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Economic assessment of crossbred cow, buffalo and local cow for milk production in Karnataka

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Abstract
The study observed variations in cost of milk production across the different categories of herd sizes and animal species. Overall cost of milk production per litre was highest for local cow (₹28.56) followed by buffalo (₹26.66) and then crossbreds (₹19.30), respectively. On an average, returns from milk production per litre was highest in case of buffalo (₹11.51) followed by crossbred (₹8.26) and local cow (₹2.98) respectively. Crossbred contributed the maximum quantity of milk for the Karnataka state though bovine stock dominated by local cow as far as species were concerned. Per litre returns from milk production was highest in case of buffalo (₹11.51) followed by crossbred (₹8.25) and (₹2.98) by local cow Net returns were also remunerative for all the species of animals across the herd size category of households. This draws attention of policy planners to chalk out the future plans to further increase the milk production enabling farmers to double their income.

Keywords: crossbred cow, buffalo, local cow, milk production

Introduction
Agriculture has been established as an important pillar to support Indian economy along with livelihood to large number of people. Total agriculture contributes about 16.5 percent to the economy and 49 percent of the people are involved in the agriculture and allied sector (GOI, 2020). In our country, the dairy industry played an essential role in the socio-economic development of millions of rural households. Livestock contributed 16 percent to the income of small farm households as against 14 percent for all rural households. Livestock provides livelihood to two-third of rural communities and employs about 8.8 percent population of India. The livestock sector contributes 4.1 percent to Indian Gross Domestic product (GDP) and shares 25.6 percent of the total Agriculture GDP. Dairying ensures the livelihood of 70 million farm families.

Livestock is a source of subsidiary income for many families in India, especially the resource-poor farmers who maintain few animals. Milch animals, including cows and buffaloes provide regular income to the farmers through the sale of milk. The country has one of the largest stock of buffaloes & cows and contributes 21 percent to global milk production and able to register an annual growth rate of 4.5 percent. The availability of 394 gram of milk per day per capita had been possible in country by record milk production of 187.7 million tonnes during 2018-19 as compared to 294 grams per day the average milk availability in the world. (Dairy of Animal Husbandry, Dairying & Fisheries, GOI, 2020)

Twenty-two state federations in country with 170 district-level milk unions along with more than 76,000 village-level co-operative societies and 11 million milk producer members. An average of 15 million litres of milk each day collected by these agencies. Total milk production in Karnataka state is to the tune of 4.10 metric tons i.e. 11th largest milk-producing state, constituting about 5 percent of the country's total milk production. Further, Karnataka ranks 3rd in India in the procurement of milk by the Milk Producers' Co-operative Societies (MPCSs). MPCSs functions at the village level, as a link between farmers and co-operative milk unions, remain active throughout the year to help the farmers to produce more milk. In Karnataka, about 1.33 crore households seeking employment, out of which approximately 60 percent of households got the employment in dairy sector directly or indirectly (Census, 2011). Milk co-operatives play a significant role in proving supplement income and employment to these households.

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The specific objective of the study are
1. To calculate the cost and returns of milk production.

Material and Methods
The study was conducted in Karnataka. In the state, Mandya and Dharwad districts were selected for the study. From each district two mandals constituting highest and lowest milk procurement were purposively selected and from each mandal, two village were selected randomly. Multistage sampling technique was used for data collection. In total, 100 dairy farmers which comprised 50 farmers from each district were selected for the study. A complete enumeration of all the selected 100 households with respect to milch bovine stock and operational holding etc. was made. In order to have comparative analysis across herd size categories, post-stratification of households was done with cumulative square root method of stratification with milch animals as the basis of classification of households into three categories, Small (1-3 SAUs), Medium (4-6 SAUs) and Large (> 6 SAUs) herd size categories. *viz.,* Primary data was collected on well-structured pre-tested schedule during the months of November, 2019 to February, 2020 by personal interview method. The data were scrutinized, computerized and analysed systematically by adopting a standard analytical framework to meet the different objectives of the study. The cost and returns of milk production was studied with the help of tabular analysis.

Standard Animal Units (SAUs)
Among the various cost items discussed, the producer incurs certain expenses for the entire herd on the farm. Fixed assets like cattle shed, feed manger, chaff cutter, milk cans and buckets etc. are used collectively by the farmer for all the cattle irrespective of their age and sex. Therefore, for assigning the joint expenditures into per animal basis, the entire herds were converted into standard animal units (SAUs).
Keeping in view the differences in regional endowments of animal species and wealth, the dairy animals have been converted into SAUs using the factors reported by Sirohi *et al.* (2015) for the southern region. The body weight of the animal along with the labour utilization was taken into consideration for estimating the SAUs.

Estimation of cost
The total costs involved in milk production comprise of fixed costs and variable costs. For estimation of different costs and return, the following methodology was undertaken.

Fixed costs
Fixed costs (FC) are the expenditure incurred by the producer irrespective of the level of production. FC don't vary with the output and remain unchanged in the long run. Various components of fixed cost include depreciation and interest on fixed capital. Capital Recovery Cost (CRC) method was used for estimation of fixed cost. Another fixed cost item *i.e.* interest on fixed capital was not estimated separately as CRC approach was followed.

Depreciation cost
Depreciation is defined as decrease in the value of fixed assets due to wear and tear, over time, accidental damage and technological obsolescence. CRC method was used to calculate the annual cost of depreciation over the useful life of asset which in turn provides economic rate of return on investment. Annual depreciation on animals, buildings, machinery and equipments used in dairy farming practices was included for calculation using CRC method.
The formula for estimation of CRC is given by:

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

Where, R is the capital recovery cost; Z is the initial value of the capital asset, r is the interest rate; n is the useful life of the assets. When the assets were purchased from borrowed capital the actual interest rate charged by the bank was taken as 'r', while in case of owned funds, the rate of interest on term deposit of 1-5 years was taken.

Variable Costs: Variable costs are those costs which are incurred on the variable factors of production and can be altered in the short run. Variable cost items include feed and fodder cost, labour cost, veterinary and miscellaneous expenses. Data on the variable expenses were collected from the farmers for entire herd size. Annual expenditures were converted to daily expenses and then apportioned into standard animal units (SAUs).

i) **Feed and fodder cost:** It includes costs of green fodder, dry fodder, concentrates and mineral mixture fed to animals. The cost was estimated as a product of quantity of certain feed/fodder fed to animals and the purchase price of respective feed. In case of home-grown feed/fodder, their farm harvest prices were considered. Where farm harvest prices were not available, imputed value of crop was taken into account as the prevailing price of standing crop in the locality. For calculating cost of the concentrated feed which was prepared at home, weighted prices of ingredients *i.e.* share of each component in the concentrate composition was taken into account. When animal feeds were grass and tea leaves collected from common property resources, its imputed value *i.e.* their expected sale price was accounted for estimation of the feed and fodder cost.

ii) **Labour Cost:** The information regarding labour requirements for various farm operations and labour cost were collected during the personal interview with the farmers. Labour cost comprises of both family labour and 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.

iii) **Veterinary and miscellaneous expenses:** Veterinary expenses included medicines, doctors' fees, vaccination charges as well as natural and artificial insemination charges. Miscellaneous expenditure included electricity, water charges, expenses on repairing fixed assets, insurance charges and other related expenses. As these expenses were joint costs, hence, apportioning was done based on SAUs.

Other Cost Concepts
Gross Cost: It is the total cost incurred by the producer which was estimated by adding all the cost components including fixed and variable costs.

Gross Cost = Total Fixed Cost + Total Variable Cost

Net Cost: The net cost was estimated by deducting the imputed income earned through dung, from the gross cost.

Net Cost = Gross Cost – Value of the Dung

Cost of milk production: In order to estimate the cost per litre of milk, the average net maintenance cost per animal per day was divided by average milk of animal per day.

$$\text{Cost per litre of milk (₹ / lit)} = \frac{\text{Net Cost Per Animal}}{\text{Avg. Milk yield of animal}}$$

Gross Returns: Milk yield of an animal x prevailing prices equals to gross returns.

Gross Returns = (Milk produced by household on daily basis) * Price of Milk

Net Returns: Difference of net cost from gross returns equated to Net return

Net Returns = Gross Returns -Net Cost

Price of Milk: Milk price differs for buffalo, crossbred cow and local cow.

Results and Discussion
A.) Costs and Returns of Milk Production
i) Costs and returns of milk production from crossbred cow
Table 1 indicated that the overall gross maintenance cost of crossbred cows varied from ₹183.97 per day for small herd size category to ₹189.77 per day for large herd size category farmers and the overall gross maintenance cost was found to be ₹187.43 per day.
The overall total fixed cost was estimated to be ₹22.86 per day which contributed about 12.19 per cent of overall gross cost.

The total fixed cost was found to be ₹23.08, ₹22.35 and ₹23.18 for small, medium and large herd size categories, respectively. The percentage contribution of total fixed cost to the gross cost was found to be 12.55 per cent, 11.77 per cent and 12.21 per cent to their individual herd size categories, respectively. The total variable cost was worked out to be ₹160.89, ₹167.51 and ₹166.59 per day with a percentage contribution of 87.45 per cent, 88.23 per cent and 87.79 per cent to the gross cost for small, medium and large herd size categories, respectively. The overall total variable cost was estimated to be ₹164.57 and contribution of total variable cost to the gross cost was found to be 87.81 per cent. The share of total variable cost to the gross maintenance cost (87.81%) was found to be higher than that of the total fixed cost (13.94%). The results obtained regarding the per cent share of total fixed cost and total variable cost to the gross maintenance cost was found to be in conformity with earlier research conducted by Vanishree (2018), Vishnoi *et al*. (2014), Nagrale (2011) and Athare (2019).
From the table 1, it was seen that the overall feed and fodder cost constituted a major portion of about 71.23 per cent of the gross cost. Total feed and fodder cost varied from ₹125.80 (75.52%) per day in case of large herd size category to ₹111.53 (69.32%) per day for small herd size category. Apart from the feed and fodder, the concentrates occupied a major share of 39.41 per cent in the gross cost, followed by dry fodder (32.78%) and green fodder (27.82%). The overall labour cost was estimated to be ₹36.63 per day with a share of 22.26 per cent to the variable cost and it was found to be highest for large herd size category (18.91%) and lowest in case of small herd size category (24.24%).
The cost of milk production was worked out to be ₹27.73, ₹27 and ₹27.98 per litre of milk in case of small, medium and large herd size category, respectively. The overall cost of production was estimated to be ₹27.56 per litre of milk. Net return was found to be positive for all the categories of households.

Table 1: Costs and returns of milk production for crossbred cow (₹/animal/day)

Particulars	Small	Medium	Large	Overall
Green fodder (F1)	29.20(26.18)	33.20(28.20)	37.37(29.70)	32.61(27.82)
Dry fodder (F2)	38.69(34.69)	37.66(31.98)	39.02(31.02)	38.42(32.78)
Concentrate (F3)	43.64(39.13)	46.89(39.82)	49.41(39.28)	46.19(39.41)
Feed and fodder cost (V1=F1+F2+F3)	111.53(69.32)	117.76(70.30)	125.80(75.52)	117.252(71.23)
Labour cost (V2)	39(24.24)	37.56(22.42)	31.50(18.91)	36.63(22.26)
Veterinary & Miscellaneous cost (V3)	10.36(6.44)	12.19(7.28)	9.29(5.58)	10.72(6.51)
Total Variable Cost (TVC=V1+V2+V3)	160.89(87.45)	167.51(88.23)	166.59(87.79)	164.57(87.81)
Total Fixed Cost (TFC)	23.08 (12.55)	22.35 (11.77)	23.18 (12.21)	22.86 (12.19)
Gross Cost (A=TFC+TVC)	183.97	189.86	189.77	187.43
Value of Dung (B)	23.74	23.34	24.76	23.86
Net Cost (C=A-B)	160.23	166.5	165.00	163.57
Average milk production (litre/animal/day) (E)	8.42	8.56	8.45	8.47
Price of milk (₹/litre)	27.73	27	27.98	27.56
Gross Return (D)	233.51	231.34	236.60	233.54
Net Returns (D-C)	73.28	64.83	71.61	69.98
Cost of milk production (₹/litre) (C/E)	19.03	19.46	19.51	19.30
Net Returns (₹/litre) (D/E)	8.70	7.58	8.47	8.26

The net return per litre of milk was worked out to be ₹8.70, ₹7.58 and ₹8.47 in case of small, medium and large herd size categories, respectively and overall net return was estimated to be ₹8.26 per litre of milk. The net returns from all the three categories of households were found to be varying with the herd size. Highest net return obtained in case of small herd size followed by medium and large herd size categories. The results obtained regarding the cost of production and net return per litre of milk was found to be similar with the studies conducted by Vanishree (2018), Nagrale (2011) and Athare (2019).
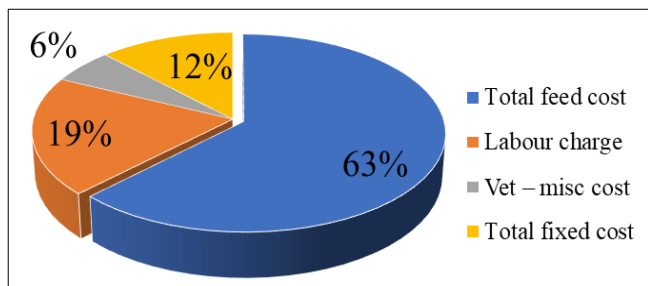
Fig 1: Costs and returns of milk production for crossbred cow

(ii) Costs and returns of milk production from buffalo
Table 2 showed that the overall total fixed cost for milch

buffalo was estimated to be ₹22.86 per day which varied from ₹ 23.08 per day for small herd size category to ₹23.18 per day for large herd size category. The share of overall total fixed cost to the overall gross maintenance cost was found to be 15.22 per cent. The contribution of individual total fixed costs to their respective gross maintenance costs was worked out to be 15.80 per cent, 15.12 per cent and 14.47 per cent for small, medium and large herd size categories, respectively. The total variable cost was estimated to be ₹122.98 per day, ₹125.43 per day and ₹136.95 per day for small, medium and large herd size categories, respectively. The overall total variable cost was ₹127.31 per day which contributed about 84.78 per cent to the gross maintenance cost.

Table 2: Costs and returns of milk production for buffalo (₹/animal/day)

Particulars	Small	Medium	Large	Overall
Green fodder (F1)	22.30(24.82)	24.09(25.81)	25.33(24.55)	23.67(25.08)
Dry Fodder (F2)	24.80(27.59)	25.62(27.45)	29.44(28.53)	29.44(31.19)
Concentrate (F3)	42.78(47.60)	43.63(46.74)	48.41(46.91)	44.47(47.12)
Feed and Fodder cost (V1=F1+F2+F3)	89.88(73.08)	93.33(74.41)	103.18(75.34)	94.38(74.14)
Labour cost (V2)	31.16(25.34)	30.23(24.10)	32.00(23.37)	31.05(24.39)
Veterinary & Miscellaneous cost (V3)	1.95(1.58)	1.86(1.49)	1.77(1.29)	1.87(1.47)
Total Variable Cost (TVC=V1+V2+V3)	122.98(84.20)	125.43(84.88)	136.95(85.53)	127.31(84.78)
Total Fixed Cost (TFC)	23.08(15.80)	22.35(15.12)	23.18(14.47)	22.86(15.22)
Gross Cost (A=TFC+TVC)	146.07	147.78	160.12	150.17
Value of Dung (B)	18.36	18.26	18.41	18.34
Net Cost (C=A-B)	127.71	129.51	141.71	131.83
Average milk production (litre/animal/day) (E)	4.87	4.85	5.18	4.94
Price of milk (₹/litre)	38.20	37.96	37.96	38.00
Gross Return (D)	186.10	184.20	196.80	189.13
Net Returns (D-C)	58.39	54.69	55.09	56.30
Cost of milk production (₹/litre) (C/E)	26.21	26.69	27.36	26.66
Net Returns (₹/litre) (D/E)	11.99	11.27	11.27	10.64

The overall gross cost for buffalo was estimated to be ₹150.17 per day which varied from ₹146.07 in case of small herd size to ₹160.12 for large herd size category. Results obtained with respect to the contribution of total fixed cost and total variable cost to the gross cost was found to be on conformity with earlier studies conducted by Singh (2013), Makarabbi (2016),Lal (2016), Patibandla L. (2018) and Athare (2019).
It is found from the above table that the overall feed and fodder cost was estimated to be ₹94.38 per day and the contribution of overall feed and fodder cost to the variable cost was found to be 74.14 per cent which varied from 73.08 per cent in small herd size to 75.34 per cent in case of large herd size category. Among the feed and fodder, the contribution of overall green fodder, dry fodder and concentrates to the gross cost was worked out to be 25.07 per cent, 31.19 per cent and 47.71 per cent, respectively. Highest cost share of concentrates was attributed to their high cost and lowest share of green fodders was due to their high productivity in the study area. The overall labour cost was estimated to be ₹31.05 per day with a contribution of 20.68 per cent to the gross maintenance cost.
The overall cost of production per litre of milk was estimated to be ₹26.66; ₹26.21, ₹26.69 and ₹27.36 per litre in case of small, medium and large herd size categories, respectively. The per litre cost of milk production was found to be negatively related with the herd size due to the economics of scale. The net return per litre of milk production was positive for all the herd size categories. The net return was found to be ₹11.99, ₹11.27 and ₹11.27 per litre of milk for small, medium and large herd size categories, respectively.
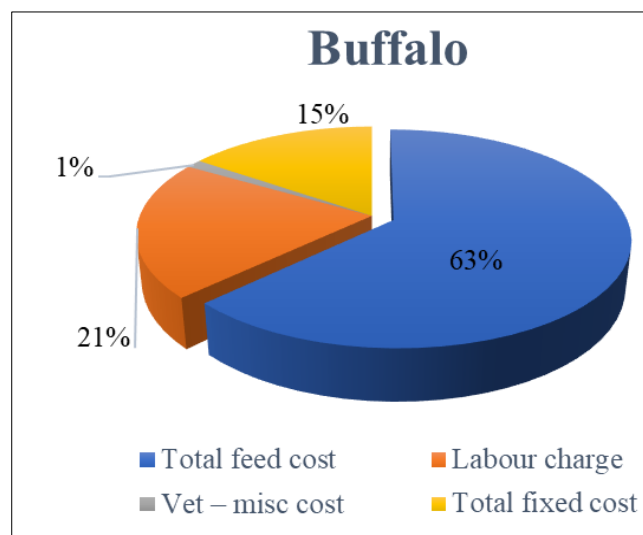

Fig 2: Costs and returns of milk production for buffalo

Costs and returns of milk production for local cow
Table 3 indicates the total costs and returns of milk production obtained from local cow in the study area. Total cost of production comprises of total fixed cost and total variable cost. The overall total fixed cost was estimated to be ₹22.85 per animal per day which accounted for ₹23.08, ₹22.34 and ₹23.17 for small, medium and large herd size category, respectively and it contributed for about 17.66 per cent of overall gross cost. The percentage contribution of fixed cost to the gross cost was found to be for small herd size

category (18.27%) and for large herd size category (17.39%). The overall total variable cost was found to be ₹106.54per animal per day which estimated to be ₹103.21, ₹107.95 and ₹110.08 for small, medium and large herd size category, respectively and it accounted for about 82.33 per cent of overall gross cost. The percentage contribution of variable costs to gross cost for individual herd size category *i.e.* small, medium and large were estimated to be 81.72 per cent, 82.84 per cent and 82.60 per cent, respectively. The overall gross maintenance cost was estimated to be ₹129.40 per day which varied from ₹130.29 per day for small herd size category to ₹ 133.26 per day for medium size category and ₹133.26 per day for large size category.

From the table 3 it is understood that the overall feed and fodder cost constituted a major share for about 72.60 per cent of variable cost which varied from ₹75.23 per day (72.89%) in small herd size category to ₹80.62 per day (73.23%) in case of large herd size category. In feed and fodder, overall share of green fodder, dry fodder and concentrate was found to be 29.68 per cent, 35.75 per cent and 34.60 per cent, respectively. Overall share of labour cost to the gross cost was found to be varied from 20.09 per cent in small herd size category to 20.90 per cent in case of large herd size category. The contribution of both fixed and variable costs to the gross cost are found to be in conformity with the earlier studies conducted by Singh (2015).

In case of cost of milk production, per litre cost of milk production was estimated to be ₹31.26, ₹32.29 and ₹30.98 for small, medium and large herd size categories, respectively. Overall cost of milk production per litre was found to be ₹31.54 per day. Per litre cost of milk production was worked out to be highest in case of medium herd size category followed by small and large size category. The result of cost of production of per litre milk is found to be similar with earlier studies (Bhawar 2019, Makarabbi 2016, Sharif and Dixit 2015).

Table 3: Costs and returns of milk production for local cow (₹/animal/day)

| Particulars	Small	Medium	Large	Overall
Green Fodder (F1)	22.61(30.05)	22.77(29.39)	23.59(29.26)	22.91(29.62)
Dry Fodder (F2)	27.76(36.89)	27.39(35.35)	27.87(34.56)	27.66(35.76)
Concentrate (F3)	24.85(33.04)	27.32(35.25)	29.51(36.16)	26.77(34.61)
Feed and Fodder cost (V1=F1+F2+F3)	75.23(72.89)	77.50(71.79)	80.62(73.23)	77.35(72.60)
Labour cost (V2)	26.00(25.19)	28.05(26.40)	27.5(24.98)	27.22(25.55)
Veterinary & Miscellaneous cost (V3)	1.97(1.91)	1.94(1.80)	1.95(1.78)	1.96(1.83)
Total Variable Cost (TVC=V1+V2+V3)	103.21(81.72)	107.95(82.84)	110.08(82.60)	106.54(82.33)
Total Fixed Cost (TFC)	23.08(18.27)	22.34(17.15)	23.1717.39	22.8517.66
Gross Cost (A=TFC+TVC)	126.29	130.29	133.26	129.40
Value of Dung (B)	17.80	17.29	18.36	17.77
Net Cost (C=A-B)	108.48	113.00	114.89	111.63
Average milk production (litre/animal/day) (E)	3.911	3.75	4.12	3.91
Price of milk (₹/litre)	31.266	32.29	30.98	31.54
Gross Return (D)	122.29	121.38	127.80	123.36
Net Returns (D-C)	13.80	8.38	12.91	11.73
Cost of milk production (₹/litre) (C/E)	27.73	30.06	27.85	28.56
Net Returns (₹/litre) (D/E)	3.53	2.23	3.13	2.98

As a result of the economics of scale in case of large herd size category, the per litre cost of milk production was found to be lowest in spite of the highest gross cost. The net return obtained from per litre milk in case of all the herd size categories was found to be positive. The overall net return per litre of milk was worked out to be ₹2.98 and it varied from ₹2.23 for medium herd size category to ₹3.53 for small and ₹3.13 for large size category. Hence, the net return from milk production was found to vary with the herd size of the households. Though the net return obtained in case of indigenous cow was less as compared to crossbred and buffalo in the study area, but the farmers preferred to rear indigenous breed viz *khilari, hallikar,* and *amruthmahal* due to broad adaptability to climate vagaries, low maintenance cost.
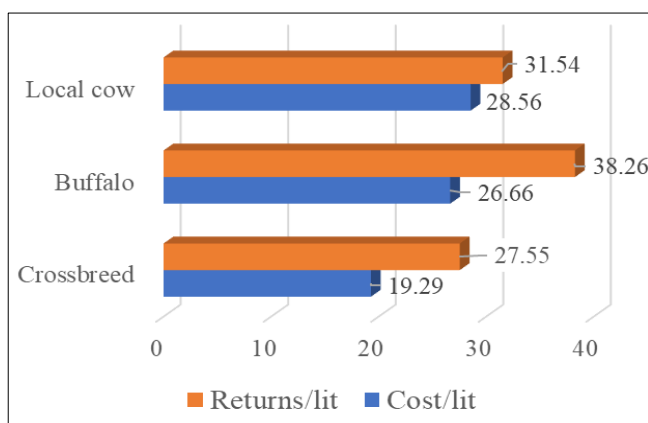
The results obtained regarding the cost and returns of milk production in case of indigenous cows was found to be in conformity with the earlier studies conducted by Lal (2016) and Athare (2019), Bhawar (2018) and Makarabbi(2016).
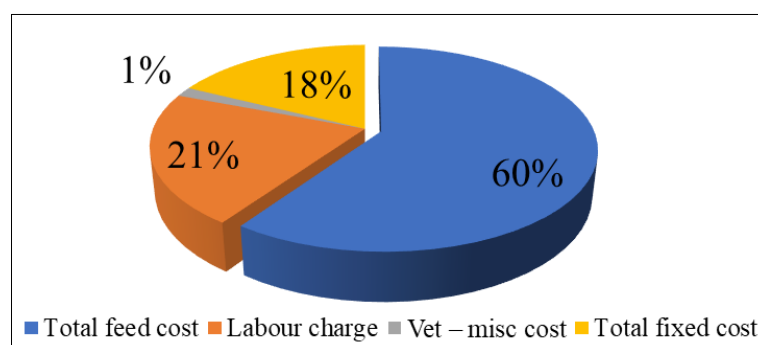
Fig 3: Total maintenance cost of local cow
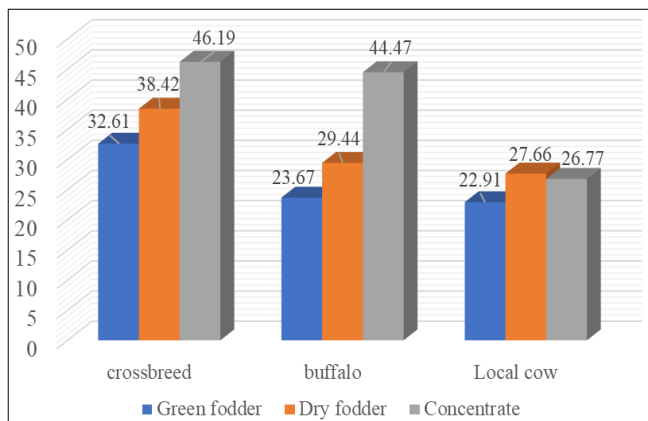
Fig 4: Total fodder cost per animal (₹)

Fig 5: Cost and returns per litre of milk (₹)

Conclusion

- Overall total maintenance cost was highest for crossbred cow (₹187.43) followed by buffalo (₹150.17) and indigenous cattle (₹129.40).
- Variable cost accounts for the highest share in total cost of milk production. Overall, it constituted around 87.81 per cent, 84.78 per cent and 82.33 per cent in case of indigenous cattle, buffalo and crossbreds, respectively.
- Among the various cost items, feed and fodder cost accounted for the major share followed by labour cost for all the species of animals across various categories of households.
- Overall cost of milk production per litre was highest for indigenous cattle (₹28.56) followed by buffalo (₹26.66) and crossbreds (₹19.30), respectively.
- On an average, returns from milk production per litre accrued to producer households was highest in case of buffalo (₹11.51) followed by crossbred (₹8.26) and indigenous cow (₹2.98).
- Net returns were found to be positive for all the species of animals across all the category of households

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