E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(3): 113-117
Received: 02-01-2024
Accepted: 06-02-2024

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Economic analysis of milk production in Himalayan state of India

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i3Sb.436

Abstract
This study was conducted to analyse the profitability of milk production from indigenous and crossbred species and to identify the constraints for technically efficient dairying in the Himachal Pradesh state. Primary data was collected during 2020-2021 from 360 dairy farming households. Tabular analysis was employed to work out the profitability of milk production and Garrett's Ranking Technique (GRT) was performed to identify constraints faced by dairy farmers. The overall gross cost for Indigenous cattle was ₹. 108 per standard animal unit (SAU) per day. Whereas, crossbred cattle accounts double the maintenance cost of indigenous species (₹. 206.02). The average daily milk yield for crossbred (6.41 liters/ day/SAU) and for Indigenous (2.42 litres /day/ SAU). The net returns per SAU per animal in case of crossbred cattle in overall category was ₹ 8.59, whereas, net returns were highest for large category farms (₹ 9.70 per liter), followed by medium and least for small category farmers i.e., ₹ 7.60 and ₹ 6.80 respectively. In study area farmers were facing major constraint were lack of organized milk marketing facility at village level (65.84) followed by non-availability of green fodder throughout the season (64.23) followed by incidence of reproductive disorder (62.00), low productivity of animals (57.30) and less availability of land for fodder cultivation (58.28) in the state.

Keywords: Economic analysis, milk production, standard animal unit

Introduction
Livestock sector is an important source of livelihood in the mountainous terrains of the Himachal Pradesh. Himachal Pradesh encompasses total livestock population of 4.41 million in the year 2017, of which 55 percent encompasses of bovine and 40.8 percent ovine population of total livestock population. Livestock sector play an important role in livelihood of state and is a major contributor in agricultural sector with an annual milk production of 1392 MT with the per capita availability of 565 g day^{-1} (Anonymous, 2021) [2]. Prospects of dairying under hilly conditions would greatly benefit the resource-poor farmers and maximize resource use efficiency. Further, this sector can make significant contribution in promoting redistributive effect on income in favour of weaker sections. Agriculture, Horticulture, hydropower and tourism are important constituent of state's economy (Anonymous, 2019) [1].

Methodology
For the construction of strata, the cumulative cube root frequency method (Singh and Mangat, 1996) [4] and Standard animal unit method (SAU) Sirohi *et al.* (2019) [7] was used as explained under. The data were collected on various aspects of dairy enterprises like the composition of the household, occupation, sex, family size, education of head of family, operational holding, herd size, type of animals and their value, dairy equipment, cattle shed along with their present value and expected life, the quantity of feeds and fodders fed to animals along with their prevailing prices, family and hired labour used along with prevailing wage rate, veterinary and miscellaneous expenditure. The information on milk production, consumption and disposal pattern milk and constraints of dairying was also collected.

Table 1: Standard animal unit for hilly region of the India

Types of Animal	Local Cow	Crossbred Cow	Buffalo
Adult Male (≥3 years)	1.48	1.11	1.43
Adult Female (≥3 years)	1.71	1.00	1.70
Young stock male (<1 year)	0.41	0.29	0.35
Young stock female (<1 year)	0.72	0.63	0.63
Young stock male (>1 year)	0.71	0.55	0.73
Young stock female (>1 year)	1.08	0.82	0.94
Heifer	1.24	0.98	1.09

Source: Sirohi *et al.* (2019) [7]

Cube-root cumulative-frequency method

In this study, SAUs was used as the covariate for the post stratification process. Dairy farmer households (360) were categorized into three classes, using the cube-root cumulative-frequency method (Singh and Mangat, 1996) [4]. For efficient distribution of households, 3- class stratification method was performed. Thus, range for Small (0.1-3.0 SAU), Medium (3.1-7 SAU) and Large (>7 SAU) were assigned.

Cumulative cube root frequency method

$$L_i = y_{i-1} + \left(\frac{S_k \div L - S_{i-1}}{\sqrt[3]{f_i}}\right)(y_i - y_{i-1})$$

Where,

L = No. of strata.

L_i = Upper limit of *i* th strata.

y_{i-1} = Lower limit of the class in which L_I lies.

S_k = Cumulative total of $\sqrt[3]{f_i}$.

$\sqrt[3]{f_i}$ = Cube root of the frequency of the *i* th class in which L_i lies.

S_{i-1} = Cumulative cube root of the frequency of preceding class to the class to which L_i lies.

y_i = Upper limit of the class in which L_i lies.

$y_i - y_{i-1}$ = Width of the class in which L_i lies.

Table 2: Cumulative cube root frequency method

Categories	Small	Medium	Large
Cumulative frequency range	0-3	3.1-6.9	≥7
Sample size (No.)	177	119	64

Cost and returns from milk production

Information relating to various aspects of dairy farming was collected from selected farmers by survey method with a well-designed and pre-tested interview schedule. The data on value of animals and investment on cattle shed and equipment were collected from dairy farmers. Details of inputs used like green fodder, dry fodder, concentrates with their quantities and price, labour employed with wage particulars, veterinary and breeding expenses and miscellaneous expenses and data on outputs like milk and manure were also collected from the sample dairy farmers. For the estimation and calculation of various costs, the following assumptions were made.

Fixed costs

Fixed costs do not vary with the level of output and remain unchanged over a short period of time. The various components of fixed cost are depreciation and interest on fixed capital. Capital Recovery Cost (CRC) method was used to calculate fixed cost. The interest on fixed capital does not need to be accounted for separately in CRC approach.

Depreciation costs: Depreciation is the loss of value of an asset due to its use over time and technological obsolescence. This was calculated by straight-line method.

The annual depreciation on cattle shed and store was calculated at the rate of 2 percent for 'pucca' shed and 5 percent for 'kachha' shed assuming the useful life of building as 50 and 20 years, respectively. The depreciation on equipment like chaff cutter, feed and water troughs, milking cans and utensils, bicycle (largely used for purchasing inputs and selling milk) were also calculated as per productive life of the individual equipment's by taking 7 percent as discount factor. The annual depreciation expenses were apportioned as per Standard Animal Unit (SAU) per day for the selected sample households.

Interest

The value of animal, cattle shed and other equipment's relating to milk production were taken as fixed capital. The interest on fixed capital was calculated at the rate of 4 percent per annum, which matches the interest rate being currently charged by the commercial banks. The annualized interest amount was calculated and apportioned per SAU per day.

Variable cost

Variable costs are those costs, which are incurred on the variable factors of production and can be altered in the short run. The major variable costs are feed and fodder cost, labour cost and veterinary and miscellaneous expenditures.

Feed cost

The dairy herd owners were using different types of green fodders and the prices of these fodders differed substantially. Therefore, to estimate the expenditure on fodder, weighted cost was used. The formula used for calculating weighted cost is given below.

$$W = \frac{G_1P_1 + G_2P_2 + G_3P_3 + \cdots + G_nP_n}{G_1 + G_2 + \cdots + Gn!}$$

$$\mathbf{W} = \frac{\sum_{i=1}^{n} G_n P_n}{\sum_{i=1}^{n} G_n}$$

Where,

W = Weighted Costs (₹).

Gi = Quantity of different types of green fodder (kg) which comprised of maize, sorghum, bajra etc.

Pi = Price of different green fodder (₹/ kg).

Expenditure on dry fodder and concentrate feed were also calculated in the same manner used for green fodder. Whereas, the imputed cost of farmers farm grown feeds and fodder were taken into consideration as per market price of feeds and fodder prevailing in the study area. In the case of collection of grasses, the cost was computed according to the cost of labour incurred in fetching the grass.

Labour cost

It included cost of family as well as paid labour (hired labour). The cost of hired labour was calculated considering type of work allotted and wages paid whereas, family labour costs were determined on the basis of existing wage rate of permanent farm labour.

Veterinary and miscellaneous costs: The expenditure on

breeding and health care of the animals was covered under the veterinary expense. It included, cost of artificial insemination (AI), natural service, vaccination, medicines, fee of veterinary doctor and other related expenses. The miscellaneous expenditure included expenses on repair of fixed assets, water and electricity charges, insurance premium and any other incidental charges. These being joint costs, apportionment of the same were based on SAU

Garrett's ranking technique

To find out the constraints faced by the farmers in production and marketing of milk in the study area, the Garrett's ranking technique (Garrett and Woodworth, 1969) [8] was used. Various constraints were framed for the study keeping in view the reports from the literature (Chand and Raju, 2008; Kumar *et al* 2013) [5]. Accordingly, constraints were identified and sub divided into breeding, feeding and other common constraints for arriving at the response from the farmers. The factors or constraints were prioritized by using Garrett's ranking technique in the following manner:

Percentage position = 100 (Rij-0.5) Nj

Where,
Rij = Rank given for the ith item by the jth, respondent and.
Nj = Number of items ranked by the jth, respondent.

The percentage position of each rank was converted into scores using Garrett table. For each constraint, scores of individual respondents were added together and divided by total number of respondents for whom scores were added. Then, mean score for each constraint was ranked by arranging them in the descending order.

Results

Costs and returns of milk production from local cattle across the dairy farm categories in Himachal Pradesh

The estimates of cost and returns of the local cow milk production across the different categories are depicted in the table 3. The findings revealed that the net cost (NC) of maintenance per standard animal unit (SAU) was ₹ 88.13 per day, whereas, gross cost per SAU was ₹ 108.73 per day for overall category. The gross cost of maintenance for small farm (₹ 103.70) was lower as compared with medium farm (₹ 113.78). Total variable cost (TVC) accounts for 88.26 percent of gross cost for overall category, whereas, for small category farm accounts (85.39%) for medium farms (91.13%).

The fixed cost (TFC) i.e. sum of rate of interest on fixed invested capital and depreciation on fixed capital accounted for 11.74 percent to gross cost. The TFC was higher on small category farms (14.61%) as compared to medium category farms (8.87%) because the farmers in hilly area were facing the higher initial establishment cost and lower maintenance cost. Feed cost accounted for 62.99 percent followed by 24.63 percent of labour cost and miscellaneous and veterinary cost accounted for only 0.72 percent of gross cost. Among the feed cost, green fodder accounted highest for indigenous cattle (34.24%) which varied between (₹ 36.43) and (₹ 38.73) for small and medium farms respectively. Emphasis on green fodder was higher for indigenous cattle because there was no much emphasis given on milk yield and managed with freely available resources. Milk productivity of indigenous cattle (2.27 liters per day) was vey less as compared to crossbred (6.6 liters per day) and buffalo (5.7 liters per day) and the emphasis on supply of concentrate feed was also low for indigenous cattle. The sale price per liter was on ₹ 36.67 which is similar to crossbred cattle milk so the sale price should be increased for indigenous milk because of its compositional quality. The net returns per liter per SAU were ₹ 0.46 which ranged between ₹ 0.05 for small farms and ₹ 0.87 for medium farms. The reason for rearing of local cattle even the net returns are negative is in sustainable milk production at lower cost of maintenance. These results are in line with Feroz *et al.* (2019) [7], also reported the returns from local were negative and as compared with crossbred and buffalo the returns were lowest.

Table 3: Costs and returns from Local cattle of milk production across the dairy farm categories in Himachal Pradesh, (₹/Day/SAU)

Particulars	Category		
	Small	Medium	Overall
Green fodder (A)	36.43 (35.14)	38.73 (33.35)	37.58 (34.24)
Dry fodder (B)	22.51 (21.71)	25.69 (22.12)	24.10 (21.91)
Concentrate (C)	6.49 (6.27)	8.60 (7.40)	7.54 (6.83)
Total feed cost (A+B+C)	65.44 (63.11)	73.03 (62.87)	69.23 (62.99)
Labour (D)	22.03(21.25)	28.34 (28.02)	25.18 (24.63)
Miscellaneous (E)	1.06 (1.02)	0.49 (0.42)	0.77 (0.72)
Total Variable Cost (X= A+B+C+D+E)	88.54 (85.39)	101.86 (91.13)	95.20 (88.26)
Total Fixed cost (Y)	15.15 (14.61)	11.91 (8.87)	13.53 (11.74)
Gross cost (GC=X+Y)	103.69 (100)	113.78 (100)	108.73 (100)
Returns from dung (VD)	19.92	21.27	20.60
Net cost (NC=GC-VD)	83.77	92.50	88.13
Average Milk Production Qty (N)	2.27	2.57	2.42
Cost per liter (C=NC/N)	36.84	35.98	36.41
Average Sale price (P)	36.77	36.85	36.81
Gross return (GR=P*N)	83.88	94.76	89.32
Net Return per liter (NR=GR-NC)	0.05	0.87	0.46

Figures in parenthesis indicates percentage to Gross cost

Costs and returns from crossbred cattle of milk production across the dairy farm categories in Himachal Pradesh

The estimates of cost and returns of milk production of crossbred cattle for different categories are depicted in the Table 4. The findings revealed that the net return per liter of milk production from crossbred cattle in overall category was ₹ 8.59, whereas, at disaggregate level net returns from crossbred cattle were highest for large category farms (₹ 9.70 per liter), followed medium and least for small category farmers i.e., ₹ 7.60 and ₹ 6.80 respectively. The cost per liter of milk production was ₹

28.54 for overall category, whereas, and it was least for large category (₹ 27.66 per liter) because the large farmers were technically efficient and the milk productivity of maintained breeds was higher than the breeds with small and medium category farmer. The large farmers were operating in economically high profitable zone compared with others. The large farmers were also having the particular consumers so that they can take risk and feed high quality feed and fodder, whereas, the small and medium category farmers can not able to take higher risk. Large farmers have absolute advantage hence purchase feed and fodder in large quantities. Among the cost components the total feed cost alone accounted for about 65.67 percent to the gross cost (GC) across the categories. Among feed cost, concentrate constitutes more than 33.50 percent to the GC. The cost of concentrates varied among categories, such as for small category it was 25.50 percent, for medium category 30.24 percent and for large farmers 32.47 percent of the GC.

Likewise green fodder cost accounted for 16.51 percent in all the categories and was highest for small category farmers (17.65%), whereas, for large farmer it was 16.29 percent. The reason for decrease in cost of green fodder was due to positive correlation between herd size and land holding. The large farmers having their own land so they instead of depending entirely on purchase, produced green fodder by them self. In principle the crossbred cows are fed with lower amount of green fodder as compared to concentrate. The labour cost accounted more than 22.97 percent for all the categories with a range of 29.17 to 22.45 percent of gross cost for small and large category farms respectively. The labour cost in case of small farms was higher than the large farms because the large farms were technically efficient and adopted mechanization such as milking machine, grass chopper and water motor for cleaning the mats, but in case of small farms everything was done manually. The result also reveals that there is a positive association between the net returns and herd size. The overall maintenance cost was ₹. 183.17 per day per SAU and was highest (₹ 183/day/SAU) as large category farmer and lowest (₹ 182.35/day/SAU) for small category farmer. These results are similar to the results reported by Bardan *et al.* (2012) [9] who also reported that the cost of maintenance was highest for large farmers and least for small farmers. Khovieo *et al.* (2012) also reported that net returns for crossbred cows were higher for large category farmers as compared to small category farmers.

Table 4: Costs and returns from crossbred cattle of milk production across the dairy farm categories in Himachal Pradesh

Particulars	Category			
	Small	Medium	Large	Overall
Green fodder (A)	36.25 (17.65)	34.51 (16.80)	33.66 (16.29)	34.50 (16.51)
Dry fodder (B)	31.92 (15.54)	33.30 (16.21)	33.28 (16.11)	32.93 (15.66)
Concentrate (C)	52.36 (25.50)	62.12 (30.24)	67.09 (32.47)	62.30 (33.50)
Total feed cost (A+B+C)	120.53 (58.71)	129.94 (63.25)	134.04 (64.88)	129.74 (65.67)
Labour (D)	59.90 (29.17)	51.84 (25.23)	46.37 (22.45)	50.94 (22.97)
Miscellaneous (E)	2.76 (1.34)	1.64 (0.80)	2.08 (1.01)	2.17 (1.05)
Total Variable Cost (X= A+B+C+D+E)	183.91 (89.23)	183.43 (89.30)	182.51 (88.35)	182.87 (89.68)
Total Fixed cost (Y)	22.10 (10.76)	22.00 (10.70)	24.00 (11.64)	23.15 (10.32)
Gross cost (GC=X+Y)	205.30 (100)	205.42 (100)	206.58 (100)	206.02 (100)
Returns from dung (VD)	22.94	22.93	22.77	22.85
Net cost (NC=GC-VD)	182.35	182.50	183.80	183.17
Average Milk Production Qty (N)	6.06	6.24	6.64	6.41
Cost per liter (C=NC/N)	30.05	29.21	27.66	28.54
Sale price (P)	36.85	36.80	37.37	36.94
Gross return (GR=P*N)	223.66	229.90	248.25	238.33
Net Return per liter (NR=GR-GC)	6.80	7.60	9.70	8.59

Figures in parenthesis indicates percentage to Gross cost

Constraints in the development of dairy Farming in Himachal Pradesh

According to the farm conditions the constraints were categorized into three groups i.e. breeding constraints, feeding constraints and financial and marketing constraints. The responses on commonly occurring problems by the farmers in the study area were arranged and analyzed by using Garret ranking technique and results of breeding, feeding and financial and marketing constraints are presented in Table 5.

Table 5: Constraints faced by sampled dairy farmers in Himachal Pradesh

	Constraints	Small		Medium		Large		Over all		χ^2
SI	Breeding Constraints	Score	Rank	Score	Rank	Score	Rank	Score	Rank	
1.	Low productivity	57.32	I	56.35	I	58.22	II	57.30	I	0.03
2.	Incidence of reproductive disorder in milch animals	53.72	II	49.57	III	62.00	I	55.10	II	1.65
3.	Inadequate Artificial Insemination (A.I.) facility in the village	46.72	III	51.39	II	41.73	IV	46.61	III	6.79
4.	Lack of veterinary facilities (vaccinations, etc.)	39.32	IV	46.37	IV	48.50	III	44.73	IV	9.07
	Feeding constraints									
6.	Non-availability of Green fodder throughout the year	63.31	I	65.70	I	63.67	I	64.23	I	2.57
7.	Non-availability of land for fodder cultivation	58.99	II	57.72	II	58.28	II	58.33	II	0.07
8.	High cost of feeds and fodders	54.70	III	53.58	III	55.05	III	54.44	III	0.44
	Financial and Marketing Constraints									
9.	Lack of organized milk marketing facilities at village level	67.59	I	67.46	I	62.46	I	65.84	I	4.11
10.	Low price of milk	47.87	III	48.74	II	45.74	III	47.45	II	5.15
11.	Inadequate availability of extension service	47.89	II	46.65	III	46.65	II	47.06	III	5.50
12.	Inadequate availability of credit and financial institutions	38.91	IV	37.15	IV	37.54	IV	37.87	IV	19.79

Breeding constraints

In case of overall category major breeding constraint was low productivity of animals with Garrett score of 57.30 and it was ranked first among all categories of farms except large farms, followed by incidence of reproductive disorder (55.10) and availability of veterinary facilities (44.73). Even in hilly state the department of animal husbandry is well connected and providing services to the dairy farmers. The other constraints as perceived by the sample farmers were the problem related to incidence of reproductive disorder in milch animals (53.72) and inadequate Artificial Insemination (A.I.) (46.72) facility in the village respectively.

Feeding constraints

Analysis of constraints related to feeding revealed the non-availability of green fodder throughout the season and non-availability of land for fodder cultivation. High cost of feeds and fodders were major hurdles among feeding constraints. The most prominent constraint perceived by the all farmers was non-availability of green fodder throughout the season with Garret score of 63.31, 65.70, 63.67 and 64.23 on small, medium, large and overall categories respectively. The non-availability of land for fodder cultivation was next constraint with the Garret's score 58.99, 57.72 and 58.28 respectively.

Financial and Marketing Constraints

Financial and marketing constraints were presented in table 4.6.1 and the perusal of table shows that, lack of organized milk marketing facilities at village level, low price of milk, inadequate availability of extension service and inadequate availability of credit and financial institutions were major financial constraints in the study area. Small farmers faced lack of organized milk marketing facilities at village level, low price of milk and inadequate availability of extension service as major constraints with score 67.59, 47.87, 47.89 and 38.91 respectively. In case of overall category the similar trends were found. The highest garrett score for all categories of farmers was found for the lack of organized milk marketing facilities at village level. Similar findings were reported by Misra and Pal (2003) [10] in various states of India

It can be concluded from the analysis that major constraint were lack of organized milk marketing facility at village level (65.84) followed by non-availability of green fodder throughout the season (64.23), incidence of reproductive disorder (62.00), low productivity of animals (57.30) and less availability of land for fodder cultivation (58.28) in the state. The chi-square results shows that there is no significant difference of problems across the farms were observed.

Conclusion and Policy Implications

The net returns from Indigenous milk was very much low, i.e., ₹. 0.05 and ₹0.87 and the population under the indigenous cattle was reducing by more than 50 percent from 2003 to 2017 census (Khalandar *et al*. 2022) [11], so the government should give emphasis to retain and enhance the indigenous cattle by increasing the sale price from ₹. 36.5 to ₹. 50 per litre, and supply the concentrates at subsidized price. Rearing of crossbred cattle was profitable enterprise in the state, the large category fetching highest returns (₹.9.70 per litre per SAU) and majorly large category farms located in plain regions of state.

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