Cost-Benefit Analysis of Buffalo Milk Production in India

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Abstract: *Context*: The vast resource of Indian livestock played an important role in improving the socio-economic conditions of people in rural areas. Dairying has provided strong support to stabilise the Indian economy by ensuring a certain degree of diversification and flexibility.

Aim: The present study aims to analyse the costs and returns from buffalo milk production in the Punjab state of India to know about the viability of the dairy business.

Methods: The present study is based on primary data collected through a detailed schedule from 420 dairy farmers belonging to different farm size categories (landless households, large, medium, small, and marginal farmers) from 21 villages situated across three different agro-climatic zones of Punjab state in 2019. A multi-stage sampling technique has been used to select the villages and dairy farmers in the study area.

Key Results: The study has revealed that the total costs of buffalo milk production are ₹180.16 per day per milch buffalo. The sale of fluid milk constitutes a major component of gross returns. The net returns are calculated as ₹6.42 per litre from buffalo milk production in rural Punjab.

Implications: Economic analysis of dairy farming is very important to know about the economic viability of dairy enterprises. The profitability from dairying depends upon the milk yield of dairy animals, the sale price of milk, and the cost involved in dairying. Adequate knowledge of the cost involved in dairying is important as it can be used for policy-making and also for providing incentives to dairy farmers.

Keywords: Buffalo, dairying, gross returns, milk production, total cost, variable cost.

INTRODUCTION

The vast resource of Indian livestock plays an important role in improving the socio-economic conditions of people in rural areas. Livestock is an integral part of agriculture [1] and is considered a significant activity in the rural areas of the country [2] as it is a major source of livelihood for most of the marginal and small farmers [3]. About 70% of the livestock production is in the hands of small and marginal farmers [4]. Dairying is an integral part of the rural economy. Dairying has provided strong support to stabilise the Indian economy by ensuring a certain degree of diversification and flexibility.

Moreover, it can potentially improve people's living standards by providing nutrition [5] and is also a source of additional income for the farming community [6]. Smallholder dairy farming is the major source of milk production in most of the developing countries [7]. Milk is one of the important dairy products [8] as it is one of the major food sources for all nations. A high demand for milk and milk products in urban areas may provide stimulus to rural dairy producers with market opportunities to increase milk production [9].

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Within two decades, world milk production increased by 53% to 887 million tonnes in 2020 from 580 million tonnes in 2000 [10]. Asia is the largest milk producer in the world as it contributes 42% of the total world milk production, followed by Europe (26%) and America (22%). The human population has increased significantly in the Asia continent, hence an increase in demand for milk and milk products [11-13]. The increase in milk production in India is one of the major reasons for the high milk production in Asia. India contributes around 21% to global milk production and is the largest milk producer globally, followed by the United States of America (11%) and Pakistan (7%). India produces 221.1 million tonnes of milk in 2021-22 [14].

Cattle and buffalo farming has emerged as an important source for generating employment in rural areas [15]. Buffalo plays an important role in the dairy industry. The buffaloes are also termed 'Black Gold' and 'Asian Economy' [16] as they contribute to food security as well as to the economy. Most of the species of buffalo are found in Asia. As of September 2018, NBAGR listed 16 buffalo breeds under the registered and recognised category [17]. India possesses the best river milk breeds in Asia, viz. Murrah, Nili-Ravi, Surti and Jaffarabadi [18]. Buffalo milk production is

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forecasted to be 117.702 million tonnes in India by 2025 [19].

The milk production in Punjab has increased to 14.076 million tonnes in 2021-22 from 13.347 million tonnes in 2019-2020 [20]. The state of Punjab contributes nearly 6% to the country's total milk production. Out of the total milk produced in the state, buffalo milk is nearly more than half of the total milk produced in the state. Economic analysis of dairy farming is very important to know about the economic viability of dairy enterprises. The profitability from dairying depends upon the milk yield of dairy animals, the sale price of milk, and the cost involved in dairying. Adequate knowledge of the cost involved in dairying is important as it can be used for policy-making and also for providing incentives to dairy farmers. Therefore, the present study aims to analyse the costs and returns from buffalo milk production in the Punjab state of India.

METHODOLOGY

Research Design

The present study has used quantitative data analysis to provide a comprehensive understanding of the objectives.

Sampling

Five-stage stratified sampling was used. In the first stage, the Punjab state has been selected as it is one of the highest milk-producing states in India. In the second stage, three districts have been selected on the basis of milk production in the state, viz. Gurdaspur, Mansa, and S.B.S. Nagar were selected from the highest, medium, and lowest milk-producing districts in Punjab. In a way, the selected districts also represent the three agro-climatic zones of the state, viz. the Shivalik-Foothills (Gurdaspur), South-West Dry (Mansa), and Central Plains (S.B.S. Nagar) regions. In the third sampling stage, all development blocks have been selected from the selected districts. Altogether, 21 development blocks (11 from Gurdaspur and 5 from Mansa and S.B.S. Nagar each) have been selected. In the fourth stage, one village from all the blocks has been selected randomly. Thus, twenty-one villages were selected for the survey. In the fifth stage of sampling, a list of households involved in dairying from all twenty-one selected villages was prepared, and households were categorised into five categories, viz. landless households, marginal farm households, small farm households, medium farm households, and large farm households. Four dairy farm households from each household category have been selected randomly from the selected villages. Thus, a sample of twenty dairy farmers has been selected randomly from each selected village, making a sample of 420 dairy farm households from the selected categories from all selected villages.

Data Collection

The study is based on the primary data collected through the pre-tested schedules for the year 2019. Two schedules were prepared, one for collecting information about sampled villages and the other for collecting information about sampled households. The schedule prepared for dairy farm households contains information about the demographic profile of respondents, particulars about dairy farming, and costs and returns from milk production.

Data Analysis

Standard statistical tools like mean values and proportions have been used while carrying out the tabular analysis. The total costs of milk production, gross returns from milk production, net returns, and break-even output level have been calculated using methodology from the literature [21, 22]. The brief description is given below:

Total Cost

It is obtained by adding all cost components, including fixed and variable costs.

Total Cost = Total fixed cost + Total variable cost

Cost Per Litre of Milk Production

It is calculated by dividing the total cost of milk production per animal by the average yield of milch animals per day.

$$Cost\ per\ litre = \frac{Total\ cost\ of\ milk\ production\ per\ day\ per\ animal}{Avearge\ yield\ of\ milch\ animal\ per\ day}$$

Gross Returns

Gross returns are obtained by multiplying the yield of an individual animal with respective prevailing prices in the study area. It also includes the value of dung and the value of young stock.

Gross Returns = Value of fluid milk + Value of dung + Value of young stock

Net Returns

Net return is calculated by subtracting total cost from gross returns.

Net Returns = Total Cost – Gross Returns

Break-Even Level of Output

$$\frac{\textit{Fixed Costs}}{\textit{Selling price per unit - Variable cost per unit}}$$

Ethical Considerations

Ethical guidelines have been followed throughout the research process, ensuring informed consent, confidentiality, and privacy of the respondents.

RESULTS AND DISCUSSION

Socio-Economic Profile of Dairy Farmers

The analysis of the social, demographic, and economic profiles of the sampled households plays an important role in any research. Table **1** provides information about the socio-economic profile of the dairy farmers. The age distribution data reveals that the highest number of dairy farmers (95.3%) belongs to the age group of 40 years and above, followed by the middle age group (31-40 years) and the young ones (20-30 years). The age of dairy farmers plays an important role in making crucial decisions regarding dairying, such as the adoption of crossbreeding programmes, dairy training, commercialisation of dairying, and choice of modern milk marketing channels. Young dairy farmers are more eager than older dairy farmers to adopt new dairy management practices to increase profitability from dairying.

In dairying, all activities are performed daily and hence, both males and females contribute something to most activities. Dairy farming activities are performed jointly by men and women in rural areas. Women play an important role in smallholder dairy farming. Generally, women are involved in milking and feeding. A majority of the dairy farmers (52.30%) are males. It has been observed during the survey that those males who are not directly involved in the cultivation process usually do not contribute to dairy farming as they are preoccupied with non-agricultural activities. It is the women of these households who carry out all the dairying activities more or less single-handedly, with the help of hired labour, wherever needed. Most of the sampled dairy farmers are literate, as the literacy rate has been improving in the state over the past few years. These findings are in line with the results of another study, which revealed that most of the dairy

Table 1: Socio-Economic Profile of Dairy Farmers

Characteristics	Categories	% (N = 420)
Age (in years)	Young (20-30)	0.26
	Middle (31-40)	4.44
	Old (above 40)	95.3
Gender	Male	52.30
	Female	47.70
Educational level	Illiterate	17.15
	Primary	22.68
	Secondary	29.73
	Higher Secondary	18.82
	Graduation	7.46
	Post-graduation	4.16
Nature of dairying as an occupation	Primary	12.84
	Subsidiary	87.16
Dairy training	Yes	4.84
	No	95.16

Source: Field Survey, 2019.

farmers are literate up to secondary and senior secondary level in Punjab [23]. Less than one-fifth of the sampled dairy farmers are illiterate. Almost 87% of the sampled dairy farmers are pursuing dairying as a subsidiary occupation to supplement their farming income. Training in dairy farming provides the farmers with certain guidelines to maintain their dairy animals scientifically and, hence, increase their profitability from dairy farming. The Indian Council of Agriculture Research (ICAR) established 'Krishi Vigyan Kendras' (KVKs) to impart training in agriculture and allied activities. Most of the dairy farmers have not received any dairy training due to a lack of awareness about the potential benefits of dairy training.

Characteristics of Dairy Farms

Table **2** exhibits the details about the basic characteristics of dairy farms, such as average farm size, location of the dairy farm, labour employed, and animal insurance. The farm contains in-milk buffaloes, dry buffaloes, and calves. The in-milk buffaloes constitute around half the average farm size, followed by dry buffaloes and calves. The number of milch animals depends upon the value of milch animals, the productivity of buffaloes, and the sale price of milk. The agro-climatic conditions of Punjab are suitable for rearing buffaloes. The location of a dairy farm is of immense importance as it requires high investment. There are many factors that affect the choice of location of the dairy farm, such as nearness to market, availability of labour, availability of feed, etc. The sampled dairy farmers have made their dairy farms either in their own villages or in nearby villages. Most of the dairy farms (95.71%) are located in their own villages of dairy farmers. Just a few dairy farmers choose to locate the farms in nearby villages due to a shortage of space near the house to construct the dairy farm.

The total use of family and hired labour for performing different dairy activities is considered human labour employment in dairying. The share of family labour to the total labour employed in dairying is 67.36%, and the remaining (32.64%) is captured by hired labour. Talking about animal insurance, approximately 2% of dairy farmers have insured their dairy animals against the potential financial loss due to the death of the buffaloes. Most of the dairy farmers have not insured their buffaloes as they consider it a hurdle in the sale-purchase of their animal. Green fodder is one of the major components of the ration mixture of the buffaloes. A majority of the dairy farmers have cultivated green fodder themselves for their buffaloes. In the case of dry fodder, wheat and rice straws are the main roughage available for feeding the dairy animals in Punjab. The farmers prefer not to feed rice straw [24] due to its high silica content.

Fixed Costs of Buffalo Milk Production

Fixed costs of buffalo milk production include depreciation on fixed capital and interest on fixed capital. The depreciation of fixed capital has three components, i.e. depreciation on milch animals, on buildings, and on equipment used in dairying. Table **3** provides information about fixed costs of buffalo milk production calculated on a per day per milch buffalo basis. The fixed cost has been worked out to be ₹30.88 per day per milch buffalo. The interest on fixed capital is found to be a major component of this fixed cost, followed by depreciation on fixed capital. The depreciation on fixed capital varies directly with the

Table 2: Characteristics of Dairy Farms

Characteristics	Categories	% (out of 100)
Average farm-size	In-milk buffaloes	50
	Dry buffaloes	16.7
	Calves	33.3
Location of Dairy Farm	Own-village	95.71
	Nearby-village	4.29
Labour employed	Family labour	67.36
	Hired labour	32.64
Animal insurance	Yes	1.67
	No	98.33

Source: Field Survey, 2019.

Table 3: Fixed Costs of Buffalo Milk Production (₹ Per Day Per Milch Buffalo)

District/Category	Fixed Cost of Buffalo Milk Production (in₹ per day per milch buffalo)									
	Depreciation						Interest on fixed capital		Total Fixed Costs	
	Milch Animals		Buildings		Equipment					
	Value	%	Value	%	Value	%	Value	%	Value	%
Large farm Households	4.83	13.06	6.33	17.12	3.51	9.49	22.29	60.33	36.95	100
Medium farm Households	5.90	18.79	4.86	15.49	2.02	6.45	18.59	59.26	31.37	100
Small farm Households	5.63	18.39	4.12	13.47	2.65	8.65	18.21	59.49	30.61	100
Marginal farm Households	6.35	22.81	3.15	11.32	1.96	7.04	16.38	58.83	27.84	100
Landless farm Households	4.83	23.39	0.98	4.74	2.48	12.01	12.37	59.86	20.66	100
Punjab	5.50	17.82	4.11	13.30	3.06	9.91	18.21	58.98	30.88	100

Source: Field Survey, 2019.

amount of fixed investment. However, these results are in contrast with the other studies that have shown that depreciation on fixed capital accounts for the major component of total fixed costs of buffalo milk production rather than interest on fixed capital [25, 26].

On the other hand, the results of the present study are supported by one study that has shown that interest in fixed capital accounts for nearly four-fifths of the total fixed costs of buffalo milk production [22]. The category-wise data on fixed costs of buffalo milk production reveals that the highest fixed cost (₹36.95) is found among large farm-size category households due to the reason that they have made huge investments in fixed capital, i.e. in the construction of shed and feed store, and purchasing high-priced buffaloes for their breed quality. The lowest fixed cost (₹20.66) is borne by landless dairy farmers as the depreciation on buildings is very low because a major proportion of landless dairy farmers do not either have a shed or feed store.

Variable Costs of Buffalo Milk Production

Variable costs include expenditure on feed and fodder, labour costs, veterinary expenses, miscellaneous expenses (expenses on electricity, water, and fuel), and interest on working capital. Table **4** provides information about variable costs of buffalo milk production, calculated on the basis of per day per

Table 4: Variable Costs of Buffalo Milk Production (₹ Per Day Per Milch Buffalo)

District/Category	Variable Cost of Buffalo Milk Production (in ₹ per day per milch buffalo)											
	Feed and fodder Costs		Labour costs		Veterinary Expenses		Miscellaneous Expenses		Interest on Working Capital		Total Variable Costs	
	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%
Large farm Households	102.11	71.63	26.60	18.66	1.09	0.76	3.57	2.50	9.18	6.45	142.55	100
Medium farm Households	99.48	70.43	28.52	20.19	0.91	0.65	4.15	2.94	8.18	5.79	141.24	100
Small farm Households	116.33	71.29	32.77	20.08	0.80	0.51	4.26	2.68	9.03	5.64	163.18	100
Marginal farm Households	105.13	65.36	41.73	25.95	0.85	0.53	3.83	2.38	9.30	5.78	160.83	100
Landless farm Households	0.00	0.00	26.70	76.17	0.57	1.62	1.46	4.18	6.33	18.04	35.06	100
Punjab	121.76	73.39	31.43	18.94	0.85	0.51	3.42	2.06	8.45	5.09	165.91	100

Source: Field Survey, 2019.

Table 5: Total Costs of Buffalo Milk Production (₹ Per Day Per Milch Buffalo)

Category	Costs of Buffalo Milk Production (₹ per day per milch buffalo)					
	Fixed Costs		Variable Costs		Total	
	Value	%	Value	%	Value	%
Large farm Households	36.95	18.56	162.20	81.45	199.15	100
Medium farm Households	31.37	17.84	144.53	82.16	175.90	100
Small farm Households	30.61	16.10	159.54	83.90	190.15	100
Marginal farm Households	27.84	14.49	164.22	85.51	192.06	100
Landless Households	20.66	15.61	111.75	84.39	132.41	100
Punjab	30.88	17.14	149.28	82.86	180.16	100

Source: Field Survey, 2019.

milch buffalo. The variable costs of buffalo milk production are found to be ₹149.28 per day per milch buffalo. The feed cost is the largest component of the variable costs, followed by labour cost, interest on working capital, miscellaneous expenses, and veterinary expenses. The feed cost varies directly with the quantity as well as the quality of the feed used to feed dairy animals. Similar findings are reported in other studies that feed cost is the major element of variable costs of buffalo milk production in Rajasthan and Telangana, respectively [27-29]. Dairy farmers who appropriately follow the feeding practices and use proper ration mixtures are able to reduce feed and fodder costs to some extent. It has been observed during the field survey that labour cost varies inversely with herd size. The higher the number of buffaloes, the lower the labour cost per milch buffalo and vice-versa. The interest in working capital depends upon all other components of variable cost. The highest variable cost is borne by marginal farm size category households due to costly labour and the high cost of concentrate feed and green fodder. The expenditure on feed is low among landless dairy farmers because they do not feed their dairy animals with an adequate quantity of concentrate feed. Hence, their expenditure on concentrate feed is lower than that of other farm-size categories.

Total Costs of Buffalo Milk Production

The costs of milk production have a significant influence on returns from milk production. Fixed cost and variable cost are two components of total cost. Table **5** shows the total cost of buffalo milk production calculated per day per milch buffalo basis. The total cost of buffalo milk production is ₹180.16 per day per milch buffalo. Variable cost is the major component of total cost as it constitutes 82.86% of the total cost of buffalo milk production. Fixed cost is the second component of total cost, and its share is 17.14% of total cost. The result is in line with the other studies providing evidence that variable cost is the major component of total costs of buffalo milk production [21, 25, 26].

Returns from Buffalo Milk Production

The returns from buffalo milk production are calculated per day on a milch buffalo basis. Table **6**

Table 6: Returns from Buffalo Milk Production (₹ Per Day Per Milch Buffalo)

Category	Returns from Buffalo Milk Production (₹ per day per milch buffalo)										
	Yield	Milk price	Milk sale (i)		Value of Dung (ii)		Sale of young stock (iii)		Gross Returns (GR) = (i+ii+iii)		Net Returns (GR-TC)
			Value	%	Value	%	Value	%	Value	%	
Large farm Households	6.66	39	259.74	97.71	3.95	1.49	2.13	0.80	265.82	100	66.67
Medium farm Households	6.54	38	248.52	97.68	3.83	1.51	2.08	0.82	254.43	100	78.53
Small farm Households	6.66	35	233.10	97.52	4.13	1.73	1.80	0.75	239.03	100	48.88
Marginal farm Households	6.07	33	200.31	97.20	3.98	1.93	1.79	0.87	206.08	100	14.02
Landless Households	5.44	31	168.64	96.64	3.99	2.29	1.86	1.07	174.50	100	42.09
Punjab	6.30	35	220.50	97.39	3.98	1.76	1.94	0.86	226.42	100	46.26

Source: Field Survey, 2019.

depicts the data on the average yield of buffaloes per day, the sale price of milk per litre, gross returns per day per milch buffalo, and net returns per day per milch buffalo. The average yield of buffaloes is found to be 6.30 litres per day in Indian Punjab. Across the categories, the highest average yield of buffaloes (6.66 litres per day) is found among large farm size category households because they own quality herd size and also they have followed better feeding, breeding, and housing management practices. On the contrary, landless households fail to provide better care to their dairy animals, hence resulting in lower milk yields of buffaloes, i.e. 5.44 litres per day.

The average sale price of milk is worked out to be ₹35 per litre. The result is in line with the findings of Bairwa *et al.* [25] and Singh and Alli [26], who have found that the sale price of milk hovered around ₹35-36 per litre in Uttar Pradesh and Rajasthan, respectively. It has been observed that the organised milk marketing channels use fat and SNF content to determine the sale price of milk. On the other hand, unorganised milk marketing channels, such as direct consumers and milk vendors, pay a flat rate for milk.

The gross returns comprise three components, viz. sale of fluid milk, sale of dung, and sale of young stock and it is calculated as ₹226.42 per day per milch buffalo. The sale of fluid milk comprises 97.56% of the gross returns, followed by the sale of dung and the sale of young stock. The maximum gross returns are squeezed by large farm-size category households due to the higher milk productivity of their buffaloes and higher milk prices. The lower average yield of buffaloes coupled with lower milk prices results in lower gross returns among landless dairy farmers and their sale of milk constitutes 96.69% of the gross returns from buffalo milk production.

The net returns from buffalo milk production are found to be ₹46.26 per day per milch buffalo. The marginal farm size category households get the lowest net returns from buffalo milk production due to the high total cost of buffalo milk production. Despite having the lowest gross returns, the net returns for landless households hover around the state figures due to their lowest variable costs of buffalo milk production.

Average Returns from Buffalo Milk Production (₹ Per Litre Basis)

The returns from buffalo milk production are also calculated on ₹ per litre basis. Table **7** provides a handful of information about the total cost per litre of buffalo milk and net returns per litre from buffalo milk production. The total cost is ₹28.58 per litre, and net returns are calculated as ₹6.42 per litre. Across the categories, maximum net returns per litre are captured by medium farm size category households, followed by large farm size category households, landless households, small farm size category households, and finally, marginal farm size category households. Net returns per litre from buffalo milk production are found to be inversely associated with the total cost per litre of buffalo milk production. The categories having the highest total cost per litre have the lowest net returns per litre from buffalo milk production and vice-versa.

Break-Even Level of Output

The break-even level of output is that output at which revenue and total costs are equal. In other words, it is a situation of neither profit nor loss. The break-even level of output is 2.73 litres, which constitutes 43.33% of the average buffalo milk production (Table **8**). Similar findings have been reported that the break-even level of output is more than two-fifths of the buffalo milk production [30].

Table 7: Average Returns from Buffalo Milk Production (Average ₹ Per Litre)

Category	Average Returns from Buffalo Milk Production (₹/litre)				
	Fixed cost	Variable cost	Total cost	Price	Returns
Large farm Households	5.54	24.34	29.88	39	9.12
Medium farm Households	4.80	22.11	26.91	38	11.09
Small farm Households	4.59	23.94	28.53	35	6.47
Marginal farm Households	4.59	27.05	31.63	33	1.37
Landless Households	3.80	20.54	24.34	31	6.66
Punjab	4.90	23.68	28.58	35	6.42

Source: Field Survey, 2019.

Table 8: Break-Even Level of Output

Category	Break-even Level of Output (in litres)					
	Average yield (in litres)	Fixed Costs (per animal per day)	Variable cost (per litre)	Price (per litre)	Break-even level of output (in litres)	Break-even output to total output (%)
Large farm Households	6.66	36.95	24.34	39	2.52	37.84
Medium farm Households	6.54	31.37	22.11	38	1.97	30.12
Small farm Households	6.66	30.61	23.94	35	2.77	41.59
Marginal farm Households	6.07	27.84	27.05	33	4.68	77.10
Landless Households	5.44	20.66	20.54	31	1.98	36.40
Punjab	6.30	30.88	23.68	35	2.73	43.33

Source: Field Survey, 2019.

CONCLUSIONS

Aiming to analyse the costs and returns from buffalo milk production, the present study has revealed that the total costs of buffalo milk production are ₹180.16 per day per milch buffalo. Out of this, variable cost constitutes more than four-fifths of the total cost, and the remaining part is captured by fixed costs of buffalo milk production. In rural Punjab, the average milk yield of buffaloes is 6.30 litres per day, and the average sale price of milk is ₹35 per litre. The gross returns and net returns from buffalo milk production are calculated as ₹226.42 and ₹46.26 per day per milch buffalo. The net returns are calculated as ₹6.42 per litre from buffalo milk production in Punjab state of India. Keeping all this in mind, it is suggested that the productivity of milch animals needs to be improved by adopting better dairy management practices, such as breeding practices, housing practices, and feeding practices. There is a dire need to impart scientific knowledge among dairy farmers by organising dairy training camps so that dairy farmers can minimise the costs therein by adopting better dairy management practices. The veterinary infrastructure should be strengthened more to provide veterinary services at the doorsteps of dairy farmers in rural areas of Punjab to reduce the incidence of diseases among dairy animals.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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DATA AVAILABILITY STATEMENT

The data that supports this study may be shared with the corresponding author upon reasonable request.

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