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NOTES

A STUDY ON RESOURCE PRODUCTIVITY IN MILK PRODUCTION*

INTRODUCTION

For increasing milk production in the country, various developmental programmes are in operation which include scientific breeding, disease control and better feeding and management. Efficient management of the herd can result not only in increasing the quantity of milk produced but also in reducing the cost of production of milk. In this context, the study of the economics of milk production attains considerable importance.

Several factors like feed, labour and depreciation on animals and capital investment contribute to the cost of production of milk. While feed accounts for the largest part, amounting to about 60 to 70 per cent of the total cost,[1] the other factors also may play some role in the economy of milk production. The present investigation deals with the estimation of the relationship of milk yield with the different factors of cost and stall size. The comparative importance of the resource inputs and their productivities with special reference to feed have also been examined.

MATERIAL FOR THE STUDY

Data from the sample surveys for estimating the cost of production of milk in the urban, suburban and rural areas of Tamil Nadu and West Bengal carried out by the Institute of Agricultural Research Statistics during 1957-59 and 1960-62 respectively[2] constitute the basis of the study. In each of these surveys a suitable sampling design was followed in order to secure an objective estimate of the cost of production of milk with satisfactory precision. In Tamil Nadu, the survey was taken up in the city of Madras, the suburban areas consisting of villages surrounding the city from which milk was being supplied to the city and a rural area, namely, the villages of Gudiatham taluk in North Arcot district. The survey in West Bengal covered the city of Calcutta, the suburban areas consisting of the thanas of Barasat, Deganga, Haringhata and Shantipur and the rural area comprising villages in Chandernagar sub-division of Hooghly district.

For collection of data, the cost accounting approach was followed. Trained investigators working on a whole-time basis were stationed in the towns and villages where the selected households were studied. Data on milk yield of individual animals and feed given to them were collected by actual weighment and other relevant information such as price of feeds, price of animals, labour employed, etc., was collected through careful observation and enquiry. The data were collected through weekly visits of the selected producers' households.

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1. V. G. Panse, V. N. Amble and K. C. Raut, "Cost of Production and Price of Milk," *Gosamvardhana*, Vol. VII, June, 1964.

2. (*a*) V. G. Panse, V. N. Amble and K. C. Raut: Cost of Milk Production in Madras, I.C.A.R. Report Series No. 6, New Delhi, 1963. (*b*) V. G. Panse, V. N. Amble and K. C. Raut: Cost of Milk Production in West Bengal, I.C.A.R. Report Series No. 28, New Delhi, 1967.

There were commercial producers who habitually sold milk as well as private producers among the selected households. For the present study the commercial households observed during the second year of the survey were considered. The study was made separately for cows and buffaloes. In the case of West Bengal in the suburban and rural areas there were practically no buffaloes and as such the study was confined only to cows. Households where stall feeding of animals were practised only were taken for the study. The mean values of milk yield and the components of cost of maintenance per milch animal per day are shown in Table I.

TABLE I—MEAN VALUES OF MILK YIELD AND COMPONENTS OF COST OF MAINTENANCE PER MILCH ANIMAL PER DAY

State	Area	Species	Number of stalls studied	Mean values				
				Milk yield (kg.)	Feed (P)	Paid labour (P)	Unpaid labour (P)	Depreciation (P)
Tamil Nadu	Urban	Cow	18	3.35	145.6	16.6	7.2	25.7
		Buffalo	24	2.71	121.0	9.1	8.5	23.3
	Suburban	Cow	26	0.49	20.0	2.8	10.2	1.4
		Buffalo	29	1.37	35.8	3.8	15.3	5.4
	Rural	Cow	26	1.06	28.3	1.7	14.4	0.9
		Buffalo	51	0.97	29.4	1.1	19.1	5.4
West Bengal	Urban	Cow	28	3.73	214.9	19.6	4.2	50.0
		Buffalo	28	5.27	313.1	18.5	14.7	111.7
	Suburban	Cow	60	0.60	21.2	0.9	16.3	0.2
	Rural	Cow	17	0.85	25.7	1.4	15.4	2.4

PROCEDURE OF ANALYSIS

The relationship between milk yield and the different factors of cost and stall size was first studied. The production function can be written as :

$$y = f(x_1, x_2, x_3, x_4, x_5)$$

where y represents the milk yield (kg.) per milch animal per day. The corresponding inputs are x_1 the feed cost (P), x_2 the value of paid labour (P), x_3 the value of unpaid labour (P), x_4 the depreciation on animals, assets and equipments (P) and x_5 the average number of milch animals in a stall.

The cost of feed was taken as the actual cost paid if purchased and imputed cost in the case of home-grown feeds. A similar procedure was followed to obtain the two factors of labour. Depreciation on animals was calculated at the end of the period by subtracting the value of the animals in stock at the end of the period and proceeds of sales during the period from the value of the stock at the beginning of the period and the cost of purchases. For the other investments which were of comparatively of a minor nature, a similar procedure was followed.

Different types of production functions were fitted to the data.[3] The functions tried in the present case were linear, quadratic, Cobb-Douglas, semi-logarithmic and the exponential. Depending upon the significance of the regression coefficients and the percentage variation explained, the appropriate forms of the production function were decided.

3. E. O. Heady and J. L. Dillon: Agricultural Production Functions, Iowa State University Press, Ames, Iowa, U.S.A., 1961.

On the basis of the equations chosen, the marginal productivities were examined, the marginal productivity of a resource being estimated by partial differentiation of the production function. The marginal revenue has also been calculated by multiplying the marginal product and the market price (average of weekly prices) of milk that prevailed at the time of the survey.

RESULTS AND DISCUSSION

Production Functions

Utilizing the data pertaining to cows and buffaloes from the urban, suburban and rural areas of Tamil Nadu and West Bengal, different functional relationships were estimated. It was seen that even though the percentage variation explained was highest for the quadratic equation, the degrees of freedom lost in estimating the coefficients were quite large with the result that only few degrees of freedom were left for the residual to permit a sensitive test of the regression coefficients. As a consequence, even the coefficients of the factor feed were often not significant. In two cases where the degrees of freedom were large it was found that the additional variation explained by the quadratic was only marginal. On the other hand, for linear and Cobb-Douglas equations, the regression coefficients for feed were generally significant. Therefore, it was felt appropriate to consider the linear or the Cobb-Douglas, whichever resulted in a higher value for the multiple correlation coefficient, for further studies. The forms of these equation are as follows:

Linear : $Y = a + b, x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5$

Cobb-Douglas : $Y = ax_1^{b_1} x_2^{b_2} x_3^{b_3} x_4^{b_4} x_5^{b_5}$.

The linear equation gave a better fit except in the case of data on cows and buffaloes from Madras city where the Cobb-Douglas function was better. Table II shows the coefficients of the fitted equations for the different sets of data. The

TABLE II—PRODUCTION FUNCTIONS—REGRESSION COEFFICIENTS OF FACTORS

State	Area	Species	Type fitted	Regression coefficients of					R^2
				Feed	Paid labour	Unpaid labour	Depre-ciation	Stall size	
Tamil Nadu	Urban	Cow	Cobb-Douglas	0.419	0.046	0.061	—0.070	0.048	0.60
		Buffalo		1.000**	—0.003	—0.032	0.393*	0.016	0.91
	Suburban	Cow	Linear	0.014*	—0.002	0.006	0.002	—0.022	0.54
		Buffalo		0.017**	0.018	0.015*	0.017*	0.012	0.58
	Rural	Cow		0.021*	—0.041	—0.027	0.027	—0.220	0.61
		Buffalo		0.012*	0.045	0.016	0.019*	0.058	0.46
West Bengal	Urban	Cow	Linear	0.015**	—0.010	—0.007	0.006	—0.004	0.79
		Buffalo		0.008**	0.004	0.002	0.005	0.008	0.56
	Suburban	Cow		0.001**	0.019*	0.013*	0.007*	0.011	0.46
	Rural	Cow		0.016	0.061	0.047	0.019	0.151	0.76

* Significant at 5 per cent level.
** Significant at 1 per cent level.

value of R^2 as could be seen from the last column of Table II ranged from 0.91 in the equation for buffaloes in Madras city to 0.46 in the case of buffaloes in the rural area of Tamil Nadu.

The regression coefficients of feed were all positive and were significant in all cases except for the data on cows in Madras city and cows in the rural area of West Bengal. In most of the cases the coefficients were significant at one per cent level. These results, as expected, show the positive response of feed to milk production.

The coefficients of the other factors were mostly not significant. However, from the results consistent over the species, the broad indication is that in the case of buffaloes in the selected rural and suburban areas of Tamil Nadu unpaid labour showed a positive influence on milk yield. The coefficients of the factor depreciation were positive and significant in the case of buffaloes in all the three selected areas of Tamil Nadu.

Feed has been consistently observed as the most significant factor influencing milk yield. So far as the other factors are concerned, a study was made to get the idea of their comparative importance. Table III shows the percentage variation explained by feed and the additional variation explained by paid labour, unpaid labour, depreciation and stall size. From Tables II and III, the indication is that after feed, depreciation was of comparative importance followed by paid labour in cities and unpaid labour in rural and suburban areas. Stall size showed only very little effect on the average milk yield per animal. In the rural and suburban areas the number of milch animals kept in a stall was mostly one or two. In the city area there was more variation in stall size, but about 75 per cent of the stalls had only 1 to 3 animals and the variation in stall size did not show any corresponding trend in the average milk yield per animal.

TABLE III—PERCENTAGE VARIATION EXPLAINED BY FEED AND OTHER INPUT FACTORS

State	Area	Species	Percentage variation explained by feed	Additional percentage variation explained by				Total percentage variation explained
				Paid labour	Unpaid labour	Depreciation	Stall size	
Tamil Nadu	Urban	Cow	32.16	4.48	1.67	19.79	1.62	59.72
		Buffalo	82.56	2.01	0.60	3.14	2.44	90.75
	Suburban	Cow	46.20	0.09	6.73	0.69	0.32	54.03
		Buffalo	30.21	1.36	15.93	10.16	0.09	57.75
	Rural	Cow	53.23	0.16	0.52	5.45	1.92	61.28
		Buffalo	27.02	0.01	10.77	7.13	0.61	45.54
West Bengal	Urban	Cow	72.21	3.43	1.04	3.17	0.04	79.89
		Buffalo	37.86	0.39	0.20	16.66	0.63	55.74
	Suburban	Cow	19.27	7.69	13.75	5.23	0.02	45.96
	Rural	Cow	48.31	1.46	11.64	10.07	4.03	75.51

Productivity

As seen from the foregoing results, feed plays the major role in explaining the variation in milk yield. The regression coefficients were highly significant in almost all cases studied. But for the other factors the bulk of the coefficients were found to be not significant. As such the productivity study was restricted to only feed.

Table IV shows the estimated values of the marginal productivity along with their standard errors.[4] In the case of Cobb-Douglas function, the productivity was estimated keeping the factors at their geometric means.

TABLE IV—ESTIMATES OF MARGINAL PRODUCTIVITY OF FEED AND THE MARGINAL RETURNS

State	Area	Species	Average milk production per milch animal (kg.) per day	Average feed cost per milch animal (P) per day	Per paisa feed: Marginal productivity Estimate (gm.)	Per paisa feed: Marginal productivity S.E. (gm.)	Per paisa feed: Marginal revenue (P)†
Tamil Nadu	Urban	Cow	3.35	146	11	6.4	0.8
		Buffalo	2.71	121	21**	4.4	1.7
	Suburban	Cow	0.49	20	14*	5.2	0.8
		Buffalo	1.37	36	17**	5.5	1.0
	Rural	Cow	1.06	28	21**	6.4	0.7
		Buffalo	0.97	29	12*	5.6	0.4
West Bengal	Urban	Cow	3.73	215	15**	1.7	1.5
		Buffalo	5.27	313	8**	2.3	0.9
	Suburban	Cow	0.60	21	11**	3.4	0.8
	Rural	Cow	0.85	26	16	9.3	0.9

* Significant at 5 per cent level.
** Significant at 1 per cent level.
† Evaluated at the price of milk that prevailed at the time of the survey.

As an illustration of the interpretation take a specific case, say, cows in urban area of West Bengal. The productivity estimate 15 indicates that an increase of one paise worth feed can be expected to result in an increase of 15 grams of milk per milch animal. Similarly, the other values also can be interpreted.

The broad indication from the table is that the productivity of feed was higher for buffaloes compared to cows in Madras city and its suburban areas in Tamil Nadu while cows seemed to be more productive in the rural areas. In the case of Calcutta city, on the other hand, the productivity was comparatively higher in cows than in buffaloes.

The values of the marginal revenue are given in the last column of Table IV. As seen from the table, in the case of buffaloes in Madras city and cows in Calcutta city, it would be more profitable to spend money for additional feed. In the remaining cases, it would not be advantageous for the producer to spend more on feed item.

Concluding Comments

It may be pointed out that the price of feed items and the price of milk have increased considerably since the surveys were undertaken. If one could assume

4. H. O. Carter and H. O. Hartley, "A Variance Formula for Marginal Productivity Estimate Using the Cobb-Douglas Function," *Econometrica*, Vol. 26, 1958.

that the feeding practices have not undergone any appreciable change and that the ratio of unit price of milk to feed has remained more or less same, one could take the results of productivity studies discussed to hold good in the present situation. In this connection, it may be stated that the Institute of Agricultural Research Statistics has recently initiated enquiries in different areas to collect information on prices of feed items, milk, etc., with a view to building up an index of cost of milk production. An examination of part of the data received from Calcutta city area indicated that feed cost per kg. of milk has increased by about 75 per cent while price of milk has increased by about 50 per cent compared to the prices which prevailed in Calcutta when the earlier survey was undertaken. This would indicate reduction in the net return to the producer. Such interesting probes can be made in the course of time when adequate data on prices of relevant commodities, wage rates, management practices, etc., become available. However, a resource productivity study specific to the current dairy practices can be carried out in full only if a full-fledged cost of production survey is undertaken afresh in the areas concerned. The present investigation will serve as a good bench-mark for such studies. In countries like U. K. such detailed enquiries are undertaken periodically. Thus the Milk Marketing Board, U. K., follow the practice of conducting the costing enquiries for a period of two years followed by three years of extension work utilizing the information thrown out by the studies. It is high time that principal milk schemes in this country should also follow such a practice which would result in giving them a fund of information on dairy practices, pattern of prices, productivities, etc. These would be useful in formulating sound procurement policy and in promoting increased milk production in the milk-shed areas.

From the feed productivity studies made, it is seen that while the feed response has been positive, it has not been often commensurate with the additional cost involved. There appears to be scope for reducing the cost by following improved feeding and management practices such as substitution of costly concentrates by green fodder, reduction of calving interval, etc. It has been accepted by animal nutritionists that concentrates can be substituted to some extent by protein-rich roughages without adversely affecting milk production.[5] A recent study made at the Institute utilizing data from a planned nutrition experiment on Thari cows also indicated that concentrates could be substituted to a good extent by protein-rich greens at lower levels of milk production.[6] It may make the dairy enterprise more paying if the farmers are helped through extension work in practicing efficient management methods and more attractive if they are assured of reasonable price for the milk produced.

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5. K. C. Sen and S. N. Ray: Nutritive Values of Indian Cattle Foods and Feeding of Animals I.C.A.R. Bulletin No. 25, New Delhi, 1964.

6. T. Jacob, V. N. Amble, M. L. Mathur and A. Subbarao, "Milk Production Functions and Optimum Feeding Schedules," *Indian Journal of Agricultural Economics*, Vol. XXIV, No. 2, April-June, 1969.

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