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Research Paper

Production Function and Resource Use Efficiency of Milk Production in Rural Punjab

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ABSTRACT

Aiming to make an empirical assessment of the resource use efficiency in milk production of different milch breeds in rural Punjab, the present study reveals that both green fodder and concentrates in case of buffalo milk production and concentrates alone in case of crossbred cow milk production, have been found as significant factors affecting the milk yield in rural Punjab. However, not even a single input is found as statistically significant for local cow milk production. The marginal value productivity of all inputs is worked out as positive in the case of buffalo and crossbred cow milk production, but negative for local cow milk production. The deviation of marginal value productivity of inputs from its unit price reveals resource use inefficiency in the study.

HIGHLIGHTS

- Green fodder and concentrates are found to be statistically affecting the milk yield of buffaloes.
- Resource use inefficiency has been found in the study area.

Keywords: Determinants, milch breeds, resource use efficiency, marginal value productivity, milk production

The livestock sector has originated as a critical sub-sector of agriculture in Punjab. The sector involves millions of resource-poor farmers, for whom critical livelihood, economic stability and sustainable farming have been ensured by animal ownership (Kaur and Toor, 2022). India has huge livestock population and its efficient utilisation is crucial to increase returns and sustain livestock production activities by encouraging agro-based industries (Dhawan and Kashish, 2016). Milk production is an economic activity playing a role in socio-economic development of any economy. Milk serves as one of the major source of food for all nations. Increasing production of milk has been major objective of dairy development in India. The Indian dairy industry has undergone noteworthy changes with tremendous increase in production of milk. The significant growth in milk production has been a matter of contentment. There are two sources of growth in milk production: increase in the population of milch animals and increase in productivity per milch animal (Nair, 1985). In 2019-2020, milk production in Punjab was 13347 thousand tonnes and the growth rate was about 5.60 per cent per annum. Per capita milk availability in the state has reached to 1225 grams per day in 2019-2020 at the growth rate of 3.73 per cent per annum (GoP, 2020).

Many studies have been done to analyse the resource use efficiency in milk production in different states of India (Sankhayan and Joshi, 1975; Venkatesh and Sangeetha, 2011; Meena *et al*. 2012; Pandian *et al*. 2013; Tanwar *et al*, 2015; Lalrinsangpuii and

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Malhotra, 2016; Chandra and Bhandauria, 2017; Kumar and Shukla, 2017). However, very less work is done on this aspect in the state of Punjab. The knowledge of determinants of milk production and resource use efficiency is very crucial for formulating any policy related to dairying. In this context, the present study has been carried out with following objectives:

1. To make an empirical assessment of determinants of milk production.
2. To analyse the resource use efficiency in milk production of different milch breeds in rural Punjab.

MATERIALS AND METHODS

Sampling

The present study is carried out in Punjab state of India and is based upon primary data collected in 2019. Five-stage stratified sample techniques has been used to select the sample. In the first stage of sampling, the state of Punjab has been selected due to the importance of dairying in agricultural dominated state. In second stage, three districts, based on production of milk, have been selected. One district each has been chosen from high, medium and low milk production districts. On milk production basis, Gurdaspur district has been selected from the high milk production districts, Mansa from the medium milk production districts and S.B.S. Nagar from the low milk production districts. In a way, these three districts also represent the three agro-climatic regions zones of Punjab viz. the Shivalik Foothills Zone (Gurdaspur), South-West Dry Zone (Mansa) and Central Plains Zone (S.B.S. Nagar). Also, the three selected districts represent the three regions of Punjab viz. Majha (Gurdaspur), Malwa (Mansa) and Doaba (S.B.S. Nagar).

In third stage of sampling, all the development blocks from the selected districts have been selected. Thus, in all, twenty-one development blocks have been selected for the survey. These include eleven development blocks from Gurdaspur, five from Mansa and remaining from SBS Nagar. Villages are selected in the fourth stage of sampling. Twenty-one villages, one from each block, have been chosen for the study. These consist of eleven villages from Gurdaspur, five from Mansa and five villages from SBS Nagar. In fifth stage of sampling, a list of households involved in dairying from all twenty-one selected villages was prepared and households were categorized into five categories viz. landless households, marginal farmers, small farmers, medium farmers and large farmers. Four dairy farm households from each category have been selected randomly from the selected villages. Thus, a sample of twenty dairy farmers has been selected randomly from each chosen village, totaling 420 dairy farm households from the selected categories from all selected villages.

DATA ANALYSIS

Cobb-Douglas Production Function

The Cobb-Douglas production function was initially used in the manufacturing industry of America by C.W. Cobb and P.H. Douglas. The production function reveals the technological relationship between the quantity of output and the number of inputs required to produce that level of output. In the present study, the functional form of the Cobb-Douglas production function is given as:

$$Y = AX_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} X_4^{\beta_4} e^{\mu}$$

Where Y is milk yield (litres per day per animal), X_1 is the quantity of green fodder (kg per day per animal), X_2 is the quantity of dry fodder (kg per day per animal), X_3 is the quantity of concentrate feed (kg per day per animal), X_4 is the human labour (hours per day per animal) and β's are the regression coefficients associated with the explanatory variables of the model.

Marginal Value Productivity (MVP)

The marginal value productivity of inputs is calculated as:

$$MVP_i = \beta_i \frac{\overline{Y}}{\overline{X}_i}$$

Where, MVP_i is the marginal value productivity of i^{th} input, β_i is the regression coefficient associated with i^{th} input, $\overline{Y}$ is the geometric mean of output and $\overline{X}_i$ is the geometric mean of i^{th} input.

Resource Use Efficiency

Resource use efficiency shows whether or not the

resources or inputs are efficiently utilised. If the MVP of the inputs equals its unit price, i.e. P_i, then the resources are said to be efficiently utilised [Meena *et al*. (2012); Lalrinsangpuii and Malhotra (2016)]. The deviation of MVP_i from P_i reveals the resource use inefficiency. The significance of the difference between MVP_i and P_i is tested using a t-test.

$$t = \frac{MVP_i - P_i}{SE(MVP_i)}$$

Where SE (MVP_i) is the standard error associated with marginal value productivity of i^{th} input and is given by:

$$SE(MVP_I) = SE(\beta_I)\frac{\overline{Y}}{\overline{X}_I}$$

and SE (β_1) is the standard error of the i^{th} input.

RESULTS AND DISCUSSION

Input-Output Relationship

The Cobb-Douglas production function shows the relationship between various inputs, such as green fodder, dry fodder, concentrates and human labour, and milk yield. Table 1 shows that in the case of buffalo milk production function, out of all, green fodder and concentrates were found to be statistically significant. It shows that the quantity of green fodder and concentrates fed to the buffaloes has a significant impact on the milk yield of buffaloes. The partial output elasticity of milk yield for green fodder reveals that a one per cent increase in the quantity of green fodder led to a 0.042 per cent increase in milk yield of buffaloes. This is because green fodder is a great source of nutrients for dairy animals and also affects their growth. On another hand, the partial output elasticity for concentrates shows that a one per cent change in the quantity of concentrates leads to a 0.043 per cent change in buffalo milk yield as concentrates are low-fibre and high-energy feeds. The results of the study conform with the findings of Meena *et al*. (2012) and Pandian *et al*. (2013) which have shown that the quantity of green fodder and concentrates significantly affects the buffalo milk yield.

In the case of local cow milk production function, the coefficient of multiple determination (R^2) is 0.35, implying that just 35 per cent of changes in milk yield of local cows were due to changes in explanatory variables of the study. The adoption of better healthcare practices could be other factors that are affecting the milk yield of local cows. Additionally, no explanatory variable is found to be statistically significant. The coefficients of dry fodder, concentrates and human labour are negative and insignificant. The results are in line with the findings of Lalrinsangpuii and Malhotra (2016), and Kumar and Shukla (2017) that have shown negative and insignificant coefficients of dry fodder in the case of local cow milk production function in Mizoram and western Uttar Pradesh, respectively.

In case of crossbred cows, the estimated coefficient of concentrates, out of all explanatory variables, was found to be statistically significant. The partial output elasticity of crossbred cow milk production for concentrates shows that a one per cent change in the quantity of concentrates leads to a 0.07 per cent change in milk yield of crossbred cows. The results

Table 1: Estimated Coefficients of Cobb-Douglas Milk Production Function

Category	Regression coefficient					R^2
	Constant	Green Fodder	Dry Fodder	Concentrates	Human Labour	
Buffalo	5.531**	0.042**	0.03	0.043**	0.023	0.62
	(0.069)	(0.013)	(0.018)	(0.016)	(0.025)	
Local cow	2.27**	0.002	– 0.052	– 0.012	– 0.062	0.35
	(0.056)	(0.024)	(0.039)	(0.032)	(0.064)	
Crossbred Cow	2.435**	0.08	0.01	0.070**	0.003	0.52
	(0.058)	(0.027)	(0.025)	(0.037)	(0.046)	

Source: *Field Survey, 2019.*

**Statistical significance at 5 per cent level of significance.*

were in agreement with the findings of Sankhayan and Joshi (1975), and Chandra and Bhadauria (2017) who have shown a positive significant coefficient of concentrates in rural areas of Punjab and among small farmers of Uttar Pradesh respectively.

Resource Use Efficiency in Milk Production

The resource use efficiency in milk production is achieved when the marginal value productivity of inputs equals their unit price. A significant higher marginal value productivity from its unit price showed that the resources were under-utilised. More units of that input can be used to increase the returns from milk production. On contrary, lower marginal value productivity than the unit price of inputs indicates over-utilisation of inputs.

Table 2: Resource Use Efficiency in Milk Production

Description	Green Fodder	Dry Fodder	Concentrates	Human Labour
Buffaloes				
MVP	0.026	0.027	0.072	0.037
P	1	1	1	1
MVP-P	– 0.974**	– 0.973**	– 0.928**	– 0.963**
	(0.008)	(0.016)	(0.027)	(0.040)
Local cows				
MVP	0.001	0.043	– 0.018	– 0.115
P	1	1	1	1
MVP-P	– 0.999**	– 0.957**	– 1.018**	– 1.115**
	(0.013)	(0.032)	(0.050)	(0.118)
Crossbred Cows				
MVP	0.056	0.009	0.120	0.006
P	1	1	1	1
MVP-P	– 0.944**	– 0.991**	– 0.880**	– 0.994**
	(0.019)	(0.024)	(0.063)	(0.100)

Source: *Field Survey, 2019.*

**Statistical significance at 5 per cent level of significance.*

Table 2 depicts the data on marginal value productivity of different inputs, such as green fodder, dry fodder, concentrates and human labour. The marginal value productivity of all inputs was worked out as positive in the case of buffalo and crossbred cow milk production. The results were supported by the findings of Tanwar *et al.* (2015) who have shown positive marginal value productivity of all inputs in Rajasthan. The marginal value productivity of dry fodder, concentrates and human labour, in the case of local cow milk production,was found to be negative. It shows that there is no possibility of augmenting local cow milk production by using more of these inputs. The results were in line with the findings of Kumar and Shukla (2017), which have shown negative marginal value productivity of dry fodder for local cow milk production in western Uttar Pradesh. On the contrary, the results were in contrast with the findings of Lalrinsangpuii and Malhotra (2016) who revealed positive marginal value productivity of all inputs for local cow milk production. The difference between marginal value productivity of inputs and their unit price was found as negative and statistically significant for all milch breeds in rural Punjab. It showed that green fodder, dry fodder, concentrates and human labour were over-utilised. The over-utilisation of these inputs can be attributed to poor feeding management practices followed by the dairy farmers in rural Punjab. The quantity of these inputs used should be reduced to achieve higher returns from milk production. The results of the study were supported by the findings of Meena *et al*. (2012) who have shown over-utilisation of resources in Rajasthan. On the other hand, the study of Pandian *et al*. (2013) has shown the under-utilisation of resources in Tamil Nadu.

CONCLUSION

Among all explanatory variables, green fodder and concentrates are found to be statistically significant for buffalo milk production function. The estimated coefficients of dry fodder, concentrates and human labour are negative and insignificant for local cow milk production function. Concentrates are found as a significant factor affecting the milk yield of crossbred cows in rural Punjab. The marginal value productivity of all inputs is worked out as positive in the case of buffalo and crossbred cow milk production, and negative for local cow milk production, implying a scope to increase these inputs for enhancing milk productivity of buffaloes and crossbred cows and not for local cows. However, the deviation of marginal value productivity of inputs from its unit price reveals resource use inefficiency in the study area. The inputs, such as green fodder, dry fodder, concentrates and human labour, are over-utilised due to poor feeding management practices followed by the dairy farmers in rural Punjab. The quantity of these inputs used should

be reduced to achieve higher returns from milk production.

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