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Resource use efficiency of cattle and buffalo milk production in Haryana

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India is the largest producer of milk producing more than 112.5 million tonnes of milk in 2009–10. Haryana holds a special place in the field of milk production and it is truly known as the 'Milk pail' of the country. The State is proud to be the home-tract of one of the best buffalo breeds of the world i.e. 'Murrah'. Around 80% of the State milk comes from buffaloes alone. According to livestock census, 2003, the buffalo population in the state is 60 lakh and is increasing annually by 3%, whereas cattle population 15 lakh and decreasing annually by 3%. In the year 2007, the shares of Hisar and Karnal in state population of buffalo are 6.62% and 8.16%, respectively; whereas in cattle populations are 10.79% and 7.95%, respectively. The per head milk availability in the state is 640/per day which is second highest next to Punjab, as against per capita milk consumption is around 263 g/day.

Dairy sector witnessed a spectacular growth between 1971-1996, i.e. Operation Flood era. Milk production grew from 21 million tonnes in 1970 to nearly 69 million tonnes in 1996 - more than 3- fold, at the compound growth rate of 4.5%. The economic reforms initiated in 1991 were aimed at restructuring the Indian economy and facilitating greater integration with the world economy. Trade liberalization was directed at quick resumption of export growth and increased exposure of domestic products to external competition. But now the Indian livestock sector is on a rising spree with its current contribution of about 26% to the agricultural gross domestic product (Ag GDP) and providing employment to over 20 million people, particularly to women folk, in principal or subsidiary status (Kumar 2009). Besides this, the sector has emerged as one of the important drivers of agricultural growth and diversification in India. Bovine husbandry plays a vital role in the agricultural economy of Haryana. Haryana is the home of Murrah buffaloes which form an important part of mixed farming system in the state. The role that the buffalo husbandry plays in economy of rural people can be appreciated from the fact that there are 59.94 lakh buffaloes compared to 15.63 lakh of cattle (Department of Animal Husbandry, 2008), in Haryana. The buffalo constitutes less than 40% of the bovine population, but accounts for more than half of the total milk production of the country. It is reputed as an efficient converter of low grade, fibrous feeds into high value milk, containing about 7% fat which is much higher than the cow milk (Bardhan *et al.* 2006). In this backdrop, it becomes essential to undertake 2 specific objectives, firstly, to determine the employment generation in cattle and buffalo husbandry; and secondly, to examine the resource use efficiency in milk production or different species of animals. The knowledge emanating from the present study would help in formulating domestic production policy and would reveal the scope of rural surplus disguised labour absorption in bovine production in the state.

The study is based on primary data pertaining to the year 2007–08.The multistage stratified random sampling technique was used for selection of the respondents. The selection of tehsils, cluster villages and dairy farmers formed the first, second and third stages of sampling, respectively. From amongst tehsils of these selected districts, one tehsil from each district was selected randomly i.e. Karnal tehsil from Karnal district and Hisar tehsil from Hisar district. All the villages of these respective tehsils were enumerated and 2 cluster villages (each cluster with 2 village hamlets) from each tehsil were selected based on maximum concentration of bovine population. All the dairy farmers were classified into 3 herd size categories of milch animals reared by them, viz. small (1 to 2 milch animals), medium (3 to 5 milch animals) and large (more than 5 milch animals) by adopting the cumulative total method. A total sample size of 200 farmers was drawn from the population. Out of total sample, numbers of small farmers were 82, medium farmers were 86, and remaining 32 were large farmers.

The Cobb-Douglas production function is a preferred choice over the semi-log and double log production function

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due to nature of cross sectional data and output elasticities are constant determined by available technology. Moreover, property of this function is a first order homogeneous, which implies constant returns to scale. According to the marginal productivity theory of distribution, in competitive economies of factors of production are paid according to the value of their marginal product i.e the marginal changes factors have the necessary production function property of diminishing marginal returns.

Production function: Production function analysis has been employed to estimate resource use efficiency in milk production. The Cobb-Douglas production function of the following form was used as :

$$Y=a\ X_1^{b1}\ X_2^{b2}\ X_3^{b3}\ X_4^{b4}$$

where, Y, value of milk/animal/day (Rs); X_1, expenditure on green fodder fed/animal/day (Rs); X_2, expenditure on dry fodder fed/animal/day (Rs); X_3, expenditure on concentrates fed/animal/day (Rs); X_4, expenditure on labour/animal/day (Rs); 'a' is the constant term and bi's are the regression coefficients to be estimated. When the value of Y and X_1, X_2, X_3 and X_4 are known, the growth of 'a' can be calculated as 'residual'. Ideally, output (Y) and inputs (Xi's) in the above functional form should be measured in physical units. However, in the present study, monetary values of inputs and output were preferred over their physical quantities because quality of feed and fodder differed remarkably from one respondent to another and can be more appreciably reflected only in value terms.

Marginal value productivity

The marginal value productivity (MVP) of input X_i (i = 1, 2, 3, 4) for Cobb-Douglas functions are given below:

$$MVP_i = b_i.\ \frac{\bar{Y}}{\bar{X}}$$

Where $\bar{X}$ and $\bar{Y}$ are geometric means of respective output and input, and b_i is the regression coefficient associated with 'X_i' input.

Resource use efficiency: Measure of resource use efficiency deciphers the profit maximization. To harness the potential of profit maximization, then level of inputs used must reach the extent where MVP becomes equal to its price. Mathematically, there exists resource use efficiency in respect of the use of input 'X_i'

$$\text{if } MVP_i = P_i$$

where P_i is the unit price of input X_i. For examining the resource use efficiency, the marginal value productivities of those inputs have been worked out whose regression coefficients were found statistically significant in the estimated production function.

Any deviation of MVP of input X_i from its unit price, may be termed as resource use inefficiency. The higher the difference between the MVP of an input and its price, the higher the resource used inefficiency and vice-versa.

Further t-statistics was used to test the statistical significance of the difference between the MVP of an input and its unit price.

The t-statistics for this purpose was computed as:

$$\text{t-value} = \frac{MVPi - Pi}{S.E.(MVPi)}$$

where SE (MVP_i) = Standard error of MVP_i

Standard errors in Cobb-Douglas form of production function were computed as follows:

$$S.E.\ (MVPi) = SE\ (bi)\ \frac{\bar{Y}}{\bar{X}}$$

where, as earlier, $\bar{X}$ and $\bar{Y}$ are the geometric means and SE (b_i) is the standard error of regression coefficient associated with 'X_i' input.

Resource use efficiency: Production functions have been estimated for different types of animals maintained by the sample households. From the empirical production functions, marginal value productivities (MVPs) of different inputs used whose regression coefficients were found significant were calculated. The regression coefficients, standard errors and coefficient of multiple determination of milk production function fitted and MVPs for buffaloes, crossbred cows and indigenous cows on sample farms of both the districts were computed separately.

The results of milk production function for buffaloes are presented in Table 1. The estimated coefficient of multiple determination (R^2) revealed that selected inputs (green fodder, dry fodder, concentrates and human labour) were capable of explaining 53 to 57% variation in milk yield of buffaloes in Hisar district and 51 to 69% variations in Karnal district across various herd size groups. The magnitude of regression coefficients of green fodder, concentrates and human labour were positive and statistically significant in case of all the herd size groups in Hisar district. This establishes the fact that per day milk production increased with an increase in green fodder, concentrates and use of human labour. For example, at aggregate level in Hisar district, the production function indicated that by increasing 1% quantity of green fodder and concentrate inputs, milk yield would increase by 0.54 and 0.72%, respectively, keeping the level of other inputs constant.

In Karnal district also, production function indicated that magnitude of regression coefficients for green fodder, concentrates and human labour were found positive and statistically significant. The regression coefficients of dry fodder were found nonsignificant across herd size groups in both the districts. The nonsignificant regression coefficients of dry fodder indicated that dry fodder had served a part of maintenance only and could not contribute significantly to milk production. Similar conclusions were also drawn from the findings of resource use efficiency in milk production

Table 1. Regression coefficients and standard errors of milk production function for buffaloes in Haryana (2007–08)

Parameters	Hisar				Karnal			
	Small	Medium	Large	Overall average	Small	Medium	Large	Overall average
Constant	–0.9276	- 1.1287*	- 0.4867	- 0.8489*	- 2.0617*	- 1.2733*	- 0.2287	- 0.6691*
	(0.8267)	(0.2245)	(0.4941)	(0.1839)	(0.8526)	(0.2447)	(0.3272)	(0.2038)
X1	0.8551*	0.6320*	0.9517*	0.5405*	0.6675*	0.6752*	0.8202*	0.6533*
	(0.3224)	(0.2114)	(04431)	(0.1725)	(0.2639)	(0.1218)	(0.2202)	(0.1236)
X2	0.0472	- 0.0180	- 0.0782	0.0943	0.1866	0.2153	- 0.0111	0.0078
	(0.2471)	(0.3830)	(0.1567)	(0.0762)	(0.2321)	(0.2047)	(0.1123)	(0.0672)
X3	0.6982*	0.7970*	0.6008*	0.7238*	0.9985*	0.7945*	0.5995*	0.894*
	(0.2275)	(0.1400)	(0.2756)	(0.1045)	(0.2844)	(0.1002)	(0.2013)	(0.1131)
X4	0.4439**	0.6169*	0.4106**	0.5054*	0.6334*	0.465*	0.3659*	0.3634
	(0.2452)	(0.1312)	(0.2205)	(0.0887)	(0.3143)	(0.1357)	(0.1594)	(0.1730)
R^2	0.53	0.67	0.53	0.59	0.51	0.69	0.55	0.54

Figures in parentheses indicate standard errors; * significant at 5% level; ** significant at 10% level; X1, green fodder; X2, dry fodder; X3, concentrates; X4, human labour.

Table 2. Regression coefficients and standard errors of milk production function for crossbred and indigenous cows in Haryana (2007–08)

Parameters	Hisar		Karnal	
	Crossbred cows	Indigenous cows	Crossbred cows	Indigenous cows
Constant	- 0.3870(0.3878)	0.9037(0.0989)	0.2295(0.1194)	0.2874(0.2181)
X1	0.9011*(0.3414)	0.3641*(0.1522)	0.2074*(0.0978)	0.4835*(0.1695)
X2	- 0.0955(0.1223)	0.0091(0.1826)	0.0571(0.0472)	0.5422(0.5535)
X3	0.5352**(0.2770)	0.3031*(0.0887)	0.6261*(0.1219)	0.5046*(0.1545)
X4	0.3364(0.3604)	0.2240(0.2229)	0.5013*(0.0986)	- 0.1581(0.3009)
R^2	0.79	0.84	0.81	0.83

Figures in parentheses indicate standard errors; * significant at 5% level; ** significant at 10% level; X1, green fodder; X2, dry fodder; X3, concentrates; X4, human labour.

(Singh *et al.* 2007, Kumar and Singh 2004 and Singh *et al.* 2005).

The results of milk production for cows are presented in Table 2, the estimated coefficients of multiple determinations (R^2) revealed that the selected inputs were capable of explaining 79 and 84% variation in milk yield of crossbred and indigenous cows respectively, in Hisar district. Similarly, in Karnal district, these inputs were capable of explaining 81 and 83% variation, respectively. Due to small number of cows being maintained by the sample households, herd size wise analysis was not undertaken. The magnitude of regression coefficients of green fodder and concentrates were found positive and statistically significant in both the crossbred and indigenous cows in Hisar district. In Karnal district, the regression coefficients of green fodder, concentrates and human labour were positive and statistically significant in crossbred cows and that of green fodder and concentrates in indigenous cows. The positive and significant regression coefficients indicated that per day milk production increased with an increase in the respective inputs.

Marginal value productivities (MVPs)

The MVPs of relevant inputs were computed at their geometric mean level. To examine the resource use efficiency, the MVPs of inputs whose regression coefficients were found statistically significant in the empirical production function were computed. The MVP of a particular input represents the return of the rupee coming with the use of one additional unit of input. If the difference between MVP of an input and its unit price is statistically nonsignificant, it indicated that input is being used efficiently. A significantly higher MVP of an input than its price shows that the input can be used further to increase production while a significantly lower MVP of an input than its unit price indicated that the input is used in excess and needs reduction. The MVPs of different inputs for different species of animals are shown in Tables 3 and 4.

In buffaloes (Table 3), the difference between MVP and marginal factor cost for green fodder was positive and statistically significant in small and medium herd size groups in Hisar district and in medium and large herd size groups in Karnal district, which showed that this input was underutilized and further increase in this input could increase milk production. The differences between MVP and marginal factor cost for concentration was positive and significant for small and medium herd size groups in Hisar district and in

Table 3. Marginal value productivities of different inputs used in Buffalo milk production (2007–08)

Inputs	Hisar				Karnal			
	Small	Medium	Large	All	Small	Medium	Large	All
Green fodder								
MVP	3.97	2.72	4.12	2.43	2.98	2.93	3.58	2.87
Price	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Difference	2.94	1.72	3.12	1.43	1.98	1.93	2.58	1.87
SE of MVP	1.497**	0.910**	1.918	0.775**	1.180	0.529*	0.962*	0.543*
Concentrates								
MVP	3.29	3.43	2.59	3.26	4.73	3.58	2.65	3.97
Price	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Difference	1.29	2.43	1.59	2.26	3.73	2.58	1.65	2.97
SE of MVP	1.0735*	0.6034*	1.1872	0.4702*	1.3491*	0.4523*	0.8900*	0.5021*
Human labour								
MVP	3.22	4.51	3.26	4.10	4.68	3.55	2.92	2.92
Price	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Difference	2.22	3.51	2.26	3.10	3.68	2.55	1.92	1.92
SE of MVP	1.781	0.960*	1.753	0.720*	2.322	1.037*	1.273	1.389

* Significant at 5% level; ** significant at 10% level.

Table 4. Marginal value productivities of different inputs used in crossbred and indigenous milk production (2007–08)

Inputs	Hisar		Karnal	
	Crossbred cows	Indigenous cows	Crossbred cows	Indigenous cows
Green fodder				
MVP	4.69**	1.68	0.89	1.95
Price	1.00	1.00	1.00	1.00
Difference	3.69	0.68	- 0.11	0.95
SE of MVP	1.55	0.7054	0.419	0.684
Concentrates				
MVP	2.43	1.57	2.66*	2.91**
Price	1.00	1.00	1.00	1.00
Difference	1.43	0.57	1.66	1.91
SE of MVP	1.257	0.459	0.5186	0.892
Human labour				
MVP	-	-	3.819	-
Price	-	-	1.00	-
Difference	-	-	2.819	-
SE of MVP	-	-	0.7511*	-

* Significant at 5% level; ** significant at 10% level.

all the herd size groups in Karnal district which indicated that further increase in use of concentrates could increase milk production. In case of use of human labour, the examination of MVP and marginal factor cost showed that in medium herd size group of both the districts, use of human labour was underutilized which indicated that their was scope to increase the use of this input. In rest of the cases which have not been mentioned above, the difference between MVP and factor cost was not significant which indicated that the use of inputs was optimal and their was no need to increase or decrease the use of these inputs. In case of indigenous cows in both the districts, difference between MVP and price of green fodder was positive but nonsignificant, which indicated that use of this input was optional and there was no need to increase or decrease its use. In case of crossbred cows in Karnal district, this difference was negative but again statistically nonsignificant, which indicated the optimality in use of green fodder. However, in Hisar district, this difference was positive and significant which indicated that by increasing the use of green fodder in crossbred cows in study area of this district, milk yield could be increased. The difference between MVP and price of concentrates was positive in both the crossbred and indigenous cows in both the districts but was statistically significant in Karnal district in both the species of cows. It indicated that use of concentrates was underutilized for milk production from cows in Karnal district and further increase in the use of concentrate could increase the milk production. The regression coefficient of human labour was found significant only in case of crossbred cows in Karnal district, so MVP was calculated only for crossbred cows maintained by sample households of this district. Table 4 indicates that MVP of human labour was higher than its acquisition cost and the difference was statistically significant which indicated that this input was underutilized. This discerns a scope to increase milk yield from crossbred cows in Karnal district by increasing the use of human labour. This confirms that technology in the form of crossbred cows was labour intensive enterprise. From employment generation perspective in rural areas, this could be an opportunity of absorbing surplus labour up to limited extent, especially for rural women folk in India.

The study concludes that the technology augmentation in the form of crossbred cows was labour intensive enterprise and discerned the scope of addition milk production with the strategic mix of additional inputs, viz. green fodder and concentrates in feed ration. Moreover, this technology provided an opportunity for enhancing marginal productivity of surplus labour up to limited extent in the study area.

SUMMARY

This paper is an attempt to estimate the resource use efficiency of cattle and buffalo milk production in Haryana. Hisar and Karnal districts were selected for collection of the primary data of a total sample size of 200 farmers pertaining to year 2007–08. Human labour was optimally utilized in buffalo milk production in Karnal but underutilized in Hisar. Human labour was underutilized in crossbred cows in Karnal. The technology in form of cressbred cows discerned not only scope of additional milk production with appropriate mix of green fodder and concentrates inputs in feed ration but also provided opportunity for enhancing marginal productivity of surplus labour to an extent.

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