The influence of scale on profitability of dairy cattle farms: a case study in eastern part of Turkey

Recebimento dos originais: 04/01/2019
Aceitação para publicação: 14/09/2019

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Abstract

The research aims at the economic assessments of dairy cattle farms associated with İkizler Village Agricultural Development Cooperative in Gevaş District of Van Province, Turkey. The data of 2009 production period were collected from 37 farms associated with the Cooperative, through questionnaires applied face-to face with the producers. The number of cows per farm, daily milk yield per cow and lactation period were 4.46 head, 11.74 kg and 237.6 days, respectively. These figures increased according to farm scale. Daily feed intake per cow was 19.93 kg (12.37 kg roughage and 7.56 kg concentrated feeds). Feed costs consisted of 91.74 % of total variable costs. Unit milk costs (the costs of 1 kg milk) was $ 0.58 and decreased in line with farm scale being $ 0.73 for small-scale and $ 0.50 for large-scale farms. Economical profitability rates in terms of gross profit were 10.18 % and increased in proportion to farm scale being 5.95 % for small-scale and 16.91 % for large-scale farms. Cobb-Douglas Production Function revealed that the total production elasticity of inputs (Σbi) was 0.945, which means decreasing return to scale.

Keywords: Dairy cattle farms. Farm scale profitability. Turkey

1. Introduction

The sufficiency of milk production and its quality is considered essential for a balanced nutrition (Yıldırım and Şahin, 2006). Increasing the milk consumption per person depends on higher yearly increase of milk supply compared to the rise in the population rate (Yıldırım et al., 2008). The profitability of dairy cattle farms is considered essential to achive this target (Costa et al., 2013).

The major factors cited by researchers on the profitability of dairy cattle farms were as follows: Cow breed, lactation period and length of cow productive life (Septiani et al., 2017; József et al., 2017; Ali et al., 2013; Topçu, 2008), feed costs and feed efficiency (Gjeçi and Bicoku, 2017; Hietala et al., 2014; Kumar et al., 2014; Heinrichs et al., 2013; Chamberlain, 2012), pasture (Browne et al., 2013; Hanrahan et al., 2018; Rojas-Downing et al., 2017; Costa et al., 2013), milk yield (Krpálková et al., 2014; József et al., 2017; Michaličková et al., 2014); prices of milk and inputs (Septiani et al., 2017; Mehmood et al., 2015; Bozic et al., 2012; Wolf, 2012; Browne et al., 2013), farm scale (Hanrahan et al., 2018; Maqbool et al., 2017; Krpalkova et al., 2016; Wolf, 2012; Yıldırım et al., 2008; Saner, 1993), government supports (Semerci and Çelik, 2017; Krpalkova et al., 2016; Michaličková et al., 2014; Hietala et al., 2014), business management (Septiani et al., 2017), and cooperation and organization (Svensson et al., 2018; Oğuz and Yener, 2017; Andersson et al., 2005; Karlı et al., 2006).

In Turkey, the quantity of dairy cattle milk production rose from 9.4 million tons in 1996 to 18.8 million tons in 2017 (TurkStat, 2018), which means yearly average annual increase of 496.6 thousand tons. The milk yield per dairy cattle during a lactatition period rose from 1586 kg in 1996 to 3143 kg in 2017 (TurkStat, 2018). This showed that productivity increased by 98% reaching 89.2 kg increase per year.

Ikizler Agricultural Development Cooperative was established in 2004 in Gevaş District of Van Province. Although the Cooperative has been established for multi-purpose activities, its main activity is dairy cattle production and marketing. The Cooperative has 50 members with its own operation building and a three-ton milk cooling tank. This study aims at the economic assessments of dairy cattle farms associated with İkizler Agricultural Development Cooperative in Gevaş District of Van Province. The major hypothesis was the larger-scale

farms would have higher profitability rates given resource efficiency and advantages of scale-economics.

2. Literature Review

Many research findings of previous studies regarding the profitability of dairy cattle farms in different countries including Turkey is available. These findings generally indicate the factors effective on the profitability of the farms. Some of them is summarized as follows:

Using an internationally recognized representative database over an 8-yr period (2008 to 2015) on pasture-based systems, Hanrahan et al. (2018) reported that net profit per hectare was associated with pasture use per hectare, year, location, soil type, grazing season length, proportion of purchased feed, protein %, kg of fat and protein per cow, dairy farm size, and capital investment in machinery and buildings per cow. József et al. (2017), who investigated the data collected for 17 years from 2000 to 2016 from a dairy cattle farm in South-Hungary, reported that profitability of dairy herd was determined mainly by milk yield per lactation and that one day increase in productive lifetime resulted from 19.32 to 29.34 kg increasing of milk yield. Krpálková et al. (2014), who made a survey on 33 commercial dairy herds in the Czech Republic in 2011 revealed that milk yield was an important factor for dairy farm profitability and that the group of farms having the highest milk yield achieved the highest net profit despite having greater fertility problems. The Cobb-Douglas regression function revealed that the profitability influenced from milk yield (milk output) among other factors for 5 small dairy farms from the Southern Romania (Popescu, 2014). The data of 2012 for 80 dairy cattle farms in Semarang regency India indicate that forage and concentrate feed costs were effective on farmers' profit (Haloho et al., 2013).

The data of 2010 production period of 110 dairy cattle farms in the district Sargodha, Pakistan revealed that total labour cost, fodder and forage cost, and concentrate feeding cost had negative relationship with dairy farm profitability while milk price showed significantly positive relationship with farm profitability. The study concluded that cost effective management practices might improve the dairy farms profitability. Inclusion of improved livestock breeds might also enhance productivity and profitability of dairy cattle farms (Mehmood et al., 2015). A multiple linear regression analysis of data belonging to 81 organic and conventional pasture-based dairy farms in southern Germany demonstrated that low feed demand per kilogram of milk, high grassland yield, and low forage area requirements per cow

were the essential factors effective on the improving a farm's profitability (Kiefer et al., 2014). A research made on Michigan dairy farmers indicated that volatility in milk and feed prices had potentials to affect dairy farm profitability and there existed many risk management tools available for use by US dairy farmers (Wolf, 2012).

The reported profitability rates in different parts of Turkey were 3.27 % in Van Province (Yıldırım and Şahin, 2006), 6.3 % in Kırklareli Province (Yıldırım et al., 2008), 2.04 % in Konya Province, (Oğuz and Yener, 2017), and 7.62 % in Hatay Province (Semerci and Çelik, 2015).

Yıldırım and Şahin (2006) indicated that the farm size was a major factor for the profitability of dairy cattle farms in Van Province, Turkey being negative with -1.93 % for small-scale farms (farms with 1-5 dairy cattle) and positive with 5.92 % for large-scale farms (farms with more than 10 dairy cattle). The reported differences between economical profitability of small-scale farms with < 10 tonnes milk production (-7.2 %) and large-scale farms with >40 tonnes milk production (24.7 %) were dramatic in Kırklareli Province, Turkey (Yıldırım et al., 2008). More research conducted on dairy cattle farms demonstrated that the farm size was a major component that contribute to dairy cattle farms' profitability in positive way (Hanrahan et al., 2018; Maqbool et al., 2017; Krpalkova et al., 2016; Wolf, 2012; Hadley et al., 2002; Erkuş et al., 1996; Saner, 1993). However, there existed research findings showing the small-scale farms had higher profitability compared to larger ones. Kumar et al. (2014), who made a survey of dairy cattle farms in districts of the Haryana State viz. Hisar and Karnal, India, indicated that net profit of milk production of a cross-bred cow per day was the highest on small herd size group (Rs. 19.49) followed by medium (C. 18.62) and large size group (C. 18.01).

3. Material and Method

The research material constituted of 50 dairy cattle producers associated with İkizler Agricultural Development Cooperative located at Gevaş District of Van Province, Turkey. The data of 2009 were collected through a questionnaire conducted face to face with the producers. Although all 50 members of Cooperative were targeted to include in the interviews, 37 producers were accessible during the questionnaire periods. Taking into consideration the percentage distribution of dairy cattle numbers, the farms were classified into two groups, namely, the farms with 1-4 dairy cattle head (small scale farms) and the

farms with 5 and more dairy cattle head (Large scale farms). Accordingly, 24 farms (64.86 %) and 13 farms (31.14 %) constituted of the first and the second groups, respectively.

The data were controlled for extreme values using outlier tests before the analysis were made. In comparison of the major physical variables of scale-groups statistically, t test was applied. The functional relationship of milk quantity per farm and the major inputs used in the study was determined by means of Coob-Douglas Production Function, which gives the production elasticities of inputs directly.

4. Results and Discussion

The average population per farm was 7.89 person. The farm managers' average age, experience and education periods were 43.65, 12.76 and 5.19 years, respectively. The average family labour potential was 1.344 man-days, which nearly two third of it (69.05 %) is not used.

The small-scale farms (farms with 1-4 dairy cattle) and large-scale farms (farms with more than 5 dairy cattle) had 3 and 7.15 dairy cattle, respectively. Daily milk yield per cow of large scale farms (13.15 kg) was nearly one-fifth (19.76 %) more than that of small-scale farms (10.98 kg). The lactation period was also longer slightly for large-scale farms (240 days) compared to that of small-scale farms with 236.26 days. This contributed to milk yield per cow per lactation of large-scale farms positively. Thus, the average milk yield per cow per lactation of large-scale farms (3156 kg) was 21.47 % higher than that of small-scale farms (2598 kg). Milk production per farm was more than three times higher for large-scale farms (22565 kg) compared to that of small-scale farms (7794 kg) given high cow numbers, high milk yield and slightly higher lactation period (Table 1).

The small-scale and large-scale farms differed statistically in terms of average means of cow number ($p=0.000$), daily milk per farm ($p=0.000$), daily milk per cow per lactation ($p=0.003$) and daily milk per cow ($p=0.004$). The lactation period of small-scale and large scale farms ($p=0.622$) were not significant statistically. Milk yield per cow in different parts of Turkey was reported as 7.63, 15.1, 18.73 and 27.45 kg in Van Province (Yıldırım and Şahin, 2006), in Kırklareli Province (Yıldırım et al., 2008), in Hatay Province (Semerci and Çelik, 2015), and in Konya Province (Oğuz and Yener, 2017), respectively. The reported milk production per cow per lactation period in Thrace region of Turkey was 5.8 tonnes (Keskin

and Dellal, 2011). It seems the milk yield per cow shows differences in various dairy cattle farms due to the factors effective on the milk yield.

The daily labour demand per cow was 1.02 hours and decreased in proportion to farm size. The small-scale farms needed more than twice labour (1.41 hours) compared to the large-scale farms (0.71 hour). Feeding labour constituted 34.36 % of total labour followed by labour allocated for milking and watering with 31.05 and 16.96 %, respectively. The difference between the average means of labor demand per cow for small-scale and large-scale farms was significant statistically (p=0.000).

Straw and dry weed (clover) and silage constituted of the main roughages. Milk meal, bran, wheat and barley break were the major concentrated feeds. Out of total daily feed intake per cow (19.93 kg), 62.06 % was made up from roughage (Table 1). Dry weed and straw constituted of 40.21 and 38.64 % of the roughage, respectively. On the other hand, the major components of the concentrated feeds were milk meal and bran with 40.21 and 29.10 %, respectively. In terms of average means of daily forage feed intake per cow (p=0.168) and daily concentrated feed intake per cow (p=0.182), the scale-groups didn't differ statistically.

Table 1: Some physical aggregates related to output and inputs

	Small-Scale Farms	Large-Scale Farms	Total
Cow number ***	3.00	7.15	4.46
Daily milk yield per cow (kg)***	10.98	13.15	11.74
Lactation period (Day)	236.26	240	237.6
Milk yield per cow per lactation (kg)***	2598	3156	2789
Milk production per farm (kg) ***	7794	22565	12440
Daily labour demand per cow (h) ***	1.41	0.71	1.02
Daily feed intake per cow (kg)	20.88	19.23	19.93
Daily forage feed intake per cow (kg)	13.93	11.17	12.37
Daily concentrates feed intake per cow (kg)	6.95	8.06	7.56

*** P<0.01

Operating assets made up 63.80 % of total assets ($30.566) while remaining was building assets (36.20 %). The greater part of operating capital was animal capital ($13.967). Animal capital made up 72.62 and 45.69 % of operating and total assets, respectively. Out of total assets 65.84 and 34.16 % consisted of self-capital (equity) and debt, respectively.

Variable costs per farm made up 62.56 % of total production costs ($12.209). Family labour cost was the biggest single costs item in fixed costs with 59.95 %. Feed costs consisted of 91.74 and 57.93 % of variable costs and production costs, respectively. The production costs, variable costs and feed costs per cow was $2738, $1713 and $1571, respectively and

decreased in proportion to farm size. Unit milk production costs (1 kg milk production) was $ 0.58 and decreased in line with farm size being $ 0.73 for small-scale and $ 0.50 TL for large scale farms (Table 2).

The reported feed costs in total production costs for dairy cattle farms of different parts of Turkey were 52.99 % in Van province (Yıldırım and Şahin, 2006); 47.31 % in Ankara province (Sapdeniz, 1993); and 42.17 % in Kırklareli province (Yıldırım et al., 2008). The feed cost constituted 84.33 and 83.24% of the variable costs in Konya Province (Oğuz and Yener, 2018) and Thrace regions of Turkey (Keskin and Dellal, 2011), respectively. Feed costs in production costs were reported as 55.4 % in Tunisia (Darej et al., 2017), 53 % in Minnesota, Wisconsin, Iowa, and South Dakota, U.S, Evink and Endres (2017), 73 % in 13 Pennsylvania counties, U.S (Heinrichs et al., 2013) and 63 to 68 % in the districts of the Haryana State viz. Hisar and Karnal, India (Kumar et al., 2014).

Gross production value per farm was $10.857 and increased according to farm size. More than half it (57.68 %) consisted of milk production values. The share of marketing part of milk production was 90.47%. Gross profit per farm and per cow were $3.219 and $722, respectively and increased in parallel with the farm size. Gross profit per farm of large-scale farms ($1.016) was more than twice of that of small-scale farms ($ 473). Economical profitability rate in terms of gross profit was 10.53 and increased in line with farm size. This ratio was 5.95 for small-scale farms and 16.91 % for large-scale farms. It seems clearly that economical profitability of of large-scale farms is nearly three times higher compared to that of small-scale farms. Net profit per farm and per cow was negative with $ -1352 and $ - 303 for small-scale farms, respectively and increased in proportion to farm size being positive with $52.9 and $7.4 for large-scale farms, respectively. Economical profitability rate in terms of net profit were –0.04 and increased according to farm size. This rate was -0.07 % for small-scale farms and 0.01 % for large-scale farms (Table 2). The reported profitability rates in differents parts of Turkey were 3.27 % in Van Province (Yıldırım and Şahin, 2006), 6.3 % in Kırklereli Province (Yıldırım et al., 2008), 2.04 % in Konya Province, (Oğuz and Yener, 2017), and 7.62 % in Hatay Province (Semerci and Çelik, 2015).

Table 2: Production costs and profits per farm and per cow

	Small-Scale Farms	Large-Scale Farms	Total
Gross Production Value Per Farm ($)	6800	19115	10857
Production Costs per Farm ($)	8562	19063	12210
Production Costs per Cow ($)	2854	2666	2737

Variable Costs per Farm	5382	11.850	7639
Fixed Costs per Farm	3180	7213	4571
Feed Costs per Cow ($)	1615	1545	1571
Costs of 1 Kg Milk ($)	0.73	0.50	0.58
Gross Profit per Farm ($)	1418	7265	3218
Gross Profit per Cow ($)	473	1016	722
Net Profit per Farm ($)	-1762	53	-1353
Net Profit per Cow ($)	-587	7.4	-303
Economical Profitability rate in terms of gross profit (%)	5.95	16.91	10.53
Economical Profitability rate in terms of net profit (%)	-0.07	0.01	-0.04

Cobb-Douglas production function was as follows;

$$Y = -2.30\, X_1^{0.576}\, X_2^{-0.304}\, X_3^{0.194}\, X_4^{0.237}\, X_5^{0.170}\, X_6^{0.071}$$

Where,

Y= Milk Quantity (kg): Milk quantity per farm per lactation period.

X_1= Number of Dairy Cattle (Head)

X_2= Lactation Period (Days)

X_3= Concentrated Feeds (kg): Concentrated feed intake of all dairy cattle per production period

X_4= Roughage Feeds (kg): Roughage feed intake of all dairy cattle per production period

X_5= Barn Capacity (m^2): Available capacity of existing stables

X_6= Labour Demand (Hours): Total labour in terms of man-days used in dairy cattle enterprises per production period.

Determination coefficient (R^2) was 0.940, which means 94 % of variances in milk quantity (production) is explained by inputs used in the model. The production elasticities of X_1 (number of dairy cattle), X_3 (concentrated feed intake), X_4 (roughage feed intake) were statistically significant at 5 % probability level ($P<0.05$). The total production elasticity of inputs (Σbi) was 0.945, which means decreasing return to scale. In case of increasing the inputs one fold, milk quantity is expected to increase by 94.5 %. On the other hand, milk quantity is expected to increase by 57.6, 19.4, 23.7, 17.0 and 0.71 %, respectively in cases of increasing one fold the inputs of X_1 (number of dairy cattle), X_3 (concentrated feed intake), X_4 (roughage feed intake), X_5 (barn capacity) and X_6 (labour demand) individually, while the other inputs being unchanged. Coob-Douglos production function applied for dairy cattle farm in Konya Province, Turkey showed that milk production could be increased by 23.4% in cases of rising the concentrate feed by 1% (Oguz and Canan, 2016).

5. Conclusions

The profitability of large-scale farms (16.91 %) was nearly three times higher than that of small-scale farms (5.95 %). Higher milk yield per cow per lactation (3.156 kg against 2.598 kg), lower labour demand per cow (0.71 hours against 1.41 hours) and higher building assests into total assests (27.46 % against 44.72 %) seem to be the major factors, which shows the size really matters. However, milk and feed price volatility is not under control of farms. We suggest more detailed researches towards determining the optimal herd size of dairy cattle farms for each region with different phycial and economical conditions for sustainable profitability of the farms.

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