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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.

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## 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.

280 millilitres[2] set by the nutritionists. At this stage when the "green revolution" has already picked up momentum and the quantitative aspect of Indian diet is showing improvements, it is essential to diversify our efforts for developing dairy industry and simultaneously bring about the "white revolution" also, so as to improve the qualitative aspect of our diet which is vegetarian for the majority of the population.

The bulk of milk production in our country is in the hands of millions of small producers scattered all over the country. To most of them, it is a supplementary or complementary enterprise only. Therefore, except for a few commercialised dairy farms in the urban areas, there still exists a vast scope for improving the lot of our rural folk by commercialising this enterprise. In the Punjab State, which is leading in the process of "green revolution" among all the Indian States, the need for developing dairy industry, specially in the rural areas, has already been realised. Consequently, programmes have been launched to improve the milk yielding capacity of indigenous cows and buffaloes through cross-breeding. But unfortunately, the economic aspects of milk production through indigenous and cross-bred animals still remain relatively unexplored. For the success of any dairy developmental programme, therefore, it is essential to fill up such gaps in economic information. The present study is an effort in this direction.

*Objectives*

Following were the specific objectives of the present investigation: (*i*) to establish input-output relationship between milk production, separately for indigenous and cross-bred cows, and various factors influencing it, (*ii*) to work out the coefficients of elasticity of milk production with respect to different explanatory variables, (*iii*) to estimate the marginal value products of various factors at their respective geometric mean levels, and (*iv*) to measure the differences in technical efficiency of milk production through indigenous and cross-bred cows.

## II

### METHODOLOGY

*Sampling Design and the Collection of Data*

Three villages, namely, Jhalla, Payal and Bija, were randomly selected from the list of villages in Ludhiana district where a substantial number of cross-bred cows is maintained. In these villages, complete list of all cows in milk at the time of this investigation was drawn separately for cross-bred and indigenous breeds. Keeping in view the resources at the command of researchers, a sample of 40 milch cows was drawn randomly from each list.

2. R.O. Whyte and M.L. Mathur: The Planning of Milk Production in India, Orient Longmans Ltd., New Delhi, 1968, p.24.

A complete record of dairy milk production along with feeds and fodders fed to each selected animal was maintained for a period of 15 days, *i.e.*, July 1 to 15, 1975, on an individual schedule which also contained information regarding other factors influencing milk production, such as, age of the animal, number of lactations, stage of lactation, etc. Besides, the data on the prices of milk and feeds and fodders for the relevant period under investigation were also collected.

*Technique of Economic Analysis*

Production function analysis was used as an analytical tool for achieving the objectives of the study. Two types of production functions, namely, linear and Cobb-Douglas were used to express the relation between milk output per milch animal and the various factors influencing it. However, before doing so, the zero-order correlation matrices were worked out and the correlation coefficients were examined for multi-collinearity. For economic and statistical considerations, only Cobb-Douglas type of functions could be selected for further economic analysis.

The variables used in the equation were as follows:[3]

$$Y=f\ (X_1,\ X_2,\ X_3,\ X_4,\ X_5,\ X_6),$$

where Y=milk production per animal in litres for a period of 15 days. It may, however, be mentioned here that it could not be corrected for fat percentage due to the obvious difficulties of equipment and trained personnel.

$X_1$=the age of the animal in years,

$X_2$=the number of lactation,

$X_3$=the stage of lactation, *i.e*, period since calving in months,

$X_4$=the quantity of concentrates fed per animal for 15 days in kilograms. The concentrate fed was invariably of the same constitution having oilseed cakes in it in all the cases. Hence, no need was felt to convert this variable in value terms or T.D.N. equivalent.

$X_5$=dry fodder fed per animal for 15 days. It consisted of wheat *bhoosa* and was measured in kilograms, and

$X_6$=the quantity of green fodder in kilograms fed per animal for the period of 15 days. It exclusively consisted of maize in all the cases, hence, as in concentrates and dry fodders, it was not considered necessary to convert it into value or T.D.N. equivalent.

In order to achieve objective (*iv*), *i.e.*, to measure the gains in technical efficiency of milk production through cross-bred cows over that of indigenous animals following formulation was used :

3. Human labour used per milch animal was not considered in the production function because its use remained almost constant.

$$Y = A X_1^{b_1} X_2^{b_2} \ldots X_6^{b_6} \exp. (\delta D + u),$$

where A is a constant, $b_i$'s are the estimates of production elasticities and $\delta$ denotes the coefficient of the dummy variable D designed to capture the effect of breed on milk production (D = 0 for non-descript indigenous breed and D = 1 for cross-bred cows). u is the random disturbance term independently distributed with zero means and finite variance. This formulation helps us in identifying the neutral productivity differences between the breeds, maintaining the hypothesis of no non-neutral differences in milk production due to the two breeds of cows under investigation.[4]

## III

### RESULTS AND DISCUSSION

*Zero-order Correlation Coefficients and the Problem of Multi-collinearity*

Before fitting the milk production functions, it was essential to examine the zero-order correlation coefficients between the various pairs of explanatory variables considered. An examination of the simple correlation coefficients revealed a high correlation between only two independent variables, *i.e.*, the age of animal and number of lactation, in indigenous as well as cross-bred cows (+0.9200 and + 0.8584) which was indicative of the problem of multi-collinearity. Hence, to get rid of this problem, variable $X_3$, namely, number of lactation, was dropped from the regression equation fitted to the data.

*The Fitted Milk Production Functions*

The milk production functions obtained along with the values of $R^2$ (coefficient of multiple determination) are given in Table I.

TABLE I—ESTIMATES OF MILK PRODUCTION FUNCTIONS FOR INDIGENOUS AND CROSS-BRED COWS IN RURAL AREAS OF LUDHIANA DISTRICT (PUNJAB) DURING JULY 1 TO JULY 15, 1975

| Type of breed | Number of observations | Constant | Coefficients of | | | | | | $R^2$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | $X_1$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | D | |
| Indigenous | 40 | 7.96 | —.2110 | —.1800*** | .5330*** | .0563** | .1832@ | — | .8163*** |
| | | | (.2807) | (.0476) | (.1064) | (.0272) | (.1400) | | |
| Cross-bred | 40 | 32.21 | —.5318* | —.1368* | .6197** | 1.0513 | 1.2818@ | — | .5058*** |
| | | | (.3053) | (.0746) | (.2624) | (.8631) | (.8482) | | |
| Pooled | 80 | 12.58 | —.3702* | —.1689*** | .5921*** | .0479 | .0902 | —.1960 | .7801*** |
| | | | (.1881) | (.0451) | (.1234) | (.0410) | (.1945) | (.2208) | |

*** Significant at 1 per cent level.
** Significant at 5 per cent level.
* Significant at 10 per cent level.
@ Significant at 20 per cent level.
Figures in parentheses are the standard errors of respective regression coefficients.
$R^2$ is the coefficient of multiple determination.

4. See also A. Zellner, J. Kmenta and J. Dreze, "Specification and Estimation of Cobb-Douglas Production Function Models," *Econometrica*, Vol. 33, October, 1966, pp. 784-795.

The various factors influencing milk production included in the milk production functions, namely, the age of animal, stage of lactation, quantities of concentrates, dry and green fodders, explained about 82, 51 and 78 per cent of the total variation in the milk production in the case of indigenous, cross-bred and pooled sample of both the breeds respectively.

In the case of indigenous cattle, $X_1$ (age of animal) turned out to be non-significant while in the milk production function for cross-bred cows, $X_5$, *i.e.*, dry fodder, was not significant. For the pooled sample, $X_5$ and $X_6$, *i.e.*, dry and green fodder, both were not significant. It may be seen that the coefficients of elasticity were negative with respect to $X_1$ and $X_3$ in all the three regression equations, indicating thereby that milk production would register a decline with any increase in these variables at their geometric mean levels.[5] However, one per cent increase in $X_4$, $X_5$, and $X_6$ would increase the milk production at the geometric mean levels by .5330, .0563 and .1832 per cent in indigenous cows and .6197, 1.0513 and 1.2818 per cent in cross-bred cows respectively. One, however, needs to be cautioned that the coefficient with respect to $X_5$ was not significant in the latter case.

*Marginal Value Products of Different Factors affecting Milk Production*

The marginal value products of various factors, as worked out at their geometric mean levels, in the case of indigenous and cross-bred cows are presented in Table II. Though the marginal value products for the pooled data on both the breeds are also presented in the same table, yet they are not discussed assuming that their interpretation can easily be done on the same basis as that for different breeds presented here.

TABLE II—MARGINAL VALUE PRODUCTS OF DIFFERENT FACTORS INFLUENCING MILK PRODUCTION OF COWS IN RURAL AREAS OF LUDHIANA DURING JULY 1 TO JULY 15, 1975

*(Rupees)*

| Breed of cattle | Age of animal (years) | Stage of lactation (months) | Concentrates fed per animal (kg.) | Dry fodder fed per animal (kg.) | Green fodder fed per animal (kg.) |
|---|---|---|---|---|---|
| | $X_1$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ |
| Indigenous .. .. .. | —2.3528 | —3.6661 | 1.8092 | 0.0337 | 0.2365 |
| Cross-bred .. .. .. | —24.4628 | —2.4962 | 1.4777 | 0.5933† | 1.4433 |
| Pooled .. .. .. | —8.3491 | —3.7485 | 4.4855 | 0.0275† | 0.1061† |

†These estimates are based on regression coefficients which were not significant.

5. Geometric mean levels of the various factors for the two breeds were as under:

| | $\bar{Y}$ (litres) | $\bar{X}_1$ (years) | $\bar{X}_3$ (months) | $\bar{X}_4$ (kg.) | $\bar{X}_5$ (kg.) | $\bar{X}_6$ (kg.) |
|---|---|---|---|---|---|---|
| Indigenous .. .. .. | 69.25 | 7.76 | 4.25 | 25.50 | 144.23 | 67.03 |
| Cross-bred .. .. .. | 132.48 | 3.60 | 9.08 | 69.44 | 293.30 | 147.05 |

Though it may be purely of academic interest, yet it would be worthwhile to note that any advancement in age and stage of lactation beyond their geometric mean levels in both the breeds resulted in a decline in the total value product from milk. An advancement of age by one year caused a loss of milk production worth Rs. 2.35 and Rs. 24.46 during the period of 15 days for indigenous and cross-bred cows. The corresponding figures of loss due to an advancement of lactation stage by one month amounted to Rs. 3.67 and Rs. 2.50. The marginal value products of concentrates, dry and green fodders were positive in all the cases for both the breeds and amounted to Rs. 1.81, Re. 0.03 and Re. 0.24 respectively in the case of indigenous cows and Rs. 1.48, Re. 0.59 and Rs. 1.44 in the case of cross-bred cows. These figures indicated the amounts by which the total value product from milk would increase due to an addition of one kilogram of concentrates, dry and green fodders at their geometric mean levels. It may be noted that the marginal value product of concentrates was higher in the case of indigenous cows, while the reverse was found true about the marginal value products of dry and green fodders. One may, therefore, infer from these results that while relatively more concentrates were being fed to the cross-bred cows, indigenous breeds received more dry and green fodders.

In order to test the efficiency of existing levels of concentrates, dry and green fodders fed to each of the two breeds, the marginal value products of these resources were compared with their respective per unit costs.[6] It was observed that there existed a vast potential for increasing returns from milk production through pushing further the use of concentrates and green fodders in both the breeds because the per unit factor costs were much lower than their marginal value products. On the contrary, the marginal value product of dry fodder being less than its per unit cost, suggested the curtailment of its use in the case of indigenous breeds if the objective of the dairy farmer is maximization of profits from milk production. However, no definite conclusion could be drawn about the use of dry fodder in the case of cross-bred animals because the regression coefficient of this variable was not significant in the milk production function.

*Technical Efficiency of Milk Production*

It may be observed from the milk production function derived on the basis of pooled data for indigenous and cross-bred cows that the coefficient of the dummy variable was not statistically different from zero. However, in view of the limited data where full lactation and dry periods and seasonality could not be taken into account, any conclusion about technical efficiency of milk production through one breed over the other would be unwarranted.

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6. Costs of $X_4$, $X_5$ and $X_6$ were Re. 0.85, Re. 0.10 and Re. 0.06 per kilogram respectively.

## IV

### CONCLUSIONS

While the age of the animal, stage of lactation, quantities of concentrates, dry and green fodders fed explained 82 per cent of the total variation in the milk production in the case of indigenous cows, the extent of variation explained by the same factors was only about 51 per cent in the case of cross-bred cows. Higher estimates of marginal value products of concentrates in the case of indigenous breed and that of dry and green fodders in the case of cross-bred cows, brought out clearly that the dairy farmers attached more importance to feed relatively larger quantities of concentrates to cross-bred cows and dry and green fodders to *desi* cows. A comparison of marginal value products of concentrates and fodders with their corresponding per unit costs exhibited a great potential for increasing returns from milk production through intensifying their use in both the breeds. On the contrary, the marginal value product of dry fodders being less than its per unit cost, suggested curtailment in its existing use for indigenous cows.

From statistical point of view, there appeared no difference in the technical efficiency of milk production through indigenous and cross-bred cows. But due to limitations of data where full lactation and dry periods and seasonality could not be taken into account, any conclusion about technical efficiency would be unwarranted. It may, however, be suggested that instead of relying only on cross-bred cows for the rapid development of dairy enterprise in the rural Punjab, it would perhaps be a worthwhile proposition to improve the existing feeding standards of indigenous cows simultaneously.

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# BOVINE FEED AVAILABILITY AND REQUIREMENT IN KARNATAKA WITH REFERENCE TO DAIRY DEVELOPMENT PROGRAMMES

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### INTRODUCTION

Bovines in Karnataka are kept for the dual purpose of draught power and milk. There is a bit of specialisation in these two functions, namely, the buffaloes among the bovines being kept mainly for the purpose of milk, and the cattle being kept for draught power. During the eleven-year period from 1961 to 1972, the bovine population in Karnataka increased by 5.70 per cent—the cattle by 3.57 per cent and the buffaloes by 6.27 per cent. The decennial growth rate of human population during the period from 1961 to 1971 was however as high as 24.07 per cent. The slow growth rate of the bovine population appears to be due to the limitation of bovine feed avai-

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