

# Factors affecting sustainable dairy production: A case study from Uva Province of Sri Lanka

D Wijethilaka<sup>1</sup>, S De Silva<sup>2</sup>, R M C Deshapriya<sup>3</sup> and L H P Gunaratne<sup>4</sup>

<sup>1</sup> Postgraduate Institute of Agriculture, University of Peradeniya, Galaha Road, Peradeniya, 20400, Sri Lanka.

<sup>2</sup> Faculty of Economics, Saga University, Honjo 1, Saga-City, Saga-Prefecture, 840-8502 Japan.

<sup>3</sup> Dept. of Animal Science, Faculty of Agriculture, University of Peradeniya, Galaha Road, Peradeniya, 20400, Sri Lanka

<sup>4</sup> Dept. of Agricultural Economics & Business Management, University of Peradeniya, Galaha Road, Peradeniya, 20400, Sri Lanka.

E-mail: [dedunuwije@gmail.com](mailto:dedunuwije@gmail.com)

**Abstract.** Dairy farming has been playing a key role by improving household incomes and food security for rural communities in Sri Lanka. Nevertheless, it has failed to meet the expected self-sufficiency. In 2015, Sri Lanka imported 51 percent of the national milk requirement spending US\$ 251 million from its debt-ridden economy. This paper aims to analyse socio-economic characteristics of dairy farmers and factors affecting dairy production efficiency in the Uva Province of Sri Lanka, a highly potential area comprising all the dairy value chain actors. Surveyed was conducted to farmers, key informants from input suppliers, collectors, transporters, processors, sellers and support service providers. Result revealed that intensive farmer's milk yields per cow was only 7.97 L/day, which was 35% and 60% higher than the yields of semi-intensive and extensive farmers respectively. The highest profit of Rs. 53.30 per litre was earned by extensive farmers, whereas it was Rs. 47.63 for semi-intensive and Rs. 44.76 for intensive farmers respectively if family labour cost was not taken into the account. The Technical Efficiency Analysis revealed that 37.1% and 20% milk production of intensive farmers and semi-intensive is being loss due to inefficiency and could be increased without any additional inputs. The main factors affecting efficiency in milk production included farmers' socio-economic characteristics and farm characteristics. Based on the results it can be concluded that sustainability dairy production depends on farmer training, collectivizing farmers into farmer societies, culling unproductive male animals, increasing the availability and access to AI/ other breeding programs and low-cost quality concentrate feed and other supplements, and, thus appropriate measures should be taken to provide these conditions if Sri Lanka aims to achieve self-sufficiency in milk production.

## 1. Introduction

Over the years dairy production has been playing a key role by providing livelihoods for rural communities and supplying nutrition to Sri Lankan consumers. Even though dairy farming has been playing a key role by improving household incomes and food security for rural communities it has failed



to meet the expected self-sufficiency. In 2015, Sri Lanka imported 51 per cent of the national milk requirement spending US\$ 251 million from its debt-ridden economy.

Moreover, Sri Lanka has a great potential to increase its milk production, while securing substantial income for rural milk producers. As stated in the report of Department of Census and Statistics in Sri Lanka, in 2015 the national cattle population was about 1.4 million while buffalo population was about 0.5 million with an estimated 540,100 milking cows and 147,190 milking buffaloes. In this background the study focused on determining factors affecting dairy production efficiency in the Uva Province, one of the nine provinces in Sri Lanka, in order to understand the prevailing causes for current situation in dairy sector and to formulate strategies and recommendations for the future development in the dairy sector

## 2. Methodology

For the purpose of this research the Uva province consisting two districts viz. Badulla and Monaragala was selected purposively considering the relative importance of this province. The two districts presently contribute about 14percent to the total milk production and holds 7.3percent of the cattle populations in Sri Lanka. This province can potentially be developed as successful cases of dairy sector in Sri Lanka as it encompasses all the value chain actors including a large scale commercial dairy plant with a processing capacity of 200,000 litres of milk per day, and many other small and medium dairy processors, collectors, and transporters.

The data for the study were gathered from three forms: 1). field questionnaire survey, 2) key informant interviews and focus group discussions and 3) review of the published and unpublished documents. For the field survey, data were collected primarily through interviews using a semi-structured questionnaire. A total of 300 questionnaires were filled and three questionnaires had to be discarded due to incomplete and non-reliable data. Interviews were conducted with three large milk collectors and one large scale milk processor and one medium scale processor. The field survey was conducted during the period of October 2014 to May 2015.

A total sample of 297 farmers, key informants from input suppliers, collectors, transporters, processors, sellers and support service providers were surveyed, while both quantitative and qualitative analyses were used to draw conclusions. The sample comprised of 278 (93.6%) small scale (up to 10 animals), and 19 (6.4 %) medium to large scale (range from 11 to 60 animals) farmers. Of them, 69 (23.23%), 216 (72.72%) and 12 (4.04%) were intensive, semi-intensive and extensive farmers. Majority of the farmers were men (69.4%), having a mean age of 47 years (range from 21 to 78 years) and with low education standards as most of them (60.9%) have completed only primary level. Most of the farmers (91.24%) owned European crossbred animals, while the herd comprised of 13 percent heifers, 40 percent lactating cows and 11 percent dry cows.

### 2.1 Technical efficiency

Stochastic frontier approach is widely used in agricultural economics studies [1] because of its ability to estimate technical efficiency while accounting for technical inefficiency factors

Stochastic frontier function is expressed as;

$$\begin{aligned} \gamma_i &= f(x_i\beta) + \varepsilon_i \\ \varepsilon_i &= v_i - u_i \quad I = 1,2,3 \dots N \end{aligned} \quad (1)$$

Where,  $\gamma_i$  is production of the  $i^{th}$  farm,  $x_i$  is vector of inputs of production of the  $i^{th}$  farm,  $\beta$  is a vector of unknown parameter to be estimated.  $\varepsilon_i$  is the composed error term consist two independent error terms  $u$  and  $v$ .  $v_i$  is independently and identically distributed random errors of  $i^{th}$  producer for all possible random variation in output due to factors outside farmer's control such as weather, animal diseases, and price increases and  $u_i$  is a non-negative error term denoting inefficiency of the  $i^{th}$  producer [2]. Technical efficiency is estimated using inferential statistical approach. Frontier 4.1 is used to estimate stochastic frontier and technical inefficiency simultaneously.

The explicit Cobb-Douglas stochastic frontier production function is defined in logarithmic form as follows,

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + V_i - U_i \quad (2)$$

Where;

$Y$  = milk production in each farm (litres)

$X_1$  = total number of milking cows (nos)

$X_2$  = average monthly cost for concentrates (Rs)

$X_3$  = average monthly cost for supplements (Rs)

$X_4$  = family labour hours

The model for the technical inefficiency effects in the stochastic frontier of equation (2) is defined as

$$U_i = \delta_0 + \delta_1 + \delta_2 + \delta_3 + \delta_4 + \delta_5 + \delta_6 + \delta_7 + \delta_8 + W_i \quad (3)$$

Where,  $\delta_1$  = District,  $\delta_2$  = Gender,  $\delta_3$  = Age,  $\delta_4$  = Education,  $\delta_5$  = Member of farmer organization,  $\delta_6$  = Main income dairy farming,  $\delta_7$  = Main income other than dairy farming,  $\delta_8$  = Availability of European cows

Farmer's monthly income, expenditure and profit are analysed to determine the financial status of the farmers. Total income of each farm is calculated based on their income components from dairy activities as well as other sources. However, in this study income from the sale of animals is not taken into consideration as it is repugnant to religious norms [3, 4] and farmer's profit is calculated by excluding family labour as well as exclusive of opportunity cost of family labour.

### 3. Results and Discussion

#### 3.1. General Characteristics of the Farmers

Out of the total sample of 297 farmers 278 were small-scale farmers (93.6%) and the rest consists of 19 medium/large scale farmers (6.4%). About 70 per cent of the milk producers were men and out of the large scale farmers, the majority of the farmers (84.2%) were men. Age of respondent was range from 21 years to 78 years with mean age of  $47.26 \pm 0.61$  years. The large scale farmers were significantly younger than the small scale farmers and this indicates that expansion of scale of the herd will pose difficulty when farmers are getting old. Only three farmers of the sample were illiterate and others have received some school education. However 61.3percent of the farmer's education was limited to primary level of education. It is noteworthy that the majority of small scale farmers have only primary education, while medium and large scale farmers' education were significantly better ( $\chi^2=12.036$ ,  $P=0.002$ ).

The 297 farmer households in the sample have 1,729 heads of cattle and on the average there were five animals per small scale farms and 21 animals per medium/ large scale farms. Only about 7 per cent of the farmers had more than 10 cattle. There are three types of dairy management systems exist in the area namely; 1) intensive (zero-grazing), 2) semi-intensive (semi-grazing) and 3) extensive (open range grazing). Intensive management system uses zero grazing that is characterized by cut and fed in a shed, farm practices of keeping high yielding cows (usually European crosses) and they are fed with concentrated feed. Extensive management system put to use the open range for free grazing by cattle, often without supplementary feeds. Semi-intensive falls somewhere in the middle and involves a combination of above two approaches

The cattle breeds found in the area belong to crosses of European breeds, Indian breeds and local. European breeds were mainly Jersey crosses or Frisian crosses (74.94 %) and local breed were only 6.9 per cent.

#### 3.2. Milk Producer's Income, Expenditure and Profit

There are different sources of income, obtained from both in farm and off-farm and family members often engaged themselves in more than one occupation. Total farmer expenditure includes expenses associated with farm level activities such as feed expenses, breeding and animal health expenses and cost for labour inclusive of family labour. In calculating opportunity cost for family labour, it is found to be the highest cost in all the three farming systems. Other studies also revealed results similar to results from calculating family labour. Even so, in reality farmers do not spend any money on family

labour. Dairy farmers extensively use family labour for farming activities and do not use family labour in any other productive manner.

As several studies have shown, if family labour is excluded, the highest cost is incurred on the concentrate and supplement feeds [5, 6]. Current study also found that the highest variable cost in the dairy farm is incurred on purchase of concentrates and supplement feeds, if family labour is not taken into the account. Naturally, it is the highest expenditure incurred in intensive farming system and the lowest in extensive farming system. The results show that intensive system farmers spent five times more on concentrate feeds than on extensive system. As stated in Ranawana [7] farmers are compelled to use expensive concentrates and this could make dairy farming uneconomical. According to him this is deemed as the main drawback regarding increasing milk production in the country [7].

Profit margin per litre of milk is the lowest for intensive farmers without considering family labour, while extensive farmers are getting the highest profit per litre (table 1). Besides, excluding family labour, intensive farmers are still the lowest and extensive farmer's profit margin is 1.19 higher than that of the intensive farmers ( $P=0.045$ ). Including family labour, the profit margin per litre on extensive farming it is 4.6 times higher than that of intensive farming.

Whilst, family labour is excluded; all three farming systems became viable and having reasonable profit margins. Therefore region has potential to increase milk productivity and efficiency to be profitable industry for the farmers if address inefficiencies properly.

**Table 1.** Monthly profit of dairy farmers in selected area of Uva province.

	Description	Intensive System	Semi Intensive System	Extensive System
Profit per month (Rs.) (Milk income –milk expenditure)	Without labour cost	17,993.00	16,938.00	21,522.00
	With labour cost	2,722.00	3,759.00	10,756.35
Profit per litre of milk (Rs.)	Without labour cost	44.76	47.63	53.30
	With labour cost	8.16	22.77	37.12
Dairy income–total expenditure (Rs./month)	Without labour cost	-1,231.00	346.00	7,035.00
	With labour cost	-16,502.00	-12,833.00	-3,731.00
Total income– total expenditure (Rs./month)	Without labour cost	7643.00	8,982.00	12,343
	With labour cost	-7628.00	-4,197.00	1,577.00

### 3.3. Technical Efficiency

Technical efficiency model was estimated only for the intensive and semi-intensive management systems farmers and didn't estimate for the extensive system farmers due to less number of farmers in the sample. Based on the estimated results, it is revealed that that technical inefficiencies do exists in intensive and semi-intensive management systems in Uva province (table 2 and table 3). The mean technical efficiency of intensive farmers is estimated as 62.9 per cent and this implies indirectly that 37.1 per cent of milk production is being lost due to inefficiency. Similarly 20 per cent of productions are being lost in semi-intensive systems due to inefficiency of production techniques.

Estimation of TE suggests that milking cows are significance for intensive and semi-intensive management systems at 1 per cent significant level with the values of 0.621 and 0.668 respectively. Concentrate feed cost and supplement cost are also significant for intensive and semi intensive farmers at 1 per cent significance and having positive relationship with milk production. Although concentrate feed and supplement feeds are important, their contributions towards to increase of milk production remain considerably at a low level.

However, these findings were found to be in line with the results of a study Masuku *et al.* [8] in their study on economic efficiency of smallholder dairy farmers in Swaziland and Wubeneh and Ehui [9] in their study on technical efficiency of smallholder dairy farmers in the central Ethiopian Highlands. These studies have revealed that concentrate feed, chemicals, herd size and labour cost significantly affect the economic efficiency of dairy farmers.

**Table 2.** Model estimate for intensive farmers

Variable		Coefficient	Standard error	t-ratio
Input Variable	Constant	4.9279	0.6745	7.3056***
	Milking cows	0.6211	0.0298	17.5108***
Inefficiency Variables	Feed cost	0.0378	0.0086	4.3915***
	Supplement cost	0.0455	0.0036	12.5518***
	Other costs	-0.0098	0.0145	-0.6816
	Labour hours	0.2197	0.1293	1.6985*
	Constant	1.5749	0.8742	1.8014
	District	-0.0597	0.3089	-0.1931
	Gender	-0.1746	0.1591	-1.0972
	Age	-0.0104	0.0078	-1.3299
	Education	-0.1149	0.1339	-0.8582
	Membership milk society	-0.0273	0.1025	-2.6609***
	Main income dairy	-0.1628	0.1842	-1.8358*
	Main income other	0.3504	0.1757	1.9943**
	Availability of European cows	-0.9823	0.4115	-2.3878**

$\gamma = \sigma_u^2 / \sigma^2 : 0.8228$ ;

MT Efficiency : 0.8054;

Sum of regression coefficients: 0.9425

(\*\*\*), (\*\*), (\*) denote levels of significance at one, five and ten per cent respectively

**Table 3.** Model estimate for semi-intensive farmers

Variable		Coefficient	Standard error	t-ratio
Input Variable	Constant	4.7120	0.5282	8.9215***
	Milking cows	0.6684	0.0566	8.2731***
Inefficiency Variables	Feed cost	0.02979	0.0107	2.7716***
	Supplement cost	0.0208	0.0107	1.9469**
	Other costs	0.0044	0.0097	0.4508
	Labour hours	0.2191	0.0722	3.0350***
	Constant	-1.4343	1.9698	-0.7282
	District	-0.0403	0.1763	-0.2286
	Gender	-0.2928	0.3509	-0.8345
	Age	0.0092	0.0087	1.0579
	Education	-0.1565	0.1154	-1.3561
	Membership milk society	-0.0951	0.1997	-0.4763
	Main income dairy	-0.3511	0.3077	-1.1408
	Main income other	0.3617	0.4429	0.8166
	Availability of European cows	-0.4311	0.3496	-1.6632**

$\gamma = \sigma_u^2 / \sigma^2 : 0.6267$

MT Efficiency : 0.8054

Sum of regression coefficients: 0.9425

(\*\*\*), (\*\*), (\*) denote levels of significance at one, five and ten per cent respectively

While considering inefficiency variables membership of milk society, availability of European cows and dairy farming as main source of income are significant determinants of efficiency in milk production for the intensive farmers and the only significant variable for the semi- intensive farmers is availability of European cows at five per cent significant level.

The main income being dairy, it is positively significant and increases efficiency by 0.163 for intensive farmers while the main income other than dairy will reduce the efficiency of milk production by 0.350 for intensive farmers. Availability of European cows increase efficiency for all management systems and for intensive farmers it is 0.982 and it is 0.431 for semi-extensive farmers respectively (table 3).

#### 4. Conclusion

The paper elaborated present situation of the dairy farming sector in the Uva Province of Sri Lanka, measurement of productive efficiency at farm level, and profitability of milk production in order to address opportunities to increase milk production.

It was revealed that higher proportions of lactating cows, expenses on concentrates and supplements and spending more labour hours in farm activities increase the efficiencies while availability of European crossbred animals, higher education levels, male farmers, full-time dairy farming and being a member of farming society decrease occurrence of the inefficiencies. Although milk yield per cow and the income per cow are relatively high for the intensive farmers, profit margins are lower for the intensive farmers, particularly due to high cost for concentrate feeds. Profit was the highest for the extensive farmers due to low cost for concentrate feeds, low labour, feeding of different forage types and handling a comparatively large number of animals. Although extensive farming is profitable there exist limitations for expansion of the extensive farming due to land scarcity, current applicable laws prohibiting straying of animals and usage of public places for free grazing, high probability of spread diseases etc.

Moreover, the region has the potential to increase milk productivity and efficiency to be profitable to farmer in the industry if farmer address inefficiencies properly and if the responsible authorities in livestock sector properly address findings by proper identification the UVA province would be an ideal model to be followed in other provinces of the country to achieve the goal of self-sufficiency in milk production.

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