FINANCIAL VIABILITY OF COMMERCIAL DAIRY FARMS ESTABLISHED UNDER THE THIRD PHASE OF THE DAIRY-CATTLE IMPORTATION PROJECT IN SRI LANKA

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Abstract

The financial viability of dairy farms, established under the third phase of the Dairy-Cattle Importation Project in Sri Lanka, is assessed in this study. The data were obtained from a primary survey. The results of the Stochastic Frontier Approach revealed that the mean technical efficiency of farms was 44.9%. The average milk production of these farms was found to be lower than the expected production and the average cost of production of milk was higher than the average farm-gate price. Even though the financial performance of medium-scale farms was marginally better than the small-scale and large-scale farms, the difference was not statistically significant. The study indicates the need and the potential to improve the production efficiency of dairy farms established under the Dairy Cattle Importation Project to make them financially viable.

Keywords: *Cost of Production, Technical Efficiency, Stochastic Frontier Model, Dairy Cattle Development Project, Sri Lanka*

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INTRODUCTION

The local dairy sector produced 424 million litres of milk in 2019, which only fulfilled 40% of Sri Lanka's demand for milk (DAPH, 2019). The country imported 98,838 metric tonnes of milk powder in 2019 to fill the demand-supply gap of milk (DAPH, 2019). Non-improved breeds, poor management, shortage of nutritious feed, and inadequate assistance from supporting agencies were cited as reasons for the stagnant growth of the industry (Perera & Jayasuriya, 2008).

To facilitate the entrance of medium and large-scale farms into the industry and thereby increase milk production, the Dairy Cattle Importation Project was initiated in 2012. During the first stage of the project, the project planned to import 4,500 high-yielding heifers from Australia, of which 500 and 1,500 dairy cows were imported in 2012 (March) and 2013 (January) respectively. These heifers were located at Menikpalama, Bopaththalawa, and Dayagama farms, while the other 2,500 pregnant heifers were located at the Ridiyagama farm of the National Livestock Development Board (NLDB). With the implementation of this project, the total daily milk production of the NLDB farms increased from 28,000 litres to 47,000 litres per day (Ministry of Finance, 2016). With the success of this first batch, a multinational company was contracted to import 20,000 heifers to Sri Lanka between 2012 and 2019 at different times (Ministry of Rural Economy, 2018; Hettiarachchi and Deane, 2019). At the second stage, 2,495 dairy cows were imported in 2015 and distributed to the NLDB Ridiyagama farm, situated in Hambantota. Under the third phase of this project, 2,000 dairy cows were imported from New Zealand and 3,000 from Australia in May 2017 and they were distributed to 68 selected investors.

The imported dairy cattle were Holstein Friesian and Jersey crossbred pregnant heifers. To provide a conducive environment for high producing imported cattle breeds, highly specific modern management, and feeding practices along with well-trained personnel to care for them were needed. Consequently, cattle sheds were developed and strengthened with new infrastructure such as misters, milking parlours, chilling tanks, cattle crushers, and Total Mix Ration (TMR) mixing wagons at a very high cost.

However, despite these large investments, as commercial intensively managed privately owned dairy farms are not common to small-scale dairy farmers in Sri Lanka, many farmers faced different problems concerning planning and management at the outset of the farm establishment. Some problems highlighted by the farmers included high costs for animals and infrastructure, absence of proper technical support to the farmers, lower milk production than expected milk yield (Perera & Perera, 2020), high feeding costs, the incidence of high abortion rates, high mortality rate, deadly diseases contracted by animals during transportation to Sri Lanka such as Bovine Viral Diarrohea (BVD), Mycoplasma, Salmonella Dublin and Heifer Mastitis (Hettiarachchi & Deane, 2019a).

Though some serious problems were reported, no scientific study has been undertaken to date to evaluate the performance of these farms. Against this background, this study was undertaken with three main objectives, viz, (i) estimate and analyse the cost of production (COP) of milk, (ii) assess technical efficiency of farms, (iii) compare COP and the technical efficiency across farms operating under different scales of operation. In this study, the production scale was defined based on the average herd size. The grouping was based on the distribution of farms in the sample.

The contribution of the paper to the existing literature is that it will be the first to examine the economic performance of farms established under the Dairy Cattle Importation Project. Evaluation of the economic performance of these farms is imperative for better decision-making on investments in the dairy sector. Furthermore, even though the technical efficiency of milk production is studied extensively in both developed and developing countries (Demircan et al, 2010; Chang, & Mishra, 2011; Gaspar et al, 2009; Špička, & Smutka, 2014; Mareth, 2019; Kimenchu, 2014; Jiang & Sharp, 2015), there is a dearth of research on technical efficiency of dairy farms in Sri Lanka. Thus, this study fills this research gap.

DATA AND METHODOLOGY

The data required for the analysis was obtained from a primary survey. The survey was carried out between February 2018 to February 2019. The data were gathered from farmers in all the farms established under the dairy-cattle importation project, except a few farmers who declined to respond, using a structured questionnaire. Altogether, 40 farms were included in the analysis. The survey collected data on demographic information of the farmer; details on the establishment, information related to farm characteristics, management practices, credit plan, workforce, disposal of waste, cost components of the farm, price of milk, and the constraints faced by the farmers.

Calculation of COP of milk

The Cost of Production (COP) of a litre of milk included fixed costs (depreciation cost of animal sheds and other physical infrastructure, farm equipment, vehicles) [1], loan repayment cost, insurance cost, the cost of permanent labours) and variable costs (cost of roughages (green and dry fodder), concentrates, medical expenses, temporary labour charges, transport, cost of breeding, electricity, water, and other miscellaneous expenses).

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[1] The depreciation of fixed assets (D) was calculated using Linear Depreciation Method. In estimating the depreciation cost, it was assumed that the productive life of a cow was 7 years (Jayaweera et al., 2007) and that the estimated value of a cow after 7 years was LKR 200,000.00. For the cattle sheds, it was assumed that they would last for 20 years, as these structures appeared to be constructed well. Furthermore, the productive life of machinery and vehicles was taken as 10 years (Dean, 2015). The salvage values for machinery and vehicles were considered as 10% and 50% lower than their purchased prices respectively.

In estimating the cost of production per litre of milk in a given farm, the calculated cost at the farm level was divided by the total milk production on the farm. When monthly or annual cost of items was available, they were converted to daily cost.

Technical Efficiency of Milk Production

Technical efficiency refers to the concept of the extent to which firms are using their input to produce output more efficiently. Battese and Coelli, 1992 defined it as the ratio of a firm's mean production to the corresponding mean production if the firm utilized its levels of inputs more efficiently. Several studies have assessed the technical efficiency of dairy farms both in developed and developing countries (Demircan et al, 2010; Chang, & Mishra, 2011; Gaspar et al, 2009; Špička, & Smutka, 2014; Mareth et al, 2019; Kimenchu, 2014; Jiang & Sharp, 2015). These studies revealed a large variation of the level of technical efficiency of milk production in farms in different geographical regions. As revealed in these studies, there is a large variation in TE across farms (Haghiri, et al, 2004; Demircan et al, 2010; Gaspar et al, 2009; Jiang & Sharp, 2015; Mareth et al, 2019; Serasinghe et al, 2003). The difference of TE across farms was attributed to breeds reared on the farm, feeding and management practices, herd size, institutional factors, management of animal welfare in the farm and the capacity of the farmer. Furthermore, studies revealed that integrated farms are technically efficient than mono-dairy farms (Barnes, 2006; Serasinghe et al, 2003; Barnes et al, 2011; Mor & Sharma, 2012).

Previous research has employed either a non-parametric method such as Data Envelopment Analysis (DEA) (Barnes, et al, 2011; Barnes, 2006; Fraser & Cordina,1999; Johansson, 2005) or parametric Stochastic Frontier Analysis (SFA) to estimate the technical efficiency (Bravo-Ureta & Rieger, 1991; Mor & Sharma, 2012; Bardhan & Sharma, 2013).

This study also used the stochastic frontier production function to estimate the technical efficiency in milk production. The general form of the stochastic model is given below;

$$y_i = f(x_{ik})\exp(v_i - u_i) \quad \text{………………………………………………} \quad (1)$$

When $y_i$is the output of the i[th] farm, x_{ik} reflect the level of k[th] input for the production process in i[th] farm. v_i is the random variable representing statistical noise and $u_i$is the non-negative random variable, which represents the technical efficiency in the farm.

Technical efficiency (TE) which is the ratio between the observed output (y_i) to the frontier output (y_t^*) relevant to the number of inputs used by the farm can be expressed as;

$$TE = \frac{y_i}{y_i^*} = f(x_{ik})exp\,(v_i - u_i)/f(x_{ik})exp\,(v_i) \quad \text{…………………………} \quad (2)$$

The value of 1 for the TE indicates the most efficient farms, whereas the value of zero indicates the least efficient farm as compared to frontier farms.

Empirical Estimation of the Model

The following Cobb-Douglas function (3) was fitted for the Stochastic Frontier Production function.

$$y = Ax_1^{\beta 1} \ldots x_n^{\beta n} \quad \ldots\ldots (3)$$

$$lny_i = ln\beta_0 + \beta_1 lnx_{1i} + \beta_2 lnx_{2i} + \beta_3 \ln x_{3i} + v_i - u_i \quad \ldots\ldots (4)$$

Where the subscript i refer to the ith farm. y_i represents the daily production of milk on the ith farm. x_{1i} refers to the daily feed cost in the ith farm. x_{2i} refers to the total labour cost in the ith farm per day in LKR. x_{3i} is the herd size of the ith farm. v_i is the random error that is assumed to be normally distributed. u_i is assumed to be an identically distributed non-negative truncated error term. β parameters are the regression parameters to be estimated.

Since there is no significant variation in the type of animals reared on the farm, in almost all farms, European cross breeds were reared, and the input-output relationship in the study has been investigated at the farm level, not at the individual animal level, the study did not include breeds of the animals in the model.

The Effect of Herd Size on Economic Performance of Dairy Farms

Once the economic performance of farms was assessed, outliers were identified using the Numeric Outlier technique and they were removed from the dataset for further analysis. Farms in the sample were clustered into three groups based on the production scale (herd size) viz, small-scale: herd size is less than 30, medium scale: herd size is between 30-75, and large-scale: herd size greater than 75. Comparison of COP and the technical efficiency of farms that belong to different scales of operation were carried out using the Kruskal Wallis test to understand the effect of herd size on the performance of the farms.

RESULTS AND DISCUSSION

Profile of the Farms

Forty per cent of the farms in the study were in Nuwara-Eliya and Matale districts whereas eighteen per cent of farms in Kurunegala District. The rest of the farms were in Kandy, Badulla and Vavuniya. All farms are managed by males. The average herd size of a farm was 90 animals. Herd size and the number of milking animals were different from farm to farm. However, the smallest herd size was ten as the private investors were allowed to purchase a minimum number of ten animals. There was no upper ceiling for the number of animals to be purchased and thus, some farms had more than 400 animals.

The average number of milking cows was 71 with a standard deviation of 11. All farms were managed intensively with a loose barn housing system. Most of the farms had infrastructure facilities developed such as properly constructed cattle sheds, storage facilities, and use modern machinery and equipment such as milking parlours, feed mixing wagons, grass choppers, milk chilling tanks, etc. 82.5% of the farms have milking machines and 10% of the farms had mist fans. However, only 35% and 36% of the farms had their forage cultivations and silage pits respectively. On average, there was an establishment cost of LKR 683,664.00 per animal; a farm with a minimum herd size of 10 animals had spent LKR 617,200.00 per animal, while a farm with a maximum herd size of 420 animals had spent LKR 603,571.00 per animal for establishment including all fixed assets inclusive of animals.

All these farms had similar feed management practices where cattle were mainly fed with a mixed ration and purchased fodder or supplied from roadsides since pastures were not available on the farm. Only 14.28 % of farms fed animals with recommended amounts of concentrates, and only 51.42 % of farms supplied adequate amounts of roughages based on recommendations on the body weight. Water was made available ad libitum. Manure was disposed to open cow dung pits constructed with cement. Machine milking was practised with portable milking machines.

Milk Production

Among the surveyed farms, the milk yield ranged between 4.27 L to 25.86 L per day per animal, while the average milk production per animal was 10.25 L/ day, which was significantly lower than the expected milk yield (20-25 L/cow/day). The milk yield in some farms was even lower than the average milk production of similar temperate crossbred animals that were reared in large-scale and medium-scale farms in up-country under intensive and semi-intensive management systems (DAPH, 2009). Therefore, it is possible to postulate that though there is genetic potential for higher milk production, due to poor management especially feeding management together with the environmental factors have led these farms to yield a low average milk production. About half of the animals (48%) in the sampled farms were underfed, with only 73% of the roughage requirement being fed to these animals. According to the observations, most of the farms fed animals with one-cob harvested maize and poor-quality roadside grasses. Only a few farms used recommended roughages such as maize and fodder sorghum harvested at the correct stage. The digestibility and energy content of these high fibrous materials, such as matured 'Guinea grass' (*Panicum maximum*) is relatively low and such poor-quality feedstuff can lead to the production of a high level of energy loss as heat energy during the digestion process (Houwers et al, 2015) which ultimately affects the milk production.

About 86% of the animals were not fed with the recommended amount of concentrates (10kg/animal/day) as a cost reduction measure. Apart from the recommended formulated cattle feed, many farmers fed these animals with locally available feedstuffs such as Poonac, Rice Bran, Dahl, and Beer Pulp. Therefore, despite the high amount of money spent on-farm infrastructure, these farms could not obtain the expected milk yields as predicted at the beginning of their investments due to inadequate nutritious feeds.

Cost of Production of Milk

The average Cost of Production (COP) per litre of milk was LKR 144.78. However, there was a large variation in COP and only around one-third of the farms had produced one litre of milk at a cost of less than LKR 100.00.

Compared to the recently published cost of production figures of DAPH and previous studies, this was a very high value. In 2019, the national average COP of milk in upcountry and mid-country was LKR 51.11 under intensive management systems (DAPH, 2019). According to Jayaweera et al. (2007), the cost of production is LKR 25.50 in Rathnapura District. A recent figure produced by Hitihamu et al, (2021), indicates that the average cost of production of litre of milk was LKR 59.63 excluding fixed costs in six milk production districts.

Breakdown of the Total Cost of Production of Milk

The average variable cost was 67% of the total cost of production. The share of the fixed cost is the remaining 33%. The breakdown of the total cost is given in Figure 1.

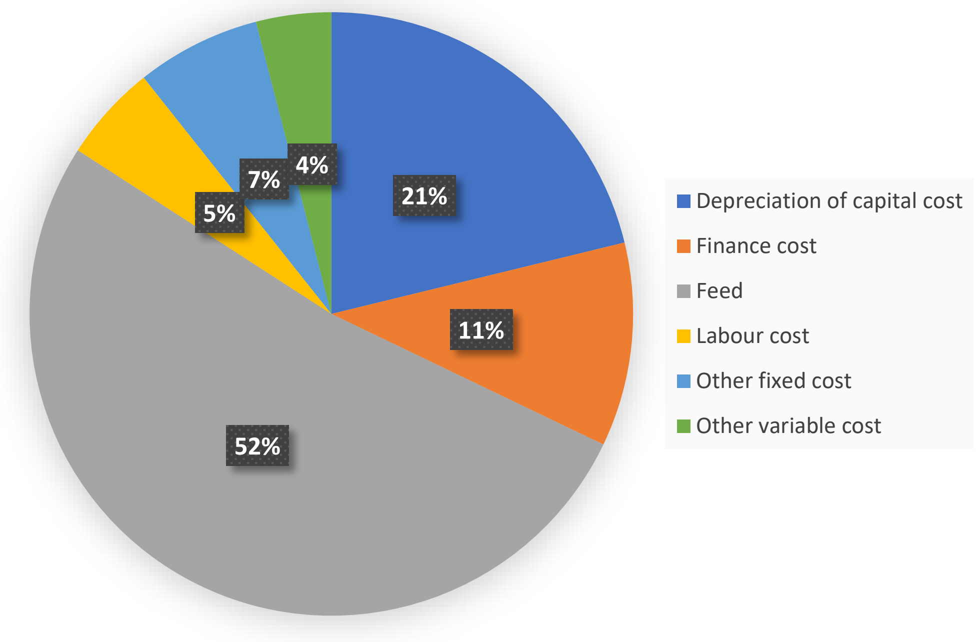


Figure 1: Share of individual cost components as a percentage of the total Cost of Production of milk

The highest cost component in these farms was the feed cost (52%), followed by the depreciation of fixed assets (21%) (Figure 1). Acharya & Malhotra (2020) also have witnessed that feed cost is higher than labour cost in large-scale farms. Even though feed cost was the largest cost component of farms, The feed cost as a percentage of the total cost was lower in these farms and it was even less than the world average (Alqaisi et al., 2011). Feed cost is considered as high when the feed cost as a ratio exceeds 70% of the total cost. The higher absolute value of feed cost (LKR 83.88), but a lower share in the total cost may indicate a proportionately higher cost for other less critical inputs. Such inputs could be fixed inputs on the farm.

Comparison of share of cost with the available literature on other farmers revealed that in other farms, the highest cost component of dairy farms is labour cost (Jayaweera et al, 2007; Hitihamu et al, 2021). In Sri Lanka, the greater majority of dairy farmers which are managed under extensive and semi-intensive systems still depend on grassland or roadside grasses for a significant proportion of their roughages need, and hence there is little or no payment for roughage in these farms. This could be one of the reasons for lower COP in other farms. However, large-scale farms which are managed under an intensive management system could not depend only on freely available roadside grasses. To increase the milk production of temperate breeds reared in large-scale farms, animals need to be fed with high-quality feed and this would lead to an increase in feed cost. Ultimately this leads to a reduction in the financial viability of farms. Similarly, Samaraweera et al (2022) also found that even though genetic improvement of cows in large-scale farms improves annual fat and protein yields, due to the higher feed cost of these farms, gains from genetic improvement become financially unattractive.

The share of labour cost in the total COP was 5% and it represented the labour cost, including permanent, temporary, and family labour. In these farms, most of the temporary labour was used to cut naturally grown pastures. Therefore, a proportion of this cost also indirectly reflected the cost of feeding animals. Compared to other farms in the country, this figure is a lower value. The use of machinery might be the reason for the low labour cost of these farms.

Out of the total variable cost, as shown in Table 1, the largest share was spent on feed cost. More specifically, 73% of the variable cost had been spent on feed. On average, the feed cost was LKR 83.88 /L of milk. Of this, 42 % was spent on roughages, while 57 % was spent on concentrates. This high feed cost was not unexpected as these improved breeds need more nutritious feed than local breeds due to their large body size. However, considering the low milk yield in some farms, it is obvious that even though farmers spent a huge cost on feed, they were unable to get a reasonable return due to the poor quality of roughages which mainly contributes to the milk fat percentage that directly determines the price of milk.

Table 1: Variable cost component of milk production

Item	**Feed**	**Temporary labour**	**Transport cost**	**Medicine**	**Mineral**	**Other**
Percentage to total variable cost	73.2	6.7	6.9	4.6	2.3	6.2

Source: Authors' estimations

Out of the total fixed cost, as shown in Table 2, the depreciation cost of animals accounted for 38%, the depreciation cost of machinery accounted for 23%, and loan payment accounted for 31%. This higher share of loan payment was a salient feature for these farms. In comparison to the other contexts (DAPH, 2009), the fixed cost of these farms was considerably high. The share of the fixed cost was found to be less than 5% in farms in Rathnapura Districts as revealed by Jayaweera et al, 2007.

Farms established under the project had constructed milking parlours and purchased vehicles, grass choppers, grass cutters, etc. Moreover, since the European cross-bred animals underperform at high ambient temperatures, to avoid possible heat stresses, some farms practiced misting of animals. Although it is a good approach to reduce the heat stress, it has increased the cost of production as the misting system was an expensive investment and there was a high operational cost (water and electricity). Even though, it is important to mechanize and provide an ambient environment for animals, unless care is taken to invest in the inputs which directly affect milk production, the investment on fixed cost would be an additional burden to farms. More specifically, it will undoubtfully reduce the financial viability of the farm.

Table 2: Fixed cost per unit milk production

Fixed Cost component	Depreciation		Labour	Loan payments	Insurance	Other
	Animals	Depreciation of other capital assets				
Percentage of cost per litre of milk	37.7	23.3	1.2	31.44	5.7	0.6

Source: Authors' estimations

Results of the Stochastic Production Frontier and Technical Efficiency in Farms

Basic summary statistics of the variables used in the estimation of the frontier production function is shown in Table 3. The average milk production of the farm was 665 litres per day. The average feed cost of the farm is LKR 45,455.31 litres per day while the feed cost is LKR 15,049.48 per day.

Table 3: Summary statistics of the variables used for the analysis

Variable	Mean	Standard deviatic	Minimum	Maximum
Milk production (L/day)	661.51	89.73	40	1,850
Feed cost (Rs/day)	45,455.31	8,941.98	0	210,200
Labour cost (Rs/day)	15,049.48	4,209.95	1,200	129,667
Herd size	90	15	8	420

Source: Authors' estimations

The parameter estimates of the stochastic production function are given in Table 4. After the estimation of the Stochastic Frontier Production function, the LR test was performed. The null hypothesis of the LR test of no technical inefficiency is rejected at 10% significance level (the estimated value of the mixed chi-square distribution is 1.691).

Table 4: Maximum likelihood estimates of the frontier production function

Variable	Coefficient	Standard Error
Feed cost (LKR/day)	0.425**	0.211
Labour cost (LKR/day)	-0.373***	0.114
Herd size	0.688**	0.270
Constant	3.196*	1.646
Technical efficiency		0.449

Note: Wald $chi^2(4) = 90.94$, Prob > $chi^2 = 0.0000$,
*, **, ***: Significant at 10%, 5% and 1% respectively

Source: Authors' estimation

According to the results indicated, a 1% increase in the daily feed cost and herd would increase the daily milk production by 0.42% and 0.68% at a 5% significant level, while a 1% increase in labour cost would decrease the daily milk production by 0.37%. Given the size of the coefficients of the parameters, it is obvious that both feed and herd size have a significant positive effect on the milk yield. The negative coefficient of the labour cost may suggest the use of excessive labour and the low levels of labour productivity.

The average technical efficiency of farms was 0.449 (Table 5), while the minimum and maximum values are 0.130 and 0.999 respectively. The average technical efficiency of these farms was very closer to the average TE value of farms studied in two previous studies in Sri Lanka (Serasinghe et al., 2003 and Thiwyadharsan et al., 2013).

Table 5: The Descriptive Statistics of Technical Efficiency Scores of Farms

Description	Technical efficiency
Average	0.449
Minimum	0.130
Maximum	0.999
Standard deviation	0.244

Source: Authors' estimation

The mean technical efficiency score of farms, 0.449 indicates substantial inefficiencies that prevailed in these farms. There is a greater potential to increase milk production of the farm without increasing inputs by improving the efficiency of inputs. Table 6 shows the distribution of technical efficiency of 33 farms. Around two-thirds of the farms operate within the technical efficiency (TE) level of 20%-49%.

Only one-third of the farms exhibit TE levels of over 50%. The lowest TE levels between 10-20% are shown by 6% of the farms while 9% of the farms show the highest TE levels of over 90%.

Table 6: Distribution of the farm level measures of technical efficiency

Technical efficiency	Number of farms	Percentage (%) of total farms
10%-19%	2	6.1
20%-29%	7	21.2
30%-39%	7	21.2
40%-49%	7	21.2
50%-59%	2	6.1
60%-69%	2	6.1
70%-79%	2	6.1
80%-89%	1	3.0
90%-99%	3	9.1
Total	33	100.0

Source: Authors' estimation

The effect of herd size on performance

To understand the effect of herd size on the farm performance, the value for each performance parameter of each group categorised based on the herd size was compared against the average values of other groups. To select an appropriate statistical technique for the comparison, the Shapiro-Wilk W test was performed to find out whether the data were normally distributed. As indicated by the P-values of the Shapiro-Wilk W test, none of the variables was normally distributed (Table 7). Therefore, for performance comparison between groups, the Kruskal Wallis test was used.

Table 7: Normality test result

Variable	W-value	p-value
Milk yield per animal	3.192	0.00770
COP	3.846	0.00246
Fixed cost per litre of milk	3.991	0.00193
Variable cost per litre of milk	3.526	0.00426
Technical efficiency	0.890	0.00306

Source: Authors' estimation

The average milk production per animal recorded for each farm group, as shown in Table 8, indicates that there was a difference in milk production among farms with different herd sizes, but a higher number of animals was not necessarily giving the highest milk production. Medium-Scale farms recorded the highest average milk yield (12.78 L) compared to small-scale and large-scale farms (Table 8). The difference was statistically significant at a 10% significance level. A posthoc test results revealed that the difference was significant only between medium and large-scale farms (p=0.092).

Table 8: The effect of Herd Size on Milk Production, Cost of production, Fixed cost, variable cost per litre of milk and technical efficiency

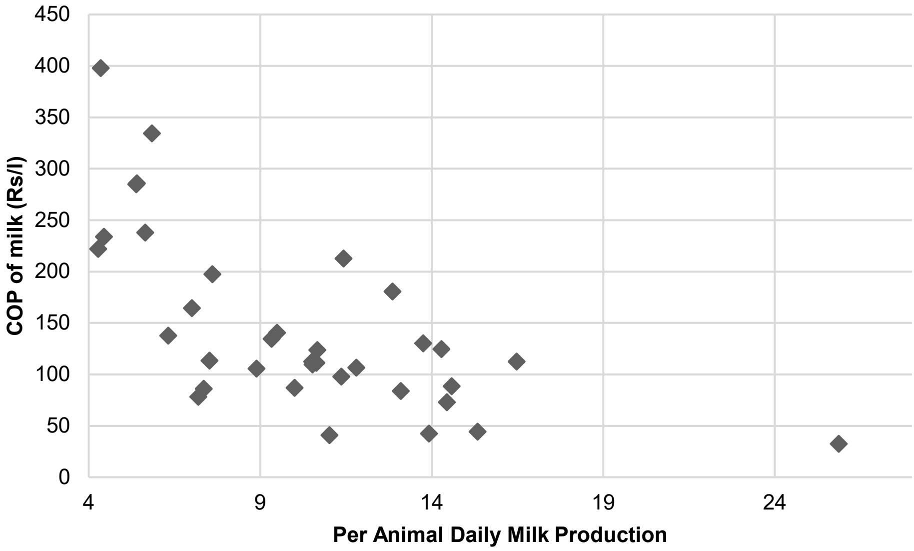
Parameters	Small-Scale	Medium-Scale	Large-Scale	Kruskal Wallis test statistics
Milk yield (L/d/animal)	9.5 ± 3.37	12.78 ± 5.15	8.74 ± 3.78	4.764 (0.092)
COP per litre of milk (LKR/L)	133.95±72.14	120.09± 85.65	171.91±92.79	4.386 (0.112)
Fixed cost per litre of milk (LKR/L)	46.73±29.79	35.15±19.75	57.93±31.98	3.358 (0.187)
Variable cost per litre of milk (LKR/L)	87.21±49.58	84.94±69.39	113.98±81.16	2.285 (0.319)
The level of technical efficiency (%)	44%	48%	44%	0.804 (0.668)

Source: Authors' estimation

The average COP per litre of milk ranged from LKR 120.09 to LKR 171.91 between the three types of farms. Although the COP was a little lesser in medium-scale farms, this difference was not statistically significant (p = 0.112). The same difference was observed for the fixed and variable cost of producing one litre of milk. This again indicated that milk production had not proportionately increased with the farm size to spread the fixed cost over a large volume of production.

However, as shown in Figure 2, the cost of production of milk decreases with the milk yield. The fact that the average cost of production of milk is lower in high productive farms and these farms are not necessarily large-scale farms again indicates that productivity of farms has not proportionately increased with the herd size.

Figure 2: COP per litre of milk against the average daily milk production recorded in the studied farm cohort.



The level of technical efficiency is also higher in medium-scale farms as compared to small-scale and large-scale farms. However, the difference was statistically insignificant. The literature on the effect of farm size on technical efficiency is inconsistent. While many have found a relationship between farm size and efficiency, some argued that the relationship between farm size and technical efficiency is positive, large farms are more technically efficient than small-scale farms (Kumbhakar, et al, 1999; Latruffe, et al, 2004; Johansson, 2005). However, few have counterargued this through empirical findings (Bardhan & Sharma, 2013). Our study indicates that there is no relationship between herd size and technical efficiency.

CONCLUSIONS AND POLICY RECOMMENDATION

The study was carried out with three main objectives, viz: estimating the cost of production of milk, assessing the level of technical efficiency of milk production, and examining the effect of herd size on the performance of farms, established under the Third Phase of the Dairy Cattle Importation project.

The cost of production of one litre of milk was calculated taking both variable and fixed costs while the technical efficiency of farms was assessed using the Stochastic Frontier Approach. The results revealed the average cost of production of milk was LKR 144.78 per litre of milk and it was below the average farm-gate price. The highest cost component was feed cost followed by depreciation cost. This suggests that farms established under the project are financially non-viable in the short run.

The level of technical efficiency of farms was 0.449 with a standard deviation of 0.224. This suggests inefficient usage of farm resources and the potential to increase milk production in these farms. As the Kruskal Wallis test revealed, increasing the scale of operation would not reduce the COP or improve the efficiency of resource usage automatically. To improve the financial viability of these farms, financially rewarding changes need to be undertaken. Switching to high-quality but low-cost roughage feeding materials, increasing the efficiency of resources in the farm, and reducing the stock of fixed inputs in the farm to a minimum level needed for the optimum operations are some of the strategies available.

Given the importance and the potential of the project to increase milk production in the country, it is suggested to monitor the performance of these farms regularly and make recommendations to improve the performance.

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