dairy cattle farm? (1=yes, 0=no)

X_5: Maize silage production; Do you producemaize silage in dairy cattle farm?(1=yes,0=no)

X_6: Dairy farming experience of farmers' (year)

Furthermore, the multicollinearity problem and the collinearity diagnostic were calculated to identify correlation among the independent variables in the model, because, the strong correlation among the independent variables is not usually preferred in the multiple regression model. According to this, the power of the model is not affected since these variable contributions to the model are at similar rates (Topçu, 2008). Therefore, coefficient of correlation was

calculated to examine the relationship among the independent variables affecting milk production cost. On the other hand, high tolerance (a tolerance close to 1) and low VIF (Variance-Inflating Factor) (VIF<10) values indicate whether or not there is the multicollinearity problem among the independent variables (Topçu, 2008; Hair et al. 2006).

3. Results and Discussion

In this study, the results regarding the farm size (head), the number of farm (n) and the share of farm (%) are given in Table 1. According to Table 1, 41.7% of the farms have the lowest number of cattle (5-10 head) and 6.3% have the highest number of cattle (≥51). Data related to some socio-economic characteristics of farmers' were explained by descriptive statistics in Table 2. According to these results, the prominent age group of the farmers' ranged from 36-46 years (45.1%) and the least age group of farmers' ranged from 60 and above years (4.6%). These values showed that majority of the farmers' belonged to the middle-age group and young population was low in agriculture. Out of the farmers took part in the survey, 69.7% involved primary school graduates. Household size of farmers was mostly 1-3 persons with the rate of 64%. Furthermore, farmers' dairy farming experience was mostly 21 and above years (56%). Out of the farmers, 12.5% had the highest income group (≥24000TL) and 28.6% had the lowest income (≤12000 TL).

Table 2. Socio-economic characteristics of farmers' (n=175)

Characteristics	Frequency	Percentage
Farmers' age (year)		
25 - 35	31	17.7
36 - 46	79	45.1
47 - 59	57	32.6
≥ 60	8	4.6
Farmers' education level		
- Primary school graduates	122	69.7
- Secondary school graduates	35	20.0
- High school and university	18	10.3
-Household size (people)		
1- 3	112	64.0
≥ 4	63	36.0
Farmers' dairy farming experience (year)		
1 - 10	14	8.0
11- 20	63	36.0
≥ 21	98	56.0
Household income (TL year^{-1})		
≤ 12000 TL	50	28.6
12001 TL - 23999 TL	103	58.9
≥ 24000 TL	22	12.5

In study, the correlation coefficient was calculated to examine the relationship among the independent variables affecting milk production cost. As can be seen in Table 3, partial correlation scores among the variables were found to be less than 0.80. This result showed that there was no the multicollinearity problem among the independent variables. Furthermore, the collinearity diagnostic was calculated to determine whether there was any the multicollinearity problem among the independent variables affecting the milk production cost or not. According to this, the independent variables that were selected for the model were found to be significant as a result of calculations such as determination coefficient (R^2=0.476), $F_{(6;143)}$ value (F=21.691 with sig. F=0.00<0.01), t (6;0.05) test and other tests. R^2 value of 0.476 showed that 47.6% of the variance in milk production cost could be explained by the independent variables (the time spent in dairy cattle farm, farmers' educational level, farmers' feed procurement, livestock diseases, maize silage production and dairy farming experience of farmers').

Table 3. Multiple regression estimates of factors affecting milk production costs in dairy cattle farms

Variables	Unstandardized coefficients		Standardized coefficients	t	p[*]	Correlations		Collinearity statistics	
	B	Std. Error	Beta			Partial	Part	Tolerance	VIF
Constant	1.025	0.025		41.483	0.000[*]				
X_1	-0.070	0.009	-0.478	-7.815	0.000[*]	-0.547	-0.473	0.978	1.022
X_2	-0.036	0.010	-0.223	-3.591	0.000[*]	-0.288	-0.217	0.950	1.053
X_3	0.047	0.009	0.323	5.113	0.000[*]	0.393	0.309	0.916	1.091
X_4	0.037	0.009	0.253	4.121	0.000[*]	0.326	0.249	0.974	1.027
X_5	-0.031	0.010	-0.198	-3.225	0.002[*]	-0.260	-0.195	0.967	1.034
X_6	-0.010	0.001	-0.146	-2.366	0.019[**]	-0.194	-0.143	0.967	1.034

Dependent variable : Y ; Determination coefficient R^2 = 0.476; P : Statistical significance $p < 0.05$** and $p < 0.01$*
Durbin-Watson = 1.655 (1.5 < 1.6 < 2.5) ; $F_{(6;143)}$ = 21.691 p = 0.000

Regression equation related to milk production cost was estimated by using the partial regression coefficients in the column B of Table 1 as follows:

$$Y=1.025-0.070X_1-0.036X_2+0.047X_3+0.037X_4-0.031X_5-0.010X_6$$

In this study, milk production cost was determined to have directly proportional relationship between farmers' feed procurement and livestock diseases. On the other hand, milk production cost was determined to have inverse proportional relationship among the time that was spent in dairy cattle farm, farmers' education level, maize silage production and dairy farming experience of farmers'.

According to the results of the analysis, it was found that there was a negative directional and significant relationship (p<0.01) between the time that was spent in dairy cattle farm and milk production cost. Furthermore, for each per unit increase in the time that is spent in the farm, milk production cost would decrease by 0.07 TL/l. In this context, with devoting more time to the dairy farming activities of farmers, it is expected to have positive effect on the profitability and the productivity of farms. On the other hand, spending more time in their farms is rather important. Because an increase on time spent in a dairy cattle farm could be helpful in early detection and solution of some problems (such as livestock diseases, death of cattle) encountered in the farm.

There is an important role of education in ensuring consciousness in active and efficient utilization of sources (Çiçek et al., 2007). On the other hand, increasing farmers' educational level is also important in terms of their adaptation to innovations regarding agricultural activity. It is expected to have an increase on the tendencies of farmers to novel production techniques and equipments as a consequence of farmers' higher educational level. So, this situation is thought to have positive effect on the profitability and productivity of the farms. In the present study, it was determined that there was a negative directional and significant relationship (p<0.01) between farmers' educational level and milk production cost. According to this, if farmers' educational level increases, milk production cost would decrease by 0.03TL L^{-1}. Previous studies carried out to explore factors affecting milk production cost reported conflicting results (Iype et al., 1993; Gunlu et al., 2003; Ngongoni et al., 2006). While some studies reported the importance of farmers' educational status on milk

production cost (Ngongoni et al., 2006), the others explained non-significant differences between milk production cost and educational level (Iype et al., 1993; Gunlu et al., 2003). Ngongoni et al. (2006) reported that farmers' educational level had influence on milk production cost.

If farmers had insufficient farm land, they purchased all or a part of their roughage. Under this circumstance, the costs of farmers' feed procurement increased when feed consumption of dairy cattle in the farms was high. Particularly, if the prices of concentrated feed increase due to high raw material prices and so milk production costs also increased. Therefore, the roughage produced within the farm, that is required for feeding dairy cattle, becomes rather important in terms of profitability of the farm. In the present study, statistical analyses revealed that there was a positive directional and significant relationship (p<0.01) between farmers' feed procurement and milk production cost. Furthermore, milk production costs of the farmers who provide the roughage from outside would increase by 0.04 TL L^{-1}.

In the present study, it was found that farmers who ensured the roughage from their own fields had more advantage than the farmers who purchased it from outside in terms of decreasing milk production costs. Çiçek et al. (2007) concluded that there was a positive and significant relationship between farmers' feed procurement and average production cost. Furthermore, the significance of ensuring the feed procurement of animals from farmers' own farmlands in dairy cattle farms was emphasized. The results of our study were similar to those obtained by Çicek et al. (2007).

Livestock diseases are among the most severe factors that have effect on production and productivity of the farms. Therefore, livestock diseases have a great impact on food supplies, trade and human health (Pearson, 2006; Thornton, 2010). On the other hand, diseases that reduce production, productivity and profitability are associated with the cost of their treatment, disruption of local markets and trade, they aggravate poverty on rural and regional communities (Rushton, 2009). In this study, it was determined that there was a positive directional and significant relationship (p<0.01) between livestock diseases and milk production cost. According to this, for each per unit increase in the number of sick animals, milk production cost would increase by 0.03TL L^{-1}. From the point of view of farmers to this statistical analysis result, livestock diseases are considered as essential economic problem. Because, the increase in the number of sick animals in dairy farms causes to drop of milk yield. Therefore, livestock diseases are also expected to increase milk production costs of farms. These findings associated with the effect of livestock diseases on milk production cost had consistency with the studies of Bulman and Terrazas (1976), Losinger (2005), Bayissa et al. (2011) and Young et al. (2012).

Maize silage that is fed to animals in periods that it is be lack of green plants is increased to milk yield. In other words, as the amount of milk that is produced in farms increased, milk production costs are also decreased. Therefore, maize silage that is produced in dairy farms is an important in terms of farms. Thus, according to the results of the analysis, it was found that there are negative directional and significant relationship (p<0.01) between two variables when analyzed relationship between milk production costs of farms and farms that produce to maize silage. Therefore, in periods that isn't fed of animals with green plants, milk production costs of farms feeding with maize silage to animals would decrease by 0.03 TL L^{-1}. In this study, it was determined that maize silage that is obtained within farm have effected on decreasing of milk production costs of farms. Similar findings regarding to this were also reported by Tümer and Birinci (2011).

Farmers who are experienced about dairy farming are expected to be effect on milk production costs. Because, increasing in their information levels about milk production and farming is also anticipated with increasing of dairy farming experiences of farmers'. According to this, it is thought that milk production costs of farmers' would decrease. Thus, in the present study, it was determined that there is a negative directional and significant relationship (p<0.01) between dairy farming experience of farmers' and milk production cost. According to this, for each per unit increase in dairy farming experience of farmers', milk production costs would decrease by 0.01TL L^{-1}.

4. Conclusions

Biga is one of the districts of Çanakkale province spending considerable effort in the development of dairy farming activity. Therefore, it is rather important to make optimum utilization of resources and cost control for farms in this study area.

In conclusion, it was ascertained that, while the farmers' feed procurement and livestock diseases had positive significant effect on milk production costs, the time that was spent in dairy cattle farm, farmers' education level, maize silage production and dairy farming experience had negative significant effect on milk production costs. It is expected to decrease milk production costs by paying attention to factors such as the time spent on the farm, the number of sick animals in dairy cattle farms, corn silage production, farmers' educational level, the farm-made roughage and dairy farming experiences of farmers.

This research model is applicable not only to milk producing farms but also to another farms engaged in livestock production. Thus, modeling the effective factors in decreasing of farms' milk production costs at the micro level can serve as a model for the studies at the macro level.

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