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Economics of Milk Production and Resource Use Efficiency of Milk Across Different Herd Size Categories in Chittoor District of Andhra Pradesh

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ABSTRACT

Background: In India dairy farming is a significant part of the rural population, providing not only supplementary income and nutritional standards but also organic manures and draught power. Andhra Pradesh ranks 5th in total milk production in India with an output of 15.04 million metric tonnes and Chittoor district is one of the leading districts for dairy farming in the state. There is an increasing trend in milk production; however, the main drawback faced by the milk producers in dairy farming is the low productivity of milch animals. Assessing the economics of milk production would be extremely beneficial in planning for the improvement of productivity of dairy animals and framing policies to increase the profitability of dairy farms.

Methods: Chittoor district of Andhra Pradesh was purposively selected for the present investigation. The primary data was collected from 80 respondents of which 40 each from two villages in the year 2021. The economics of milk production and the resource use efficiency of milk were computed based on collected data.

Result: The per-day gross cost for maintaining local cow, crossbred cow and buffalo was found to be ` 161.09, ` 246.16 and ` 196.07, respectively. The overall cost per litre of milk was found to be slightly high in the case of buffalo (` 31.45), followed by the local cow (` 31.33) and crossbred cow (` 19.69), respectively. The net returns per litre of milk were found to be highest in the case of the crossbred cow (` 7.45), followed by buffalo (` 3.66) and local cow (` 0.12). It was observed that the net return per litre of milk for local cows was very less due to high feed cost, labour cost and low productivity of milk. Green fodder, dry fodder and concentrate were observed underutilized whereas labour was found to be over-utilized.

Key words: Buffalo, Crossbred, Local, Milk, MVPs, Resource use efficiency.

INTRODUCTION

India holds the world's largest dairy herd consisting of 193.46 million cattle population and 109.85 million buffalo population with a growth rate of 1.34 per cent and 1.06 per cent, respectively (Anonymous, 2019). India is the largest milk-producing country with a total of 211 million tonnes in 2021 and the per capita availability of milk is around 425 gm/day (Anonymous, 2021). Over the last three decades, the dairy industry in India has grown at a rate of 5.00 per cent per year. Dairy farming is a significant part of the rural population in India, providing not only supplementary income and nutritional standards but also organic manures and draught power. Andhra Pradesh stands 5th position in India's total milk production with an output of 15.04 million metric tonnes having a per capita availability of milk of around 623 gm/day (Anonymous, 2019) and Chittoor district is one of the potential districts for dairy farming in the state with the highest total bovine population (cow and buffalo) of 10.36 lakhs. Milk is a valuable commodity that serves as a nutritive food as well as a source of many dairy products. Even though there is an increasing trend in milk production, the main drawback faced by the milk producers in dairy farming is the low productivity of milch animals. Hence, the knowledge of the economics of milk production would be extremely beneficial in planning for the improvement of productivity of dairy animals and framing policies to increase the profitability of dairy farms.

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MATERIALS AND METHODS

The present research work was conducted at Dr. Rajendra Prasad Central Agricultural University, Pusa (Samastipur), Bihar during 2019-21.

Sampling plan and data collection

Andhra Pradesh having 5th rank in total milk production in India (Anonymous, 2021) was selected purposively based

on the highest per capita availability of milk among the Southern Indian States. From Andhra Pradesh, the Chittoor district was purposively selected based on the highest livestock bovine population. From the Chittoor district, one mandal Bangarupalem was selected randomly from which two villages Ragimanipenta and Mothagunta were selected randomly based on the multistage sampling technique. 40 respondents from each village comprising a total of 80 respondents were selected randomly. Further, these respondents were categorized into Small (1-3 milch animals), Medium (4-6 milch animals) and Large (7 and above milch animals) based on the number of milch animals per household by using the Cumulative Square Root Frequency Method.

Economics of milk production

Fixed cost

Interest on fixed capital as well as depreciation on animals, cattle sheds and machinery is included in fixed cost. Depreciation was calculated by using the Capital Recovery Cost (CRC) method. The following formula was used for the CRC method:

$$R = Z\left[\frac{(1+r)^n r}{(1+r)^n - 1}\right]$$

Where,
R= The capital recovery cost (`/annum).
Z= Initial/current value of the capital asset (`).
r= Interest rate (%)
n= Useful life of assets (years).

Total CRC was calculated with this formula and further these fixed costs were apportioned to individual dairy animals based on the SAU (Standard Animal Units) as suggested by Sirohi *et al.* (2015) shown in Table 1. While calculating CRC for cattle, the interest rate 'n' was taken as 8 years for crossbred cows10 years for both local cows and buffalo. Some of the fixed costs were jointly used for animals of all age groups.

Variable costs

Variable cost consists of feed and fodder cost, labour cost and miscellaneous cost *etc*., feed and fodder costs were calculated on the prevailing market price in the study region. Labour cost was computed according to the work and wages paid to them. Family labour cost was estimated according to the wage rate prevailing in the study region.

1 day of female labour = 0.67 man day (3 women = 2 men)

Miscellaneous costs like veterinary expenses, costs of artificial insemination, medicines, vaccination and recurring expenses like the cost of repair, water charge, buckets, ropes, electricity charges *etc*., were calculated per milch animal per day as well as per SAU.

Further, gross cost, net cost, gross returns, net returns, cost per litre of milk and profits per litre of milk were worked out.

Functional analysis

The expenditure incurred on green fodder, dry fodder, concentrate, labour and miscellaneous inputs per household or per farm were regressed on income from selling of milk by using the log-log functional form and also marginal value products of these inputs were calculated for resource use efficiency by using the formula:

$$MVP_i = b_i \frac{\overline{Y}_i}{\overline{X}_i}$$

Where,
b_i= Regression coefficient of i^{th} input.
$\overline{Y}_i$ and $\overline{X}_i$= Geometric means of Y and i^{th} input.

RESULTS AND DISCUSSION

Feeding pattern

A perusal of Table 2 reveals that the quantity of green fodder and concentrate was fed more for crossbred cows (17.55 kg), followed by buffalo (15.25 kg) and local cow (12.73 kg) across all herd size categories due to the high productivity of milk as compared to buffalo and local cow. The quantity of dry fodder was fed more to buffalo (6.72 kg), followed by the local cow (5.48 kg) and crossbred cow (5.48 kg).

Labour cost

Labour cost consists of family labour cost and hired labour cost is shown in Table 3. The overall costs of own labour and hired labour for local cow, crossbred cow and buffalo were ` 25.17 and ` 3.23, ` 36.15 and ` 5.96, ` 33.28 and ` 3.28, respectively. The total labour cost was highest for crossbred cows (` 42.11), followed by buffalo (` 36.56) and local cows (` 28.40), respectively. The overall percentage of family labour cost was higher than that of the hired labour cost which varies from 85.86 per cent for crossbred cows, 88.64 per cent for local cows and 91.02 per cent for buffalo, respectively. The costs of family labour decreased with the increase in the herd size category whereas the cost of hired labour increased with the increase in the herd size category. Similar findings were found in the earlier study by Kumari *et al.* (2020).

Maintenance cost and returns from milch cattle across different herd size categories

Table 4 revealed that the overall gross cost of rearing milch cattle was recorded highest at ` 255.03 in the case of cross-bred cow, followed by buffalo (` 196.07) and ` 161.09 (local cow). Out of gross cost, the share of total variable cost in the case of buffalo was observed to be 88.64% (` 173.79/animal/day), followed by cross-bred cow 87.79% (` 216.10/animal/day) and local cow being 87.74% (` 141.34/animal/day) separately. The major expenses incurred on feed and fodder costs could be calculated to be comparatively high in crossbred cows (` 162.27), followed by ` 130.59 in the case of buffalo and ` 109.66 for local cows, separately. Regarding the analysis of income, it was found that the overall income was estimated to be comparatively large ` 332.24 per animal/day for a crossbred cow followed by buffalo ` 213.92 per animal/day and ` 159.45/animal/day for the local cow. Finally, the overall returns per litre were obtained very high (` 7.54) for crossbred cow per animal/day, while it was found

` 3.66/animal/day in case of buffalo and lowest in case of local cow ` 0.12/animal/day.

Further cost and returns per animal per day from milch cattle across different herd size categories were analysed and found that the average daily gross cost of rearing a milch local cow was found to be higher for the large herd size category (` 176.83), followed by the medium herd size category (` 165.47) and small herd size category (` 149.75), respectively. The major share of the total variable cost was occupied by the feed and fodder cost accounted for 77.58 per cent, followed by labour cost at 20.09 per cent and vet. and misc. cost at 2.33 per cent, respectively.

From the in-depth analysis of herd size categories, it was observed that the profit per litre of milk was found to be negative for the small herd size category (` 1.41) due to the high cost of feed and fodder and lower milk yield in case of the local cow, whereas profit per litre was observed to be positive in the case of other herd size categories because of the high productivity of milk.

The cost of milk per litre of the crossbred cow was observed to be high in the case of the small herd size category (` 19.92), followed by the medium herd size category (` 19.60) and least in the case of the large herd size category (` 19.39), respectively. The profit per litre of

Table 1: Standard animal units (SAU) for the Southern region.

Type of animal	Buffalo	Crossbred cow	Local cow
Adult male (≥3 years)	1.04	1.12	0.97
Adult female (≥3 years	1.24	1.62	1.00
Young stock male (<1 year)	0.24	0.24	0.22
Youngstock female (<1 year)	0.28	0.3	0.27
Young stock male (> year)	0.6	0.63	0.54
Young stock female (>1 year)	0.51	0.52	0.47
Heifer	0.77	0.86	0.82

Source: Sirohi *et al.* (2015).

Table 2: Average quantity of feed and fodder fed to different species of animals across herd size categories (kg/animal/day).

Feed and fodder	Animal type	Herd size category			
		Small	Medium	Large	Overall
Green fodder	Local cow	12.28	12.94	13.32	12.73
	Crossbred	17.12	17.75	18.09	17.55
	Buffalo	14.94	15.16	15.95	15.25
Dry fodder	Local cow	5.08	5.61	6.08	5.48
	Crossbred	4.28	4.83	5.10	4.65
	Buffalo	6.39	6.87	7.13	6.72
Concentrate	Local cow	1.31	1.98	2.15	1.72
	Crossbred	3.39	3.71	4.04	3.64
	Buffalo	2.47	2.83	3.11	2.73

Table 3: Labour cost across different herd size categories (`/animal/day).

Animal type	Herd size category	Own labour cost	Hired labour cost	Total labour cost
Local cow	Small	26.35 (94.24)	1.61 (5.76)	27.96
	Medium	24.93 (87.57)	3.54 (12.43)	28.47
	Large	23.25 (79.81)	5.88 (20.19)	29.13
	Overall	25.17 (88.64)	3.23 (11.36)	28.40
Crossbred cow	Small	37.65 (91.07)	3.69 (8.93)	41.34
	Medium	34.68 (82.30)	7.46 (17.70)	42.14
	Large	35.26 (81.00)	8.27 (19.00)	43.53
	Overall	36.15 (85.86)	5.96 (14.14)	42.11
Buffalo	Small	33.59 (94.14)	2.09 (5.86)	35.68
	Medium	33.37 (90.38)	3.55 (9.62)	36.92
	Large	32.56 (86.23)	5.2 (13.77)	37.76
	Overall	33.28 (91.02)	3.28 (8.98)	36.56

(Figures in parentheses show the percentage of row total).

Table 4: Average cost and returns from milch cattle across different herd size categories (`/animal/day).

Cost components	Local cow				Crossbred cow				Buffalo			
	Herd size category				Herd size category				Herd size category			
	Small	Medium	Large	Overall	Small	Medium	Large	Overall	Small	Medium	Large	Overall
Total fixed cost (TFC)	18.72	19.97	21.42	19.75	28.89	30.37	31.87	30.06	21.12	22.46	24.23	22.28
	(12.50)	(12.07)	(12.11)	(12.26)	(12.03)	(12.25)	(12.50)	(12.21)	(11.11)	(11.35)	(11.81)	(11.36)
Green fodder (F1)	59.00	61.31	62.15	60.47	79.27	80.79	81.82	80.35	63.28	64.58	65.69	64.26
	(58.94)	(53.83)	(50.87)	(55.14)	(49.84)	(49.39)	(49.09)	(49.52)	(49.56)	(49.19)	(48.59)	(49.21)
Dry fodder (F2)	14.82	16.53	17.08	15.89	11.93	14.10	14.96	13.33	18.67	19.83	20.94	19.57
	(14.81)	(14.51)	(13.98)	(14.49)	(7.50)	(8.62)	(8.97)	(8.21)	(14.62)	(15.11)	(15.49)	(14.99)
Concentrate (F3)	26.28	36.06	42.95	33.30	67.84	68.67	69.91	68.59	45.73	46.87	48.57	46.76
	(26.25)	(31.66)	(35.15)	(30.36)	(42.66)	(41.98)	(41.94)	(42.27)	(35.82)	(35.70)	(35.92)	(35.81)
Feed and fodder cost (V1=F1+F2+F3)	100.10	113.90	122.18	109.66	159.04	163.56	166.69	162.27	127.68	131.28	135.2	130.59
	(76.39)	(78.28)	(78.62)	(77.58)	(75.25)	(75.17)	(74.70)	(75.09)	(75.59)	(74.87)	(74.70)	(75.14)
Labour cost (V2)	27.96	28.47	29.13	28.40	41.34	42.14	43.53	42.11	35.68	36.92	37.76	36.56
	(21.34)	(19.57)	(18.74)	(20.09)	(19.56)	(19.37)	(19.51)	(19.49)	(21.12)	(21.06)	(20.86)	(21.04)
Vet. and Misc. expenses (V3)	2.97	3.13	4.10	3.29	10.96	11.89	12.94	11.72	5.56	7.15	8.02	6.64
	(2.27)	(2.15)	(2.64)	(2.33)	(5.19)	(5.46)	(5.80)	(5.42)	(3.29)	(4.08)	(4.43)	(3.82)
Total variable cost (TVC=V1+V2+V3)	131.03	145.50	155.41	141.34	211.34	217.59	223.16	216.10	168.92	175.35	180.98	173.79
	(87.50)	(87.93)	(87.89)	(87.74)	(87.97)	(87.75)	(87.50)	(87.79)	(88.89)	(88.65)	(88.19)	(88.64)
Gross cost (A=TFC+TVC)	149.75	165.47	176.83	161.09	240.23	247.96	255.03	246.16	190.04	197.81	205.21	196.07
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
Value of dung (B)	2.07	2.36	2.58	2.28	4.98	5.1	5.29	5.09	4.21	4.43	4.92	4.45
Net cost (C=A-B)	147.68	163.11	174.25	158.81	235.25	242.86	249.74	241.07	185.83	193.38	200.29	191.62
Price of milk	30.15	32.32	32.45	31.37	26.77	27.14	27.75	27.12	34.83	35.07	35.62	35.09
Average milk production/animal/day (E)	4.68	5.12	5.74	5.07	11.81	12.39	12.88	12.25	5.83	6.21	6.44	6.09
Gross return (D)	141.10	165.48	186.26	159.45	316.15	336.26	357.42	332.24	203.06	217.78	229.39	213.92
Net return (D-C)	-6.58	2.37	12.01	0.63	80.90	93.40	107.68	91.17	17.23	24.40	29.10	22.29
Cost/litre (C/E)	31.56	31.86	30.36	31.33	19.92	19.60	19.39	19.69	31.87	31.14	31.10	31.45
Return/litre	-1.41	0.46	2.09	0.12	6.85	7.54	8.36	7.45	2.96	3.93	4.52	3.66

(Figures in parentheses show the percentage of the gross cost).

Note: Small (1-3 milch animals); Medium (4-6 milch animals); Large (7 and above milch animals).

Table 5: Coefficients of various variables regressed on income per household per day from the selling of milk.

Variables	Coefficients			
	Small	Medium	Large	Overall
Intercept	1.675** (0.732)	2.285** (0.972)	2.384*** (0.918)	1.320*** (0.280)
Expenditure on green fodder per household per day	0.470** (0.216)	0.609** (0.301)	0.743** (0.349)	0.591*** (0.149)
Expenditure on dry fodder per household per day	0.538*** (0.172)	0.025 (0.113)	0.245 (0.185)	0.143** (0.073)
Expenditure on concentrate per household per day	0.617* (0.327)	0.637*** (0.186)	0.253 (0.489)	0.305** (0.150)
Value of labour used per household per day	0.101 (0.104)	0.220* (0.123)	1.027** (0.405)	0.179*** (0.050)
Vet. and misc. expenses per household per day	0.128 (0.096)	0.023 (0.060)	0.076 (0.098)	0.052 (0.050)
R^2	0.713	0.753	0.688	0.923
N	36	25	19	80

***1% level of significance, **5% level of significance and *10% level of significance.

(Figures in parentheses show the Standard error).

Table 6: Marginal value products of inputs.

Variables	MVP			
	Small	Medium	Large	Overall
Green fodder	1.487	2.152	2.498	1.968
Dry fodder	9.062	0.434	3.876	2.439
Concentrate	2.444	2.876	1.053	1.277
Labour cost	0.374	0.875	3.655	0.673
Vet. and misc. expenses	3.672	1.347	6.620	2.488

milk was highest in the case of the large herd size category (` 8.36), followed by the medium herd size category (` 7.54) and small herd size category (` 6.85), respectively.

In the case of buffalo, the cost per litre of milk was observed to be high in the case of the small herd size category (` 31.87), followed by the medium herd size category (` 31.14) and least in the case of the large herd size category (` 31.10). The profit per litre of milk of buffalo was observed highest in the case of the large herd size category (` 4.52), followed by the medium herd size category (` 3.93) and small herd size category (` 2.96). Similar findings were reported by Kumari *et al.* (2020), Kumari and Malhotra (2018), Lakshmipriya and Raju (2019) and Satyanarayana *et al.* (2022).

Milk production function

Many functional forms were tried but the log-log functional form was observed to be the best fit (Table 5). In the case of the small herd size category, the expenditure incurred on green fodder, dry fodder and concentrate was found to be positive and significant and explained 71.00 per cent of the total variation. Therefore, a one per cent increase in expenditure on green fodder, dry fodder and concentrate per farm per day leads to a 0.470 per cent, 0.538 per cent and 0.617 per cent increase in income from milk per farm per day, respectively. In the case of the medium herd size category, the expenditure on green fodder, concentrate and labour was observed to be positive and significant and explained 75.00 per cent of the total variation. In the case of the large herd size category, the expenditure on green fodder (0.743) and labour (1.027) was found to be positive and significant leading to an increased income per household per day. On average, for the overall category, the income from the sale of milk was increased by 0.591 per cent, 0.143 per cent, 0.305 per cent and 0.179 per cent with a one per cent increase in expenditure on green fodder, dry fodder, concentrate and labour, respectively. Similar findings were reported by Kumari *et al.* (2020) and Rangnath *et al.* (2015). In nutshell, results reveal that the coefficient on green fodder was found to be positive and significant in all herds size categories. Similar findings were reported by Choodambigai (2011).

Resource use efficiency

The ratio of MVP to the factor prices provides a measure of resource use efficiency. This ratio should be compared with unity to determine in which direction a resource will be used. A perusal of Table 6 implies that in the case of the small herd size category, MVPs of green fodder (1.487), dry fodder (9.062) and concentrate (2.444) were significantly positive and greater than unity which implies that these are underutilized and a further increase in these inputs can increase the income from milk production (Choodambigai, 2011). In the case of the medium herd size category, MVPs of green fodder (2.152) and concentrate (2.876) were significantly greater than unity, indicating their underutilization whereas MVP of labour (0.875) was observed to be less than unity signifying its overutilization. This means an increase in the use of green fodder and concentrate and a decrease in the use of labour can increase the income from milk production. In the case of the large herd size category, MVPs of green fodder (2.498) and labour (3.655) were found to be significantly greater than unity indicating their underutilization which concluded that an increase in the use of these resources can increase the returns from milk production whereas that of concentrate (1.053) was not significant but equal to unity indicating that it was optimally used. Further, for the overall category, the MVPs of green fodder (1.968), dry fodder (2.439) and concentrate (1.277) were significantly greater than unity signifying their underutilization whereas that of labour (0.673)

was significantly less than unity indicating its overutilization. (Tanwar *et al.,* 2015, Meena *et al.,* 2019). This implies that a further increase in the use of green fodder, dry fodder and concentrate and a decrease in the use of labour can increase the returns from milk production.

CONCLUSION

It may be summarized from the foregoing discussion that the cost per litre of milk was more for buffalo, followed by the local cow and crossbred cow. The net returns per litre of milk were revealed high for the crossbred cow as compared to local cow and buffalo. Further, the study implies that the productivity of crossbred cows maintained by all types of herd size categories was observed high as compared to local cows and buffalo. Hence, there is an urge to the adoption of scientific farming technologies in dairying to increase the productivity of local cows and buffaloes. The study also revealed that the overall quantity of green fodder, dry fodder and concentrate was found underutilized whereas that of labour was overutilized in the study area. Hence, the milk producers in the study area should put more effort to utilize these inputs in an efficient way to increase milk production. The extension agencies also should be given the task to provide training to sensitize the farmers about better feeding management of milch animals by providing quality feeds and fodder.

Conflict of interest: None.

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