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The internal rate of return was 44 per cent; this indicated that the scheme provided a positive net present value for all rates of returns below 44 per cent.

Conclusion

The analysis offers enough evidence to conclude that institutional financing for dairy development could be organized to suit the interests of all parties concerned. The dairy development scheme was viable and feasible from the point of view of its impact on the direct beneficiaries (farmers and the bank) and the indirect beneficiaries (co-operative societies and the dairy). The scheme assured the farmers of a continuous source of income through self-perpetuation of the cattle loan. The bank recovered all the expenses incurred in running the scheme. The feasibility criteria of the scheme ensured that the investment in the cattle development scheme was justified on economic considerations, and at the same time, provided a built-in tool for demonstrating that it was self-liquidating.[6]

The findings of this paper also endorse the view that dairying could be used as an effective means for increasing the income position of the rural poor if adequate finances linked with extension and marketing facilities are provided. In many regions it is not necessary to introduce any direct subsidies; the creation of infrastructure facilities for production enhancement, procurement, processing and marketing is sufficient.

ECONOMIC OPTIMA IN MILK PRODUCTION

Parmatma Singh and Dayanatha Jha*

India has nearly one-fourth of world's cattle and 60 per cent of the buffalo population. With this population one would normally expect a very high contribution of these animal resources to the national income of the country. In reality, not more than three and half per cent of the national income (nearly 7 per cent of the income from agricultural sector) is derived from animal husbandry and dairying. This seeming paradox is an indicator of continued neglect of livestock enterprise in general and of dairy enterprise in particular. This highlights the need for investigating the resources allocation and output performance in livestock production with a view to detect the irrationalities and for devising appropriate ameliorative measures.

6. For a detailed discussion on this point, see V. M. Jakhade and M. V. Gadgil, "Production and Repayment Capacity-Oriented Lending for Farm Investment," *Reserve Bank of India Bulletin*, Vol. XXIV, No. 1, January, 1970, p. 56.

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Feed and labour are the principal inputs in milk production and the former, particularly concentrates form a critical input. Feed costs alone constitute nearly two-third of the total cost of milk production and concentrates, in turn, represents a substantial portion of this cost. Based on surveys conducted over a large tract in the country, Amble and associates[1] estimated that in spite of relatively high feeding costs, the diets of the animals are deficient in respect of proteins. In terms of requirements the deficiency in digestible crude protein ranges from 70 per cent for animals in milk to about 12.8 per cent for buffalo young stock.

Increase in the productivity of animals may stem from two directions, namely, feeding and management and breeding. Compared to the former, breeding and selection are slower processes. Moreover, the high-yielding ability of the cross-bred animals can be sustained only if proper feeding is resorted to. Better feeding is thus a most important method for increasing the milk yield of cows and buffaloes. The available experimental evidence, meagre as it is, shows that better feeding alone can increase the average yield of animals by 50 per cent or more.[2] In view of this, a study inquiring into the maximization of milk yield with limited resources, assumes considerable importance. The specific objectives of this study were (*i*) to establish input-output relationship in milk production, (*ii*) to determine the marginal value productivities of different inputs used in milk production, and (*iii*) to find out the extent of increase in the milk yield by reallocation of resources optimally.

METHODOLOGY

This study relates to Etah district of Uttar Pradesh. In 1963, the Hindustan Lever established a milk processing plant in Etah district. This encouraged the farmers to maintain dairy animals on commercial lines as against subsistence rearing. The sampling process consists of three stages: (*i*) selection of milk collection centres, (*ii*) selection of villages, and (*iii*) selection of farmers. The multi-stage stratified sampling design was used. The milk collection centres were selected on two grounds, firstly, on the amount of milk collected at different centres in Etah district from 1965 to 1967, and secondly on the basis of the number of Murrah buffaloes distributed by the Hindustan Lever by the end of March, 1968 at various centres. Two milk collection centres having highest figures in respect of the above criteria were selected. Similarly, the villages having the highest number of Murrah buffaloes were selected. Thus, two villages having the highest number of Murrah buffaloes were selected from each of the two milk collection centres. The criterion for the selection of the farmers was that they should have as many Murrah buffaloes as non-descript buffaloes, as the major emphasis was on Murrah buffaloes.

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1. V. N. Amble, V.V.R. Murthy, K. V. Sathe, and B.B.P.S. Goel, "Milk Production of Bovines in India and Their Feed Availabilities," *The Indian Journal of Veterinary Sciences and Animal Husbandry*, Vol. XXXV, No. 3, September, 1965, pp. 221-238.
2. N. C. Write : Report on the Development of Cattle and Dairy Industry in India, Manager of Publications, Government of India, 1957 (Reprinted from 1937).

Thus 70 per cent of the cultivators satisfying this criterion were selected randomly. In all, 60 cultivators from four villages covered by the two milk collection centres were finally selected. The study refers to the period June, 1967 to May, 1968, but the data for buffaloes which started their lactation earlier and were in milk, were also collected. The data relating to feed (fodders and concentrates) and milk output of all the milk animals—buffaloes and cows—reared on these farms were obtained on a suitably designed questionnaire. The data were collected by survey method by personally interviewing the selected farmers. The data regarding fodders (green and dry) and concentrates fed to individual milch animal were obtained on daily basis. Similarly, the use of labour inputs for individual milch animal was obtained by enquiring from the farmer. The labour input (family and hired) includes labour used in bringing fodder from the field, chaffing, feeding the animal, milking the animal, cleaning the animal house, etc. Wherever the use of labour was on aggregate basis, it was apportioned to different animals by ascertaining from the farmer.[3] Besides these, the data on the age of the animal and advancement of lactation of these animals were also obtained. In the case of milk output, it was also obtained on daily basis for individual milk animal. The data covered the entire lactation period of the animal.

To establish input-output relationship, production equations were fitted separately for both the breeds, Murrah and non-descript and for the seasons,[4] namely, rainy, winter part I, winter part II and summer. Since the number of cows reared on these farms was very small, the data pertaining to the cows were dropped from the analysis. The seasons were framed on the basis of availability of different green and dry fodders. The variables were taken in physical terms to circumvent the problems emanating from price differentials over time. Linear, Cobb-Douglas, quadratic and square root forms of relationships were tried.

The variables included in the production functions were as follows:

$$Y = f(x_1, x_2, \ldots\ldots\ldots\ldots, x_{11})$$

where

Y=average milk yield per day in litres. This refers to the proportion of lactation in a season.

x_1=kilograms of *sarson* cake fed per animal per day.

x_2=kilograms of gram and other grains fed per animal per day.

x_3=kilograms of cotton seed fed per animal per day.

3. The unit of measurement for feeds and fodders was kilogram, for labour it was labour hours and for milk it was in litres.

4. Rainy season = from 15th July to 15th October.
Winter part I = from 16th October to 30th November.
Winter part II = from 1st December to 28th February.
Summer = from 1st March to 15th July.

x_4=kilograms of "Gold Mohur"* fed per animal per day.
x_5=kilograms of wheat *bhoosa* fed per animal per day.
x_6=kilograms of jowar *chari* fed per animal per day.
x_7=kilograms of *karabi* (straw) fed per animal per day.
x_8=kilograms of leguminous green fodder (mainly green pea) fed per animal per day.
x_9=labour hours used per animal per day.
x_{10}=age of animal in years.
x_{11}=advancement of lactation in days.

FINDINGS AND DISCUSSION

Linear, Cobb-Douglas, quadratic and square root forms of production equation were tried. The quadratic and square root results were unsatisfactory with respect to signs and significance levels of the variables. The Cobb-Douglas type of production functions was finally chosen for presentation of economic analysis on the basis of their inherent conformity to production logic and also the significance levels of the variables. The functions were fitted for Murrah and non-descript buffaloes separately seasonwise. By deletion of the non-significant variables in successive stages, the final run of equations consisting of significant variables were obtained and these are presented in Table I.

An examination of the coefficient of multiple determination of the production equations indicated that the values were slightly lower in the equation for Murrah buffaloes than for the non-descript ones. In the former case the independent variables explained 60 to 77 per cent of variation in the milk yield, the highest and lowest being for the equations for rainy and winter part I season respectively. For non-descript buffaloes the range in explained variation was 72 to 82 per cent, maximum being for winter part I and minimum for summer season equations.

The labour inputs (x_9) were highly significant in all the cases, followed by *sarson* cake (x_1). In the case of winter part II and summer seasons, the latter (x_1) was significant only at 10 per cent for Murrah buffaloes. In the summer season only gram (x_2) was significant for non-descript buffaloes while in the case of Murrah buffaloes all the concentrates, namely, *sarson* cake (x_1), gram (x_2), cotton seed (x_3) and 'Gold Mohur' (x_4) were significant. In winter part II, none of the concentrates was significant for non-descript. In the case of roughages, the seasonal fodders were significant in most cases except in the summer season for Murrah buffaloes and summer and rainy seasons for non-descript where none of the seasonal fodders emerged significant. The green leguminous fodder was also not significant for the non-descript buffaloes. Advancement of lactation (x_{11}) was negatively correlated with the milk output and it was highly significant in all the seasons for Murrah buffaloes. For the non-descript it was significant only in winter part II and

* Gold Mohur is a Hindustan Lever feed.

TABLE I—FINAL RUN PRODUCTION FUNCTIONS FOR MILK : BREED AND SEASONWISE

Breed	Seasons	Observations (number of lactating animals)	Constant	Regression coefficients: *Sarson* cake (x_1)	Gram (x_2)	Cotton seed (x_3)	"Gold Mohur" (x_4)	Wheat *bhoosa* (x_5)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Murrah	Rainy	100	6.15	0.10*** (0.03)	0.07** (0.02)			0.03@ (0.02)
	Winter part I	80	17.67	0.08** (0.03)			0.04@ (0.02)	0.03* (0.01)
	Winter part II	83	14.85	0.02@ (0.01)				
	Summer	102	9.86	0.06@ (0.03)	0.04* (0.02)	0.05@ (0.03)	0.06* (0.03)	
Non-descript	Rainy	20	0.93	0.15* (0.05)	0.07* (0.03)			
	Winter part I	20	0.90	0.19* (0.07)				
	Winter part II	23	3.01					
	Summer	28	12.96		0.10** (0.03)			

Regression coefficients

Breed	Seasons	Jowar *chari* (x_6)	*Karabi* (x_7)	Green leguminous fodder (x_8)	Labour (x_9)	Age (x_{10})	Advancement of lactation (x_{11})	Coefficient of multiple determination (R^2)
(1)	(2)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Murrah	Rainy	0.07** (0.02)			1.89*** (0.33)		—0.30*** (0.05)	0.77
	Winter part I		0.05** (0.01)		0.83*** (0.16)		—0.22*** (0.05)	0.60
	Winter part II		0.07** (0.02)	0.10* (0.05)	1.04*** (0.13)		—0.38*** (0.06)	0.75
	Summer	—	—	—	0.97*** (0.26)		—0.16*** (0.04)	0.66
Non-descript	Rainy				1.22* (0.45)	0.59@ (0.32)		0.78
	Winter part I		0.59** (0.16)		0.99** (0.29)			0.82
	Winter part II		0.25* (0.11)		1.17*** (0.26)		—0.14* (0.07)	0.74
	Summer						—0.25*** (0.06)	0.72

Figures in parentheses indicate standard errors.
@ Significant at 10 per cent level of significance.
* Significant at 5 per cent level of significance.
** Significant at 1 per cent level of significance.
*** Significant at 0.1 per cent level of significance.

summer seasons. Age variable was eliminated from all the equations for both the breeds, except the rainy season for the non-descript buffaloes equation where it was significant at 10 per cent probability level.

Marginal Value Productivity of Inputs

The marginal value of products of a rupee invested on various inputs, namely, *sarson* cake, gram, cotton seed, "Gold Mohur," wheat *bhoosa*, jowar *chari*, *karabi*, green leguminous fodders and labour were worked out at their geometric mean levels. These are presented in Table II.

TABLE II—MARGINAL VALUE PRODUCT OF INPUTS PER RUPEE OF INVESTMENT

(*Rupees*)

Items	Marginal value product of inputs at geometric mean level in rupees			
	Rainy	Winter part I	Winter part II	Summer
Murrah buffaloes				
Sarson cake (x_1)	0.86	0.84	0.24	0.50
Gram (x_2)	0.90	—	—	0.61
Cotton seed (x_3)	—	—	—	16.62
"Gold Mohur" (x_4)	—	26.60	—	30.33
Wheat *bhoosa* (x_5)	19.30	1.17	—	—
Jowar *chari* (x_6)	0.42	—	—	—
Karabi (x_7)	—	0.70	0.48	—
Green pea (x_8)	—	—	1.19	—
Labour (x_9)	12.26	5.76	7.50	5.95
Non-descript buffaloes				
Sarson cake (x_1)	1.21	1.09	—	—
Gram (x_2)	1.13	—	—	2.26
Wheat *bhoosa* (x_5)	—	—	—	—
Jowar *chari* (x_6)	—	—	—	—
Karabi (x_7)	—	3.23	1.31	—
Green pea (x_8)	—	—	—	—
Labour (x_9)	8.89	8.28	7.54	—

An examination of Table II reveals that for Murrah buffaloes, among concentrates, the marginal value productivity of "Gold Mohur" was highest in both the summer (Rs. 30.33) and winter part I (Rs. 26.60) seasons followed by cotton seed (Rs. 16.82) in the summer season. In the case of gram, it varied from Re. 0.90 in the rainy season to Re. 0.61 in the summer season while for that of *sarson* cake from Re. 0.86 in the rainy season to Re. 0.24 in winter part II. The reason for the high marginal value productivity of "Gold Mohur" and cotton seed was their use in small quantities. As against this, the lowest marginal value productivity of *sarson* cake in winter II was because of its smaller elasticity of production in this season. The marginal value productivity of gram was more than that of *sarson* cake in the rainy and summer seasons because the former was used in smaller quantities as compared to the latter.

In the case of roughages, the marginal value productivity of wheat *bhoosa* varied from Rs. 19.30 in the rainy season to Rs. 1.17 in winter part I while for *karabi*, it varied from Re. 0.70 in winter part I to Re. 0.48 in winter part II season. In the case of leguminous fodders and jowar *chari* it was Rs. 1.19 and Re. 0.42 in winter part II and rainy season respectively. The higher marginal value productivities were associated with lower inputs use and vice versa.

For labour, the marginal value productivity varied from Rs. 5.76 in winter part I to Rs. 12.26 in the rainy season. The differences were mainly because of the elasticities of production for labour in different seasons.

In the case of non-descript buffaloes, the marginal value productivity of *sarson* cake varied from Rs. 1.21 in the rainy season to Rs. 1.09 in winter part I and for gram, it varied from Rs. 2.26 in the summer season to Rs. 1.13 in the rainy season. For roughages the marginal value productivity of *karabi* varied from Rs. 3.23 in winter part I to Rs. 1.31 in winter part II season. The marginal value productivity of labour varied from Rs. 8.69 in the rainy season to Rs. 7.54 in winter part II and Rs. 8.28 in winter part I. Again the reason for differences were the same as mentioned above. Dhondyal and Singh[5] fitted linear production function to assess the impact of feed, labour and other inputs on milk production and found that feed has negative coefficient in the case of buffaloes and labour had a positive coefficient. The marginal value product of labour was Rs. 2.64 while for feed it was (—) Re. 0.14. This suggested an increase in labour use and reduction in feeds.

To make the allocations nutritionally sound and realistic, the minimum and maximum limits of total dry matter intake and the supply of dry matter from roughages, in different seasons were fixed. A maximum restriction, consistent with availability, was also put on the amount of wheat *bhoosa* as an off-season fodder and green fodders in winter part II. Only significant variables capital were pooled together for reallocation. In the case of non-significant feeds and fodder variables, it was assumed that these will be fed at their existing mean levels. In the optimal allocation care was also taken that dry matter supply from concentrates should not exceed one-third of the total dry matter supply. The optimally allocated levels of feeds and fodder inputs in different seasons from both the breeds along with their existing levels are presented in Table III.

5. S. P. Dhondyal and P. Parmatma Singh, "Economics of Livestock Enterprise in Uttar Pradesh," *Indian Journal of Agricultural Economics*, Vol. XX, No. 1, January-March, 1965, pp. 107-116.

TABLE III—OPTIMAL AND EXISTING LEVELS OF FEEDS AND FODDER INPUTS

(*kgs.*)

Breed/season	Level	*Sarson* cake (x_1)	Gram (x_2)	Cotton seed (x_3)	"Gold Mohur" (x_4)	Wheat *bhoosa* (x_5)	Jowar *chari* (x_6)	*Karabi* (x_7)	Green fodder (x_8)
Murrah									
Rainy	Existing	1.21	1.13			1.40	32.38		
	Optimal	1.97	1.15			1.40[a]	19.79		
Winter part I	Existing	1.42			0.25	3.88		6.22	
	Optimal	1.35			0.82	2.92[a]		4.99	
Winter part II	Existing	1.13						8.51	8.82
	Optimal	0.59						11.77	8.82
Summer	Existing	1.09	1.04	0.07	0.11	10.47[c]			
	Optimal	0.67	0.42	0.53	0.94				
Non-descript									
Rainy	Existing	1.17	1.03			1.85[c]	26.83[c]		
	Optimal	1.64	0.62					8.88	
Winter part I	Existing	1.45						8.88	
	Optimal	1.27						10.00[b]	

a This indicates the total minimum permissible amount.
b This indicates the maximum permissible amount.
c The fodder items which were not significant has been kept at their existing levels.

It is observed that in the case of Murrah, in the rainy season, the level of *sarson* cake and gram increased from 1.21 kg. and 1.13 kg. in the existing plan to 1.97 kg. and 1.15 kg. respectively, after optimal allocation, while that of jowar *chari* decreased from 32.38 kg. in the existing plan to 19.79 kg. in the optimal allocation. The amount of wheat *bhoosa* was extended to its maximum available amount, that is, 1.40 kg. This indicated a shift from jowar *chari* to concentrates, particularly *sarson* cake.

In winter part I, the amount of wheat *bhoosa* and *karabi* decreased from 3.88 kg. and 6.22 kg. in the existing situation to 2.92 kg. and 4.99 kg. respectively in the optimal plan. Among concentrates the amount of *sarson* cake also decreased from 1.42 kg. to 1.35 kg. but the quantity of "Gold Mohur" increased from 0.25 kg. to 0.82 kg. after optimal allocation. This suggested an increase in the amount of "Gold Mohur" and decrease in roughages and other concentrates.

In winter part II, unlike the first two seasons discussed above, the amount of *karabi* increased from 8.51 kg. in the existing situation to 11.77 kg. after reallocation of inputs. The amou. of *sarson* cake decreased from 1.13 kg. to 0.59 kg. while green fodder reached the maximum available amount. This revealed a shift of inputs from concentrates to roughages.

In the summer season, only concentrates were significant. The existing amounts of concentrates were 1.09, 1.04, 0.07 and 0.11 kg. while the adjusted amounts were 0.67, 0.42, 0.53 and 0.94 kg. for *sarson* cake, gram, cotton seed and "Gold Mohur" respectively. This suggested a decrease in the amount of the first two concentrates and an increase in the amount of the others.

In the case of non-descript buffaloes, in the rainy season the amount of *sarson* cake increased from 1.17 kg. in the existing feeding to 1.64 kg. in the adjusted feeding but for gram the same decreased from 1.03 kg. to 0.62 kg. indicating an increase in the amount of *sarson* cake and decrease in that of gram as against the existing practice.

In winter part I, the optimally allocated amount of *sarson* cake was 1.27 kg. as against 1.45 kg. in the existing feeding plan. For *karabi* the amount reached to the maximum possible amount, that is, 10.00 kg. against 8.88 kg. in the existing situation. This suggested a shift from concentrate feeding to roughage in this season.

Maximization of Milk Yield through Resource Adjustment

To examine the extent of increase in the milk yield through the optimal allocation of feeds and fodder inputs, the optimally allocated quantities worked out were fed back into the equations of different seasons for both the breeds and the total outputs of milk were obtained. These outputs were compared with the milk yields estimated by substituting the existing quantities of inputs in the equations. The results are given in Table IV.

TABLE IV—INCREASE IN MILK YIELD THROUGH ADJUSTMENTS IN FEEDS AND FODDER

Breed	Season	Estimated milk yield (kg.)	Milk yield (kg.) after adjustments of inputs	Percentage increase in milk yield
Murrah	Rainy	4.69	5.58	18.79
	Winter part I	7.95	8.15	2.48
	Winter part II	5.94	6.00	0.94
	Summer	4.87	5.72	17.63
Non-descript				
	Rainy	5.82	5.93	1.81
	Winter part I	5.74	6.00	4.56

It is observed that the increase in the milk yield through the adjustment of feeds and fodder inputs in the case of Murrah buffaloes was 18.79 per cent, 2.48 per cent, 0.94 per cent and 17.63 per cent in the rainy, winter part I, winter part II and summer seasons respectively. For non-descript, it was 1.81 per cent and 4.56 per cent in the rainy and winter part I season, respectively. In the case of Murrah buffaloes this suggested better possibilities of increase in the milk yield by input adjustments in the rainy season followed by summer season. In both the winter parts the extent of increase in the milk yield was meagre. The reason for higher extent of increase in the milk yield in the rainy season was because of a marked reduction in the amount of jowar *chari* and increase in the *sarson* cake in the optimal plan as compared to existing ones. Similarly, in the summer season there was a shift in favour of cotton seed and "Gold Mohur" at the cost of *sarson* cake and gram in the optimal plan which raised the amount of milk yield. In the case of non-descript buffaloes the extent of increase in the milk yield through optimal allocation of input was relatively higher in winter part I as compared to the rainy season though in winter part I the extent of increase was low. Broadly, the results indicated a higher possibility of increase in the milk yield in the case of Murrah as compared to non-descript through input adjustment.

CONCLUSION

The multiple regression analysis showed high association between the inputs considered and milk output. The importance of better care and management of the animals was thrown in sharp focus by the very higher marginal value product of labour input. The final analysis suggested a significant scope for raising milk production by a readjustment of the feed inputs in the summer and rainy seasons.

The general conclusions arrived at, on the basis of more comprehensive production function analysis, were: (*i*) The results confirmed the general observation that farmers cared more for the Murrah than for non-descript buffaloes. (*ii*) It was always profitable to replace the off-season fodders by the seasonal ones and that the leguminous fodders were the cheapest source of nutrients. (*iii*) In the rainy and summer seasons, significant increase in the milk yield could be obtained by a reallocation of feed inputs.

RESOURCE PRODUCTIVITY IN MILK PRODUCTION OF CROSS-BRED AND INDIGENOUS COWS IN RURAL AREAS OF LUDHIANA DISTRICT (PUNJAB)

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INTRODUCTION

The average per capita consumption of milk in India is only 130 millilitres per day as against the world's average of 303 millilitres, which clearly shows that dairy enterprise is relatively ignored in this country. In Punjab, the position is better and the per capita consumption in the State was 444 millilitres[1] per day during 1972-73 as against the minimum requirement of

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1. Statistical Abstract of Punjab, 1974, Economic Advisor to Government, Punjab, Chandigarh.