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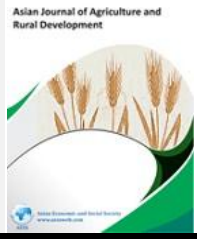

Comparison of Technical Efficiency and Socio-economic Status in Animal-crop Mixed Farming Systems in Dry Lowland Sri Lanka

Upul Yasantha Nanayakkara Vithanage
Postgraduate Institute of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka
Lokugam H. P. Gunaratne
Professor; Department of Agricultural Economics and Business Management, Faculty of Agriculture, University of Peradeniya, Sri Lanka
Kumara Mahipala M. B. P.
Senior Lecturer; Department of Animal Science, Faculty of Agriculture, University of Peradeniya, Sri Lanka
Hewa Waduge Cyril
Professor; Department of Animal Science, Faculty of Agriculture, University of Peradeniya, Sri Lanka

Abstract

Pre-tested, structured questionnaires covered management aspects, inputs, outputs, socio-economic situations and constraints in dairy farming among Semi-intensive (SIFS) and Extensive farming systems (EFS) in dry-lowland Sri Lanka. Parametric data were analyzed using two-tailed '*t*' and '*Z*' tests, and non-parametric values were analyzed using Chi-square and Fisher's extract tests. Cobb-Douglas model was used to calculate meta-frontier and system-specific frontiers. Returns in SIFS are lower than EFS. Labor costs are 91.72% and 87.26% in EFS and SIFS respectively. Counting family labor, SIFS has no comparative surplus. Excluding this, dairying is profitable even in SIFS. Dairying provides EFS family insurance where selling animals increases income. Discouragement of this in SIFS impacts negatively on sustainable income. Integration is comparatively minimal in EFS. Established with the best practices and technologies available, SIFS requires external resources to enhance efficiencies. If all EFS farmers achieved best farmer TE, output could increase by 45.09%. Similarly, SIFS output could increase by 57.08%. Farmer education and training programs contribute to improved production efficiency. Grassland scarcity and low productivity affect output adversely; poor veterinary and extension services are major constraints. Farmers consider dairying as profitable, which secures its future. Contrastingly, 35.19% of farmers believe it is low status, preferring professional jobs despite lower comparative incomes.

Keywords: Buffalos, cattle, farming systems, technical efficiency

Introduction

Agriculture and livestock in Sri Lanka account for 11.2% and 0.84% of total GDP respectively (CBSL, 2011). National milk production in 2011 was estimated as 256.78 million litres with approximately 201.17 million litres supplied from neat cattle. It is estimated that total milk production grew by 2.3% from 250.99 million litres in 2010 (CBSL, 2012). In 2011, the value of the total milk and milk products importation was 38,182 LKR millions, a 30.69%

Corresponding author's
Name: Upul Yasantha Nanayakkara Vithanage
Email address: nvuyasantha@yahoo.co.uk

increment since 2010 (CBSL, 2011). In 2007, the total milk consumption of Sri Lanka was around 612,000 MT (32 kg per capita consumption). Compared to the per capita consumption of developed countries, Sri Lankan per capita milk consumption is among the lowest in the world (Ranawana, 2008). Obviously, the dependency on milk powder importation and low liquid milk consumption due to low supply will probably continue.

In Sri Lanka there are four cattle based farming systems namely up and mid country, coconut triangle, wet lowland and dry lowland (Ibrahim *et al.*, 1999). Dairy (cattle and buffalo) in the dry lowland zones is an important capital asset for the peasant farmers. Moreover, dairy farming is predominantly a smallholder mixed crop-livestock farming operation (Ibrahim *et al.*, 1999; Bandara, 2000; Premarathne and Premalal, 2005).

In 2011, the dairy population of dry lowland was 1,009,390 (63.21% of the total population) and the total average daily milk production of dry lowland was 320, 850 L (45.6% of total production) (CBSL, 2012). Total land extent of the dry lowland is around 37, 600 km^2 and limited land for fodder and forage production is a critical issue in dairy production (Ranaweera, 2007). Therefore, national milk self sufficiency could be achieved only by enhancing the production in dry lowland. The development of the dairy industry in the country has stagnated mainly for political, technical and socio-economic reasons (Perera and Jayasuriya, 2008). Further, a poor understanding of socio-economic and cultural factors was the main reason for unsatisfactory outcomes of the dairy development programs in the country (Zemmelink *et al.,* 1999). Against this background, the objective of this study is to identify the farm-level socio-economic and technical efficiency in the above systems that would provide further support to increase national dairy production, which would thereby ensure long-term sustainability. This finding may have regional application for countries with similar tropical farming systems. The paper is organized as follows. The following section presents the methodology adopted which will be followed by results, and discussion sections. The conclusions and implications are presented in the last section.

Methodology

Data collection

The study was conducted in dry-lowland dairy farming systems in Polonnaruwa and Baticaloa districts of Sri Lanka. This area accounts 23.41% of dairy population and 30.02% of milk production out of total in dry-lowland in 2011 (CBSL, 2012). Prior to the survey, fifteen in-depth discussions were held with selected small and large scale farmers, officers of major large-scale dairy farming companies (i.e. CIC Holdings), officers of formal milk collecting networks (i.e. Milk Industries of Lanka Company Ltd., Nestle Lanka Ltd.), small-scale milk collectors, veterinary surgeons, livestock development instructors and artificial insemination technicians. Approximate numbers of dairy farmers were found from the different 10 administrative divisions. Then, stratified random sample was drawn, probability proportion to size thus end up with a sample of 96 farms. This information supplemented the conceptual framework of the survey instrument. The structured questionnaire was pre-tested twice. The questionnaire covered dairy management aspects, inputs used, outputs, socio-economic situations, constraints and involvement of households in dairy farming.

Analytical framework

The stakeholder discussions as well as field observations reveled that there are two distinct dairy farming systems existed in the study area that could be named as Extensive farming system (EFS) and Semi-intensive farming system (SIFS). The socio-economic and production details were analyzed for two systems separately and compared if needed.

Dairy production economics - A cost benefit analysis was carried out considering the expenditure and revenue on dairy farm activities for a period of one month. The cost of labor was calculated based on the duration (hours/day) spent on dairy farming activities and the daily labor wage following Mahipala *et al.*, 2006. All data were analysed using SAS (1998) statistical package. Parametric data were analysed using the two-tailed '*t*' test and '*Z*' test. Non parametric values were analysed using Chi-square and Fisher's extract tests.

Technical efficiency - TE shows the farmer's ability to produce the maximum level of output by using an existing set of inputs (i.e. output oriented) or produce the same level of output using fewer inputs (i.e. input oriented) (Lawson *et al*., (2004); Pierani and Rizzi (2003). Furthermore, TE is the ability of a decision-making unit (e.g. farm) to produce maximum output by using a given set of inputs and technology (Thiam *et al*., 2001). The analysis based on the concept of TE in terms of deviation from best-practice frontier as described by Farrell (1957). Further, TE is defined as the capability of the farm to reach its maximum possible production level by using a given set of inputs and available technology. According to Farrell (1957) there are two ways to quantify technical efficiency either by estimating econometric frontiers such as production or cost frontier or by estimating a free disposal convex hull of the observed input-output ratios using mathematical programming techniques. Since most of the agriculture production systems analysis used the stochastic frontier analysis (Bauer, 1990), this study deals with the parametric approach.

In the parametric approach, the stochastic frontier production function approach independently proposed by Aigner *et al.* (1977) and Meeusen and Van den Broeck (1977) is used where the error term has two components that are systemic random error and one sided technical inefficiency terms. The stochastic frontier model is described as below,

$$Y_i = f(X_i; \beta) \exp(V_i - U_i)$$

Where i = 1, …, n observations in the sample; Y_i is the observed output level of i-th farm; f (X_i; β) is a production functional form with respect to input vector, X_i, and unknown parameter vector β; U_i is a non-negative random variable representing technical efficiency; and V_i is the random error term which is assumed to be distributed independently and identically as N (0, σ_v^2) and independent of U_i. The frontier output (Y_i^*) is represented by f (X_i; β) exp (V_i) (Gunerathne and Leung, 1997).

Maximum likelihood estimate of the parameters are measured in order to parameterization, $\sigma_v^2 + \sigma^2 = \sigma_s^2$ and $\gamma = \sigma^2 / (\sigma_v^2 + \sigma^2)$ where σ and σ_v are indicated standard deviation of U_i and V_i respectively. Also, the ratio of the observed output to the corresponding frontier output refers the TE of i-th farm. The Cobb-Douglas model is used here due to its simplicity, absence of multicolinearity and homogeneity.

$$\text{Therefore, } TE_i = Y_i/Y_i^* \exp(-U_i)$$

The milk production is affected by several variables (Singh *et al*., 2006). The number of cows and all other costs including labor were considered as independent variables, while milk production represented the dependent variable.

The Cobb-Douglas stochastic frontier in this study is specified as;

$$In(Y_i) = \beta_0 + \beta_1 In(X_{1i}) + \beta_2 In(X_{2i}) + \beta_3 In(X_{3i})$$

$$Y_i = A(InX_{1i})\beta 1(InX_{2i})\beta 2 + a_0 + a_1(X_{1i}) + a_1(x_{1i}) + a_2(x_{2i}) + a_3(x_{3i}) + a_4(x_{4i}) + a_5(x_{5i}) + a_6(x_{6i})$$

Where Y_i is the value of milk production for the i^{th} farm in the sample [in Sri Lankan rupees (LKR)/farm]; X_1 is the total number of cows of the herd; X_2 is the total cost of the farm (LKR/farm/month); and β_1, β_2 and β_3 are output elasticity of total cows of the herd, total cost of the farm and other factors respectively.

Technical efficiency was calculated by two methods using Frontier 4.1. Meta-frontier and system specific frontiers were estimated for each farming system. When TE is measured among different groups of famers, TE should be measured with respect to a common frontier (meta-frontier) instead of depending on separate frontiers for each group (system specific frontier) (Victor *et al*., 2010). A major assumption in meta-production function is that all considered groups have similar access to technology (Gunaratne and Leung, 1997). System specific frontier was calculated relatively to all farms belonging to a particular farming system (either EFS or SIFS) whereas meta-frontier was calculated considering all farms as a pool. The outputs obtained from the two models were compared. Non-compatibility of the data across the system is one of the major limitations when using meta-production function. The surveyed data was gathered by using same questionnaire over the same period throughout different systems. Therefore, it greatly eliminates the non-compatibility among the data (Gunaratna and Leung, 1997). In the second level, six other factors (size of the farm family, farmer's ethnicity, age, education, knowledge of dairy farming and farming systems) were analysed to determine their effect on technical efficiency of dairy farming.

Constraints and other social issues - The three main production constraints as well as service constraints were identified using open-ended questions. Other than that, social issues related to dairy farming i.e. reasons for being engaged in dairy farming, recognition as a dairy farmer, children's willingness of continuation and the future of dairy farming were also identified using open-ended questions.

Results

Dairy production economics

The direct costs and revenues of dairy farming were considered in calculating the profit of the dairy enterprises. Costs account for expenditure on feeding, breeding, health care, labor and so on. Revenues were generated from selling milk and live animals for meat purposes.

Expenditure - The cost of concentrate and mineral feeding was significantly higher ($p<0.05$) in SIFS than EFS (Table 1). Furthermore, the cost of family labor and hired labor was significantly greater ($p<0.05$) in EFS than SIFS. The cost of drugs and total cost including family labor for dairy farming was found to be significantly higher ($p<0.05$) in EFS than SIFS.

Table 1: Monthly expenditure on dairy farming

Expenditure	LKR/farm/month		P values
	EFS[1]	SIFS[1]	
Dairy animal purchasing	416.67 (2165.08)	622.58 (1404.07)	0.5838
Concentrate and mineral supplement	31.67 (161.55)	1081.40 (1892.00)	0.0206
Drugs	209.25 (340.45)	47.84 (103.83)	0.0006

Veterinary service	19.60 (81.11)	17.33 (43.53)	0.8597
Artificial insemination	0.00 (0.00)	23.59 (62.13)	0.0523
Natural breeding (stud bull)	0.00 (0.00)	0.60 (4.98)	0.5344
Family labor	20995.74 (8534.82)	12375.00 (5103.97)	0.0001
Hired labor	1203.7 (3442.55)	0.00 (0.00)	0.0043
Equipment	0.00 (0.00)	10.43 (54.91)	0.3280
Other	15.43 (80.18)	2.66 (15.53)	0.2061
Total cost excluding family labor	1896.33 (4026.13)	1806.44 (2797.59)	0.9013
Total cost including family labor	19003.97 (11301.48)	13662.05 (6835.27)	0.0057

[1]Mean, Values in the parentheses are standard deviations
Means significantly different between systems ($p<0.05$)

Revenue - Dairy farming was the major income generating enterprise in EFS and it accounted for 63.91% of total farm income. The revenue from milk and meat (selling culled animals) was significantly ($p<0.05$) higher in EFS than SIFS (Table 2). There was a significant difference ($p<0.05$) in total dairy farm income between the two farming systems, and it was greater in EFS than SIFS. Moreover, the profit of the dairy farm including or excluding family labor was significantly greater ($p<0.05$) in EFS than SIFS.

Table 2: Monthly revenue from dairy farming

Revenue	LKR/farm/month		P values
	EFS[1]	SIFS[1]	
Milk	25888.89 (21967.52)	3913.04 (4132.46)	0.0001
Meat (sell cattle/buffalo)	23725.31 (23066.40)	1077.29 (2361.07)	0.0001
Total dairy farm income	49614.20 (43222.12)	4990.34 (5269.97)	0.0001
Profit excluding family labor cost	47717.86 (42727.55)	3183.90 (4701.47)	0.0001
Profit including family labor cost	30610.23 (40081.09)	-8598.32 (5712.65)	0.0001

[1]Mean, Values in the parentheses are standard deviations
Means significantly different between systems ($p<0.05$)

Technical efficiency

The technical efficiencies in EFS varied from 0.05 to 0.8847 with respect to system specific frontier whereas it ranged from 0.0211 to 0.9316 in SIFS. The system specific values are significantly different between two farming systems. The mean TE in EFS (system specific frontier) was greater than the mean TE in all farms (meta-frontier) (Table 3). The mean TE in system specific frontier was lower than the mean TE in meta-frontier in SIFS. There was an association between the level of TE in dairy farming and variables such as farmers' age, education, ethnicity and knowledge (Table 4). When considering Sinhala/Tamil farmers in both farming systems, the majority belongs to the TE level of 51-75%, whereas, majority of Muslims belongs to the TE levels of 25-50% in EFS and <25% in SIFS. In EFS >75% TE level was achieved by the farmers between 31-55 years only and that age group was more efficient than other farmers in the system. The majority of farmers who achieved TE level of >75% belong to the age category of >55years in SIFS. Meanwhile, TE increased with farmers' age. The majority of the farmers in EFS who were educated up to primary level show the highest TE level compared to others. However, the TE did not increase along with education. In SIFS, the highest TE level was achieved by the greater part of farmers who have a basic education level. In addition, TE increased along with farmers' education. Only the farmers having a 'satisfactory' level of knowledge indicated >75% TE level in EFS. In SIFS, the majority of the farmers who reached the >75% TE level have 'moderate' knowledge of dairy farming. Furthermore, in both systems the level of TE increased with farmers' knowledge of dairy farming.

Table 3: Mean technical efficiencies in EFS and SIFS based on system specific models and meta-production frontier models

	Mean TE	
	System specific	Meta-frontier
Extensive farming system[1]	0.5491 (0.2045)	0.4129 (0.1907)
semi-intensive farming system[1]	0.4292 (0.2638)	0.4719 (0.2425)
P values	0.0453	0.2804

[1]Mean, Values in the parentheses are standard deviations

Means are significantly different between systems at p<0.05 level

Table 4: Level of TE in dairy farming

Variables		Frequency (%) TE in Extensive farming system				TE in Semi-intensive farming system			
		<25%	25-50%	51-75%	<75%	<25%	25-50%	51-75%	<75%
Ethnicity*	Sinhala/Tamil	30.00	20.00	40.00	10.00	16.33	26.53	40.82	16.33
	Muslims	12.50	68.75	18.75	0.00	80.00	20.00	0.00	0.00
Age*	15-30 years	22.22	55.56	22.22	0.00	100.00	0.00	0.00	0.00
	31-55 years	7.14	57.14	28.57	7.14	19.51	29.27	36.59	14.63
	> 55 years	66.67	0.00	33.33	0.00	18.18	18.18	45.45	18.18
Education*	No formal education	0.00	100.00	0.00	0.00	100.00	0.00	0.00	0.00
	Basic education (<5 grade)	33.33	66.67	0.00	0.00	25.00	50.00	0.00	25.00
	Primary education (5-9 grade)	7.69	61.54	30.77	0.00	29.03	16.13	38.71	16.13
	Ordinary level (10-11 grade)	0.00	100.00	0.00	0.00	5.56	38.89	44.44	11.11
Knowledge*	Very poor	0.00	50.00	50.00	0.00	100.00	0.00	0.00	0.00

Poor	25.00	62.50	12.50	0.00	25.93	25.93	33.33	14.81
Moderate	20.00	20.00	60.00	0.00	16.67	38.89	27.78	16.67
Satisfactory	0.00	0.00	0.00	100.00	12.50	0.00	75.00	12.50

*There is an association among TE and variables ($p<0.05$)

Constraints and other social issues

In EFS, the major production constraint among the majority of the farmers was lack of grasslands (Table 5). Low productivity of existing animals and water scarcity were identified second as production constraints. Unavailability of well-structured sheds was the third production constraint in EFS. Lack of grasslands was the major production constraint identified among the majority of the farmers in SIFS as well. Low productivity of existing animals and unavailability of well-structured sheds were the second and third production constraints in SIFS respectively.

Table 5: Constraints among different farming systems

Issues	**Frequency (%) First Production Constraint***		**Second Production Constraint***		**Third Production Constraint***	
	EFS	SIFS	EFS	SIFS	EFS	SIFS
Lack of grasslands	81.48	68.12	3.70	17.39	7.41	13.04
Low productivity of existing animals	7.41	10.14	33.33	33.33	25.93	21.74
Unavailability of well-structured sheds	7.41	15.94	11.11	15.94	37.04	26.09
Water scarcity	3.70	5.80	33.33	23.19	3.70	15.94
Lack of stud bulls	0.00	0.00	3.70	4.35	0.00	5.80
Scarcity of high yielding animals	0.00	0.00	0.00	4.35	3.70	13.04
Rules and regulations of the Mahaweli authority	0.00	0.00	0.00	1.45	0.00	4.35
Diseases	0.00	0.00	14.81	0.00	22.22	0.00
Issues	First Service Constraint*		Second Service Constraint*		Third Service Constraint*	
	EFS	SIFS	EFS	SIFS	EFS	SIFS
Poor extension	18.52	27.54	62.96	36.23	3.70	23.19
Poor veterinary service	48.15	33.33	22.22	27.54	25.93	23.19
Lack of subsidies	0.00	2.90	3.70	4.35	3.70	7.25
Lack of market facilities	18.52	24.64	3.70	13.04	7.41	20.29
Lack of trainings	3.70	8.70	7.41	17.39	40.74	20.29
Poor security	11.11	2.90	0.00	1.45	18.52	5.80

*There is an association among farming systems and variables

Poor veterinary service, poor extension service and lack of training were identified as the first, second and third service constraints respectively of the majority of the farmers in EFS. In SIFS, poor veterinary service and poor extension service were identified as the first and second service constraints respectively. Poor veterinary and extension services were identified as the third service constraint among majority of the farmers in SIFS.

In both farming systems, a majority of the farmers engaged in dairy farming with the purpose of increasing their income (Table 6). A negligible number of famers rear dairy animals, mainly for the purpose of collecting cow dung. The status of the dairy farmer was well recognized in both farming systems; however a considerable number of farmers stated that there was no satisfactory recognition (‘bad’) for dairy farmers in the society.

Table 6: Social issues among different farming systems

	Frequency (%)			Frequency (%)	
Reasons for doing dairy farming*	EFS	SIFS	Recognition for dairy farming*	EFS	SIFS
Increased income	88.89	78.26	Good	51.85	57.97
Home consumption	3.70	7.25	Bad	37.04	33.33
Preference	3.70	10.14	Neutral	11.11	7.25
Tradition	3.70	2.90	No idea	0.00	1.45
In order to get cow dung	0.00	1.45			
	Frequency (%)			**Frequency (%)**	
Children's willingness of continuation*	EFS	SIFS	Future of cattle farming	EFS	SIFS
Yes	85.19	81.16	Good	92.59	94.20
No	14.81	15.94	Bad	3.70	2.90
No idea	0.00	2.90	No idea	3.70	2.90

*There is an association among farming systems and variables

In both farming systems, the majority of children (next generation) were interested in carrying out dairy farming as a source of income in future. Also, majority of the farmers stated that 'the future of dairy farming is secured'.

Discussion

Dairy production economics – The majority of the farmers in dry zone (50% in the EFS and 51.18% in the SIFS) are educated up to primary level (grades 5-9). And, they mainly depend on dairy farming or crop cultivation, especially paddy (88.37% in the EFS and 86.72% SIFS) which is passed on over generations. Moreover, a lack of alternative sources of income or employment opportunities in the dry zone restricts many people to the only available option – livestock keeping (Ratnayaka *et al.*, 1992). In these mixed farming systems, dairy acts as insurance. De Silva and Sandika (2012) have reported this especially for poor farmers if there is a loss by crop cultivation, especially paddy, the farmers try to compensate for it by selling animals such as bulls, male calves and old cows. Further, diversification in agriculture can act as a mitigating factor against crop failure. Dairying is emerging as a better alternative in diversification especially under mixed farming systems (Bharadwaj *et al.*, 2006).

Generally, farmers in the dry zone do not invest more in purchasing dairy animals. For instance, they try to breed animals themselves via natural breeding or artificial insemination (AI). One the interesting observation is that the farmers in the EFS generally do not spend money on breeding their animals. Because of the large herd size and the free grazing system, it is difficult to practise AI. On the other hand, it is not required to hire stud bulls as the herd already contains stud bulls. Farmers do not have knowledge on breeding to select stud bulls therefore; this situation leads to inbreeding and low production performances of the cows in the EFS. Reproductive and productive performances of dairy cows could be improved by adapting proper management practices, improved nutrition and new reproductive technologies (Kollalpitiya *et al.*, 2012). Farmers in the SIFS usually practise both natural breeding and AI. However, their cost of natural breeding is closer to zero as they borrow bulls from others without any payment and this social exchange mechanism could minimize the trend of inbreeding. Feeding rice straw is common in the dry zone. Generally, concentrates are not fed (Ibrahim *et al.*, (1999). Compared to the EFS, farmers in the SIFS usually spend more on concentrates and mineral supplements, around 7.63% of the total cost. There is a common trend in foot and mouth disease, mastitis and worm problems in the

EFS as the animals are enclosed densely in a paddock during night time. Therefore, the drug cost is significantly higher in the EFS. The labor cost is the major component of the dairy expenditure at 91.72 % and 87.26 % in the EFS and SIFS respectively. Moreover, 89% of the total expenditure on dairy farming was accounted for by labor in the dry zone Ratnayaka *et al.* (1992) and those figures concur with these research findings. Farmers require more labor (13.61 hr/day) on dairy farming in the EFS as farmers have to look after their animals during the whole grazing period. Some farmers require hired labor only during cultivating and harvesting periods of paddy, when they are unable to dedicate their time to dairy farming.

Revenue is generated via on-farm or off-farm activities in both farming systems. On-farm revenue included the income generated by animal husbandry and crop cultivation. The income generated by selling milk is 6.6 times higher in the EFS than the SIFS as the total cow unit (CU) (Lactating/Milking/Dry cow = 1CU; Heifer = 0.75 CU; Calf = 0.50 CU; Bull = 1.5CU) is 11.86 times higher in the EFS than the SIFS. Income generated via selling animals for meat purposes was 22 times higher in the EFS than the SIFS for two reasons. One is the large herd size (51.33±8.46) in the EFS, and the other is the socio-religious background where the majority of the EFS population is Muslim. There is no religious barrier to dairy animal slaughtering in Islamic culture. Comparatively, in the SIFS, the herd size is smaller (4.64±0.43) and the majority is Buddhist, and animal slaughtering is not encouraged. The SIFS has not a surplus if family labor is taken into account compared to the EFS. If family labor is not considered, dairy farming is a reasonably profitable enterprise even in the SIFS. Parallel studies have also reported that Sri Lankan small scale dairy farmers earn a marginal profit by their dairy farming activities (Navaratne and Buchenrieder, 2003; DAPH, 2009).

Technical efficiency - Even though the EFS showed the highest performances with respect to system specific frontier, it dropped by 0.136 when farms were compared with meta-frontier. The results revealed that the EFS farms have more capability to increase their production by using the best resources and technologies available in the area. Comparatively, SIFS where majority of the farmers are doing their farming efficiently, perform better than EFS. On the other hand, greater meta-frontier value in the SIFS implies the system has already adopted the best practices and technologies available in the area. In the light of that, the system required external resources and technologies to enhance their efficiencies. Paris (2002) reported that farm productivity and household incomes could be increased by introducing specific technologies. However, poor technology intervention could be observed among Sri Lankan smallholding dairy farmers because of a lack of understanding of the complexity of the systems (Bandara, 2000). Farmers who are in both farming systems carry out dairy farming with crop farming (upland and lowland crops). Therefore, new interventions should be introduced after considering animal and crop farming and their interactions. Further, in small-scale mixed farming systems in South Asia, low productivity of the animals could be observed because introduced technologies have not been adopted or their update has not been sustainable. Also, crop-livestock systems were considered as single production units and new technologies applied accordingly. Nevertheless, before applying new technologies, complexity and diversity of the farming systems should be considered (Thomas *et al.,* 2002). The mean TE of farmers in the EFS was found to be 54.91% which indicates that the output could be increased by 45.09% if all farmers achieved the TE level of the best farmer. In the same way, the output of SIFS farmers could be increased by 57.08%. Some farms performed well, whereas others did not, even with the same system. This interesting observation could be found in both farming systems and this situation was created due to other factors such as farmers' culture, age, education and knowledge, which correlated with farm business management.

Some farms owned by Muslims are usually managed by herdsmen. At the end of each year the owner earns a large sum of money by selling animals for slaughtering. The herdsmen look after the herds throughout the year and practise milking in order to fulfil their daily necessities, but they do not try to manage the business in an efficient way. Therefore, those farms are relatively less efficient than the others. On the other hand, Sinhalese and Tamils manage their farms efficiently by themselves, by using available resources and technologies. Dairy farming has been carried out by farmers over generations. For instance, a particular farmer engaged in rearing dairy animals since his childhood would have his farming experiences enhanced over his life time. Yeamkong *et al.* (2010) showed that farm production and revenue is increased with farmers' experiences. Therefore, there was a positive relationship between TE and the age of the farmers in the SIFS. Moreover, positive relationships were found between education and knowledge of the farmers with TE in the SIFS. However, such an association could not be observed in the EFS where the majority consists of Muslims, because those farms were managed by the herdsmen. Farm could be changed by farmer education Ondersteijn *et al.* (2003) because there is a stronger influence of education on farm productivity in a modernizing environment (Phillips, 1994). As well, there is a positive relationship between farmer education and farm production (Yeamkong *et al.*, 2010) and farm efficiency (Latruffe *et al.*, 2005). Therefore, well planned farmers' training programs (Wubeneh and Ehui, 2006) and policy interventions such as farmer education and agricultural extension (Fuwa *et al.*, 2007) contribute to improve farm production efficiency.

Integrated farming is a method in which two or more enterprises (crops, livestock, fish) are combined to get maximum efficiency from resources used, considering their relationships and interactions provided that an output from one enterprise would be an input for another (Ibrahim and Schiere, 2002). In contrast, there is no proper integration among different enterprises in either farming system. Moreover, paddy straw and crop residues (by-products of crop cultivation) are used as dairy animals' feed in the SIFS during drought periods when fresh roughage becomes limited. Cow dung is used in upland crop cultivation, but not for paddy in the SIFS. Poultry manure is used neither in upland crop cultivation nor paddy farming in the SIFS. Only paddy straw is used as dairy feed and crop residues are not fed to dairy animals in the EFS. Neither cow dung nor poultry manure is used for upland crop or paddy cultivation in the EFS. Therefore, the integration among different enterprises is minimal in the EFS compared to the SIFS. Proper livestock-crop integration ensures increasing farm TEs in both farming systems. Furthermore, farm productivity could be improved by integrating crop and livestock enterprises. In both farming systems, farmers are rearing dairy and poultry. Even though there is a high potential in rearing goats, farmers did not take the opportunity. Therefore, farm efficiency could be increased by introducing goats into both farming systems. Further to this, it has been shown that mixed livestock farming is a very important method to increase farm efficiency (Gaspar *et al.*, 2009).

Constraints and other socially-related issues - Major production constraints were almost similar in both farming systems. Grasslands became limited over time due to the population pressure. Moreover, the grassland of Sri Lanka has low productivity and has deteriorated due to mismanagement under the existing socio-economic position in the country (Premaratne *et al.*, 2003). Therefore, the lack of grasslands was the major constraint to expanding dairy farming today and in future. The best solution for the scarcity of grasslands was having a lower number of highly productive animals instead of having a larger number of unproductive animals. Other than that, an intensive or semi-intensive management system was more viable than extensive management practices. Feed scarcity become a severe problem during the dry season and farmers should use feeding technologies such as urea treated straw feeding, urea molasses mineral block feeding etc. especially, during drought periods. Similar recommendations are suggested for dairy farms in Kurunagala district of Sri Lanka and the study revealed that proper feeding technology is required for the dry season. Further, farmers should be trained in feed management (Kubota *et al.,* 2010). Extension officers and veterinary surgeons were reluctant to work in these rural areas due to poor infrastructure and other facilities. Therefore, the lack of extension and veterinary services has become a major barrier to expanding the dairy sector. Premarathna and Premalal (2005) reported that access to extension services in dry lowland is very difficult. Most of the studies revealed that efficient and effective extension services for the dairy farmers are a paramount requirement in many parts of the country (Bandara *et al.*, 2011).

A majority of the farmers consider dairy farming as a profitable venture, which secured its future as their children were willing to carry out dairying in future. In contrast, there was another group of farmers (35.19%) who believe it is a low status they occupation in their society. They prefer professional jobs even though they may generate a lower income compared with dairying.

Conclusion

Although dairy farming maintenance cost per animal was relatively high in SIFS, system returns were lower in comparison with EFS, which used low external inputs. Labor cost is considerably high in both systems. If family labor inputs are considered, SIFS has no surplus compared to EFS. However, if family labor is not considered, dairy farming is reasonably profitable. Dairying acts as insurance for the family if farmers are willing to sell culled animals. Selling animals for meat purposes was strongly discouraged due to cultural and religious ethics and barriers which have had a direct negative impact on monthly income as well as the financial security of the farm family. Appropriate livestock-crop integration and mixed livestock farming ensure increasing farm production and efficiency in both systems. Established with the best practices and technologies available, SIFS required external resources and technologies to enhance its efficiencies. In both systems, improved farm production efficiency was achieved through well-planned farmer education and training programs. Lack of grasslands, low productivity, water scarcity and unavailability of well-structured sheds affected production adversely, whereas poor veterinary services, poor extension services and lack of training were major service constraints. The future of dairy farming seemed secure because most farmers considered it to be profitable, and their children were willing to continue that way of life. However, policy implementers and social workers should work cooperatively to enhance the social status of dairy farmers.

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