

Improving Labour Productivity of Smallholder Dairy Farmers: A Case Study from Kurunegala and Anuradhapura Districts

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ABSTRACT

Understanding factors affecting smallholder dairy farmers' productivity is essential to implement dairy sectors' policies in Sri Lanka. Using a sample of farmers from the two main dairy producing districts in Sri Lanka, factors contributing to marginal productivity increases of labour is assessed. Improving labour productivity in the dairy sector is of importance because dairying is a highly labour intensive production activity. We use a two stage estimation process to assess the factors contributing to higher productivity. In the first stage, a Cobb-Douglas production function is estimated. Results of this is used calculate the marginal product of labor for each farmer, which is related to policy variables in a second-stage regression. Results reveal that addition of labor hours into production by educated and experienced farmers increase production while labor hours spent by the older farmers tend to reduce productivity. Additional labor hours spent by larger farmers are more productive than smaller farmers. Training and extension provided positive signs, although not significant in the present data set. Involvement in off farm work proved to be increasing marginal product of labour. The paper concludes that the development of human capital and increasing herd size may prove to be important in maintaining continuous supply of farm labor in the years to come.

KEYWORDS: Smallholder dairy farmers, Productivity, Marginal Product of Labour, Elasticity

INTRODUCTION

Milk production in Sri Lanka is growing at a slow rate. It has grown only from 177 million liters in 1998 to 208 million liters in 2008 (Department of Census and Statistics, 2008). Nevertheless, demand, especially in urban areas has increased dramatically.

Thus, domestic milk production in Sri Lanka can fulfill only 17% of the need, and the rest has to be imported eating up the invaluable foreign exchange earnings (Ministry of livestock development, 2007). However, dairy industry is believed to have a vast potential to develop the country's economy.

Dairy farming in Sri Lanka is mainly carried out as a small holder activity. In fact, it is mostly a mixed crop-livestock farming operation (Bandara, 2000). Dairy production in Sri Lanka is faced by a multitude of perceived and often experienced risks, which contribute to high costs of production and low average productivity. These factors cause low profit to the producer and price fluctuations for the consumer (FAO, 2009).

Most empirical studies using econometric models habitually relate the adoption decision to household and technological characteristics. Numerous studies have found that constraints imposed by these factors have discouraged technology adoption (Umali and Schwartz 1994; Nicholson et al 1999). These factors influence the awareness, availability, costs, benefits and risks associated with the different livestock technologies and management practices (Benin et al 2003).

Being a pre-dominantly a smallholder activity, dairy industry depends on farmers using their own time in dairy activities. Therefore, understanding the factors which affect marginal productivity of household labor of dairy farmers is critical. By looking after these factors it helps in increasing supply of labor in dairy production, where it is difficult to assign a wage rate to assess its returns.

This study mainly focuses on the factors contributing marginal productivity of labor. It is organized as follows. The paper initially proposes a model for production of milk in smallholder dairy sector to calculate the marginal product of labour (MPL). The focus then turns to find out the factors that affect farmer productivity by developing another model taking MPL as the response variable. The last section of this paper pays attention to results, conclusion and policy implication.

METHODOLOGY

Data Collection

Total neat cattle population in Sri Lanka was 1,195,610 in 2008. From those 141,720 cattle were reared in Kurunegala District and 158,855 were reared in Anuradhapura District (Census and Statistics, 2008). Number of holdings reporting cattle's in Sri Lanka in 2002 was 209,050. From them, 39,478 were in Kurunegala District and 19,701 were in Anuradhapura District (Census and Statistics, 2002). Therefore, these two districts were selected for collecting data for this study.

Farmers were selected from the veterinary officers lists in the areas data are collected. The preliminary questionnaire was validated by piloting with a small sample of 5 respondents. Then the questionnaire was revised to be used in the final survey from March to April in 2009. The size of the sample was 160 with 80 respondents from each district.

Conceptual Framework

Marginal Product (MP) of a particular input shows the change in total production if the input is increased by one unit. Therefore, for a production function given by; $Y=f(X_1, X_2, \dots, X_n)$, The MP of variable X_1 is; $MP_{X_1} = \partial Y / \partial X_1$. If Y above is production of milk and X_1 is labor hours used in production, then the MP_{X_1} gives the increase in milk production when the number of hours of labor used in cattle

rearing increases by one unit. If we calculate this MP for each farmer, it would give us an idea of how the production would change if farmers put more effort (i.e. more labor hours) into production. However, the question is how would farmers' circumstances such as his intellectual capital, managerial ability, his physical ability, knowledge etc affect the increase in production? Does the increase in the household labor supply into their production affect different farmers differently? If so, returns on investment of labor into production may differ among farmers. The attempt here is to identify the factors that can increase this return on investment and to improve farmers' income. This is particularly important as majority of farmers use only family labor in production and if they feel that their return on investment is poor in dairy, they will use their labor elsewhere, and migration of labor from dairy to other sectors would inevitably take place.

The estimation strategy here is as follows. First, a Cobb-Douglas production function is estimated. Then, the MP of labor is obtained from the estimated production function by differentiating with respect to labor hour variable. Calculated marginal products are related to a set of policy variables using a separate regression to see the impacts.

Econometric Model

The production function estimated is;

$$\ln Q_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + \beta_6 D_{1i} + \beta_7 D_{2i} + e_i$$

Where,

Q_i = Milk yield in liters per year for the i^{th} farmer (household)

X_{1i} = Number of cows in milk in the i^{th} household

X_{2i} = Labour hours per year used by the i^{th} household

X_{3i} = Cost of feeds per year by the i^{th} household

- X_{4i} = Grazing hours per year by the i^{th} household
 X_{5i} = Veterinary cost per year by the i^{th} household
 D_{1i} = Feed cost dummy (1=feed cost, 0=no feed cost)
 D_{2i} = Grazing dummy (1=free grazing 0=no grazing)
 β = values are the coefficients to be estimated
 e = Error

The problem of zero observation when estimating such a log function is overcome by introducing dummy variables D_{1i} and D_{2i} as in Battese (1997). The MP of labor was related to following variables in the second regression.

$$\ln Y_i = \alpha_0 + \alpha_1 \ln Z_{1i} + \alpha_2 \ln Z_{2i} + \alpha_3 \ln Z_{3i} + \alpha_4 \ln Z_{4i} + \alpha_5 \ln Z_{5i} + \alpha_6 \ln Z_{6i} + \alpha_7 D_{1i} + \alpha_8 D_{2i} + \alpha_9 D_{3i} + \alpha_{10} D_{4i} + v_i$$

- Y_i =Marginal product of labor of the i^{th} farmer
 Z_{1i} = Age of i^{th} farmer
 Z_{2i} = Education level of the i^{th} farmer
 Z_{3i} = Experience of the i^{th} farmer
 Z_{4i} = Cross bred ratio of the i^{th} farm
 Z_{5i} = Total number of cows in i^{th} farm
 Z_{6i} = Number of visits of extension officer
 D_{1i} =Training programs dummy (1=attend 0=not attend)
 D_{2i} =Milk society dummy (1=member 0=not member)
 D_{3i} =Employment dummy (1=employed 0=not employed)
 D_{4i} =Milking time dummy (1=two times per day, 0=one time per day)
 α values are the coefficients to be estimated
 v_i = random error

RESULTS AND DISCUSSION

Descriptive Statistics of Variables Used in Study

Descriptive statistics of the variables used in the two functions are given in Table 1 and 2.

Table 1: Descriptive statistics of dummy variables used

Dummy Variables	Yes	No
Give concentrates	67.53	32.47
Let animals for grazing	87.66	12.34
Went for a training	63.64	36.36
Member of a milk society	70.78	29.22
Employed in off-farm	24.68	75.32
Milk two times	17.53	82.47

All values are in percentages

Table 2: Descriptive statistics of the variables used in the analysis

Variables	Min	Mean	Max
Milk yield (liters)	182.5	3023.3	14600
No. milking cows	1	2.3	10
Labour hours	182.5	1623.5	4380
Cost of Feed (LKR)	0	1681.5	15000
Grazing hours	0	3039.8	8760
Veterinary cost (LKR)	0	4954.1	38500
Marginal Product of Labour	0.044	0.343	1.247
Education level (Grade)	0	7	11
Experience in dairy sector (Years)	0.021	12.879	60
Age of the farmer (Years)	22	46-47	70
Extension visits	0	3	50
Total cows	1	8	45
Crossbred ratio	0	0.78	1

All values in the table in per year basis

The Production Function

The results of the estimation of Cobb-Douglas production function is given in Table 3. All five inputs used in the production function are found to be significant. Number of cows, hours spent

in dairy activities, cost of feeds, hours of grazing and cost for veterinary services positively influenced milk production.

As expected, the number of cows had the highest elasticity of production. The significant and negative dummy variable with respect to grazing indicates a lower intercept for farmers who graze their animals than farmers who do not. This implies that farmers who use cut and fed systems achieve more production.

The number of cows milked increased milk production positively (Table3). The positive coefficient for number of animals suggested that for 1 percent increase in number of cows will increase milk production by 0.478 percent.

Similarly a one percent increase in labor hours spent increases production by 0.184 percent and a one percent increase in feed cost, grazing hours and cost of veterinary will lead to an increase of 0.14, 0.228 and 0.03 percent of production respectively.

Table 3: Estimates of Cobb-Douglas production function

Variable	Coefficient	P>[t]
No. milking cows	0.478**	0.000
Labour hours	0.184**	0.034
Cost of Feed	0.148**	0.027
Grazing hours	0.228**	0.015
Veterinary cost	0.031*	0.061
Dummy Feed	-0.790	0.113
Dummy grazing	-2.141**	0.005
Constant	5.939**	0.000

**Significant at the 0.05. *Significant at the 0.1 level Number of observations = 154, R Square = 0.4489, Probability>F = 0.000

Average milk production per year in the sample was 3023.33. Based on the estimated coefficient and the elasticities of production, table 4 describes the addition to milk production of an average farmer if each input is increased by 100 percent.

Table 4: Increase of the milk yield with the increase of inputs by 100 percent for an average farmer

Variable	Additional milk produce (liters / year)
No. milking cows	1445.15
Labour hours	556.293
Cost of Feed	447.453
Grazing hours	689.319
Veterinary cost	93.723

Average milk production of a farmer per year was 3023.33 liters; Elasticities are in percentages

Factors Affecting Marginal Productivity

The result for this second regression is given in Table 5. Six variables were significant at 95% confidence level ($P < 0.05$) and the dummy for milking time was significant at 90% confidence level ($P < 0.1$). Three variables were found to be non-significant ($P > 0.05$) in explaining the marginal product.

Education level, Experience in dairy sector, Dummy of attended training programs, Number of visits of extension officer, Dummy of employed or not, Number of total cows and Dummy of milking times per day variables positively influenced marginal productivity of dairy farmers in the sample. But Age of the farmer, Dummy of member of milk society and cross bred to local cattle ratio had negatively influenced it (Table 5).

Education level of the farmer increased the marginal productivity of the farmer (Table5). Experience in dairy sector increased the productivity of the farmer. This happens because of the specialization. Marginal productivity of the farmer increased if he attends for training programs. Because of the knowledge about the dairy industry and the awareness of the physiology of cattle's farmers' productivity can increase. Also training programs increased the attitude of the farmers in dairy sector. This will guide for high productivity.

Table 5: Regression model of productivity of farmers in Sri Lanka

Variable	Coefficient	P>[t]
Education level	0.315**	0.000
Experience in dairy sector	0.122**	0.001
Age of the farmer	-0.408**	0.002
Training program dummy	0.083	0.316
Extension visits	0.010	0.326
Society member dummy	-0.009	0.913
Employed or not dummy	0.294**	0.006
Total cows	0.175**	0.013
Crossbred ratio	-0.300**	0.040
Milking time dummy	0.136*	0.100
Constant	-1.005*	0.090

**Significant at the 0.05. *Significant at the 0.1 level Number of observations = 123, R Square = 0.3409, Probability>F = 0.000

Productivity of the farmer increases if he worked off-farm. Off-farm employment increased farmers' exposure to opportunities for extra money. It seems that they use their scarce time resource efficiently. Marginal productivity of farmers who milk twice a day is more than those who milk once, as the average milk production per day is increased. When the crossbred to local cattle ratio increased productivity of farmer decreased. This means that when the number of crossbred cattle in the herd increases farmers' productivity goes down. It seems that farmers are unable to obtain the potential production of a cross bred cow with their efforts. Productivity of farmer increased when the number of visits of extension agents increased. This suggested that if the extension agent visited more time to farm productivity of the farmer increased marginally. Extension is an important activity that generates knowledge and the latest technology for the farmers to increase their productivity.

Productivity of the farmer decreased when he became a member of a

milk society. This sign is counter intuitive. However, it was not significant. The total number of cows was included in to the analysis to see the impact of size of the holding on marginal productivity. The positive sign indicate that larger farmers are more have higher possibility of increasing production by using more time in dairy activities.

CONCLUSION

The findings suggest that addition of labor hours into production by educated and experienced farmers increase the production while labor hours spent by the older farmers tend to reduce productivity. Additional labor hours spent by larger farmers are more productive than the smaller farmers. Training and extension provided positive signs though not significant. However, off-farm work confirmed to be increasing marginal product. These findings have important implications for labor supply by smallholder farmers in to dairy industry. As discussed before, supply of labor to the industry depends on the return on using an additional hour of labor, which is given by the marginal product. The positive impacts of education and experience suggest that high quality human capital leads to the return on investment to labor. Thus, development of human capital is important through training and extension. In addition, taking younger generation in to dairy production is important in maintaining continuous supply of labor in the future. Further, as larger farmers were found to be getting increased returns for additional hour of labor invested, it is important that efforts be made to increase the herd sizes. This may be by means of credit or subsidies in obtaining animals.

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