

Full Length Research Paper

Milk production function and resource use efficiency in Jaipur District of Rajasthan

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Received 27 June, 2015; Accepted 16 July, 2015

The study was undertaken during 2013 and 2014 in Jaipur District of Rajasthan with the objectives to examine the input-output relationships and assess the resource use efficiency in milk production. The study covered 100 commercial dairy farms. The results of Cobb-Douglas production function revealed that expenditure on dry fodder and green fodder for small category of herd size were found to be positive and significant. The results for medium category of herd size revealed that partial regression coefficients for expenditure on green fodder and miscellaneous expenditure for were found positive and significant. The results for large category of herd size revealed that the partial regression coefficient for expenditure on concentrate and miscellaneous expenditure were found positive and significant. In case of small category of herd size, it was observed that dry fodder, green fodder, labour and miscellaneous expenses were optimally utilized. In case of medium category it was observed that dry fodder, green fodder and miscellaneous expenses were optimally utilized. In case of large category of herd size, dry fodder, concentrate and miscellaneous expenditure were optimally utilized.

Key words: Concentrate, dry fodder, green fodder, labour, milk, mvp and resource use efficiency.

INTRODUCTION

One of the most significant changes in India's agricultural economy over the past three and a half decades has been the rising contribution of livestock sector in the agricultural gross domestic product. Between 1970 and 2012, the share of livestock in agricultural gross domestic product has risen from 17 to 26% (Govt. of Rajasthan, 2014). The milk production is influenced by various genetic and non-genetic factors. The non-genetic factors influencing the milk production are quantity and quality of feeds and fodders fed, order of lactation, stage of lactation, herd size, labour use etc. Hence the selection

of suitable variables to study the milk production is very essential. To ensure the optimal use of various inputs used by the milk producers is matter of primary concern. It is important to know whether the inputs owned by commercial dairy farmers are used efficiently or not. An empirical assessment of determinants of milk production and resource use efficiency are important for planning, projecting and formulating dairy development policies in a particular region of the country. The input-output relationship in milk production and resource use efficiency have been studied by several researchers in

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the various parts of the country and found different for different areas depending upon the type of milch animals and the milk production technology. No study has been carried out to investigate the milk production function and resource use efficiency in respect of commercial dairy farms in Jaipur district of Rajasthan.

The present study was undertaken to fill this vital gap with the specific objectives to (i) examine the input-output relationships in milk production across different categories of herd sizes of commercial dairy farms, and (ii) Study the resource use efficiency in milk production across different herd size categories of commercial dairy farms.

REVIEW OF LITERATURE

Mahajan (2010) in his study economic analysis of rural and peri urban farm in Ludhiana district of Punjab indicated that Cobb Douglas function was best fit. In production function of peri urban dairy farm, the partial regression coefficient of expenditure on concentrate for crossbred cattle were found positive and significant with total explained variation, that is, R^2 as 84.3%.

Singh (2008) in his study on economic analysis of milk production of milk production in Varanasi District of Uttar Pradesh concluded that green fodder; dry fodder and concentrate were underutilized indicating that feeding of more quantity of green fodder and concentrate will further increase the productivity of milch buffaloes in the study area.

Wani et al. (1992) studied input-output relationship in milk production and estimated the marginal value product of relevant input variables separately for non-descript and crossbred cows in the Kashmir valley.

METHODOLOGY

The study was conducted during 2013 to 2014 in Jaipur district of Rajasthan. The sampling design consisted of selecting the ultimate sampling unit, that is, dairy commercial farms using multistage random sampling method. The tehsils, villages and sample commercial dairy farms consisted the first, second and third stage of sampling. Jaipur district has 13 tehsils namely Amer, Chomu, Jamwaramgarh, Phagi, Phulera, Bassi, Sanganer, Muzamabad, Viratnagar, Kotputli, Chaksu, which were classified on the basis of water and type of animal into different zones. Out of thirteen tehsils, six tehsils namely Amer, Bassi, Shahpura, Sanganer, Phulera and Jaipur theseil were selected consisting of 590 commercial dairy farms. Among 590 commercial dairy farms 100 commercial dairies were selected on the basis of probability proportional to size.

The selected 100 commercial dairies were post stratified into three categories using Cumulative Square Root Frequency Method on the basis of number of milch animals. The commercial dairy farms were thus categorized into three herd size categories namely small (up to 31 milch animals), Medium (32-45 milch animals) and large (above 45 milch animals). The distribution of sampled commercial dairy farms in the small, medium and large herd size categories were found to be 43, 41 and 16 respectively. The primary data of commercial dairy farms were collected with help of

well structured pre-tested schedule by personal interview/enquiry method. The data were collected on milk production, quantity of green fodder, dry fodder, concentrate and miscellaneous expenditure along with their monetary values.

Analytical framework

Specification of milk production function

The specification of milk production function used in the present study for functional analysis is as follows:

$$Y = f(X_1, X_2, X_3, X_4, X_5)$$

Where, Y = Income from milk per farm per day (Rs.); X_1 = Expenditure on green fodder per farm per day (Rs.); X_2 = Expenditure on dry fodder per farm per day (Rs.); X_3 = Expenditure on concentrate per farm per day (Rs.); X_4 = Value of labour used per farm per day (Rs.); X_5 = Miscellaneous expenses per farm per day (Rs.).

Four types of functional forms, viz., Cobb-Douglas, Linear and Semi log (both linear-log and log-linear models) were tried which are as follows:

$$Y = a + \sum_{i=1}^n b_i X_i + \mu$$

Linear:

$$Y = a \prod_{i=1}^n X_i^{b_i} e^{\mu}$$

Cobb Douglas:

$$\ln Y = a + \sum_{i=1}^n b_i X_i + \mu$$

Semi Log(Log-Lin):

$$Y = \ln a + \sum_{i=1}^n b_i \ln X_i + \mu$$

Semi log(Lin-Log):

Where, Y = value of output; X_i = value of i^{th} input used; a = constant term; b_i = partial regression coefficient of the i^{th} input to be estimated; μ = random error distributed normally with zero mean and constant variance, and e = base of natural log.

The best function will be selected on the following economic and statistical criteria:

1. The higher value of coefficient of multiple determination (R^2)
2. Significant level of individual regression coefficients, and
3. The ability of the function to provide economically meaningful results.
4. The minimum value of Root Mean Square Error (RMSE).

Cobb-Douglas production function was found best fit for all categories of commercial dairy farms because it has high value of R^2 and low value of Root Mean Square Error (RMSE) among all other fitted production functions (Table 1).

Ideally, the output (Y) and inputs (X_i) in the above production functions were measured in monetary values rather than their

Table 1. Root mean square error (RMSE) and R² (%) values of different fitted production functions.

Type of function	Category of commercial dairy farm					
	Small		Medium		Large	
	RMSE	R ² (%)	RMSE	R ² (%)	RMSE	R ² (%)
linear	0.629	23.520	18.180	84.360	0.123	87.780
log lin	0.253	21.910	0.062	84.760	0.047	87.790
Cobb-Douglas	0.235	32.420	0.066	82.740	0.043	89.630
lin log	0.586	33.260	0.197	81.600	0.114	89.600

Table 2. Various fitted production function and their marginal value product

Type of function	Marginal value product
Linear	b_i
Cobb Douglas	$b_i \times \frac{\bar{Y}}{\bar{X}}$
Semi log (lin log)	$\frac{b_i}{\bar{X}}$
Semi log (log lin)	$b_i \times \bar{Y}$

b_i = partial regression coefficient of the i^{th} input to be estimated; \bar{Y} = geometric mean of output Y, and \bar{X} = geometric mean of input X

physical quantities. This was done because the quality of different feeds and fodders differ from one respondent to the other and can be more appreciably reflected in value terms. The monetary values of inputs in production functions have been preferred over physical quantities by many of earlier researchers e.g. Sharma and Singh (1993), Shiyani and Singh (1996) etc.

Marginal value product

Marginal value productivity of inputs was estimated from the fitted production function (Table 2).

Recourse use efficiency

Recourse use efficiency of an input measures whether or not the input is used optimally. The inputs are used optimally if the MVP of the input is equal to its price, that is,

$$MVP_i = P_i$$

Where P_i is the unit price of input

In order to examine the resource use efficiency, the marginal value productivity of various inputs was worked out for significant regression coefficients in the estimated milk production function. Any deviation of MVP of input from its unit price may be termed as resource use efficiency. The higher the difference between MVP of an input and its unit price, the higher is the resource use inefficiency and vice versa.

Further, t-statistics given below was used to test the statistical significance of the difference between MVP and its unit price. If the

difference between MVP of an input and its unit price is statistically non significant, it indicates that the inputs is being utilized efficiently. A significant higher MVP of an input than its unit price shows that the input can be used further to increase productivity, while a significantly lower MVP of an input is being used in excess and hence needs reduction.

t statistic:

$$t = \frac{MVP_{x_i} - P_{x_i}}{S. E. (MVP_{x_i})}$$

S.E (MVP_i) = Standard error of MVP, and P_i is the unit price of input.

RESULTS AND DISCUSSION

The Cobb-Douglas production function for all categories of commercial dairy farms has been presented in Table 3. A close perusal of the table revealed that the coefficient of multiple determination (R²) for the small, medium, large and overall category was 32.42, 82.74, 89.63 and 17.73% of total variation in income from milk per farm per day, respectively, were explained by the variables included in the selected regression model.

It was revealed from Table 3 that partial regression coefficients of expenditure on dry fodder and green

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Table 4. Estimated coefficients of milk production function for different categories of commercial dairy farms.

Category	No. of dairy farms	Constant	Regression Coefficients					R ² (%)
			G.F (X ₁)	D.F (X ₂)	Conc. (X ₃)	Labor (X ₄)	Misc. (X ₅)	
Small	43	2.571 (1.977)	0.155* (0.062)	0.487** (0.151)	0.736 (0.410)	-0.499* (0.229)	-0.293* (0.121)	32.42
Medium	41	3.100 (1.074)	0.631** (0.152)	-0.086* (0.136)	0.0966 (0.303)	0.191 (0.097)	0.297* (0.124)	82.74
Large	16	-8.967 (3.629)	-0.200** (0.022)	0.185 (0.281)	3.986*** (0.765)	-1.655** (0.417)	1.188** (0.240)	89.63
Overall	100	3.423 (1.193)	0.043 (0.083)	0.112 (0.099)	0.605* (0.242)	-0.344** (0.113)	-0.009 (0.083)	17.73

Figures in parenthesis indicate the standard error of regression coefficient. *Significant at p<0.05, ** significant at p<0.01.

fodder for small category of herd size were found to be positive and significant. The production function analysis indicated that milk production could be increased through effective feeding of concentrates. The table further revealed that partial regression coefficients for labour and miscellaneous expenditure were negative and significant. The concentrate, was, thus, found to have no impact on income from milk.

The partial regression coefficients for expenditure on green fodder and miscellaneous expenditure for medium category of herd size were found to be positive and significant with total explained variation, that is, R² as 82.74%. The production function analysis indicated that milk production could be increased through effective feeding of green fodder and miscellaneous expenditure.

The partial regression coefficient for expenditure on concentrate and miscellaneous expenditure for large category of herd size were found to be positive and significant. The production function analysis indicated that milk production could be increased through effective feeding of concentrate and by increasing miscellaneous expenditure. The table further revealed that partial regression coefficient for labour and green fodder, it was negative and significant which implied that by increasing expenditure on green fodder and labour income from milk production will decrease. The partial regression coefficient for dry fodder, was, thus, found to have no

impact on income from milk. The study is similar to Mangesh (2003).

The partial regression coefficients for expenditure on concentrate and labour for overall were found to be positive and significant which implies that income from milk production could be increased through effective feeding of concentrate and by decreasing use of labour. The table further revealed that partial regression coefficients for rest of variables were found statistically non-significant which implied that these variables not have impact on income from milk. The study is similar to Das (2004)

In order to find out whether or not the significant inputs viz. green fodder, dry fodder, labor and miscellaneous in case of small category of herd size and green fodder, dry fodder and miscellaneous expenditure in case of medium herd size and green fodder, concentrate, labour and miscellaneous in case of large category, concentrate and labour in case of overall farm were used efficiently, Marginal value of productivities (MVP) of these inputs has been worked out (Table 4).

Resource use efficiency in milk production

In order to examine the resource use efficiency, the marginal value productivities (MVP) of inputs whose

Table 5. Resource use efficiency in milk production.

Small category	MVP	Input Price	Difference	S.E	t-value
Dry fodder	1.51	1.00	0.51	0.06	0.34
Green fodder	7.29	1.00	6.29	0.15	0.86
Labour	2.69	1.00	1.69	0.23	0.63
Miscellaneous	17.66	1.00	16.66	0.12	0.94
Medium category					
Dry fodder	3.57	1.00	2.57	0.15	0.72
Green fodder	7.65	1.00	6.65	0.14	0.87
Miscellaneous	23.25	1.00	22.25	0.12	0.96
Large category					
Dry fodder	0.57	1.00	-0.43	0.15	-0.11
Concentrate	1.95	1.00	0.95	0.30	1.23
Labour	8.14	1.00	7.14**	0.10	3.78
Miscellaneous	49.22	1.00	48.22	0.12	1.89
Overall					
Dry fodder	1.03	1.00	0.03	0.80	0.03
Green fodder	5.66	1.00	4.66	4.87	0.96
Concentrate	1.44	1.00	0.44	0.58	0.76
Labour	-5.03	1.00	-6.03**	1.66	-3.62
Miscellaneous	-1.52	1.00	-2.52	14.22	-0.18

**Significant at $p < 0.01$.

regression coefficients were found statistically significant in estimated milk production function were compared with their acquisition cost, that is, marginal factor cost (MFC).

The inputs viz., green fodder, dry fodder, labour and miscellaneous expenditure in case of small category, green fodder, dry fodder and miscellaneous expenditure in case of medium, green fodder, concentrate, labour and miscellaneous in case of large and concentrate and labour in case of overall herd size category of commercial dairy farm were found to be statistically significant. The marginal value productivity of all the significant inputs was computed at their geometric mean level. The results of the different herd size categories are presented in Table 5 along with their prices. Since all the inputs were expressed in monetary terms in the production function, the acquisition cost of the inputs was taken as Re.1. The estimated marginal value productivity was, therefore, compared with unity to examine the resource use efficiency. t-statistic was used to test the significance of deviation of MVP of an input from its unit price. A significant higher difference of MVP of an input from its unit price shows that more of that input can be used to increase productivity, while a significant lower difference MVP of an input from its unit price indicates that the input is used in excess and needs curtailment. The marginal value productivity (MVP) of significant inputs for all categories of commercial dairy farms, their difference with unit price of respective inputs (MFC) and t-statistic are given in the

Table 5.

In case of small category of herd size, it can be observed that marginal value productivity of dry fodder, green fodder, labour and miscellaneous expenses were found to be positive but statistically non-significant. Similar findings were also observed in case of medium category of herd size, it can be revealed that marginal value productivity of dry fodder, green fodder and miscellaneous expenses were found to be positive but statistically non-significant.

The marginal value productivity of dry fodder, concentrate and miscellaneous expenses were found to be statistically non-significant in case of large category of herd size while it was positive and statistically significant for labour. The marginal value productivity of labour was under utilized as the difference between its MVP and unit price was positive and significant in the study area.

The marginal value productivity of concentrate was found to be statistically non-significant in case of overall category of herd size. The marginal value productivity of labour was negative and significantly lower than their acquisition cost which indicated that labour was over-utilized in the study area.

Conclusions

The green fodder, dry fodder, labour and miscellaneous

expenditure were found to be statistically significant in case of small category of commercial dairy farm, green fodder, dry fodder and miscellaneous expenditure in case of medium, green fodder, concentrate, labour and miscellaneous in case of large and concentrate and labour in case of overall herd size category. The results of resource use efficiency indicated that none of the marginal value productivity of all inputs was statistically significant across and overall herd size category except labour in large category and overall herd size category in the study area.

Conflict of Interest

The authors have not declared any conflict of interest.

ACKNOWLEDGMENTS

The author avail the opportunity to express their deep sense of gratitude to Dr. Ravinder Malhotra, Principal Scientist, Division of Dairy Economics, Statistics and Management, NDRI, Karnal and Major adviser for his guidance, sustained encouragement. He owe his deepest gratitude to Dr. A.K. Srivastava, Director, NDRI for providing the necessary facilities and support for research work. He is also thankful to his brother Dr. sanwermal Vishnoi (Veterinary officer) and mother Mrs. Mohani Devi for providing datas and guideline for research work.

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