

## Factors Affecting Milk Yield of Cattle in the Mid-Country

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**ABSTRACT.** *There is a large potential to rear temperate cattle in the mid-country of Sri Lanka. At present it contributes about 17.5 percent to the total milk collection of the island. However, the milk yield varies with the agro-ecology due to several factors. This study examines the impact of some major factors on per cow milk yield. Multiple regression of Generalized Linear Models were fitted using the OLS procedure. The necessary corrections were made for the problems of violation of assumptions and data problems. The factors considered in the analysis include feed, breed, family labour, family income, type of management, management experience, level of education and the size of land. After making the necessary corrections to the problems of multicollinearity and heteroscedasticity, explanatory power of the model was increased from 48 percent to 94 percent. In terms of policy implications, it is found that the small land extent, family labour use, breeds, feeds and the type of management are the major constraints to improve the milk yield of dairy cattle in the mid-country.*

### INTRODUCTION

Sri Lanka produces 450,000 litres of milk per day. This is about 33 percent of the total estimated milk requirement in the country. Another 55 percent of milk and milk products needs of the island are imported leaving a 12 percent deficit (Soni *et al.*, 1991). With the growing human population, land limitation and reduction in the profit margin of the livestock operations the gap between the consumption and the production of milk and related products in the country tends to widen. Further, the liberalized economic policies have encouraged the traders to import more milk and related products.

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Development programmes launched by the government, with the prime aim of improving milk production, utilize millions of rupees annually. However, they have not been successful in achieving the expected goals related to milk production (Livestock Statistics, 1986/87). It is clear that many factors would cause such conditions to prevail in the livestock sector. Livestock activities in Sri Lanka are often considered an integral part of small scale agricultural systems. Although many components come under livestock activities, dairying is the most important activity practised by the average farmer in the country (Abeygunawardena, 1991).

At present, 17.5% of the total national milk collection is obtained from the mid country (Soni *et. al.*, 1991). This amount is collected by 9.18% of the total cattle population (Abeygunawardena, 1991). These figures clearly indicate that the milk yield in the mid country is higher than the national average. However, it is much lower than the full potential of breeds such as *Friesian* and *Jersey* reared in this area (Dirkson, 1986).

Cattle rearers in the mid - country predominantly practise intensive and semi - intensive (include tethered grazing) management systems. The herd size varies from two to seven animals (Soni *et. al.*, 1991). A small fraction of the farming population possesses their own source of pasture. Animals are fed with a heavy bulk of low quality grass with an average of 2.5 kg (sd  $\pm$  2.3) of coconut poonac per herd. In terms of labour division, it has been observed that females in households take part in many cattle rearing activities (Ratnayake *et. al.*, 1990).

Most of the animals living in the mid - country are potentially better yielders (Richards *et. al.*, 1981), and their technical ceiling ranges from 3000 to 5000 litres of milk/cow/year, though presently they produce only 900 to 1500 litres milk/cow/year (Soni *et. al.*, 1991). Therefore, any development policy towards increasing milk production in this area, should consider yield improvement as one of the prime tasks to be achieved.

Hence, the objective of this study is to determine the factors affecting milk yield of cattle in the mid country.

## METHODS

Data were collected using a structured questionnaire in a field survey of randomly selected 125 mid country dairy farmers. Other livestock such as buffaloes, poultry and goats were also found among the selected group of farmers. However, information from only 115 farmers was used for the final analysis. Data gathered from 10 farmers had to be omitted from the analysis due to inconsistencies found within the information.

After information was collected from the survey basic statistics such as arithmetic means and standard deviations were used to analyze the data. Further, a multiple regression model was fitted to examine the relative importance of the factors affecting milk yield. Finally, results of the study were improved making the necessary corrections to the data problems and violations of classical assumptions.

### Testable hypothesis

A limited number of studies have been conducted by previous researchers to examine the factors affecting the milk yield in different parts of the world. However, no study has been conducted to examine the same, in the mid – country. Milk yield is a product of several factors of varying importance (Dirkson, 1986). Basically, the effect of these factors vary with the agro – ecological regions (Richards *et. al.*, 1981). According to the perceptions of the farmers some relationships were considered to be apparent. Based on these relationships the following hypothesis were established to be tested in this study.

1. Milk yield per cow was expected to have a positive relationship with type of feed, amount of family labour used, owned land extent, number of years experience in cattle farming, farmers' education level and the type of management.
2. When the family income earned from sources other than livestock activities increases, the attention paid to cattle rearing decreases.

After development of these hypotheses the following linear model was formulated to be tested. The Ordinary Least Square method was used to estimate the intercept ( $\alpha$ ) and the slope of the curve ( $\beta$ ).

$$Y = \beta_1 x_1 + \dots + \beta_8 x_8 + \alpha \text{ where}$$

|                   |  |
|-------------------|--|
| (Y)               | = milk yield (l/cow/day)                         |
| (x <sub>1</sub> ) | = feed (kg concentrate/herd/day)                 |
| (x <sub>2</sub> ) | = breed of cattle                                |
| (x <sub>3</sub> ) | = family labour use (hr/day)                     |
| (x <sub>4</sub> ) | = income from non-livestock sources (Rs/month)   |
| (x <sub>5</sub> ) | = type of management                             |
| (x <sub>6</sub> ) | = experience in cattle rearing (number of years) |
| (x <sub>7</sub> ) | = education level of the rearer                  |
| (x <sub>8</sub> ) | = owned land extent (ha)                         |

### Binary variables

|              |                                 |                         |
|--------------|---------------------------------|-------------------------|
| <u>Feed:</u> | 1 = grass alone                 | 2 = Grass + Straw       |
|              | 3 = Concentrate + Straw         | 4 = Concentrate + Grass |
|              | 5 = Concentrate + Grass + Straw |                         |

|                |                      |                         |
|----------------|----------------------|-------------------------|
| <u>Breed :</u> | 1 = Local            | 2 = Local x Indian      |
|                | 3 = Local x European | 4 = Indian              |
|                | 5 = Indian x Indian  | 6 = Indian x European   |
|                | 7 = European         | 8 = European x European |
|                |                      |                         |

|                     |                    |               |
|---------------------|--------------------|---------------|
| <u>Management :</u> | 1 = Extensive      | 2 = Tethered  |
|                     | 3 = Semi-intensive | 4 = Intensive |

|                    |               |                |
|--------------------|---------------|----------------|
| <u>Education :</u> | 1 = Below O/L | 2 = O/L to A/L |
|                    | 3 = Over A/L  |                |

|              |          |            |
|--------------|----------|------------|
| <u>Sex :</u> | 1 = Male | 2 = Female |
|--------------|----------|------------|

## RESULTS AND DISCUSSION

Model correlation matrix (Table 1) was obtained to examine the multicollinearity among the explanatory variables. It was found that five variables (use of family labour, income from non-livestock sources, type of management, owned land extent and education level of farmer) had correlation coefficients higher than 0.5 indicating possible multicollinearity problems among them. However, theoretically it is not possible to drop those variables (Judge, *et. al.*, 1982b). Hence, they were further tested calculating the condition numbers to assess how severe the problem of multicollinearity was. Calculated condition numbers were below 100 (condition numbers varied from 4.28 to 65.69) indicating that the multicollinearity is not a serious problem among the variables. According to Judge, *et. al.*, (1982b), the condition numbers below 100 do not show a severe multicollinearity. Hence, it was decided to work with the data further.

The data set consisted of both continuous and binary variables. Therefore, it is necessary to carry out a General Linear Model (GLM) technique to treat both variables equally, rather than use the linear regression model (Judge, *et. al.*, 1982a). Finally, the analysis was done with the assistance of the computer package of Statistical Analysis System.

Results of the General Linear Model (GLM) are presented in Table 2. Based on these results it is clear that the adjusted R-square is low (0.48) while only four variables are significant at 10% or lower probability levels. Further, the explanatory power of the model was not at an acceptable level. Such low values can be used as classical indicators of the existence of undiscovered data problems or violations of assumptions. Therefore, it was decided to carry out subsequent diagnostic checking of the set of data.

As the first step to correct these problems, residuals were plotted against the milk yield (dependent variable) and it showed several outliers. Six of these outliers were removed to enhance the explanatory power of the model. The R-square value obtained was 0.76. Further, in the next residual plotting four more outliers were identified and these observations were also deleted from the set of data. Then the explanatory power reached 0.94 (Table 3).

Table 1. Correlation matrix - independent variables of the model.

|                | X <sub>1</sub> | X <sub>2</sub> | X <sub>3</sub> | X <sub>4</sub> | X <sub>5</sub> | X <sub>6</sub> | X <sub>7</sub> | X <sub>8</sub> | X <sub>9</sub> |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| X <sub>1</sub> | 1.0000         |                |                |                |                |                |                |                |                |
| X <sub>2</sub> | 0.0000         | 1.0000         |                |                |                |                |                |                |                |
| X <sub>3</sub> | 0.2343         | 0.7869*        | 1.0000         |                |                |                |                |                |                |
| X <sub>4</sub> | 0.0913         | 0.0001         | 0.0000         | 1.0000         |                |                |                |                |                |
| X <sub>5</sub> | 0.1362         | 0.6815*        | 0.7664*        | 0.0001         | 1.0000         |                |                |                |                |
| X <sub>6</sub> | 0.3308         | 0.0001         | 0.0001         | 0.0000         | 0.1294         | 0.8187*        | 0.6313*        | 0.7150*        | 1.0000         |
| X <sub>7</sub> | 0.3554         | 0.0010         | 0.0001         | 0.0001         | 0.0000         | 0.3554         | 0.0010         | 0.0001         | 0.0000         |
| X <sub>8</sub> | -0.2099        | -0.0742        | -0.0979        | 0.1173         | -0.0286        | 1.0000         | 0.1314         | 0.5977         | 0.4857         |
| X <sub>9</sub> | 0.3809         | 0.6359*        | 0.6028*        | 0.5139*        | 0.5708*        | -0.0742        | 1.0000         | 0.0049         | 0.0001         |
|                | 0.1254         | -0.2165        | -0.1798        | -0.1736        | -0.1703        | 0.0718         | -0.1068        | 1.0000         | 0.3711         |
|                | 0.1294         | 0.1425         | 0.0456         | 0.6523*        | 0.3542         | 0.0021         | 0.2653         | 0.1552         | 1.0000         |
|                | 0.0001         | 0.0001         | 0.0001         | 0.0010         | 0.0001         | 0.0001         | 0.0010         | 0.0001         | 0.0000         |

\* found with multicollinearity problem.

Table 2. Results of the general linear model (before corrections performed).

| Estimated Variable              | Coefficient | Sig. level | Std. error |
|---------------------------------|-------------|------------|------------|
| Intercept                       | 7.94385     | 0.04480*   | 3.84141    |
| Feeding                         | 0.14793     | 0.89920    | 1.16125    |
| Type of breed                   | 0.09425     | 0.88330    | 0.63835    |
| Family labour                   | 1.18035     | 0.00010*   | 0.23596    |
| Income by other sources         | -0.00009    | 0.00030*   | 1463.34614 |
| Type of management              | 0.52683     | 0.39800    | 0.61700    |
| Experience in cattle management | 0.02157     | 0.34010    | 0.02236    |
| Education level of the farmer   | -0.00472    | 0.98780    | 0.30667    |
| Sex of the rearer               | 1.05712     | 0.27100    | 0.54867    |
| Land extent                     | 0.54268     | 0.00250*   | 0.15362    |

Model R-square = 0.48,  
No. of observations = 125F value = 41.91,  
\* significant at 5% level

Table 3. General Linear Model results (after corrections performed).

|                                 | Coefficient | Sig. level | Std. error |
|---------------------------------|-------------|------------|------------|
| Intercept                       | 8.76982     | 0.00120**  | 2.36540    |
| Feeding                         | 0.15236     | 0.00540**  | 1.00215    |
| Type of breed                   | 0.42586     | 0.00030**  | 0.44513    |
| Family labour                   | 1.19765     | 0.00010**  | 0.22156    |
| Income by other sources         | -0.02365    | 0.45861    | 1276.96256 |
| Type of management              | 0.54546     | 0.00040**  | 0.31256    |
| Experience in cattle management | 0.03356     | 0.00510**  | 0.01155    |
| Education level of the farmer   | -0.02564    | 0.02540*   | 0.30154    |
| Sex of the rearer               | 1.08250     | 0.00010**  | 0.45625    |
| Land extent                     | 0.66421     | 0.00050**  | 0.04587    |

Model R-square = 0.94,  
 No. of observations = 115  
 \*\* significant at 1% level

F value = 163.24,  
 \* significant at 5% level

Land extent, types of feed, types of breed, use of family labour, experience in cattle farming and the level of management showed positive relationships with the milk yield, and they were all at a significant level of 1%. However, the level of education did not explain the expected behaviour. The hypothesis of expecting of a positive relationship between the milk yield and the rearers education level was rejected at 5% probability level. Although a positive relationship between the milk yield and the higher education level was expected the analysis expressed a negative relationship. This may be because educated people tend to leave agriculture including cattle rearing and seek other sources of employment.

When farmers income from other sources such as crop production, carpentry, masonry, trading and other off farm activities increase they refrain from livestock keeping.

### CONCLUSIONS

The results of this study reveal that the most crucial factors affecting milk yield are extent of land owner, type of breed, type of feed, use of family labour and type of management. Available land for dairy activities (such as growing pasture, tethering *etc.*) in the mid-country is extremely limited and it is very important therefore to

investigate the alternative ways of addressing this problem in the future. This limited land factor must be looked at jointly with the types of breed and the types feed for dairy activities. In other words, when the available land is limited, technological advancement in terms of better feeds will have to be introduced in the future to increase the milk yield.

Further, it is essential to introduce better management practices such as intensive method of cattle rearing to enhance the milk production under these circumstances. Farmers should be encouraged to incorporate available nutritive feeds in their herd feeding programmes as a substitute to the expensive feeds whereby farmers can reduce the cost of milk production.

A better programme must be embarked on providing temperate breeds such as *Friesian*, *Jersey* and *Ayrshire* for the area which have been found to be appropriate. This programme must be coupled with an effective extension network. The importance of cattle rearing should be emphasized as a part of an integrated farming system, allowing the farmers to optimize the returns to the scarce resources especially land and cash inputs.

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