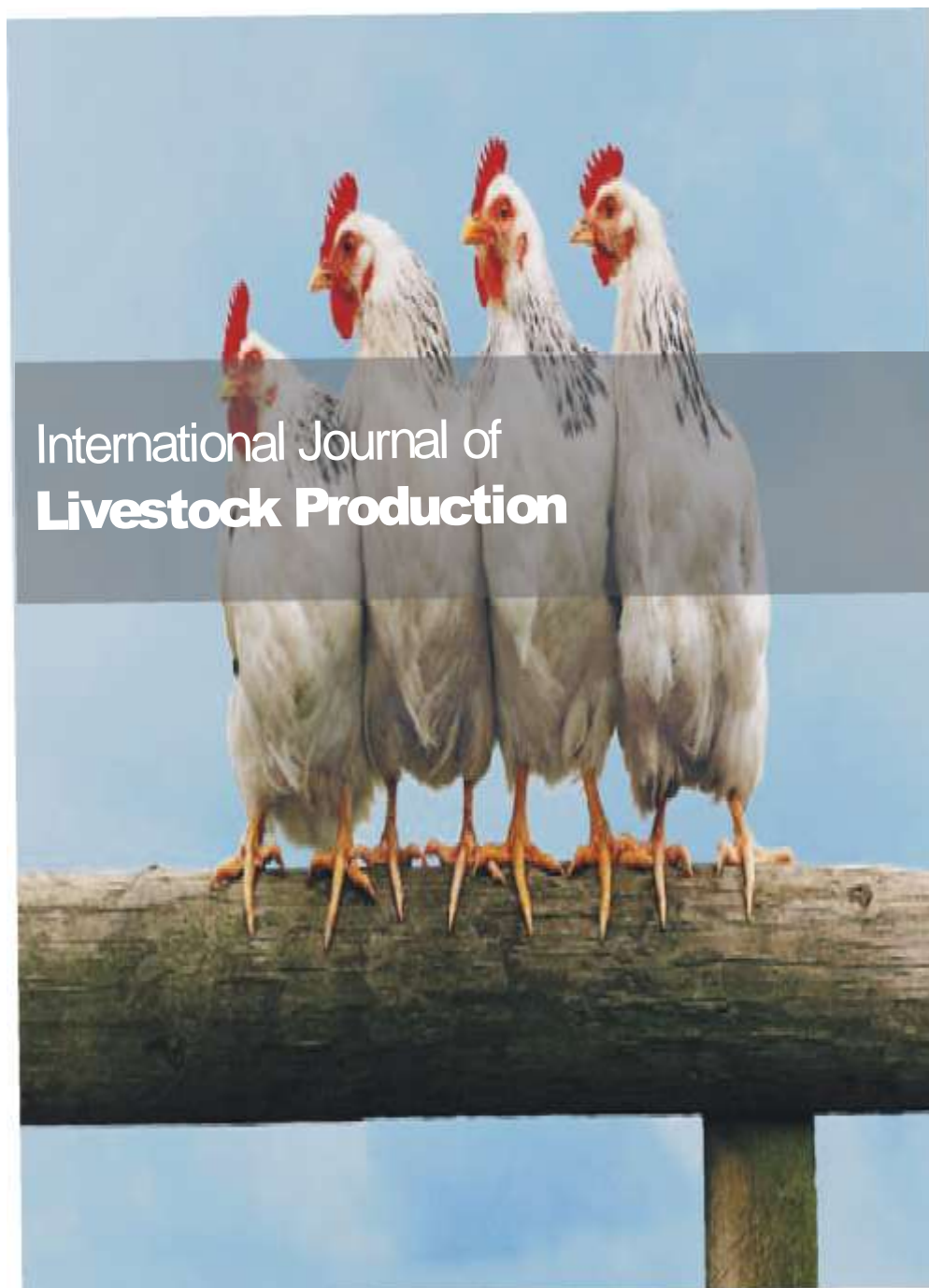


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Full Length Research Paper

Identifications of the major factors that influence milk production: The case of dairy farmers in Badulla district, Sri Lanka

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Dairy farming remains the economic backbone of livestock farmers in high potential area like Badulla district in Sri Lanka. Though, milk production has been quite low. Therefore, this study was carried out to investigate the factors affecting dairy cattle milk production in Badulla. Total of 500 dairy farmers were selected using multistage stratified and simple random sampling techniques. Milk production and socio-economic data were collected using a pre-tested structured questionnaire covering 15 divisional secretariats in Badulla. Data were analyzed for descriptive and inferential statistics followed by regression analysis. Results of the study revealed that the intensive dairy cattle farming is operated (87.14%) in up country wet zone. Jersey breed was the major breed (86.4%) accounting for 6.19 L/cow average daily milk production. The highest (10.89±1.73 L/cow/day) and lowest (3.17±0.38 L/cow/day) milk productions were reported in Haputhale and Mahiyangana, respectively. The best fitted multiple linear regression model predicted that R² value of 62.91% daily milk production suggesting farmers experience, farmer's age, number of milking cows, forage type, shed condition, concentrate feeding supplement, frequency of concentrate supplement, frequency of water supplement, calves feeding amount age at wean, feeding method of cow, mineral supplement and monthly income of the farmers were significantly ($p < 0.05$) affected by the daily milk production of Badulla district. However, lack of high yielding cross breeds, less success rate in artificial inseminations, low quality pasture and seasonality in pasture production, poor milk collection network and low farmer gate price, high price of concentrates, and inadequate facilities for animals in the estate area were reported as key constraints which need to be properly focused on in future to increase milk production in Badulla district, Sri Lanka.

Key words: Dairy cattle farming, milk production, factors, regression analysis.

INTRODUCTION

Dairy plays an important role as a contributor to gross domestic production and is an important source of livelihood for a huge portion of Sri Lankan rural population. The agricultural sector of the country consists

of the domestic sector and the plantation sector. The domestic agricultural sector is synonymous with the rural sector. In Sri Lanka almost 30 % of land is allocated to agriculture industry. Almost 75% of the agricultural

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land is under smallholdings and the balance under estates. About 70% smallholdings have been especially devoted to crop production, the remaining has a mixture of crops and livestock and in few cases solely livestock. Livestock plays a vital role in rural economic development in Sri Lanka. The total contribution of livestock sector to national GDP in 2011 was around 1.0 % (Annual report Department of Animal Production and Health (DAPH), 2011). Dairy sector is the most important livestock subsector. Dairy farming is accepted by all ethnic cultures than other livestock subsectors such as poultry, swine etc. Domestic dairy industry has capacity and capability of producing substantial amount of quality milk and milk products (Ministry of Livestock and Rural Community Development, 2012b). The dairy sector in Sri Lanka could be divided into milk production, milk processing and importation. The production sector comprises the dairy farmers and their service providers whilst the processing sector includes the milk collectors and processors. In National milk production in the country is 332.9 million liters in 2017 year with compare it 2016 it was 329.2 million liters. According to the report of national output of expenditure it is shown that Milk production grew by 1.1 per cent to 330 million liters in 2017. (Central Bank of Sri Lanka, Annual Report 2016).

In Sri Lanka, livestock is spread throughout all regions of the country with concentrations of certain farming systems in particular areas due to cultural, market and agro climatic reasons (Ministry of Livestock and Rural Community Development, 2012a). Further livestock production systems in Sri Lanka categorized based on agro ecology, climate, husbandry, breeds managed, rainfall pattern, cropping system, etc. Abeygunawardena et al. (1997) classified dairy production systems as dry zone traditional village system, dry zone irrigated settlement system, intermediate system and wet zone system. In another study, Mahipala and Gunaratne (2003) classified farming systems as up-country, mid-country, wet-lowland, coconut triangle and dry-lowland. According to the 2002 agriculture census, the largest cattle populations are found in the country's dry and intermediate zones. The wet mid- and up-country areas are often perceived as the main dairy-producing areas. The dry and dry intermediate zones produce 50% more milk than the wet and wet intermediate zones (Vithanage et al., 2013).

In Badulla district, milk production has significant place when compare with the other districts, in the last year (2017) and it is fifth place in Sri Lanka (www.daph.gov.lk). Also in Badulla district, dairy farming is an important traditional economic activity where it is mostly integrated with small-scale vegetable cultivation through utilization of cattle manure and it is part of a partially closed, mixed farming system of them (Bandara et al., 2011). The climatic condition of district (up country wet and intermediate zones) is favorable for dairy farming activities, and 9% of contribution to the total milk

production of Sri Lanka is provided by the Badulla district from 16,059 registered farms having 27,500 of local and 15,450 of improved cattle (<http://www.statistics.gov.lk>, 2018). In this content, the objectives of this study were to identify the characteristics and significant factors that influence cattle milk production while investigating the prevailing constraints and farmer's perception towards the dairy farming in Badulla district, Sri Lanka.

MATERIALS AND METHODS

Description of study area and sample design

Badulla district was deliberately selected as study area due to high potential to improve living standards of the poor people in this area and more so for smallholder dairy farmers who account for the largest share of milk produced nationally. Badulla district is located to the east of the central highlands in Uva Province, Sri Lanka. It is a complex region that extends to entire land area of 2,861 km² with mountain ranges, dissected plateaus, escarpments and narrow valleys covering a greater proportion of the district. The average annual rainfall in the area is around 2000 mm and average annual temperature is 23.2°C. District has three distinguish agro-ecological zones within the district as the upcountry wet zone, the intermediate zone and the dry zone. It is reported that total of 837,000 populations is scattered in the area belonging to multi ethnic and cultural background. The natural vegetation of the district consists of non-productive wet-zone forests, non-productive intermediate zone forest, scrubland and grasslands suitable for livestock production.

This study was an applied research study in term of nature, a field research in terms of monitoring and control, and a survey research in terms of data collection. It was enabled to generalize the findings to a larger population and it has been credited due to the fact that it allows analysis and relations of variables. The sampling used in this survey was a multi-stage method through stratified and systematics sampling to ensure greater precision. In the first stage, sampling was done with probability proportional to the number of milk farmers in all 15 district secretary (DS) and systematic sampling was applied to select farmers from all DS in the second stage (Table 1). Primary data for the study were gathered through field questionnaire survey, interviews and focus group discussions.

The questionnaire consisted of open-ended and closed ended questions sections related to covering farmers' demographic information, livestock rearing system, management practices, veterinary practices, breeding, farm expenditures, farmers knowledge, constraints and future perception of dairy farming. This enables a better understanding and an insightful interpretation of the results from the study. In order to ensure the content validity of the questionnaire, pilot survey was conducted in Hali-ella Milco center with 31 farmers and the instrument was further refined based on the implications of responses. The reliability of the measurements in the survey was tested using Cronbach's alpha (α) and it was estimated to be $\alpha=0.81$. The field survey was conducted during May to September, 2018 and data were gathered from 500 farmers in Badulla district from 15 divisional secretariats (Badulla, Soranathota, Meegahakivula, Kandakatiya, Ridimaliyadda, Mahiyanganaya, Passara, Lunugala, Hali-Ela, Ella, Bandarrawela, Haputhale, Haldummulla, Welimada, and Uva Paranagama). Further secondary data related to the population distribution of the dairy cattle farmers were collected from reviewing the published and unpublished documents, the Department of Animal Production and Health (DAPH), Badulla and Department of Census and Statistics.

Table 1. Summary information of milk production related factors in Badulla district.

Divisional secretariat	Average milk production (L/cow/day)	Average milking cows	Average fat percentage	Average amount of night feeding (kg)	Average amount of concentrate feeding (kg/cow/day)	Average amount of mineral supplement (g/cow/day)
Badulla	6.91±0.59	25	3.9±0.01	21	1.32±0.11	17.0±1.2
Bandarawela	7.55±0.49	34	3.8±0.02	15	1.14±0.13	22.0±2.9
Ella	6.25±0.27	68	3.8±0.01	17	1.61±0.94	17.3±1.1
Haldummulla	6.21±0.64	56	3.9±0.11	18	1.20±0.11	12.8±0.9
Hali-Ella	7.71±0.61	101	3.9±0.11	16	1.52±0.14	21.4±1.5
Haputhale	10.89±1.73	34	4.0±0.05	18	1.95±0.41	15.4±1.1
Kandakatiya	3.99±0.49	22	3.9±0.02	12	0.99±0.17	36.6±8.0
Lunugala	7.03±1.15	32	4.0±0.05	16	1.12±0.14	15.2±2.1
Mahiyanganaya	3.17±0.38	73	4.0±0.02	6	0.40±0.12	5.1±1.4
Meegahakivula	9.80±10.7	4	4.0±0.15	18	4.00±1.15	7.3±3.7
Passara	6.00±0.49	68	3.8±0.02	14	2.24±0.21	15.2±1.3
Ridimaliyadda	3.55±0.29	23	4.0±0.04	11	0.95±0.05	11.1±0.9
Soranathota	10.55±2.13	20	4.0±0.04	23	1.5±0.25	10.9±4.4
Uva Paranagama	4.69±0.26	142	3.9±0.01	18	1.1±0.05	15.2±0.8
Welimada	6.24±0.30	95	3.9±0.03	21	1.4±0.1	24.6±2.1

*All the results are given with their Standard Error of Mean (SEM).

Data description and multiple-regression analysis

Dependent variable of the study was measured using average milk production of liters per animal per day (L/animal/day). Subsequently, the following characters were recorded as independent variables: Farmer's information (age of the farmer (years), education level of the farmer, labor power (h/day), herd size (counted), experience of the farmer (years), livestock sector, roughage feeding (kg/day), concentrate feeding (kg/day), mineral supplement (kg/day), provision of water (L/day), calf management, herd milk production (L/day), sales and marketing, manure production (ton/year) and use, expenditure (Rs/month) (for veterinary service, for breeding, for feeding), monthly farmer income (Rs) farmer's knowledge in cattle keeping (liked scale), farmers perception on dairy cattle farming and traditional medicine methods use for the diseased animals.

Subsequently, data were subjected to descriptive analysis and confirmatory analysis using Minitab 17 software. The confirmatory statistical analysis was done by using the Multiple Linear Regression model, to predict average milk production (L/cow/day) with the quantitative and categorical predictor variables. The form of the multiple linear regression model is as follows:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \dots + \beta_n x_n + \epsilon$$

where, $\beta_0, \beta_1, \dots, \beta_n$ are regression model parameters, ϵ is random error and x can be a categorical or continuous predictors and y is a quantitative dependent variable.

RESULTS AND DISCUSSION

Demographical and socio-economic characteristics

Results of the descriptive statistical analysis of

demographic data of farmer's gender showed a clear demarcation between male (59.8%) and female (40.2%) while male farmer's had higher involvement in dairy cattle farming in Badulla district. However, in state regions, male involvement is much greater (>75%) compared to female involvement in dairy farming. Reasons might be the difficulties in finding feeds in state areas and relatively large distance need to travel in drought seasons to find feed. Furthermore, the ethnicity distribution of the farmers showed majority in Sinhala (69.3%) followed by Tamil (28.6%) and other religious (2.1%). Further age distribution results of both male and female summarized that majority of farmers belong to 45 to 55 years age group whereas an average age of the farmers and experience in cattle farming were recorded as 50 and 20 years, respectively. It was well evident that the youngers involvement in dairy was very little in all the 15 DS divisions and reasons were moving them from villages to urban areas for educations, employments and reluctant to continue traditional dairy farming due to poor social recognition. Furthermore, results clearly indicated that majority of the dairy farmers had only primary education (40.6%) and only 5.52% of farmers had diploma/bachelor level education; however, there was a negative correlation between education level and daily average milk production of the farm. Reason for little involvement of educated people in dairy (12.3%) might be the shifting of the job to government (32.8%) or private sector (46.5%) where farmers gain more financial income without risk of in farm failures. Also results implied that average daily income from milk production as 489.08

rupees.

Moreover, the descriptive analysis of the feeding management practices, it showed average amount of concentrate supplement as 4.09 kg daily, whereas amount of mineral supplement was 58.02 g daily. Also, majority of farmers had cattle shed (95.3%) while 4.7% do not have the cattle shed.

According to result of Table 1, the average milk production was 6.29 ± 0.21 (L/cow/day) in the Badulla district and the highest milk production were in the Haputhale (10.89 ± 1.73) and Soranathota (10.55 ± 2.13) divisional secretariats meanwhile the lowest production was recorded in the Mahiyanganaya (3.17 ± 0.38). Moreover, Haputhale, Lunugala, Mahiyanganaya, Meegahakivula, Ridimaliyadda, and Soranathota recorded the highest fat percentage in the milk per liter and Bandarawela, Ella and Passara recorded the low fat percentage than the others.

Main cattle management system in the area was intensive (87.14%) followed by semi-extensive (6.56%) and extensive (6.30%). In up country wet zones (Welimada, Uva Paranagama, Haputale, Haldummulla, Hali Ela, Passara, Bandarawela, Ella), small scale intensive farms with few number of animals and zero grazing, small shelters and low input were considered as dominant characteristics of the dairy farming, whereas in dry zones and intermediate zones (Badulla, Lunugala, Mahiyanganaya, Rideemaliyadda, Soranathota, Kandaketiya, Meegahakiula), intensive small herds and relatively large semi intensive and extensive herds with free grazing and cut and feeding, with or without shelters were common. Abeygunawardena (1998) have also revealed that free-grazing extensive management system and semi-intensive management system as most widespread management systems across the Sri Lanka. Supplying of concentrates was at a very lower level in the area where farmers considered cut and feeding and concentrate feeding as difficult task in dairy cattle farming in dry and intermediate zones due to relatively large herds.

Jersey, Freshien and Jersey cross breeds, Sahiwal cross breeds and local breeds were identified in the Badulla district. However, majority of the farmers in up country wet zone and up country intermediate zone, mid country intermediate zone reared Jersey (86.4%) and Freshien. Low country intermediate zone and low country dry zone farmers reared Jersey, Jersey cross breeds and Sahiwal and local breeds. Feeding management results of the study summarized that majority of the farmers have not adopted to quality forage variety, however, very few number of farmers have cultivated CO-3 and CO-4 (*Pennisetum purpureum*), whereas other farmers rely on the grass (*Panicum maximum* eco type A) and weeds in road side, paddy fields, tank bunds and abandon lands. However, no forage conservation methods were practiced in the surveyed area which is aiming to be used during drought seasons of the year (June - August).

Further, concentrate feeding (coconut poonac, cattle feed pellets) and mineral supplementation were practiced for milking cows. Thiwyadharsan (2013) also revealed in his study, these concentrations have used dairy cattle farmers in Monaragala, Uva province.

The secondary data analysis, multiple linear regression model, was fitted to the dependent variable of daily average milk production (L/cow/day) in order to determine the factors affecting milk production in Badulla district.

Result of the multiple linear regression was revealed that there is a significant (p value-0.00) relation between the average milk production and predictors (Table 2). The fitted model predicts 62.91% (R^2) of total variation of the average milk production along with the management practices at 0.05 level of significance. The results revealed that farmers experience age of the farmer, number of milking cows in the herd, type of the forage, shed condition, concentrate feeding supplement, frequency of concentrate supplement, frequency of feed, frequency of water supplement, feeding amount in bucket/bottle to the calves, age at wean, feeding method of cow, mineral supplement and monthly income of the farmer were significantly influenced by the average milk production (L/cow/day) of the Badulla district. The results of the final fitted multiple linear regression model are as follows:

$$\begin{aligned} \text{Average milk production (L/cow/day)} = & 0.05 * \\ & \text{farmer's experience} - 0.04 * \text{farmer's age} + 1.68 * \\ & \text{number of milking cows} + 3.76 * \text{forage type} + 4.21 * \\ & \text{shed condition} + 1.37 * \text{concentrate frequency} + 0.56 * \\ & \text{frequency of feed} - 0.66 * \text{frequency of water} + 4.71 * \\ & \text{feeding amount to calves} - 0.39 * \\ & \text{age at wean (months)} + 1.03 * \text{feeding method} + 3.21 * \\ & \text{concentrate feeding} + 3.66 * \text{mineral supply} + 0.01 * \\ & \text{monthly farmer income} \end{aligned}$$

It can be noted that those daily working hours, gender of the farmer, education level of the farmers, housing facilities for the cows, amount of night feeding for cows, and concentrate type were not significantly influenced by the average daily milk cattle milk production. Further, the survey revealed that farmer's had a positive perception towards the dairy cattle farming however results of the study revealed that the dairy cattle farmers in the Badulla district run their livelihood under several constraints. Lack of high yielding cross breeds, less success rate in artificial inseminations, low quality pasture and seasonality in pasture production, poor milk collection network and low farmer gate price, high price of concentrates, and inadequate facilities for animals in the state area are the prioritized key constraints of the area.

Moreover, results further suggested those farmers in the region need to be improved with adequate awareness on dairy cattle feeding, forage conservation methods, trainings on milk product processing and value addition and further results recommended that it is important to

Table 2. Summary of the parameters estimated in the regression model.

Variable	Coefficient	SE coefficient	P value
Total working hours per day	0.10	0.09	0.253
Experience of the farmer*	0.05	0.02	0.013
Age of the farmer*	-0.04	0.02	0.045
Gender	-0.08	0.35	0.822
Level of education	1.37	3.81	0.056
Milking cows*	1.68	0.21	0.000
Forage type*	3.76	1.06	0.000
Housing facility	-2.73	3.49	0.435
Shed condition*	4.21	3.28	0.026
Amount of night feed (kg)	0.01	0.01	0.135
Frequency of concentrate*	1.37	0.37	0.000
Frequency of feed*	0.56	0.32	0.046
Frequency of water*	-0.66	0.44	0.034
Feeding amount in bucket/bottle*	4.71	0.65	0.000
Age at wean (months)*	-0.39	0.11	0.000
Feeding method*	1.03	1.69	0.001
Concentrate feeding*	3.21	2.94	0.025
Type of concentrate	2.47	1.45	0.275
Mineral supplement*	3.66	1.61	0.024
Monthly farmer income (LKR)*	0.01	0.0003	0.000

*Variables with P values less than 0.05 are significant.

introduce bank loans at reasonable interest rates, improve the milk collection network and establish healthy farmer gate price to improve the livelihood of the dairy farmers in the Badulla district. Moreover, it was well elucidated that many farmers practice traditional ethno veterinary practices in this district and those practices need to be well documented and further research to conserve before disappearance.

Conclusion

Even though Badulla district has more favorable characteristics for dairy cattle farming, daily average milk production is significantly low and many constraints have impeded the expansion of the sector. Demographic characters such as farmers experience, age and herd composition (number of milking cows), feeding practices such as type of the forage, concentrate feeding supplement, frequency of concentrate supplement, frequency of feed, frequency of water supplement, feeding amount in bucket/bottle to the calves, age at wean in months, feeding methods to the milking cow, mineral supplement, shed condition and monthly farmer income were significantly influenced by the daily average milk production (L/cow) in the district. Therefore, it is necessary to address these areas in order to increase the dairy production in the district and continuous agitation of these results in policy formulation is essential to both

dairy sector and livelihood development of the farmers in the Badulla district.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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