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MILK PRODUCTION FUNCTIONS AND RESOURCE PRODUCTIVITY IN BOVINE

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SUMMARY

Feed-milk data on 32 Hariana cows and 30 Murrah buffaloes were collected both in the morning and evening by actual weighing throughout their lactation at a regular inlerval of one week to study milk production functions and resource productivity in bovine around Karnal under village conditions. Linear and log linear milk production functions were tried. The averge milk yield porday of lactation was estimated at 3.08 kg for cows and 3.75 kg for buffaloes. The intake of DCP per day of lactation was worked out to 0.26 kg and 0.32 kg whereas TDN 4.08 kg and 5.72 kg for cows and buffaloes respectively. The intake of DCP and TDN was less during dry period. Linear milk production functions were found more suitable compared to log-linear both in cows and buffaloes. Animals were given more nutrients during dry period than the requirement in relation to milk yield. The elasticities of inputs were generally higher for buffaloes compared to cows. The marginal value product of resources suggested that the milk producers would afford cost of DCP upto Rs. 8 for cows and Rs. 15 for buffaloes for enhancing the milk productivity. Thus it was revealed that the reallocation of feed resources can play a significant role in increasing the milk production of both cows and buffaloes.

Introduction

Milk production is the net outcome of feed, breed, management and environmental effects. Feed alone accounts for about 60 percent of the total cost of milk production (Kuber Ram *et al.* [5]). Improved feeding practices and better management play a significant role in increasing the milk production of bovine (Agarwal *et al.* [1]). Feeds and fodders have been consistently observed as the most important inputs in milk production (Jacob *et al.* [2]). and Kumar *et al* [3]). The present study deals with milk production functions and resource productivity using feed-milk data collected for individual animal by actual weighing.

2. Materials and Methods

The present data were taken from the survey conducted around Karnal during 1977-79. Feed-milk data were collected both in the morning and evening by actual weighing on 32 Hariana cows and 30 Murrah buffaloes, throughout their lactation at a regular interval of one week. Besides this, information on consumption of fodders and feeds during dry period was also collected. The feeding regime can best be judged from the availability of nutrients through fodder and feeds. On the basis of information available on nutritional values (Morison, [6]), and Sen and Ray [7] of various fodders and feeds the quantity of digestible crude protein (DCP) and total digestible nutrients (TDN) worked out. Systematic sampling was used in estimating the average daily milk production, daily intake of feed nutrients (DCP and TDN) per day of dry period, per day of lactating period and variance of estimates of feed intake, i.e. variation in the intake of feed nutrients for individual animal. The estimated intake of DCP, TDN during dry and lactating period and their variation in dry period were used as explanatory variables to study their effect on milk yield. DCP and TDN are the major feed nutrients which have been considered for explaining the feed-milk relationship. It has been found that the relative value of DCP over TDN was 7.5 (*ibid.*). Using this prior information ($b_1/c_1 = b_2/c_2 \ldots = 7.5$, b's and c's are regression coefficients of DCP and TDN at previous stages of lactation; Kumar and Singh [4]) estimates of feed index given by DCP + (TDN/7.5) were worked out during dry and lactating period for an individual animal. This index and its variance in dry period were used as explanatory variables in regression models. This led to the following three fypes of milk production models;

Linear : Model I $Y = a_1 + b_1 X_1 + b_2 X_2 + b_3 X_3 + U$

Model II $Y = a_2 + b_4 X_4 + b_5 X_5 + b_6 X_6 + U$

Model III $Y = a_3 + b_7 X_7 + b_8 X_8 + b_9 X_9 + U$

Log-linear : Model I $Y = a_1 X_1^{b1} X_2^{b2} X_3^{b3} e^u$

Model II $Y = a_2 X_4^{b4} X_5^{b5} X_6^{b6} e^u$

Model III $Y = a_3 X_7^{b7} X_8^{b8} X_9^{b9} e^u$

where, Y is the estimated milk yield (kg) per day of lactation, x_i's ($i = 1, 2, \ldots 9$) are estimated explanatory variables, viz. X_1 = intake of DCP (kg) per dav of dry period, X_2 = intake of DCP (kg) per day of lactation, X_3 = variance or variation in DCP intake during dry period, X_4 = intake of TDN (kg) per day of dry period, X_5 = intake of TDN (kg per day of lactation, X_6 = variance or variation in TDN intake during dry period. X_7 = average feed index (kg) per day of dry period; X_8 = average feed index (kg) per day of lactation, X_9 = variance or variation in feed index per day of dry period and u is the random error distributed normally independently with zero mean and constant variance.

3. Results and Discussions

3.1 *Estimates of Daily Milk Yield and Feed Intake*

The average daily milk yield, intake of DCP, TDN and feed index per day of dry period, per day of lactation and variance of daily intake of DCP, TDN and feed index during dry period were worked out. The estimates of daily milk yield and feed intake are given in Table 1 separately for cows and buffaloes.

The average milk yield per day of lactation was estimated at 3.08 kg for cows and 3.75 kg for buffaloes. The average intake of DCP, TDN and Feed index per day of lactation was estimated at 0.26 kg, 4.08 kg and 0.80 kg for cows and 0 32 kg, 5.72 kg and 1.08 kg for buffaloes respectively. These figures per day of dry period were found to be less than those per day of lactation as expected. However, the coefficients of variation of intake of DCP. TDN and feed index were found to be 26, 15 and 17 per cent in cows and 34, 64 and 11 percent in buffaloes respectively.

TABLE 1—ESTIMATE OF AVERAGE DAILY MILK YIELD AND FEED INTAKE

Item	*Cows*		*Buffaloes*	
	Estimate	*S. E.*	*Estimate*	*S. E.*
Milk yield per day of lactation (kg)	3.08	0.09	3.75	0.16
DCP per day of dry period (kg)	0.19	0.011	0.23	0.012
DCP per day of lactation (kg)	0.26	0.012	0.32	0.020
Variance of daily intake of DCP during dry period	0.128	0.008	0.137	0.009
TDN per day of dry period (kg)	3.50	0.135	5.59	0.228
TDN per day of lactation (kg)	4.08	0.105	5.72	0.068
Variance of daily intake of TDN dry period	1.03	0.073	1.04	0.068
Feed index per day of dry period (kg)	0.67	0.018	0.97	0.036
Feed index per day of lactation (kg)	0.80	0.024	1.08	0.021
Variance of daily feed index during dry period	0.225	0 013	0.215	0.014

3.2 *Estimated Milk Production Equations*

It is obvious that during dry period, if the animal is pregnant, the variation in feed input would be more compared to those animals which are dry but not pregnant. In order to study the effect of variation in DCP intake (X_3), variation in TDN intake (X_6) and variation in feed index (X_9) per day of dry period on milk yield the variances of X_3, X_6 and X_9 were used as explanatory variables in milk production function. These variances were worked out using usual systematic sampling procedure.

Linear and log linear milk production functions were estimated separately for cows and buffaloes using various combinations of feed intake as explanatory variables, viz. (i) intake of DCP per day of dry period (X_1), per day of lactating period (X_2) and its variance per day of dry period (X_3), (ii) intake of TDN per day of dry period (X_4), per day of lactation (X_5) and its variance per day of dry period (X_6), and (iii) feed index per day of dry period (X_7). per day of lactation (X_8) and its variation per day of dry period (X_9).

Linear type of milk production equations which explained more variation compared to log-linear were used for further interpretation of results. The estimated linear milk production equations using different combinations of feed input are given in Table 2 separately for cows and buffaloes.

It was observed that among cows the average daily intake of DCP in dry period, lactating period and its variation in dry period together explained 59 percent of total variation (model I). The regression coefficient of DCP intake per day of lactation was found to be positive and significant. The average daily intake of TDN in dry period, lactating period and its variation in dry period together explained 40 percent of the total variation (Model II). The regression coefficient of TDN intake per day of lactation was positive and significant. While average daily feed index in dry period, lactating period and its variation in dry period together explained 76 percent of total variation (model III). Regression coefficient of feed index per day of dry period was negative and significant while regression coefficient of feed index per day of lactation was positive and significant.

It clearly indicated that the cows were given more feed nutrients during dry period than the requirement in relation to milk yield. Among buffaloes it was observed that average daily intake of DCP in dry period, lactating period and its variaion in dry period together explained 80 percent of total variation (Model I). The regression coefficient of DCP per day of lactation was positive and significant. The average daily intake of TDN in dry period, lactating period and its variation per day of dry period together explained 70 percent of total variation (Model II). The regression coefficient of TDN per day of dry period was negative and significant whereas per day of lactation it was positive and significant indicating that buffaloes were given more of TDN than the requirement during dry period. The average daily feed index in dry period, lactating period and its variation in dry period together explained 75 percent of total variation (model III). The regression coefficient of feed index per day of dry period was negative and significant while per day of lactation it was positive and significant. It clearly indicated that buffaloes were also given more feed nutrients during dry period than the

TABLE 2—ESTIMATED MILK PRODUCTION EQUATIONS

Species	*Model*	*Estimated milk production equations*	R^2
Cows	I	$Y = 1.5563 + 0.7005\,X_1 + 5.6035^{**}X_2 - 0.5686\,X_3$	58.8
		(2.1954) (1.2111) (0.8939) (1.5970)	
	II	$Y = 1.4871 - 0.1282\,X_4 + 0.5125^{**}X_5 - 0.0460\,X_6$	40.0
		(0.2610) (0.1032) (3.1228) (0.1931)	
	III	$Y = 1.2833 - 1.0651^{*}X_7 + 3.0928^{**}X_8 + 0.2250\,X_9$	76.[illegible]
		(0.8473) (0.4512) (0.3430) (0.6282)	
Buffaloes	I	$Y = 1.0912 + 0.2975\,X_1 + 7.4361^{**}X_2 + 1.5985\,X_3$	80.0
		(2.5480) (1.4959) (0.7446) (1.9221)	
	II	$Y = 3.2560 - 0.6450^{**}X_4 + 0.7919^{*}X_5 - 0.4204\,X_6$	70.3
		(0.4023) (0.0833) (0.2832) (0.2572)	
	III	$Y = -0.2785 - 1.4848^{*}X_7 + 4.8454^{**}X_8 + 1.0529\,X_9$	74.6
		(1.6306) (0.4479) (0.9571) (1.1980)	

Figures in parenthesis indicate standard error of regression coefficients; ** significant at 1% and * significant at 5% level of significance.

requirement in relation to milk production. Thus it was revealed that reallocation of feed nutrients during dry period and lactating period can play a significant role in increasing the milk production of both cows and buffaloes.

3.3 *Production Elasticity and Resource Productivity*

The production elasticities of resource inputs were worked out for comparing the relative importance of various resources used. The production elasticities (E_p) and marginal value products (*MVP*) were worked out both for cows and buffaloes. The same have been presented in Table 3.

TABLE 3—PRODUCTION ELASTICITIES AND MARGINAL VALUE PRODUCTS

Items	*Cows*		*Buffaloes*	
	E_p	*MVP*	E_p	*MVP*
DCP per day of dry period	0.04	1.05	0.02	0.60
DCP per day of lactation	0.48	8.40	0.63	14.87
Variation in DCP per day of dry period	−0.02	−0.85	0.06	3.20
TDN per day of dry period	0.15	−0.19	0.96	−1.29
TDN per day of lactation	0.68	0.77	1.21	1.58
Variation in TDN per day of dry period	0.02	−0.07	0.12	−0.84
Feed index per day of dry period	−0.23	−1.60	−0.38	−2.97
Feed index per day of lactation	0.80	4.64	1.40	9.69
Variation in feed index per day of dry period	0.02	0.34	0.06	2.11

The elasticities of production and productivity for inputs were generally higher for buffaloes compared to cows. The elasticities of production were higher for feed index per day of lactation followed by TDN and DCP both in cows and buffaloes. The production elasticity of feed index per day of lactation was estimated at 0.80 for cows and 1.40 for buffaloes. The marginal values of feed index per day of lactation suggest that the milk producer can afford the feed index cost per point of index upto Rs. 4.6 in cows and Rs. 9.7 in buffaloes. The elasticites of DCP per day of lactation were estimated to 0.48 in cows and 0.63 in buffaloes. The marginal values of DCP per day of lactation suggest that milk producer can afford cost of DCP per day of lactation upto Rs. 9.4 in cows and Rs. 14.9 in buffaloes. The marginal values of TDN per day of dry period were negative both for cows and buffaloes, whereas these values per day of lactation were positive both for cows and buffaloes. The study thus suggested that the productivity of dairy animals could be increased by the judicious feeding of animals during dry period and lactating periods.

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