Assessment of profitability of subsistence dairy cattle farms from size perspective: a case study in Eastern part of Turkey

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Abstract

The major purpose of the study was to determine the profitability rates in comparison for small-scale, medium-scale and large-scale subsistence dairy farms in Eastern part of Turkey (Van Province). The data collected from 66 dairy farm managers through questionnaires belong to 2009 production year. Daily milk yield per cow was 9.88, 7.71 and 9.06 kg, for small, medium and large-scale farms, respectively. Feed costs per farm was the single major item and accounted for 85.37, 86.62 and 83.56 % of total variable costs for small-scale, medium-scale and large-scale farms, respectively. Profitability rates decreased in proportion to farm size being 8.78 % for small-scale farms against 3.28 % for large-scale farms. The total production elasticity of inputs (Σbi) was 1.82, which means increasing return to scale.

Keywords: Dairy cattle farms. Profitability. Farm size. Turkey

1. Introduction

Providing a steady income for rural families and employing a great part of family labour contribute a lot to subsistence dairy farms in Eastern part of Turkey. Furthermore, dairy sector socially and economically benefits the economy in terms of mitigating the migration to urban areas and earning foreign exchange.

Economic pressures, technological innovations, demographic shifts, consumer expectations, and an evolving regulatory framework have contributed to the impetus for changes in the global dairy industry (Barkema et al., 2015). Given the continuous changes in

productions costs, milk yield and prices, the behavioural attitude of producers regarding new production methods, and business management; regionally conducted researches are required for certain time intervals.

For the sufficiency of milk production and a balanced nutrition of population dairy farming need to be sustainable (Yıldırım and Şahin, 2006). Profitability play key role to this end (Costa et al., 2013; Chamberlain, 2012).

There exist a lot of factors effective on the profitability of dairy farms, revealed by researchers, namely, breed, and length of productive life (Saleh et al., 2016; Kinambuga et al., 2012; Horn et al., 2012), feed costs and efficiency (Gjeci and Bicoku, 2017; Hennings, 2016; Michaličková et al., 2014; Hietala et al., 2014; Spurlock and VandeHaar, 2013; Riddler, 2008); pasture (Hanrahan et al., 2018; Rojas-Downing et al., 2017; Browne et al., 2013; Costa et al., 2013; Sanderson et al., 2006), milk yield (Ferrazze et al., 2020; Syrůček et.al., 2019; József et al., 2017; Popescu, 2009; Çiçek and Tandoğan, 2008); inputs and milk prices (Syrůček et al., 2019; Barkema et al., 2015; Popescu, 2014; Mehmood et al., 2015; Michaličková et al., 2014, Browne et al., 2013, Çiçek and Tandoğan, 2008); farm size (Luby et al., 2020; Hansen et al., 2019; Hanrahan et al., 2018; Maqbool et al., 2017; Krpalkova et al., 2016; Yıldırım et al., 2008); government and international institutions supports (Semerci and Çelik, 2017; Hietala et al., 2014; Frelich et al., 2011), wellfare (Molina et al., 2019); business management (Septiani et al., 2017; Moran and Brouwer, 2013), cooperation and organization (Svensson et al., 2018; Oğuz and Yener, 2017); technological advances (Hansen et.al., 2019; Saleh et al., 2016; Khanal and Gillespie, 2013 ; Bijl et al., 2007).

In Turkey, the quantity of dairy cattle milk production rose from 12.4 million tons in 2010 to 20.8 million tons in 2019 (TurkStat, 2021), which means yearly average annual increase in milk quantity between 2010-2019 periods was realized as 807 thousand tons. The milk yield per dairy cattle was nearly the same in the last decade (2010-2019 period) both for culture-breed and crossbreed dairy cattle being 3879 and 2721 kg in 2010, respectively and 3861 and 2722 kg in 2019, respectively. Thus, no productivity increase was recorded in this period. The average milk yield per cow in Turkey was 12.9 kg and 9.1 kg for culture-breed and cross-breed dairy cattle, respectively, given 300 day lactation period in the last decade (2010-2019 period) (TurkStat, 2021).

The major hypothesis of the study was that the larger-scale farms would have higher profitability rates given resource efficiency and advantages of scale-economics. However, this validity of this hypothesis is restricted to that all the farms investigated are subsistence-types taking into consideration the small numbers of dairy cattle per farm.

2. Literature Review

Many researches on the profitability of dairy cattle farms including the subsistence ones are available. Each of them has a great value given the research conducted regionally at certain time interval and for different circumstances. Some of the findings are as follows:

Ferrezza et al. (2020) who investigated 61 dairy cattle farms in Brazil, reported that milk production per lactating per cow and area were the indexes most positively correlated with profitability. In contrast, total unit cost in relation to the price of milk, total operating cost in relation to total revenues, and total unit operating cost in relation to the price of milk were the indexes most negatively correlated with profitability. Overall, these results indicate that profits could significantly increase if dairy farm production is conducted with more intensive use of inputs and production factors and better combinations of inputs and outputs. (Molina et al., 2019) who, had a research on 20 representative dairy cattle in Southern Spain, reported that feeding assessment showed relatively low variability among farms, whereas housing and health assessments exhibited high variability. Hanrahan et al. (2018) who analyzed ten years of database based on pasture systems (2008-2015), summarized the major factors effective on the profitability as pasture use, grazing season length, farm size, and capital investment per cow. (Kiefer et al., 2014), who investigated 81 organic and conventional pasture-based dairy farms in Southern Germany reported that in improving the profitability of the farms, low feed demand per kilogram of milk, high grassland yield and low forage area requirement per cow were the essential components to be considered. A research on 110 dairy cattle farms in district of Sargodha, Pakistan indicated that while milk prices had positive relationship with farm profitability, the major costs items such as feed and labor costs affected the profitability negatively. The concluded remark of the study was that cost effective management together with improved livestock breed could enhance the profitability of the farms (Mehmood et al., 2015). A research conducted for Michigan, U.S dairy farms revealed that the major two single components, which could potentially affect the profitability, were volatility in milk and feed prices as well as risk management tools (Wolf, 2012).

Altıntaş and Akçay (2010) suggested cross-breeding and culture- breeding for dairy cattle farms in Tokat Province, Turkey against domestic dairy cattle breeding in terms of economically feasibility. Inefficiency of business management and the lack of investment

capital were cited as two prominent components in profitability of 125 dairy cattle farms in Konya Province, Turkey (Oğuz and Yener, 2018).

A research on 33 commercial dairy herds in the Czech Republic revealed that despite having serious fertility problems, the farms with highest milk yield achieved the highest net profit (Krpalkova et al., 2014). Popescu (2014) reported that the prominent component in profitability rate was milk yield per cow for 5 small dairy farms in Southern Romania. Milk yield per cow and economic efficiency were cited as the major components for the profitability of Romanian dairy cattle farms (Pirvutoiu and Popescu, 2012).

The profitability is reported to be influenced by farm size. (Krpalkova, et al., 2016), who investigated 60 commercial dairy farms in Czech Republic cited the farms size as the single major component for higher milk per cow and the overall efficiency. The profitability rate of dairy cattle farms in Eastern part of Turkey (Van Province) was reported as – 1.93 % for small-scale farms (farms with 1-5 dairy cattle) and 5.92 % for large-scale farms (farms with more than 10 dairy cattle) (Yıldırım and Şahin, 2006). Size was also mattered in Western Part of Turkey (Kırklareli Province) the profitability being -7.2 % for small-scale farms with less than 10 ton milk production per lactation) against 24.7 % for large-scale farms with more than 40 ton milk production (Yıldırım et al., 2008). Kumar et al. (2014) indicated that in Haryana States of Hisar and Karnal, India, net profit of small-scale dairy cattle farms was higher than that of large-scale farms.

3. Material and Method

The main material of the study consisted of 282 dairy cattle farms in the villages of Alaköy, Atmaca, Göllü, Kasımoğlu, Mollakasım and Otluca, where dairy cattle farming is intensely carried out in the Central District of Van Province, Turkey. The data was collected through questionnaires with the dairy cattle farm managers between March 10 and April 17, 2009 year.

The following stratified random sampling formula was applied to determine the optimum sample size given 10 % error margin and 90 % confidence interval (Erkuş et al., 1996).

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

Where;

n = Sample size

N = Total number of dairy cattle farms

N_h = The number of farms in the h_{th} strata

S^{2h} = Variance in the h_{th} strata

$D^2 = d^2 / Z^2$ value

d = The error allowed from the population average

Z = Z Value in the standard normal distribution table

The optimum sample size was determined as 66 farms. These farms were classified into three groups given the percentage distribution of dairy cattle numbers. Thus, the farms with 1-3 dairy cattle number constituted the small-scale farms (25 farm), while the farms with 4-9 dairy cattle and with 10 and more dairy cattle number constituted the medium-scale (24 farm) and the large-scale farms (17 farm).

Before the data analysis, outlier test was applied for extreme values that could deteriorate the results. The production elasticity of inputs was determined using Coob-Douglas Production Function. Thus, milk quantity increase was estimated in case the input used rose by one-fold.

4. Results and Discussion

The average population per farm was 6.20 people. The age of managers, their experience in dairy farms and education levels were 48.5, 25.9, and 5.4 years, respectively. The average family labour potential was 1,165 man-days; however, a great part of it (43.32 %) was not used at all.

The small, medium and largescale farms had 2.46, 5.29 and 15.75 dairy cattle, respectively. Daily milk yield per cow was 9.88, 7.71 and 9.06 kg, for small, medium and large-scale farms, respectively. These figures are compatible to the average milk yield per cow of cross-breed (9.1 kg) in Turkey for the last decade (2010-2019 periods) (TurkStat, 2021).

The lactation period was 248.5, 257.5 and 239.3 days, for small, medium and large-scale farms, respectively. The average milk yield per cow per lactation was 2455, 1985 and 2168 kg, for small, medium and large-scale farms, respectively. Milk production per farm was 6038 10502 and 34158 kg, respectively for small, medium and large-scale farms. The yield per farm of large-scale farms was 5.65 and 3.25 times of those small-scale and medium-scale farms, respectively.

Overall, it seems that medium-scale farms had relatively lower productivity while the large-scale farms had relatively higher productivity in regard of daily milk per cow and milk yield per cow per lactation period. Thus, from our hypothesis point of view that the large-scale farms would have higher productivity, the medium-scale farms failed. However, observing the productivity numbers carefully (Table 1), it is understood that there exist no significant differences among the groups in terms of absolute means. Generally, daily milk yield per cow in all groups was less than 10 kg, which is very low considered the average culture and cross-breed daily dairy cattle milk nowadays. However, these productivity should not come as surprise taking into consideration that average daily milk per culture-breed and cross-breed dairy cattle in Turkey was only 12.9 and 9.1 kg in Turkey, respectively, for the last decade (2010-2019 period) (TurkStat, 2021).

Depending on various factors, which affect the productivity directly including cow breed, lactation period, feed efficiency and business management, daily milk yield per cow varied in different parts and for various dairy farms in Turkey. The research findings reported regarding daily milk per cow was 7.63 kg in Eastern part of Turkey (Van Province) (Yıldırım and Şahin, 2006); 15 kg in Western part of Turkey (Kırklareli Province) (Yıldırım et al., 2008); 13 kg and 27.45 kg in Central Anatolia Region (Kayseri and Konya Provinces, respectively) (Şahin, 2001; Oğuz and Yener, 2018); and 18.73 kg in Mediterranean Region (Hatay Province) (Semerci et al., 2015).

The daily labour demand per cow was 1.83, 1.58 and 0.92 hours for small-scale, medium-scale and large-scale farms, respectively and decreased in proportion to farm size. The daily labour demand per cow needed in the small-scale farms (1.83 h) was nearly two-fold to that of large-scale farms (0.92 h.). From labour productivity point of view, it seems that the size really matters, which is compatible to our hypothesis.

Straw and dry weed (clover) and silage constituted of the main roughages intakes. Milk meal, bran, wheat and barley break were the major concentrated feed intakes. Out of total daily feed intake per cow (12.08 kg), 77.69 % was made up from roughage while the remaining 22.31 % being concentrated feeds (Table 1). Straw constituted 68.02 % of the roughage while the bran was the major component of concentrated feed with 72.39 %. From Table 1, it is understood that in terms of both daily forage and concentrated feed intake per cow there is no significant differences.

Table 1: Major Productivity Indicators

	Small-Scale Farms (1-3 Head)	Medium-Scale Farms (4-9 Head)	Large-scale Farms (10+Head)	Total
Cow number	2.46	5.29	15.75	6.71
Daily milk yield per cow (kg)	9.88	7.71	9.06	8.89
Lactation period (Day)	248.5	257.5	239.3	249.6
Milk yield per cow per lactation (kg)	2,46	1,99	2,17	2,22
Milk production per farm (kg)	6,04	10,50	34,16	14,89
Daily labour demand per cow (h)	1.83	1.58	0.92	1.24
Daily feed intake per cow (kg)	12.31	11.13	13.10	12.08
Daily forage feed intake per cow (kg)	9.74	8.64	9.91	9.38
Daily concentrates feed intake per cow (kg)	2.57	2.49	3.20	2.69

Production costs per farm were the lowest with $ 6.981 for the small-scale farms and the highest with $ 36.304 for the large-scale farms. Variable costs per farm in the production costs constituted of 45.37, 45.66 and 59.19 %, for small-scale, medium-scale and large-scale farms, respectively. Feed costs per farm was the single major item and accounted for 85.37, 86.62 and 83.56 % of total variable costs for small-scale, medium-scale and large-scale farms, respectively. Feed costs per farm in the total production costs were also high with 0.39, 0.40 and 0.49 % for the small-scale, medium-scale and large-scale farms (Table 2).

Feed costs per cow were the lowest for the medium-scale farm with $ 985 and the highest with $ 1,134 for the large-scale farms. From the feed cost per cow point of view, the medium-scale farms was relatively efficient compared to the large-scale farms (1,134 $) and small-scale farms (1,098 $). (Table 2).

Family labour costs was predominant single item in the fixed costs with 85.37, 86.62 and 83.56 % for the small-scale, medium-scale and large-scale farms. It seem all scale groups employed family labour in great extent instead of hired labour and the other fixed items was less than one-fifth of total fixed costs.

The costs 1 kg milk was the highest for the medium-scale farms with $1.04 and the lowest for the large-scale farms with $ 0.87. In regard of costs of 1 kg milk, large-scale farms were consistent with our hypothesis that scales matter.

The reported feed costs in total production costs for dairy cattle farms of different parts of Turkey were 52.99 % in Eastern part of Turkey (Van Province) (Yıldırım and Şahin,

2006); 42.17 % in Western part of Turkey (Kırklareli Province) (Yıldırım et al., 2008); 46.52 % and 47.82 % in Aegean Region (Aydın and Afyonkarahisar Provinces) (Nizam and Armağan, 2006; Çiçek and Tandoğan, 2008) and 48.30 % in Central Anatolia Region (Konya Province) (Bayramoğlu ve Direk, 2006).

Feed costs in production costs were reported as 55.4 % in Tunisia (Darej et al., 2017), 53.0 % in Minnesota, Wisconsin, Iowa, and South Dakota, U.S, (Evink and Endres, 2017), 73.0 % in 13 Pennsylvania counties, U.S (Heinrichs et al., 2013) and 63.0 to 68.0 % in the districts of the Haryana State viz. Hisar and Karnal, India (Kumar et al., 2014).

The feed cost in total variable costs were 84.33 % in Central Anatolia Region (Konya Province) (Oğuz and Yener, 2017); 86, 80 % in Thrace Region (Keskin and Dellal, 2011); 58,45 % in Aegean Region of Turkey (Afyonkarahisar Province) (Günlü et al., 2001) .

Gross production value per farm was $ 4,262, $ 7,557 and $ 23,790, respectively for small-scale, medium-scale and large-scale farms, respectively. The average amount of gross production value of large-scale farms was 3.15 times and 5.58 times in comparison to that of medium-scale and large-scale farms (Table 2). Milk and milk products value accounted for nearly three third in total gross production value being 72.84, 70.49 and 72.75 % for small-scale, medium-scale and large-scale farms, respectively.

Gross profit per farm increased in parallel with the farm size being the lowest with $ 1,095 for small-scale farms and the highest with $ 2,408 for large-scale farms. The average gross profit per farm of small-scale farms was 2.2 times and one times that of large-scale and medium-scale farms, respectively.

Gross profit per cow decreased in line with farm size being the highest with $ 445 for the small-scale farms and the lowest with $ 153 for the large-scale farms. Gross profit per cow of small-scale farms, which is a critical indicator of success, was 2.90 and 1.53 times higher in comparison with that of large-scale and medium-scale farms. This situation contradicts our hypothesis that the large-scale farms would have higher profitability.

Profitability rates in terms of gross profit was 8.78, 6.77 and 3.28 % for the small-scale, medium-scale and large-scale farms, respectively. Profitability rates of large-scale farms were less than half (48.4 %) that of medium-scale and nearly one-third (% 37.4) of large-scale farms. This clearly shows that in investigated subsistence farms economics of scale could not be exploited in a desired level.

The reported economical profitability rates in different parts of Turkey were 5.95 % in Eastern part of Turkey (Van Province) (Gençdal et al., 2019); 6.3 % in Western part of Turkey (Kırklareli Province) (Yıldırım et al., 2008); 6.90 % in Central Anatolia Region

(Konya Province) (Oğuz and Yener, 2018); 7.62 % in Mediterranean Region (Hatay Province) (Semerci et al., 2015); 19.73 % in Black sea Region (Samsun Province) (Gözener and Mollaoğlu, 2021), 21.17 and 13.94 % in Aegean Region (Aydın and Afyonkarahisar Provinces) (Türkyılmaz and Aral, 2002; Günlü et al., 2001).

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

	Small-Scale Farms (1-3 Head)	Medium-Scale Farms (4-9 Head)	Large-scale Farms (10+Head)	Total
Production Costs per Farm ($)	6,981	13,190	36,123	16,303
Production Costs per Cow ($)	2,838	2,493	2,294	2,430
Variable Costs per Farm	3167	6022	21382	8621
Variable Costs per Cow ($)	1287	1138	1358	1285
Fixed Costs per Farm ($)	3,814	7,168	14,741	7,682
Fixed Costs per Cow ($)	1,550	1,355	936	1,145
Feed Costs per Farm ($)	2,701	5,211	17,861	7,287
Feed Costs per Cow ($)	1,098	985	1,134	1,086
Costs of 1 Kg Milk ($)	0,96	1,04	0,87	0,90
Gross Production Value Per Farm ($)	4,262	7,557	23,790	10,140
Gross Profit per Farm ($)	1,095	1,535	2,408	1,519
Gross Profit per Cow ($)	445	290	153	226
Profitability rate (%)	8.78	6.77	3.28	4.91

Cobb-Douglas production function was as follows:

$$Y = 0.286\, X_1^{0.662}\, X_2^{0.802}\, X_3^{0.237}\, X_4^{0.082}\, X_5^{0.037}$$

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

Determination coefficient (R^2) was 0.901, which means 90.1 % of variances in milk quantity are explained by inputs used in the model. The production elasticity of X_1 (number of dairy cattle), X_2 (lactation period), X_3 (concentrated feed intake) were statistically significant at 5 % probability level ($P<0.05$).

The total production elasticity of inputs (Σbi) was 1.82, which means increasing return to scale. In case of increasing the inputs one fold, milk quantity is expected to increase by 1.82 times. On the other hand, milk quantity is expected to increase by 66.2, 80.2, 23,7, 8,2, and 3.7 %, respectively in cases of increasing one fold the inputs of X_1 (number of dairy cattle), X_2 (lactation period), X_3 (concentrated feed intake) X_4 (roughage feed intake) and X_5 (labour demand) individually, while the other inputs being unchanged. It was determined that milk production would be increase 23.4% if the concentrate feed was increased by 1% (Oğuz and Canan, 2016).

5. Conclusions

It is well known that the scale of economics matter in profitability of the farms. However, the subsistence dairy farms are generally not large enough to exploit the scale of economics. In our case, the small-scale farm had higher profitability rates against large-scale farms thanks to higher daily milk yield per cow and lower forage and concentrated feed intake per cow resulting in higher gross profit per cow. These findings clearly show that researches should be done and repeated regionally to suggest optimum size scale of the farms at certain time intervals.

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