Cost analysis and technical efficiency of dairy cattle farms: a case study of Artvin, Turkey

Reception of originals: 10/04/2019
Release for publication: 04/14/2020

Aslıhan Aydemir
MSc in Agricultural Economics
Address: Faculty of Agriculture, Department of Agricultural Economics.
P.O.Box:60250, Tokat, Turkey
E-mail: **aslihan_aydemir08@hotmail.com**

Bilge Gözener
PhD in Agricultural Economics
Institution: Tokat Gaziosmanpaşa University
Address: Faculty of Agriculture, Department of Agricultural Economics.
P.O.Box:60250, Tokat, Turkey
E-mail: **bilge.gozener@gop.edu.tr**

Oğuz Parlakay
PhD in Agricultural Economics
Institution: Hatay Mustafa KemalUniversity
Address: Faculty of Agriculture, Department of Agricultural Economics. Hatay, Turkey
E-mail: **oparlakay@mku.edu.tr**

Abstract

In this study, cost analysis and technical efficiency was performed for dairy cattle farms in Artvin province of Turkey, milk production costs were calculated and the factors influencing milk production were identified. Technical efficiency scores of dairy farms were also calculated with Data Envelopment Analysis (DEA). Research data were gathered through the questionnaires with 118 dairy cattle farms selected through random sampling method. Total production costs per farm was calculated as 17 557.64 USD and 57.76% of such a sum was constituted by variable costs and 42.24% by fixed costs. The average cost of 1-liter milk was calculated as 0.32 USD. Of average active capital of the dairy cattle farms, 61.27% was composed of operational capital and 38.73% was composed of land capital. Economic rentability was 39.44%, financial rentability was 39.50% and rentability factor was 67.94%. Of milk production costs, 57.76% was composed of variable costs. According the DEA, average efficiency scores of dairy farms was identified as 65.00%. The Tobit analysis performed to put forth the relationships between DEA efficiency scores and socio-economic variables of the dairy farms revealed that inefficiency scores increased with increasing herd sizes.

Keywords: Dairy cattle farms. Milk cost. Technical efficiency

1. Introduction

Milk and dairy products play as much significant role as the other animal products in solution of national nutrition and development problems. Recent worldwide economic developments have influenced production, consumption and trade of milk and dairy products. Increasing income per capita together with increasing population especially in developing countries resulted in a significant increase in demands for essential foodstuffs such as milk and dairy products. Such increasing demands then generated a market attracting national and international investments in milk and dairy sector (Turan et al., 2017).

In 2018, there were 1 110 421 dairy cattle farms in Turkey. Of these farms, 51.69% have only 1-5 dairy cattle. Considering the total dairy cattle inventory of Turkey, number of animals per farm is 10.60 (Anonymous, 2017). By the year 2018, there were 6 337 907 dairy cattle in Turkey and annual total milk production was 20 036 877 tons (Anonymous, 2018).

By the year 2018, number of bovines in Artvin province was 61 943, number of dairy cattle was 26 392. Şavşat town with 7 467 dairy cattle constitutes 29.29% of dairy cattle inventory of Artvin province. With such a ratio, Şavşat town has the first place in number of dairy cattle in the province. Number of ovine in Artvin province is 129 794 (Anonymous, 2018).

2. Lıterature Revıew

There are various studies conducted about economic analysis of dairy cattle farms worldwide and in different provinces of Turkey (Weerinsk, Tauner, 1990; Şahin et al., 2001; Tauer, 2001; Yılmaz et al., 2003; İçöz, 2004; Coşkun et al., 2005; Nizam, 2006; Bayramoğlu and Direk, 2006; Koyubenbe and Candemir, 2006; Oliveira et al. 2006; Segala e Silva, 2007; Lopes et al., 2008; Silva et al., 2008; Tümer and Kumbasaroğlu, 2008; Demir and Aral, 2009; Gündüz and Dağdeviren, 2011; Keskin and Dellal, 2011; Tokmak et al., 2011; Murat and Sakarya, 2012; Külekçi, 2013; Michalickova et al., 2013; Demir et al., 2014; Souza, Rasıa E Almeıda, 2015; Özyürek et al., 2014; Ata and Yılmaz, 2015; Semerci et al., 2015; Aşkan and Dağdemir, 2016; Şahin and Gürsoy, 2016; Umamagesvari and Sivaram, 2017, Tapki, 2019).

Şahin et al. (2001) conducted a study on the economics of intensive dairy cattle production in Adana province and found that the highest share of gross production value in

dairy farms was 63.70% in milk sales. 74.80% of the changing costs in the enterprises were determined to be feed costs.

Tauer (2001), as a result of the research found that almost all of the small-scale enterprises are due to inefficiency of high costs. It was stated that unit dairy production cost for a farm with 50 cattle was 4.00% higher than a farm with 500 cattle, and as a result, it was emphasized that small dairy farms could compete with large dairy farms.

Yılmaz et al. (2003) found that 76.00% of total gross production value of dairy and dairy products, 22.00% increase in productive value and 2.00% of fertilizer production value in enterprises. In the calculations made as a result of the study, financial profitability in projected enterprises is calculated as 3.50%, economic profitability is 6.40% and in non-projected enterprises is calculated as 8.90% and 9.00%, respectively. As a result of the study, it is determined that there are significant differences between labor and capital use between project enterprises and non-project enterprises.

Nizam (2006) determined that 63.37% of the gross production value in the enterprises examined is composed of milk sales revenues. Feed costs constitute 72.82% of the variable costs of the enterprises. As a result of the activity analysis, it was found that 15 enterprises were working with 100% efficiency. The average efficiency of enterprises was found to be 79.43%.

Bayramoglu, Direk (2006), 59.13% of production costs per business in the changing costs of 40.87% of fixed costs have been determined. When the accepted milk sales price is taken into consideration, it is stated that as the average of the business, 7.59% loss was made from milk sales and 11.21% profit was made in large scale enterprises.

Oliveira et al. (2006) reported that with the help of GEROLEITE Project it was possible to reduce the cost of per litre of milk around 14% and the total production cost around 17%. The monthly production and cow productivity increased up to 9% and 4% respectively. In general, their problems were related to low price of the product (milk) paid by the cooperative. The participating group had an average increase in milk production by 9%. In this specific case, this producer reduced its monthly expenses by 24%; its unit cost remained unchanged while the producer has more time to find its new sustainable production footprint. In a way this analysis can prove that production volume is not the most important factor while it is all about keeping the production at competitive costs.

Segala e Silva (2007) argues that the use of cost accounting in rural areas can qualify managers' decision-making process, thus providing information that can meet the information requirements that arise in companies outside rural areas.

Silva et al. (2008) conceptualizes cost accounting as a branch of accounting science used to determine, measure, store and present the costs of products, goods or services sold. For authors, cost accounting should apply accounting principles to calculate results and evaluate inventories, alert managers to correctable results.

Souza, Rasia and Almeida (2015) observed that the adoption of strategic cost management practices when separated by countries offers a higher frequency of use in developed countries such as Japan, Italy and the United States.

In the study of Tapki (2019), the variable cost ratios in total costs were 74.38%, 82.12%, 79.07% and 75.70% (average 77.52%); the fixed cost ratios in total costs are 25.62%, 17.88%, 20.93% and 24.30% (average 22.48%); production costs per liter of raw milk were determined as USD 0,275, 0,285, 0,290 and 0,305 (average USD 0,283), and milk sales prices including premiums were determined as 0,325, 0,328, 0,345 and 0,370 USD (average 0,333 USD) for I, II, III groups. and IV dairy enterprises respectively. The results show that the milk selling price per liter is high and the cost of milking cows (group IV) is lower than that of other cows (milk production).

However, there aren't any studies conducted in the present research site. The present research site, Artvin province, has limited employment and business opportunities and quite available for livestock production activities. Thus, livestock raising or dairy farms constitute a significant business opportunity for the region.

The objectives of the present study were set as; to identify performance indicators and to calculate milk production cost, functional analysis of the factors with potential impacts on milk yield, to perform technical efficiency analyses for dairy farms, to provide recommendations to improve efficiency and finally to identify milk production-related problems and to propose solutions for these problems. Livestock sector of Turkey has various performance and efficiency problems. The present study will be the first report about the performance of dairy farms of the research site.

3. Material and Method

In this study, Şavşat town was selected purposefully since the town constitutes 29.29% dairy cattle inventory of Artvin province. The data gathered through face-to-face questionnaires with the dairy farms of Şavşat town constituted the primary material of the present study. Questionnaire data belong to 2016-2017 period.

To find out sample volume, initially the records of Şavşat Town Directorate of Agriculture and Forestry were analyzed and the villages with intensive dairy farms were determined purposefully. The number of farms to be surveyed was calculated as 118 with the aid of simple randomized sampling method (Çiçek and Erkan, 1996). For sample volume, 10% error margin and 95% confidence interval were taken into consideration. Size groups were determined by taking dairy cattle inventories of the farms and all analyses were performed based on these groups. Capital structure of the dairy farms was analyzed through functional classification of the capital (Açıl and Demirci, 1984; İnan, 1998). To assess the animals based on the same criteria, all parameters were converted into Bovine Unit (BU) with the aid of relevant coefficients (Erkuş et al., 1995).

For analysis of annual operational outcomes, gross output, operational costs, actual costs, net output, agricultural income, disposable agricultural income, total household income and rentability ratios were calculated. Rentability ratios were used to assess the operational functions and to compare the farms with each other.

In calculations for milk production costs of the dairy farms, total milk productions were taken into consideration assuming the milk produced were not processed into any products. The following equation was used to calculate milk production costs:

$$\text{Unit cost } \left({}^{\text{TL}}/_{\text{l}}\right) = \frac{\text{Total Milk Productino Costs} - \text{Inventory Increment}}{\text{Total Milk Production}} \qquad (1)$$

In this research, non-parametric Data Envelopment Analysis (DEA) was used. In DEA, yield levels of well-performing dairy farms were used to generate efficiency threshold. Then, the efficiency of the other decision-making units was determined through measuring the distances from this threshold (Coelli et al., 2005).

In economic analyses, annual milk yield (liter/cattle) was used as output and roughage quantity (kg/cattle), concentrate feed quantity (kg/cattle), veterinary cost ($/cattle), fixed costs

($/cattle) and labor costs ($/cattle) were used as inputs (Dollar Exchange rate of the production period was taken as 1 $ = 3,48 TL from the records of Turkish Central Bank).

Technical efficient scores (VRS – variable returns to scale) obtained through efficiency analysis of investigated farms were reassessed with the appropriate regression analysis model (Tobit) and the reasons of inefficiency were put forth. Definitions of the variables used in analysis are provided in Table 1.

Table 1: Definition of variables used in Tobit analysis

Variable	Definition of variable
Education	Educational level of farm owner (year)
Experience	Experience of owner in dairy farm (year)
Herd size	Number of dairy cattle of the farm
Age	Age of farm owner (year)

4. Results and Discussion

4.1. Annual activity outcomes of the investigated farms

While calculating annual activity outcomes, the enterprise was considered as a whole, and operational outcomes were assessed and interpreted accordingly. The gross income of the farms was composed of total production outcomes of plant and animal products, service revenues (tool-machine rent revenues), inventory increments and housing rent cost (Table 2). Increasing gross outputs were observed with increasing farm sizes. As the average of farms, the gross output was calculated as 141 334.59 USD.

As expected, animal products production outcomes constituted the largest part (94.81%) of gross income of the farms. Plant production outcomes constituted a small portion of gross income since the regional climate is not available for plant production activities and dairy farms were selected in this study. As the average of farms, the ratio of gross income to active capital was calculated as 58.05%.

Among the gross income items, animal product outputs had quite high share. In similar studies conducted about dairy farms, ratio of animal product outcomes in gross income was reported as 42.57% (Bayramoğlu, 2003), 46.32% (Öztürk and Karkacıer, 2008), 79.46% (Gündüz and Dağdeviren, 2011) and 83.00% (Semerci et al., 2015).

Table 2: Gross income (USD/farm) and rational distribution (%)

		Farm Groups				Average of Farms	
		1st Group (65)		2nd Group (53)		(118)	
		Value	%	Value	%	Value	%
Animal Products	Milk sold and consumed by family	5 158.02	5.65	8 975.82	4.43	6 872.80	4.86
	Gorcolo cheese	18 728.47	20.50	41 498.86	20.48	28 955.85	20.49
	Besili cheese	24 472.15	26.79	53 326.56	26.32	37 432.18	26.48
	Oil	31 013.37	33.95	73 620.69	36.33	50 150.56	35.48
	Salty ayran	2 014.85	2.21	12 674.04	6.25	6 802.45	4.81
	Total	81 386.86	89.09	190 095.97	93.82	130 213.84	92.12
	Honey	3 327.01	3.64	2 356.32	1.16	2 891.10	2.05
	Egg	777.45	0.85	1 064.68	0.53	906.46	0.64
	General total	85 491.32	93.58	193 516.97	95.50	134 011.40	94.81
Plant Products	Potato	0.66	0.001	3.31	0.002	1.85	0.001
	Bean	2.98	0.003	6.21	0.003	4.43	0.004
	Total	3.64	0.004	9.52	0.01	6.28	0.005
Service Revenues	Tool-machine renting	91.61	0.10	576.61	0.28	309.45	0.22
Inventory Increments	Material and ammunition asset	210.98	0.23	374.18	0.18	284.28	0.20
	Animal asset	4 414.26	4.83	7 144.82	3.53	5 640.70	3.99
	Total	4 625.24	5.06	7 519.00	3.71	5 924.98	4.19
Household Rent		974.40	1.26	1 003.58	0.50	1 082.48	0.77
General Total		91 355.15	100.00	202 625.68	100.00	141 334.59	100.00
Income per BU (USD /BU)		4 484.79		4 109.22		4 235.38	
Ratio of gross income to active capital (%)		49.12		64.53		58.05	

As the average of farms, operational costs were calculated as 45 309.83 USD (Table 3). Among the cost items of operational costs, material costs had the greatest share with 51.60%.

Table 3: Operational costs (USD/farm) and rational distribution (%)

		Farm Groups				Average of Farms	
		1st Group (65)		2nd Group (53)		(118)	
		Value	%	Value	%	Value	%
Labor Costs	External labor	354.76	0.90	493.11	0.94	416.91	0.92
	Household labor equivalent	8 826.08	22.32	7 251.91	13.85	8 119.06	17.92
	Total	9 180.84	23.22	7 745.02	14.79	8 535.97	18.84
Material Costs	Plant production	4.64	0.01	2.17	0.01	3.53	0.01
	Feed (bovine)	12 635.04	31.95	18 930.62	37.25	15 720.85	34.70
	Feed (ovine)	194.25	0.49	136.63	0.26	168.37	0.37
	Salt	21.82	0.06	50.45	0.10	34.68	0.08
	Chain-halter	4.42	0.01	10.03	0.02	6.94	0.01
	Animal purchase value	6 657.82	16.83	8 411.95	16.06	7 445.69	16.43
	Total	19 517.98	49.35	28 116.55	53.70	23 280.06	51.60
Marketing Costs	Transport	67.20	0.17	104.91	0.20	84.14	0.19
	Feed transport	178.60	0.45	244.52	0.47	208.21	0.46
	Total	245.80	0.62	349.43	0.67	292.35	0.65
Other Running Costs	Insurance premium	797.35	2.02	1 673.82	3.19	1 191.02	2.63
	Tractor fuel cost	209.77	0.53	501.52	0.95	340.81	0.75
	Tool-machine repair maintenance	946.72	2.39	1 549.77	2.96	1 217.58	2.69
	Building annual repair maintenance	1 922.19	4.86	2 280.96	4.35	2 083.33	4.60
	Veterinary-vaccine-care	1 853.45	4.69	3 553.73	6.78	2 617.13	5.77
	Total	5 729.48	14.49	9 559.80	18.23	7 449.87	16.44
Amortization	Tool-machine	2 377.84	6.01	2 285.78	4.37	2 336.49	5.16
	Building	2 298.28	5.81	2 364.21	4.51	2 327.89	5.14
	Land reclamation	87.03	0.22	28.69	0.05	60.82	0.13
	Animal	110.52	0.28	1 926.92	3.68	926.36	2.04
	Total	4 873.67	12.32	6 605.60	12.61	5 737.76	12.47
Total operational costs		39 547.80	100.00	52 364.97	100.00	45 309.83	100.00
Operational costs per BU (USD /BU)		1 941.47		1 061.95		1 357.80	

The quantity of actual costs allocated to different units and ratio to active capital are provided in Table 4. As the average of farms, actual costs were calculated as 37 595.86 USD. Ratio of actual costs to active capital was calculated as 15.44%.

Table 4: Actual costs of investigated farms (USD/farm)

	Operation Groups		Average of Farms (118)
	1st Group (65)	2nd Group (53)	
Total operational costs (A)	39 547.80	52 364.97	45 309.83
Household labor (paid) (B)	8 826.08	7 251.95	8 119.05
Rents and contractor share (C)	225.46	338.92	276.42
Dept interests (D)	134.99	120.91	128.66
Total actual costs [(A-B)+(C+D)]	31 082.17	45 572.85	37 595.86
Actual costs per BU (USD /BU)	1 525.88	924.21	1 126.63
Ratio of actual costs to active capital (%)	16.71	14.51	15.44

In enterprise analysis, net output is used for interfirm comparisons (Erkuş et al., 1995). Net output of investigated farms and allocation of net output to different units are provided in Table 5.

Table 5: Net output of investigated farms (USD/farm)

	Farm Groups		Average of Farms (118)
	1st Group (65)	2nd Group (53)	
Gross Output (A)	91 355.14	202 624.66	141 334.59
Operational Costs (B)	39 547.80	52 364.97	45 309.83
Net Output (A-B)	51 787.34	150 259.69	96 024.76
Net output per BU (USD /BU)	2 543.31	3 047.27	2 877.58
Ratio of Net Output to Active Capital (%)	27.86	47.86	39.44

Net output per farm was calculated as 96 024.76 USD. As the average of farms, the ratio of net output to active capital was calculated as 39.44%. Such a high ratio indicated high profitability of the farms. Öztürk and Karkacıer (2008) conducted a study in Tokat province and reported the ratio of net output to active capital as 10.68%.

Agricultural income of farms, allocation of agricultural income to different units and ratio to active capital are provided in Table 6.

Table 6: Agricultural income of investigated farms (USD/farm)

	Farm Groups		Average of Farms (118)
	1st Group (65)	2nd Group (53)	
Gross Output (A)	91 355.14	202 626.66	141 334.59
Actual Costs (B)	31 082.16	45 572.85	37 595.86
Agricultural Income (A-B)	60 272.98	157 052.81	103 738.73
Agricultural Income per BU (USD/BU)	2 958.91	3 185.00	3 108.74
Ratio of Agricultural Income to Active Capital (%)	32.41	50.02	42.61

As the average of farms, agricultural income was calculated as 103 738.73 USD (Table 4.5). Ratio of agricultural income to active capital was calculated as 42.61%. Such a ratio indicated that almost half of active capital was composed of agricultural income. Inventory increment was deducted from agricultural income to calculate disposable income of the family. Disposable incomes of present farms and disposable income per BU are provided in Table 7.

Table 7: Disposable agricultural income of farms (USD /farm)

	Farm Groups		Average of Farms (118)
	1st Group (65)	2nd Group (53)	
Agricultural Income (A)	60 272.98	157 052.58	103 741.89
Inventory Increment (B)	4 625.24	7 518.99	5 924.98
Disposable Agricultural Income (A-B)	55 647.73	149 533.82	97 816.91
Disposable Agricultural Income per BU (USD/BU)	2 731.85	3 002.08	2 931.28

The disposable agricultural income per farm was calculated as 97 816.91 USD (Table 4.6). Total household income was calculated by adding agricultural income and non-agricultural income as provided in Table 8.

Table 8: Total household income of the farms (USD / farm) and rational distribution (%)

	Farm Groups				Average of Farms (118)	
	1st Group (65)		2nd Group (53)			
	Value	%	Value	%	Value	%
Agricultural Income (A)	60 272.98	88.57	157 052.81	96.31	103 741.89	93.69
Non-agricultural Income (B)	7 777.63	11.43	6 015.61	3.69	6 986.22	6.31
Total Household Income (A+B)	68 050.61	100.00	151 037.20	100.00	96 755.67	100.00

Total household income increased linearly with increasing farm sizes. The total household income was calculated as 68 050.61 USD in 1st group, as 151 037.20 USD in the 2nd group farms and the average of farms was calculated as 96 755.67 USD. The share of non-agricultural income in total household income was calculated as 6.31%. Economic rentability, financial rentability and ratios of rentability factors are provided in Table 9.

Table 9: Rentability ratios of investigated farms (%)

	Farm Groups		Average of Farms (118)
	1st Group (65)	2nd Group (53)	
Economic Rentability	27.86	47.86	39.44
Financial Rentability	28.07	48.08	39.50
Rentability Factor	56.71	74.16	67.94

As the average of the farms, economic rentability was calculated as 39.44%, financial rentability was calculated as 39.50% and rentability factor was calculated as 67.94%. Greater financial rentability than the economic rentability indicate more efficient use of equity capital (Aydın and Unakıtan, 2016). Financial rentability values were greater than the economic rentability values in both groups of farms.

In previous studies conducted on dairy farms, Bayramoğlu (2013) reported economic rentability as 4.19%, financial rentability as 2.41% and rentability factor as 19.21%; Tokmak et al. (2011) reported economic and financial rentability as 7.25%; Murat and Sakarya (2012) reported economic rentability as 1.24%, financial rentability as 0.93% and rentability factor as -0.01%. Present findings were quite different from those earlier ones since the present research site has quite limited business opportunities apart from livestock, especially from

dairy farms and such conditions directed farms to the most profitable dairy activities. Such differences were also attributed to direct sale of dairy products to consumers over the prices determined by the farm owner because of limited marketing options and sale of more income-generating products like butter, gorcolo cheese, besili cheese and salty ayran instead of raw milk.

4.2. Milk production costs, gross and net profit levels

Production costs of investigated dairy farms are provided in Table 10.

Table 10: Production costs of dairy farms and rational distribution (%)

		Farm Groups				Average of Farms (118)	
		1st Group (65)		2nd Group (53)			
		Value	%	Value	%	Value	%
Variable Costs (A)	External feed	4 839.93	40.31	8 827.20	36.22	6 630.83	37.77
	Internal feed	919.54	7.66	3 090.43	12.68	1 894.60	10.79
	Salt	22.10	0.18	50.45	0.21	34.84	0.20
	Feed transport	178.60	1.49	244.52	1.00	208.21	1.19
	Veterinary, medicine	325.60	5.70	1 286.60	5.28	954.61	5.44
	Labor (care)	325.60	2.71	328.02	1.35	326.68	1.86
	Transportation	67.20	0.56	104.91	0.43	84.14	0.48
	Chain-halter	4.42	0.04	10.03	0.04	6.29	0.04
	Total	7 041.31	58.64	13 942.18	57.21	10 140.85	57.76
Fixed Costs (B)	General Administration (A*0.03)	211.24	1.76	418.26	1.72	304.22	1.73
	Building capital amortization	1 215.43	10.12	1 675.53	6.88	1 422.08	8.10
	Building capital interest	512.82	4.27	662.81	2.72	580.19	3.30
	Building capital maintenance	433.24	10.79	1 646.60	6.76	1 453.10	8.28
	Cattle amortization	110.52	0.92	1 926.91	7.61	926.36	5.28
	Cattle capital interest	889.59	7.41	2 355.91	9.67	1 548.19	8.82
	Tool-machine capital amortization	605.51	5.04	1 385.14	5.68	955.68	5.44
	Tool-machine capital	126.11	1.05	356.39	1.46	226.95	1.29

	interest						
	Total	4 966.53	41.36	10 427.58	42.79	7 416.79	42.24
Total production costs (A+B)(C)		12 007.84	100.00	24 369.76	100.00	17 557.64	100.00

Production costs were assessed under two categories as of variable and fixed costs. Total production costs per farm was calculated as 17 557.64 USD and 57.76% of such a sum was constituted by variable costs and 42.24% by fixed costs. Among the production costs, external feed supply had the greatest share (37.77%). Since investigated farms graze their animals over the pastures, feed costs were low. Gündüz and Dağdeviren (2011) reported that 74.58% of production costs were constituted by variable costs and Tokmak et al. (2011) indicated such a ratio as 86.10%. Production values of dairy farms are provided in Table 4.11.

Table 11: Production values of investigated dairy farms (USD/farm) and distribution (%)

	Farm Groups				Average of Farms (118)	
	1st Group (65)		2nd Group (53)			
	Value	%	Value	%	Value	%
Milk production	31 807.14	87.81	72 695.71	91.05	50 172.35	89.89
Inventory increment	4 414.26	12.19	7 144.81	8.95	5 641.70	10.11
General total	36 221.40	100.00	79 840.54	100.00	55 813.05	100.00

Production value of dairy farms was calculated as 55 813.05 USD. Of that sum, 89.89% was constituted by milk production. Unit milk cost of dairy farms is provided in Table 12. The cost of 1-liter milk was calculated as 0.33 USD in the 1st group, 0.31 USD in the 2nd group farms and the average cost was calculated 0.32 USD.

Table 12: Unit milk cost of dairy farms

	Farm Groups		Average of Farms (118)
	1st Group (65)	2nd Group (53)	
Total production costs (USD) (A)	12 007.84	24 369.76	17 557.64

Inventory increment (USD) (B)	4 414.26	7 144.81	5 641.70
Net production cost (USD) (A-B)	7 593.58	17 224.95	11 915.94
Milk production (liter) (C)	36 685.38	78 550.94	55 489.41
Unit milk cost (USD /liter) [A/C]	0.33	0.31	0.32

Production values of investigated dairy farms are provided in Table 13.

Table 13: Production values of investigated dairy farms

	Farm Groups		Average of Farms (118)
	1st Group (53)	2nd Group (65)	
	Value	Value	Value
Gross production value (USD /farm)(A)	36 221.40	79 840.54	55 813.05
Production costs (USD /farm) (B)	12 007.84	24 369.76	17 557.64
Production value (USD) (A-B)	24 213.56	55 470.78	38 255.41

Production values increased with increasing size of farms. Production value was calculated as 24 213.56 USD in the 1st group, as 55 470.78 USD in the 2nd group of farms and the average of farms was calculated as 38 255.41 USD.

Data envelopment analysis (DEA) was used in this study to identify the required input for full-active farm of decision units and to find out the outputs the farms should increase. DEA method results are provided in Table 14.

Table 14: Distribution of input-oriented DEA technical efficiency values

Efficiency	Number of Farms		
	CRS	VRS	Scale Efficiency
≤0.50	53	39	0
0.51-0.60	23	28	4
0.61-0.70	15	13	3
0.71-0.80	13	10	22
0.81-0.90	5	7	37
0.91-1.00	9	21	52

Summary statistics			
Mean	0.544	0.650	0.860
Minimum	0.328	0.353	0.546
Maximum	1.000	1.000	1.000

According to data envelopment analysis (DEA), total efficiency score (constant returns to scale - CRS) was calculated as 0.544, technical efficiency score (variable returns to scale – VRS) was calculated as 0.650 and mean scale efficiency was calculated as 0.860. It was observed that for an efficient farm, when the input quantity was reduced by 14%, the same quantity of output could be achieved and 14% saving could be achieved in inputs. Koyubenbe and Candemir (2006) conducted an output-oriented DEA and reported total efficiency score as 0.939 for Ödemiş, 0.943 for Tire, 0.984 for Bayındır and 0.989 for Torbalı towns of İzmir province. Kumbar (2015) reported technical efficiency of the farms as 0.49 and scale efficiency as 0.80. Bozoğlu et al. (2017) stated that the average technical efficiency of the inefficient farms was 0,80 which could reduce the average input utilization of inefficient farms by 20%.

The relationships between DEA-induced efficiency scores and socio-economic variables of the farms were assessed through Tobit analysis. Education, age, experience of farm owner and herd size of the farm were considered as the socio-economic variables. Tobit regression analysis results are provided in table 15.

Table 15: Tobit regression analysis results

Variables	Coefficient	Standard error	P value
Constant	0.6018	0.1362	0.0000
Age	-0.0028	0.0017	0.0992
Education	0.1586	0.0241	0.7444
Experience	0.0008	0.0012	0.5301
Herd size	0.0101	0.0014	0.0000

Regression analysis revealed increasing efficiencies with increasing herd sizes. Nizam (2006) conducted a study in Aydın province and indicated that farm efficiency did not have significant correlations with the age, educational level and experience of farm owner, but BU had significant effects on farm efficiency. Külekçi (2013) indicated age, experience of farm

owner, milking technique and incentives as significant factors and reported negative coefficients for these variables.

5. Conclusion

This study focused on dairy farms in Şavşat town of Artvin province. Performance, milk production cost and technical efficiency scores of dairy farms were calculated and following conclusions were drawn from the present findings:

Among the performance indicators, animal production value had a quite high share in gross output. The ratio of gross product to active capital was calculated as 58%. Such a case was an expected case since the present research site has limited agricultural fields. Land structure of the region is more suitable for animal production than for plant production. As expected, feed costs had the greatest share in operational costs. The ratio of net output to active capital was high and such a high value for this performance indicator indicated high profitability levels of the present farms. Almost all of the total family income (93.69%) was composed of agricultural income. In other words, farm owners were not working any other income-generating businesses other than agriculture. Greater financial rentability (39.50%) than the economic rentability (39.44%) indicated more efficient use of equity capital. Present findings revealed that producers did not have problems in milk production. Dairy farms were processing milk into butter, gorcolo cheese, besili cheese and salty ayran to increase their incomes. Trainings can be provided them about better income-generating processes and marketing methods. Producers should also be encouraged to form producer associations like İzmir Tire Milk Producers Association or Konya Dairy Producers Cooperatives to support producers in every aspects of dairy farms from input supply to marketing. Supports also should be provided to producers to increase herd sizes and to reduce input and production costs.

6. References

AÇIL, A.F.; DEMIRCI, R. *Tarım Ekonomisi*. Ankara University Agricultural Faculty Publishes, Lecture Book, 225-372 s, Ankara. 1984.

ANONYMOUS, *General Directory of Meat and Milk Board of Turkey*. https://www.esk.gov.tr/upload/Node/10255/files/Et_ve_Sut_Kurumu_2017_Sektor_Raporu.pdf (10.09.2018). 2017.

ANONYMOUS, *Turkish Statical Institute*. https://biruni.tuik.gov.tr/medas/?locale=tr (15.03.2019). 2018.

AŞKAN, E.; DAĞDEMIR, V. Milk Production Cost and Profitability in Financially Supported Dairy Livestock Farms in TRA1 NUTS II Region. *TEAD*, v. 2, n. (1, p. 1-12, 2016.
.

ATA, N.; YILMAZ, H. Reflections of Implementations of Livestock Production Support Polices On Dairy Farms in Turkey: The Case of Burdur Province. Süleyman Demirel University. *Journal of Agricultural Faculty*, v. 10, n. 1, p. 44-54, 2015.

BAYRAMOĞLU, Z.. Analysis of Economics of Farms Considered in Dairy Cattle Projects (100 X 2) For Konya Province. *Master Thesis*, Selçuk University Graduate School of Natural and Applied Sciences. Department of Agricultural Economics. Konya. 2003.

BAYRAMOĞLU, Z.; DIREK, M. The Econometric Analysis of Dairy Farms Which Members of Development Cooperatives In Konya Province. *Selçuk Journal of Agriculture and Food Sciences*, v. 20, n. 40, p. 12-20, 2006.

BOZOĞLU, M.; SAĞLAM, O.; TOPUZ, B.K. Economic sustainability of family dairy farming within the scope of technical efficiency: a case study of Bafra district, Turkey. *Custos e @gronegócio on line* - v. 13, n. 2, p. 295-316, 2017.

COELLİ, T.J.; RAO, D.S.P.; O'DONNELL, C.J.; BATTESE, G.E. *An Introduction to Efficiency and Productivity Analysis*. Springer Science, ISBN:038 724 265 1. 2005.

COŞKUN, H.; TUNÇTÜRK, Y.; ALTINDAĞ, S.; DEMIR, A. Available Status, Problems and Suggestions for Dairy Plants in Van. Yüzüncü Yıl University, Agricultural Faculty, *Journal of Agricultural Sciences*, v. 15, n. 1, p. 11-15, 2005.

ÇIÇEK, A.; ERKAN, O. *Tarım Ekonomisinde Araştırma ve Örnekleme Yöntemleri*. Gaziosmanpaşa University, Agricultural Faculty Publishes, No:12, p.188 , Tokat. 1996.

DEMIR, P.; ARAL, S. The faced problems and solution proposals of dairy farms in Kars province. *Turkish Veterinary Medical Society*, v. 80, n. 3, p. 17-22, 2009.

DEMIR, P.; YILMAZ, A.; SARIÖZKAN, S. Socio-Economic Structure and Production Costs of Dairy Cattle Farms in Kars Province. *Yüzüncü Yıl University Journal of Veterinary Faculty*, v. 25, n. 1, p. 1-6, 2014.

ERKUŞ, A.; BÜLBÜL, M.; KIRAL, T.; AÇIL, A.F.; DEMIRCI, R. *Tarım Ekonomisi*. Ankara University Agricultural Faculty Publishes, No:5, Ankara. 1995.

GUJARATI, D. *Ekonometrika Dasar*. Penerbit Erlangga, Jakarta, 62. 1995.

GÜNDÜZ, O.; DAĞDEVIREN, M. Determination of Production Cost of Cow Milk and Functional Analysis of Factors Affecting Milk Production in the Bafra District. *Yuzuncu Yıl University Journal of Agricultural Sciences*, v. 21, n. 2, p. 104-111. 2011.

İÇÖZ, Y. *The Analysis of Profitability and Productivity of Dairy Cattle Enterprises in Bursa Province*. Agricultural Economy Research Institute, No: 166, ISBN: 975-407-148-9. 2004.

KESKIN, G.; DELLAL, İ. Gross Margin Anaysis For Dairy Cattle in Trakya Region. *Journal of the Faculty of Veterinary Medicine*, Kafkas University, v. 17, n. 2, p. 117-182. 2011.

KOYUBENBE, N.; CANDEMIR, M. Comparison of the Technical Efficiencies of Dairy Farms in Ödemiş, Tire, Bayındır and Torbalı Districts, the Basin of Küçük Menderes. *Journal of Animal Production*. V. 47, n. 2, p. 9-20, 2006.

KUMBAR, N. An Efficiency Analysis of Breeding Farm Enterprises in Trakya Region. *Ph.D. Thesis*, Namık Kemal University Graduate School of Natural and Applied Sciences, Tekirdağ. 2015.

KÜLEKÇI, M. Efficiency Analysis of Dairy Cattle Farms: Case Study in Erzurum. Atatürk Univ., *J. of the Agricultural Faculty*, v. 44, n. 2, p. 103-109, 2013.

LOPES, M.A.; CARDOSO, M.G.; CARVALHO, F.M.; LIMA A.L.R.; DIAS, A.S.; CARMO, E.A. Economical results of milk production sytems in Lavras region (MG) throughout the years 2004 and 2005: a multicase study. *Arquivo Brasileiro de Medicina Veterinaria e Zootecnia*, v. 60, n. 2, p. 428-435, 2008.

MICHALICKOVA, M.; KRUPOVA, Z.; KRUPA, E. Technical Efficiency and its determinants in dairy cattle. *Review of Agricultural and Economics*, v. 16, n. 1, p. 2-11, 2013.

MURAT, H.; SAKARYA, E. The economic analysis of dairy cattle enterprises in Centre Anatolia Region which members of cattle breeders association of Turkey. *Journal of Turkish Veterinary Medical Society*, v. 83, n. 1, p. 5-14, 2012.

NIZAM, S. *Determination of the Productivities of Dairy Farms in Aydın Province*. MSc Thesis, Adnan Menderes University Graduate School of Natural and Applied Sciences, Aydın. 2006.

UMAMAGESWARI, M.; SIVARAM, P.D.M. Economics of milk production in Tamil Nadu-A comparative study. *Indıan Journal of Dairy Science*, v. 70, n. 2, p. 221-227, 2017.

OLİVEİRA, C. A.; ALMEIDA, J.C. DE C.; PİMENTEL, F. J.; LİNHARES, M. L. AND BRANCO, C. A. C. Geroleite Project dairy farmer training: Cooperative Miracema-RJ case. *Custos e @gronegócio on line* - v. 2 - n.2 – Jul/Dec. 2006.

ÖZTÜRK, D.; KARKACIER, O. Economic Analysis of Dairy Farms (The Case of Yeşilyurt District of Tokat Province). *Journal of Agricultural Faculty of Gaziosmanpasa University*, v. 25, n. 1, p. 15-22, 2008.

ÖZYÜREK, S.; KOÇYIĞIT, R.; TUZEMEN, N. Structural Features of Dairy Farmers In the Erzincan: The Example of Çayırlı District. *Journal of Tekirdag Agricultural Faculty*, v. 11, n. 2, p. 19-26. Tekirdağ. 2014.

SEMERCI, A.; PARLAKAY, O.; ÇELIK, A.D. Economic Analysis of Dairy Farms: The Case of Hatay Province. *Journal of Tekirdag Agricultural Faculty*, v. 12, n. 3, p. 8-17, 2015.

SEGALA, C. Z. S.; SİLVA, I. T. Apuração dos custos na produção de leite em uma propriedade rural do município de Irani, SC. *Custos e @gronegócio On Line*, Recife, v. 3, n. 1, p. 61-86. 2007.

SILVA, H. A.; KOEHLER, H. S.; MORAES, A.; GUIMARÃES, V. D. A.; HACK, E.; CARVALHO, P. C. F. Análise de viabilidade econômico da produção de leite a pasto e com suplementos na região dos Campos Gerais - Paraná. *Ciência Rural*, v. 38, n. 2, p. 445-450, mar. 2008.

SOUZA, M. A.; RASIA, K. A. AND ALMEIDA, L. B. Práticas de gestão estratégica de custos adotadas por empresas brasileiras de segmentos do agronegócio. *Custos e @gronegócio on line*, v. 11, n. 3, Jul/Set. 2015.

ŞAHIN, K. GÜRSOY, A.K. Socio Economic Structure of Dairy Cattle Raising Enterprises in Iğdır Province. *Nevsehir Journal of Science and Technology*, Special Issue, v. 5, p. 118-129. Nevşehir. 2016.

ŞAHIN, K.; GÜL, A.; KOÇ, B.; DAĞISTAN, E. Intensive Dairy Cattle Production Economics in Adana Province. *Yuzuncu Yıl University Journal of Agricultural Sciences*, v. 11, p. 2, p. 19-28. 2001.

TAPKİ, N. The comparison of dairy farms in different scales regarding milk production cost and profitability in Turkey: A case study from Hatay province. Custos e @gronegócio *on line* - v. 15, n. 2, Apr/Jun. 2019.

TAUER, L.W. Efficiency and competitiveness of the small New York dairy farm. *Journal of Dairy Science*, v. 81, n. 11, p. 2573-2576, 2001.

TOKMAK, T.; ÜNALAN, A.; ÇIÇEK, R. *Economic Analysis of Dairy Cattle Farms in Niğde*, 7. National Animal Science Congress, 14-16 September 2011, Çukurova University Agricultural Faculty Department of Animal Sciences, Adana. 2011.

TURAN, Z.; ŞANVER, D.; ÖZTÜRK, K. The Importance of Dairy Cattle Breeding in The Livestock Sector in Turkey, Contribution to Domestic Output And Comparison With Foreign Countries. Ömer Halisdemir University, *Academic Review of Economics and Administrative Sciences*, v. 10, n. 3, p. 60-74, 2017.

TÜMER, E.İ.; KUMBASAROĞLU, H. The Calculation of the Cost of Milk in Enterprises with and without Animal Insurance: A CaseStudy in Turhal District in Tokat Province. Atatürk University, *Journal of the Faculty of Agriculture*, v. 39, n. 2, p. 187-194, 2008.

YILMAZ, İ.; DAĞISTAN, E.; KOÇ, B.; ÖZEL, R. Analysis of Dairy Farming Activities and Factor Productivity in Projected and Non-Projected Dairy Farms in Hatay Province (Turkey). *Mediterranean Agricultural Sciences*. v. 16, n. 2, p. 169-178, 2003.

WEERSINK, A.; TAUNER, L.W. Regional and temporal impacts of technical change in the US dairy sector. *American Journal of Agricultural Economics*, v. 72, n. 4, p. 923-934. 1990.