Indian Journal of Animal Sciences **90** (2): 275–280, February 2020/Article

Profitability of dairy and goat production system: A multivariate typology of farm households

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Received: 26 August 2019; Accepted: 20 September 2019

ABSTRACT

Using households' data from four different agro-climatic zones of Maharashtra, a typology was developed with an aim to identify factors influencing the profitability of dairy and goat production system. Multivariate statistical techniques, i.e. Cluster analysis (CA) were used to classify the groups of farm households with similar farm characteristics into four homogenous clusters, (1) households possessing small landholding, a larger high yielding dairy stock with small goat flock size, (2) households having small landholding with a small stock of high yielding dairy animal and small goat flock size, (3) households having large landholding with large high yielding dairy stock and small flock size, (4) households possessing small landholding with small high yielding dairy stock and large flock size. The households with small high yielding dairy stock and large flock size were most profitable than others because of scale of economies, while households with larger high yielding dairy stock and small flock size were least profitable, implying a need for more integration of Dairy+Goat unit to augment profitability. Price of milk, total SAU and flock size has been identified as the main factors influencing profitability. This implies that increase in number of SAU, flock size and price of milk can augment profitability in dairy and goat production system.

Key words: Dairy farming, Goat farming, Multivariate typology, Profitability

Livestock plays an important role in the economy of farmers. It is producing about 176.34 million tonnes of milk in a year (2017–18) at an annual growth rate of 6.6% and accounting 66.7% of the total value of the output of livestock (Anonymous, 2018–19). In India, about 85% of the small and marginal farmers own 45% of total land and 75% of the bovine (Planning Commission Report, 2012–17). A number of studies on cost and return from dairy and goat production have been carried out in different agro-climatic regions of India (Pundir *et al*. 2018, Feroze *et al*. 2019 and Bijla and Singh 2019). However, scant research attention has been given on identification of typical farm households based on socio-economic criteria, herd size and flock size and examining how profitability varies across these households. In the given context, present study was carried out with the objective of assessing profitability in Dairy+Goat production system and identifies the factors influencing profitability.

MATERIALS AND METHODS

Sampling and Data: The study was carried out in four different agro-climatic zones of Maharashtra. Multistage purposive and stratified random sampling was followed. Four agro-climatic zones (Scarcity zone, Assured rainfall zone, Moderate rainfall zone, and Eastern Vidarbha zone) of Maharashtra state were selected purposively to provide better representation of livestock, highest and lowest productive zone, besides two other zones at equidistant places were selected. Further, two districts from each zone were selected purposively having 50% and more coverage area in a particular zone. From each of the districts, two blocks selected randomly and a cluster of two villages were selected based on the population of livestock (dairy and goat). Further, from the purposively selected cluster of two villages, 25 farmers' were selected randomly with equal representation to livestock production system on the basis of possessing of minimum 2 adult animals (dairy, goat). Thus, a total of 400 farmers' were included in the study from 8 districts.

Data were collected through personal interview on parameters like demographic particulars of households, farm inventories, technical characteristics of dairy and goat enterprise, cost of feeding, veterinary and miscellaneous expenses, family and hired labour, prevailing wage rates and price of milk, feed inputs and selling price of goat flocks, etc.

A typology study was used to classify the groups of farm households with similar farm characteristics, viz.

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Table 1. Socio-economic profile of respondents belonging to different clusters

Particulars	Cluster-1	Cluster-2	Cluster-3	Cluster-4	Overall	F Value
Respondents specific characters						
Age (Years)	39.8^{c} (0.78)	38.03(0.65)	36.57(0.85)	35.5^{c}(0.88)	38.25(0.42)	3.87**
Education(Mean±SE))	2.6 (0.13)	1.66(0.13)	2.88(0.234)	1.97(0.22)	2.21(0.08)	12.09**
Illiterate	11.3	35.9^{ab}	13.0	10	17.55	
Primary	16	19.2	13	35	18.8	
Middle school	22.7^{c}	17.3	14.1^{ac}	27.5	20.4	
High school	17.3	9.6^{ab}	16.7	12.5	13.8	
Higher secondary	15.3^{c}	6.4^{ab}	22.2^{ac}	5.0^{c}	11.8	
Graduate and above	17.3	11.5	21.0^{ac}	10	14.95	
Occupation(Mean±SE)	4.76 (0.17)	4.94 (0.16)	6.18 (0.05)	5.82 (0.18)	5.13(0.09)	
Dairy	23.3^{a}	0	0	0	8.8	
Goat	1.3	27.6	0	2.5	11.5	
Goat+agriculture	1.3^{ab}	35.9^{a}	0	52.5^{a}	19.8	
Dairy+ Agriculture	74^{a}	0	81.5^{ab}	0	38.8	
Dairy+Goat+Agriculture	0	32.1	18.5	45	19.5	
Dairy+Goat	0	4.5	0	0	1.8	
Gender(Mean±SE)	0.78(0.03)	0.80(0.03)	1.00(0.00)	0.87(0.05)	0.83(0.01)	
Male	78.7^{c}	80.1	100^{ab}	87.5	83	
Female	21.3^{c}	19.9	0	12.5^{a}	17	
Household specific characteristics						
Family type (Mean±SE)	0.63 (0.039)	0.64 (0.03)	0.5 (0.06)	0.7 (0.07)	0.63 (0.024)	0.76^{NS}
Nuclear	63.3	64.7	55.6	70	63.5	
Joint	36.7	35.3	44.4	30	36.5	
Family size	5.82^{b} (0.16)	5.27^{ab} (0.17)	4.81^{ac} (0.31)	6.2^{c} (0.38)	5.5 (0.11)	4.9**
Annual income (₹)	88853.83^{ab} (5802.1)	103071.46^{ab} (5230.14)	4,47,760.60^{c} (34081.1)	2,23,835.46^{c} (15165.0)	156348.50 (8298.5)	152.64**
Dairy income (₹)	59493.8^{c} (5246.0)	16721.1^{ab} (2308.39)	94686.52^{c} (8802.01)	14700^{ab} (3011.85)	43084.1 (2869.4)	43.34**
Goat income (₹)	620^{ac} (474.46)	62734.92^{c} (3404.10)	1592.52^{bc} (556.71)	126410.4^{c} (6773.68)	37555.1 (2869.4)	254.33**
Agriculture income (₹)	28740^{bc} (2058.7)	23615.3^{bc} (1896.86)	351481.4^{c} (32169.8)	82725^{c} (13516.9)	75710 (7207.7)	187.2**
Credit linkage (Mean±SE)	2.22 (0.31)	2.37 (0.32)	0.92 (0.39)	2.4 (0.66)	2.12 (0.194)	2.03^{NS}
No finance source	66.7	70.5	90.7	70	71.8	
Friends and relatives	11.3	5.8	0	7.5	7.3	
Pvt money lenders	3.3	1.9	0	0	2.0	
Govt. financial institute	18.7	21.8	9.3	22.5	19	
Farm specific characteristics						
Herd size (SAU)	3.90^{c} (0.13)	1.41^{ab} (0.18)	6.77^{c} (0.27)	1.348^{ac} (0.29)	3.06 (0.13)	116.09**
Flock size	0.18^{ac} (0.09)	17.30^{c} (0.38)	1.2 ^{bc} (0.44)	35.77^{c} (1.13)	10.57 (0.611)	1102.5**
Land owned (Acres)	2.50^{bc} (0.16)	2.08^{bc} (0.14)	8.8^{c} (0.45)	4.25^{c} (0.42)	3.3 (0.15)	132.8**
Housing (Mean±SE)	5.5 (0.19)	4.44 (0.23)	6.44 (0.246)	5.75 (0.27)	5.27 (0.12)	
No house	2.0^{c}	15.4^{ab}	0	0	6.8	
Hut	3.3^{c}	16.7^{ab}	0	0	7.8	
Kutcha	48.7^{c}	27.6	24.1	21.5^{b}	30.47	
Pukka	17.3^{c}	19.2	37	40^{b}	28.37	
Concret	17.3	12.8	31.5	30	22.9	
Mixed	11.3^{c}	8.3	7.4	8.5	8.8	
Livestock production system (Mean±SE)	1.00 (0.01)	2.36 (0.38)	1.37 (0.10)	2.45 (0.07)	1.73 (0.39)	
Dairy	97.3	0	81.5	0	47.5	
Goat	2.7	63.5	0	55	31.3	
Dairy+goat	0	36.5	18.5	45	21.3	
Farming experience	5.11^{ab} (0.21)	2.91^{c} (0.19)	6.72^{c} (0.35)	5.10^{bc} (0.22)	4.47 (0.13)	40.31**

*Figures in parenthesis indicate the standard error of corresponding values. *P<0.05**P<0.01.

*The figures having different superscript across clusters are significantly different up to 5% level of significance between them

Table 2. Cost measures across different clusters (₹/Household/Day)

Particulars	Cluster 1	Per cent share	Cluster 2	Per cent share	Cluster 3	Per cent share	Cluster 4	Per cent share	Overall	Percent share
Investment/ Household/year	144012[bc]	98371.15[ab]	307555[c]	176700[a]	181659.53					
Fixed cost										
Interest on fixed capital	39.54 (1.57)	13.2	27.32 (2.14)	17.5	84.2 (3.69)	20	48.41 (2.28)	20.7	49.8 (2.42)	17.8
Depreciation	47.13 (1.93)	15.8	32.79 (2.57)	21.12	101.1 (4.43)	24.0	80.01 (3.37)	34.2	62.25 (3.07)	23.7
Variable cost										
Dry fodder	103.6 (3.99)	34.80	32.55 (3.41)	20.97	158.8 (7.30)	37.80	42.33 (4.28)	18.11	84.32 (4.74)	30.47
Green fodder	53.15 (2.34)	17.85	22.38 (2.29)	14.42	79.96 (3.88)	19.01	26.14 (2.77)	11.18	45.40 (2.82)	16.40
Concentrate	28.89 (1.15)	9.70	20.26 (1.12)	13.05	50.37 (2.96)	11.99	36.86 (3.46)	15.77	34.09 (2.17)	12.32
Grazing cost	19.34 (3.67)	6.49	16.59 (0.47)	10.68	0	0	14.18 (1.70)	6.06	12.52 (1.46)	2.71
Feed and fodder cost	194.19 (6.97)	65.2	75.16 (6.71)	48.42	289.2 (13.63)	68.8	105.3 (7.53)	45.05	165.9 (8.71)	59.85
Hired labour	4.10 (0.44)	1.37	17.50 (3.70)	11.27	43.48 (3.08)	10.34	31.41 (2.49)	13.44	24.12 (2.42)	8.71
Veterinary expenses	6.963 (0.20)	2.33	4.01 (0.14)	2.58	8.22 (0.39)	1.95	7.56 (0.34)	3.23	6.68 (0.26)	2.41
Miscellaneous	12.3 (0.37)	4.13	4.93 (0.34)	3.17	9.43 (0.40)	2.24	6.92 (0.26)	2.96	8.3 (0.34)	2.99
Total variable cost	217.52 (7.71)	73.0	118.2 (7.10)	76.15	350.3 (15.48)	83.3	165.5 (8.92)	70.8	212.9 (9.80)	76.9
Total cost TFC+TVC	297.7 (10.5)		155.2 (9.38)		420.1 (18.20)		233.7 (10.37)		276.7 (12.1)	
Cost of production/litre of milk	21.98 (0.75)	7.38	19.85 (0.69)	12.78	16.38 (0.50)	3.89	18.49 (0.77)	7.91	19.17 (0.67)	10.84

*Figures in parenthesis indicate standard error

*Figures in per cent share column indicate the share of each cost component in gross cost. * superscripts across clusters significantly different up to 5% level of significance between them.

landholding (in acres), number of crossbred, buffaloes, indigenous cattle and goat were measured in Standard Animal Unit (SAU). Typology constitutes essential steps in the realization of any opportunities and constraints exist within the farm households. For this purpose typology described by Bidogeza *et al.* (2009) and Baral and Bardhan (2016) were used. Farm household typologies were constructed by using multivariate statistical techniques, i.e. Cluster Analysis (CA). A multiple regression equation as given below was fitted to identify the factors significantly influencing profitability in dairy and goat production system (net returns/households/day).

$P = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, C_1, C_2, C_3, C_4)$

Where, P, net return/household/day; X_1, Age of the household head; X_2, Education level of the Household head (Number of years of schooling/ education completed); X_3, Flock size in numbers; X_4, Operational landholding in acres; X_5, Milk output (litre/day/household); X_6, Price of milk (₹/litre/day); X_7, Imputed value of labour charges (₹/household) ; X_8, Feeding cost (₹/household); X_9, Herd size (measured in Standard Animal Unit); C_1, Dummy to represent Cluster 1 (C_1=1 for small landholding households with larger high yielding dairy animal stock and small goat flock size, 0=otherwise); C_2, Dummy to represent Cluster 2 (C_2=1 for Small landholding households with smaller high yielding dairy animal and small goat flock size, 0= otherwise); C_3, Dummy to represent Cluster 3 (C_3 =1 for large landholding households with large high yielding dairy animals stock and small flock size, 0= otherwise); C_4, Dummy to represent Cluster 4 (C_4=1 for small landholding households with small high yielding dairy animals and large goat flock size, 0= otherwise).

The fitted function was estimated through the OLS technique.

RESULTS AND DISCUSSION

Multivariate typology of farm households: In the typology study, cluster analysis was carried out with the five farm variables. Four clusters emerged from this analysis. Out of which, 39% of the sample households were belonging to cluster 2, followed by 37.5%, 13.5%, and 10% from cluster 1, 3 and 4 respectively. In order to name each of the clusters, one way ANOVA was conducted to determine which classifying factors are significantly different between clusters. With a significant ANOVA and four clusters, a Tukey post-hoc test was conducted to determine where exactly the difference existed.

Socio-Economic Profile: The socio-economic profile of the respondents belonging to different clusters as identified in typology study is presented in Table 1. The average age of the households was significantly higher in cluster 1 than other clusters. Education profile of the respondents revealed that majority of the respondents were educated up to middle school followed by primary school level. The overall inference can be drawn across clusters that cluster 4 and 3 had high education level. Similar findings were reported by Sone *et al.* (2015) in their study conducted in Uttarakhand hills.

Regarding occupation profile, majority of the respondents (38.8%) had dairy + agriculture followed by goat+agriculture principal occupation across the clusters. Similar findings were reported by Naik *et al.* (2013). The proportion of male households in cluster 1 was significantly lower than cluster 3, while for female households proportion was significantly high for cluster 1 than the cluster 4 which are consistent with the findings of Sone *et al.* (2015) and Baral and Bardhan (2016).

The disaggregated analysis of annual income across whole clusters revealed that income from dairy and goat was significantly different across all four clusters. Mohan *et al*. (2016) reported that the majority of goat farmers had an annual income of (₹ 10,000–20,000) per annum. Average herd size in terms of the standard animal unit (SAU) per household was significantly high in cluster 3, while flock size was significantly high in cluster 4. Average landholding per household was significantly low in cluster 2 than other clusters. Similar findings were reported by Bidogeza *et al.* (2009) while Sone *et al*. (2015) reported different findings and found average herd size; flock size and landholding 1.70, 11.58 and 1.01, respectively. Mohan *et al*. (2016) reported that 39.24% of goat farmers had mixed type of house. The profile of respondents across clusters for a livestock production system (LPS) revealed that 47.5% of the respondents had dairy followed by goat (31.3%) and Dairy+Goat (21.3%) as major livestock production systems. The profitability of livestock production system across different clusters.

Investment pattern across different clusters: Total investment comprising expenditures made on the purchase of animals, equipment and construction of animal shed was assessed for each household throughout each cluster (Table 2). Data revealed that average household investment of cluster 3 (large landholding with a large high yielding dairy animal) was significantly higher than other clusters. Similar findings were reported by Baral and Bardhan (2016).

Cost measures across different clusters: Fixed cost comprised interest on fixed capital like the value of an animal, animal shed and equipment was calculated at 10% per annum. Further, depreciation on a shed, equipment and the animal was worked out at 12% per annum using straight-line method taking into account the useful life of the asset concerned. Data revealed that fixed cost was highest in cluster 3 than other clusters (Table 2).

The average cost per household was found lowest (₹ 118.2) for Cluster 2 Households among all clusters. This category holds low landholding with smaller yielding dairy stock and flock. Baral and Bardhan (2016) found overall maintenance cost (₹ 96.74) per SAU for whole clusters. Within the variable cost, feed and fodder cost contribute the highest share, which is in consonance with the findings of Ghule *et al.* (2012). Cluster 4 households had the highest cost (₹ 289.2) of feed and fodder per day, while Cluster 2 households had the lowest proportion. This finding is

Table 3. Income measures across different clusters (₹/household/day)

Items of income	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Overall
Gross income	151.94 (15.26)	217.68 (11.82)	531.19 (24.26)	391.93 (17.85)	323.18 (17.29)
Net income	71.78 (16.65)	180.71 (10.43)	193.96 (22.02)	323.76 (16.70)	192.55 (16.45)
Net income with family labour input (Gross income-cost C)	–125.26	–45.27	–401.45	33.3	–134.67
B:C Ratio	2.71	2.99	1.44	2.46	2.4
Profit Margin	55.33	55.61	26.98	57.56	48.87
Farm labour income (Gross income-cost A)	199.37 (15.81)	83.24 (12.06)	187.68 (18.78)	160.62 (16.76)	63.88 (15.85)
Family labour income (GM-cost B)	152.23 (14.86)	55.91 (12.59)	271.94 (19.19)	112.21 (16.87)	12.10(15.87)

Cost A, Expenditure on feed and fodder + Veterinary expenditures + Miscellaneous Expenditure + Hired labour charges + Depreciation on fixed assets; Cost B, Cost A+ Interest on fixed capital; Cost C, Cost B + Imputed value of family labour charges.

consonance with Baral and Bardhan (2016). This implies that share of feed and fodder cost tends to increase with more number of high yielding stocks. The next component of variable cost is grazing cost, it was low for cluster 3 households (stall-fed animals), while for Cluster 2 it was high (10.68%) due to smaller landholding with low yielding stock. The next important component is labour charges which are accounted 8.71% of the gross cost. This finding is consonance with the study of Ghule *et al.* (2012) in Maharashtra, while Baral and Bardhan (2016) in Uttarakhand found that labour charge account 30% of the gross cost. The other components of variable cost, viz. veterinary expenses and miscellaneous expenses accounted for minor shares of the total cost for the overall category. This finding is consonance with the study of Bardhan and Sharma (2012) in Uttarakhand and Dixit *et al*. (2017) in Uttar Pradesh.

Cost of production of milk per litre, across all clusters, was lowest for Cluster 3 households. This is understandable as households with larger high yielding dairy stock with commercial orientation are expected to manage their enterprises more efficiently so as to lower down the cost of milk production. This is confirmatory with the study of Baral and Bardhan (2016) in Uttarakhand, Ghule *et al*. (2012) in Maharashtra.

Income measures: Various income measures across different clusters were studied (Table 3). Cluster 4 households were most profitable followed by Cluster 3. However, when the net return was calculated with the input of family labour charges net returns turn negative for all except cluster 4 households which possess larger goat flock and small yielding dairy stock. This clearly show that cluster 4 was most profitable among all clusters. Further, when family labour charges excluded from the gross margin, family labour income turns positive for all clusters. Similar findings were reported by Bardhan and Sharma (2012) and Baral and Bardhan (2016) in Uttarakhand.

The profit margin percentage was high (57.56%) for Cluster 4 followed by the households of Cluster 2 (55.61%). The benefit-cost ratio was found highest for Cluster 2 followed by Cluster 1 households with larger high yielding dairy stock and small goat flock size. The overall benefit-cost ratio was 2.4 and the profit margin was 48.87% across whole clusters. This make it explicit that households with small landholders possessing integration of goat flock and high yielding dairy stock is most profitable.

Factors affecting profitability: The multiple regression analysis was carried out to identify the factors significantly influencing the profitability (Table 4).

During the course of multiple regressions, the software calculated the intercept by including a hidden extra variable which is a constant, i.e. 1 for each and every observation in the data set. So as to avoid perfect collinearity in the data set, the software automatically dropped one dummy variable from the data set. The dropped dummy variable was Cluster 2.

Overall the factors significantly affecting the profitability were flock size, total SAU, price of milk, feeding cost and labour cost. This clearly implies that profitability increases

Table 4. Factors affecting profitability (Multiple regression analysis)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	–151.081	42.366	–3.566	0.000	
Age	–0.238	0.764	–0.012	–0.312	0.755
Education	1.375	3.823	0.014	0.360	0.719
Flock size	12.305	1.899	0.891	6.481**	0.000
Land	–3.038	2.427	–0.188	–1.251	0.212
Milk output	0.025	0.474	0.003	0.052	0.959
Price of milk	3.635	0.856	0.268	4.245**	0.000
Labour cost	–1.487	0.224	–0.292	–6.629**	0.000
Feeding cost	–1.464	0.156	0.310	–2.979**	0.003
Total SAU	26.837	6.621	0.434	4.053**	0.000
Cluster 1	67.549	38.864	0.194	1.738	0.083
Cluster 3	–19.224	45.356	–0.039	–0.424	0.672
Cluster 4	14.361	74.793	0.026	0.192	0.848

a. Dependent Variable: Net return, R^2 =0.47, F=29.29**, **P<0.01.

with an increase in the price of milk, flock size and number of SAU. This finding is consistent with the earlier finding in this study which revealed that households of Cluster 4 were profitable, having large goat flock and small high yielding dairy stock. Similar findings were reported by Baral and Bardhan (2016). The labour and feeding cost was affecting negatively on net return. This implies that lower the cost of feeding and labour, the more will be profitability which revealed that clusters of all households were having positive net income when the value of family labour excluded.

The study concluded that gross income, net return per household was high in cluster 4 and 3 while profit margin were high in cluster 4 followed by cluster 2. Therefore, the profitability of small landholders can be increased with the integration of goatry and high yielding dairy stock. Further, it was found that the overall factors that affected profitability positively were flock size, total SAU and price of milk while feeding and labour cost affected negatively. Hence, profitability can be increased by the introduction of green fodder technologies, mechanization of farming practices and provision of remunerative prices for the milk. Government policies regarding dairy and goat production system are likely to be more effective if they consider the heterogeneity of farms in the design and delivery of extension approaches and interventions.

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