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## **Economic Analysis of Commercial Dairy Herds in Arid Region of Rajasthan**

**Khem Chand, Kulwant Singh and Raj Vir Singh\***

### INTRODUCTION

Dairying in India has emerged as an independent agricultural enterprise. In addition to the maintenance of livestock in the mixed farming systems, a large number of specialised dairy herds have come up in the urban and suburban areas of the country, which fulfill a part of the need of urban population. The commercial buffalo farms cater to the needs of about one-fourth of urban population in Hyderabad city of Andhra Pradesh (Rao *et al.*, 1991).

Rajasthan with 5.5 million tonnes of annual milk production has emerged as the third largest milk producer state of the country (Government of India, 2000, p. 133). In Bikaner city of Rajasthan a major portion of the milk produced on about 300 commercial dairy herds is used as raw material in the production of the milk product Rasogolla and other Chhana based indigenous milk products, which are marketed not only inside the country, but are also exported to other countries. The commercial herdsmen in Bikaner mainly keep crossbred cattle because of their higher productivity (7.42 litres/day) and preference of cow milk over buffalo milk for production of Chhana based milk products. Since private dairies are more efficient in their operations more particularly in revising the prices as compared to URMUL dairy, they procure a major portion of the milk produced by commercial herds. Thus these dairies play an important role but they are not well aware of the costs and returns aspects and the economic size of their dairy herd. Therefore, in this paper an effort has been made to work out the economics of milk production on commercial dairy herds in Bikaner city of Rajasthan. Specifically, an attempt has been made (i) to study the investment and resource use pattern, (ii) to examine the variation in the cost structure of milk production on different sizes of dairy herds and (iii) to assess the break-even level of milk production and optimum size of herd across different categories.

### METHODOLOGY

#### *Sampling Framework*

Majority of the dairy herds in Bikaner city constitute only crossbred cattle for

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milk production purpose; hence the study was confined to crossbred dairy herds. For the selection of sample households/stalls, a complete enumeration of commercial dairy herds in Bikaner city of Rajasthan was undertaken. The dairy herds were categorised into small, medium and large based on cumulative square-root frequency method of stratification since no standard classification of various size of herds in urban areas is available and besides, the herd size varies from area to area. Finally, 100 dairy herds were selected on the basis of probability proportionate to the number of dairy herds in each category (Table 1).

TABLE 1. SELECTION OF SAMPLE STALLS IN BIKANER

Category	Total number of stalls	Stalls selected
(1)	(2)	(3)
Small (1 to 20 animals)	104	39
Medium (21 to 37 animals)	104	39
Large (38 and above animals)	56	22
Total	264	100

The relevant data were collected through well-structured and pre-tested schedules by personal interview method for the year 1996-97. The year was divided into three seasons, viz., winter (November to February), summer (March to June) and rainy (July to October) and each of the selected stall was visited during the season.

#### *Analytical Technique*

Tabular analysis was used for working out the fixed capital investment, resource use structure, cost and returns in milk production. The break-even level of milk production per animal per year was estimated using the following method (Pappas and Brigham, 1979, p. 326):

$$\text{Breakeven level of output} = \frac{\text{Total fixed cost per animal}}{\text{Price per litre of milk} - \text{Variable cost per litre of milk}}$$

For estimating optimum herd size, the average cost function was fitted for different categories of herds. The equation fitted was:

$$C = b_0 + b_1Y + b_2Y^2$$

where C = cost per litre of milk (Rs.), and

Y = quantity of milk produced (litres) per herd.

From the fitted equation, the optimum scale of milk production was estimated.

The optimum herd size was estimated as follows:

$$\text{Optimum herd size} = \frac{\text{Optimum scale of milk production per herd}}{\text{Average milk yield per animal}}$$

## RESULTS AND DISCUSSION

*Investment Pattern*

The income generating capacity of dairy owners is reflected through their investment pattern. Total capital investment in a dairy herd in Bikaner city was over Rs. 4 lakhs, out of which milch animals alone accounted for about 79 per cent (Table 2). Majority of the dairy owners were having Holstein Friesian and Jersey crosses in their herds. It was also observed that the proportion of investment on milch animals increased with the increase in the size of herd, while it was reverse for cattleshed and stores (buildings). Total capital investment per milch animal showed inverse relationship with the size of herd.

TABLE 2. INVESTMENT PATTERN ON DAIRY HERDS

Items (1)	Category of dairy herd (Rs./herd)			
	Small (2)	Medium (3)	Large (4)	Overall (5)
A. Animals:				
(i) Milch animals	1,73,584 (75.03)	2,96,182 (78.63)	6,31,550 (82.59)	3,22,150 (79.47)
(ii) Young stock and heifers	7,483 (3.24)	8,413 (2.23)	16,450 (2.15)	9,818 (2.42)
(iii) Bulls	1,625 (0.70)	2,760 (0.73)	9,000 (1.18)	3,690 (0.91)
(iv) Draft animals	740 (0.32)	3,240 (0.86)	4,250 (0.56)	2,487 (0.61)
Total (i to iv)	1,83,432 (79.29)	3,10,595 (82.45)	6,61,250 (86.48)	3,38,145 (83.41)
B. Cattleshed and store	42,995 (18.58)	54,018 (14.34)	84,804 (11.09)	56,492 (13.94)
C. Machinery and equipment	4,925 (2.13)	12,093 (3.21)	18,613 (2.43)	10,732 (2.65)
Total capital investment (A+B+C)	2,31,352 (100.00)	3,76,706 (100.00)	7,64,667 (100.00)	4,05,369 (100.00)
Total capital investment per milch animal	15,091	13,644	12,852	13,585

Note: Figures in parentheses indicate percentages to total capital investment.

*Resource Use Pattern*

The income on a dairy herd depends primarily on the entities of various factors of production used in the production process and the output (level of milk production). The pattern of use of major factors of production has been analysed and discussed below:

*(a) Floor space availability*

All the dairy herds in the Bikaner city were situated either inside the walled city or in the adjoining areas. A part of the residential house was converted into

cattlesheds to house the animals. No additional land was available with the dairy owners to grow fodder for the animals. On an average, 404, 623 and 1309 sq. metres (sq.m) area was available to maintain an average small, medium and large herd respectively. In other words, the area allocated to each animal varied from 17 to 18 sq.m, which included the area for feeding, milking and free movement. This area was quite close to the recommended floor space (15 sq.m) per animal (Nagarcenkar, 1979, p. 13).

(b) *Labour utilisation pattern*

The utilisation of human labour in a dairy herd reflects the extent of employment available which largely depends on the size of dairy herd, availability of fodder and feeds, distance of the market from where these are available, and other facilities. Over 34 man-days per year were required for maintenance of an animal in Bikaner city (Table 3). The contribution of male, female and child labour in the total labour utilisation was 65, 27 and 8 per cent respectively and their composition was almost the same in all the categories of stalls. The labour use per animal decreased with the increase in herd size which could be due to the economies of scale. Higher share of male labour on the commercial dairy herds is contrary to the rural areas, where female labour contributes more in the dairy activities.

TABLE 3. LABOUR UTILISATION IN DAIRY ENTERPRISE

Category of herd (1)	<i>(man-days/year/animal)</i>			
	Male Labour (2)	Female labour (3)	Child labour (4)	Total (5)
Small	25.24 (68)	9.10 (25)	2.51 (7)	36.86 (100)
Medium	21.36 (62)	9.96 (29)	2.93 (9)	34.25 (100)
Large	18.99 (65)	8.02 (27)	2.32 (8)	29.33 (100)
Overall	22.35 (65)	9.20 (27)	2.63 (8)	34.18 (100)

*Note:* Figures in parentheses indicate percentages to total labour use.

(c) *Dairy management practices*

The scientific management of a dairy herd is essential not only to exploit the genetic potential of the animals, but also for taking care of the animals and use the resources in an optimal manner. The management input has been decomposed into various aspects like breeding, feeding, housing, health management and general upkeep of animals.

Almost all the stalls maintained their own bulls for breeding purposes. Though the State Government has set up stockmen/artificial insemination (AI) centres in the vicinity of the area where most of the stalls are located, yet the majority of stall

owners preferred natural service to AI because of high success rate. The success rate in AI is reported to be low (Janakiraman, 1990).

The milch animals in Bikaner city are solely maintained on purchased fodder and feeds. The green fodder fed to these herds was almost negligible. The dry fodder available is *pala* (dry leaves of *Ziziphus nummularia*), groundnut haulm, sewan grass (*Lasiurus indicus*), wheat straw, sorghum stover, moth bean stalks, etc. An important source of digestible crude protein to animals is the concentrate mixture prepared by each stall owner. The composite concentrate mixture was not used. The major ingredients of concentrate mixture are cottonseed cake, moongbean churi (crushed grains), urd bean churi, gram churi, mothbean churi, barley grit, jaggery, fenugreek seeds, wheat bran, barley husk, etc. The proportion of ingredients in the concentrate mixture varied depending upon their availability and prices. Less than 10 per cent of the dairy owners fed mineral mixture to the animals whereas salt is rarely given to them.

Majority of the dairy owners used part of their residence as stalls for animals; however, in some herds separate stalls are maintained for the animals. Animal sheds are *pucca*, *semi-pucca* and *kutchha* depending upon the capacity of the owner.

The cattle keepers generally arranged to vaccinate their animals for foot and mouth disease as a prophylactic measure. In case of treatment of any disease-affected animal, the veterinarian is generally called at the stall itself. Grooming is done occasionally in the dairy herds. Measures to control external and internal parasites are also adopted.

General upkeep and the management practices followed on a dairy farm play a dominant role in increasing the milk production and hence the returns. In Bikaner city, most of the dairy herds provided open cement tanks on one side of the feed mangers for drinking water. There is a general practice of milking the animals twice a day at the same place where they are fed or tied.

#### ECONOMICS OF MILK PRODUCTION

##### 1. *Cost and Returns*

To ascertain the economics of milk production, cost, and returns per milch animal across different seasons, viz., winter, summer and rainy, were worked out. The average cost of maintaining a cow was the highest in winter season, followed by rainy and summer season. This was mainly attributed to the higher expenditure on fodder and feeds in winter and rainy season as compared to summer season. In the overall cost of maintenance, feed cost alone accounted for more than 70 per cent per animal per day (Table 4). The overall net cost per animal per day was Rs.53, Rs. 51 and Rs. 50 on small, medium and large herds respectively. The milk yield showed an increasing trend from summer to winter season. The overall milk yield per animal per day in small, medium and large herds was 7.72, 7.30 and 7.13 litres respectively (Table 5). The dairy owners realised the highest price per litre of milk in summer

TABLE 4. SEASONWISE MAINTENANCE COST OF MILCH COW IN DIFFERENT CATEGORIES OF HERDS

Items (1)	<i>(Rs./animal/day)</i>								
	Small			Medium			Large		
	Winter (2)	Summer (3)	Rainy (4)	Winter (5)	Summer (6)	Rainy (7)	Winter (8)	Summer (9)	Rainy (10)
A. Cost due to fixed capital investment									
(i) Interest on fixed capital	4.60 (7.71)	4.64 (9.55)	4.62 (8.37)	4.10 (6.98)	4.14 (8.63)	4.13 (7.75)	3.91 (6.95)	3.94 (8.31)	3.92 (7.58)
(ii) Depreciation on fixed assets	2.29 (3.84)	2.31 (4.76)	2.31 (4.19)	2.17 (3.70)	2.19 (4.56)	2.18 (4.09)	2.10 (3.74)	2.12 (4.47)	2.11 (4.08)
Total (i + ii)	6.89 (11.55)	6.95 (14.31)	6.93 (12.56)	6.27 (10.68)	6.33 (13.19)	6.31 (11.84)	6.01 (10.69)	6.06 (12.78)	6.03 (11.66)
B. Variable costs									
(i) Dry fodder	20.04 (33.60)	14.34 (29.52)	17.44 (31.61)	19.78 (33.68)	13.82 (28.80)	17.05 (32.00)	19.67 (34.99)	15.24 (32.15)	17.08 (33.02)
(ii) Concentrate	24.96 (41.85)	19.16 (39.45)	22.74 (41.21)	25.22 (42.95)	19.97 (41.61)	22.27 (41.80)	24.02 (42.72)	19.21 (40.53)	21.94 (42.41)
Total feed cost	45.00 (75.45)	33.50 (68.97)	40.18 (72.82)	45.00 (76.63)	33.79 (70.41)	39.32 (73.80)	43.69 (77.71)	34.45 (72.68)	39.02 (75.43)
(iii) Human labour	6.28 (10.53)	6.58 (13.55)	6.54 (11.85)	6.08 (10.36)	6.43 (13.40)	6.25 (11.73)	5.22 (9.29)	5.52 (11.65)	5.35 (10.34)
(iv) Miscellaneous expenditure	1.47 (2.47)	1.54 (3.17)	1.53 (2.77)	1.37 (2.33)	1.44 (3.00)	1.40 (2.63)	1.30 (2.31)	1.37 (2.89)	1.33 (2.57)
Total variable cost	52.75 (88.45)	41.62 (85.69)	48.25 (87.44)	52.45 (89.32)	41.66 (86.81)	46.97 (88.16)	50.21 (89.31)	41.34 (87.22)	45.70 (88.34)
C. Gross cost (A+B)	59.64 (100)	48.57 (100)	55.18 (100)	58.72 (100)	47.99 (100)	53.28 (100)	56.22 (100)	47.40 (100)	51.73 (100)
D. Value of dung	1.85	1.88	1.79	2.07	2.09	1.92	1.60	1.62	1.43
E. Net cost (C-D)	57.79	46.69	53.39	56.65	45.90	51.36	54.62	45.78	50.30

Note: Figures in parentheses indicate percentages to gross cost.

TABLE 5. SEASONWISE RETURNS FROM COW MILK PRODUCTION IN DIFFERENT CATEGORIES OF HERDS

Particulars (1)	<i>(Rs./animal/day)</i>											
	Small				Medium				Large			
	Winter (2)	Small (3)	Rainy (4)	Overall (5)	Winter (6)	Small (7)	Rainy (8)	Overall (9)	Winter (10)	Small (11)	Rainy (12)	Overall (13)
1. Milk production (litres)	8.77	6.84	7.56	7.72	8.45	6.33	7.12	7.30	8.31	6.01	7.07	7.13
2. Price of milk (Rs. Per litre)	8.60	9.50	9.40	9.13	8.50	9.00	8.85	8.76	8.40	8.90	8.75	8.66
3. Gross returns	75.42	64.98	71.06	70.48	71.83	56.97	63.01	63.94	69.80	53.49	61.86	61.74
4. Net cost	57.79	46.69	53.39	52.62	56.65	45.90	51.36	51.29	54.62	45.78	50.30	50.22
5. Net returns (3-4)	17.63	18.29	17.67	17.86	15.18	11.07	11.65	12.65	15.18	7.71	11.56	11.52
6. Returns to fixed resources	24.52	25.24	24.60	24.78	21.45	17.40	17.96	18.95	21.19	13.77	17.59	17.55
7. Family labour income	23.91	24.21	23.23	23.88	21.26	16.86	16.96	18.46	20.40	12.68	16.11	16.50



season, followed by rainy and winter season. The price was high in summer season due to comparatively higher demand and lower supply of milk that could be due to lower productivity in summer season.

The highest milk yield per milch animal per day was observed in small stalls, which could be due to the better personal care given to the individual animal. Since 66 per cent of the total milk production in small herds category was being sold to the consumers directly, it received the highest price per litre of milk. The net return per milch animal in a day was Rs. 18, Rs. 13 and Rs. 12 on small, medium and large herds respectively, which again shows that small producers are better managers and took better care of their animals.

## 2. *Marketing of Milk in Bikaner*

In Bikaner, four agencies are engaged in the collection of milk, viz., (a) consumer, (b) sweet manufacturing units, (c) private dairy plant, (d) others (teashops, milk vendors, etc.). A peculiar system of sale of milk is prevalent in the area. Everyday, both in the morning and the evening, the auction of milk takes place in the vicinity of commercial dairy herds. The sweet manufacturing (Rasogolla) units paid the price decided through such auctions to the dairy herd owners. Private dairy plant (Modi Dairy) has made a procurement contract directly with the milk producers for a specific period of time at fixed price. As per this contract, dairy herds could sell any amount of milk to the private dairy plant.

Small stall owners sold the maximum quantity of milk (66 per cent) directly to the consumers, while the medium and large sized herd categories sold 39 and 42 per cent of their production respectively to the private dairy plant. Overall, the private dairy plant has the largest share in total milk procurement because of better procurement prices and timely payments. Due to procurement contract made by the private dairy plant, producers got assured price for milk, which ultimately affected the milk price during daily auction also. The price fixed by the private dairy plant served as the baseline and helped the producers to get good price in the auction. A contractual arrangement for procurement of milk by the private dairy plant has benefited the milk producers through assured price. Consequently, the number of dairy herds has increased by more than 30 per cent in a span of three years after the establishment of the dairy plant.

### *Break-even Level of Milk Production*

The break-even level of output estimated was 30, 37 and 38 per cent of the total output on small, medium and large herds respectively (Table 6). The small stall owners were able to cover their total expenditure at a much lower level than the medium and large herd owners. It may be due to the fact that as noted earlier, the small stall owners sold around 66 per cent of milk production directly to the consumers and received the highest sale price per litre of milk. However, Rao *et al.*

(1991) in a study of commercial dairy farms in Hyderabad city found that large herds were able to cover their total expenditure at a much lower level than the small and medium dairy farms. The overall break-even level of output was estimated to be 928 litres per milch animal per year, which varied from 850 litres on small herds to 991 litres on medium size herds.

TABLE 6. BREAK-EVEN LEVEL OF MILK PRODUCTION ACROSS CATEGORIES OF HERDS

Herd size categories	Average milk yield (litres)	Fixed cost per animal (Rs.)	Variable cost per animal (Rs.)	Total cost per animal (Rs.)	Variable cost per litre of milk (Rs.)	Price per litre of milk (Rs.)	Break-even output (litres)	Percentage of break-even output to total output
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Small	2,817.80	2,526	17,352	19,878	6.16	9.13	850.44	30.18
Medium	2,664.50	2,300	17,162	19,462	6.44	8.76	991.16	37.20
Large	2,602.45	2,201	16,695	18,896	6.42	8.66	982.57	37.75
Overall	2,710.64	2,366	17,134	19,500	6.33	8.88	927.87	34.23

### Optimum Herd Size

Prior to the estimation of optimum herd size, the optimum scale of operation was worked out by fitting average cost functions for different categories of dairy herds. The equations derived for different categories of dairy herds are as follows:

Small herd size (N=39)

$$C = 9.6525 - 0.0347177* Y + 0.0001035 Y^2 \quad R^2 = 0.2751$$

(0.0201342)      (0.0001042)

Medium herd size (N=39)

$$C = 15.3307 - 0.0701791*** Y + 0.0001446*** Y^2 \quad R^2 = 0.6876$$

(0.0142376)      (0.0000351)

Large herd size (N=22)

$$C = 10.2124 - 0.0138723** Y + 0.0000152** Y^2 \quad R^2 = 0.2589$$

(0.0057449)      (0.0000066)

\*\*\*, \*\*, \* Significant at 1, 5 and 10 per cent level respectively.

The optimum herd size ascertained was 22, 33 and 64 milch animals (Table 7) for small, medium and large categories respectively. From this analysis it may be concluded that in order to achieve the optimum herd size under the prevalent conditions of breeding, feeding and management, the number of milch animals has to be increased by 31, 17 and 7 per cent on small, medium and large categories respectively.

TABLE 7. OPTIMUM HERD SIZE IN BIKANER CITY

Herd size category (1)	Scale of operation (litres)		Herd size (Number of milch animals)	
	Existing (2)	Optimum (3)	Existing (4)	Optimum (5)
Small	118.35 (70.56)	167.72 (100)	15.33 (70.58)	21.72 (100)
Medium	201.55 (83.06)	242.67 (100)	27.61 (83.06)	33.24 (100)
Large	424.24 (92.97)	456.33 (100)	59.50 (92.97)	64.00 (100)

Note: Figures in parentheses indicate percentages to optimum scale of operation and optimum herd size respectively.

#### CONCLUSION

The study reveals that milk production on commercial dairy herds is an economically viable and profitable enterprise in Bikaner city. It generated around 973 man-days of gainful employment per year in an average dairy herd. The contractual procurement and auctioning system of milk has helped a lot in increasing the number of dairy herds in the city. The optimum herd size analysis has suggested the scope for further increase in the number of milch animals in the dairy herds. Though these dairy herds have helped in increasing the supply of milk, they have created many problems too. The herd owners many times set their animals free, which generally results in traffic jam and road accidents. Sometimes the sewerage system is also choked due to disposal of animal waste in it. These problems are created by around 40 per cent of dairy herds which are maintained inside the city. The shifting of dairy herds to the outskirts of the city can solve the problem. Another way to improve upon the situation is by developing a modern dairy complex along the lines of Aarey milk colony, Mumbai with provision of good infrastructure facilities.


This study leads to some implications on the functioning of co-operative dairies also. As the private dairy plant in Bikaner city has been able to procure more of the milk produced on commercial dairy herds, comparative studies of milk procurement systems at private and co-operative dairies are needed to identify the specific causes and means for improving the role of co-operative dairies in the dairy sector.

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