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Multivariate Typology of Milk Producing Households in Uttarakhand Hills: Explaining Profitability in Dairy Farming†

Shibashish Baral and D. Bardhan*

ABSTRACT

In this paper, using household data from two hill districts of Uttarakhand, we have developed a typology of dairy farmers with an aim to identify the factors influencing profitability of dairying. Multivariate statistical techniques, viz., principal component analysis and cluster analysis are used to categorise dairy farmers into four homogenous clusters; (i) small dairy farmers with low family labour (37 per cent),(ii) female dairy farmers with low level of education (12 per cent), (iii) market-oriented dairy farmers (13 per cent) and (iv) low income households (39 per cent). Market-oriented dairy households were more profitable than others because of scale economies, while female dairy farmers with low level of education were the least profitable, implying a need for empowerment of women through training and institutional support so as to improve their scale of dairy production and competitiveness. The proportion of milk sold along with price has been identified as the main factor influencing profitability of dairying.

Keywords: Multivariate typology, Dairy farming, Profitability, Uttarakhand, India

JEL: Q13, I32

I

INTRODUCTION

India is presently the largest milk producing country in the world with production of 132.4 million tonnes per annum in the year 2012-13 (NDDB, 2015). The study on livestock ownership across operational land holdings in 2003 showed that the marginal farm households with less than 1 hectare of land, comprising 47 per cent of the farming households, possessed more than 51 per cent of the country's cattle and buffalo population and 66 per cent of the small ruminants, against their share of 24 per cent in land (NSSO, 2003). This distributional pattern of livestock in favour of the rural poor indicates that development of this sector will result in a more equitable development of rural economy and hence alleviation of poverty. Moreover, recent

*MVSc (Veterinary Economics Scholar) Department of Veterinary and Animal Husbandry Extension, College of Veterinary and Animal Sciences, G.B. Pant University of Agriculture and Technology, Pantnagar-263 145 (Uttarakhand) and Senior Scientist, Division of LES & IT, ICAR-IVRI, Izatnagar, Bareilly-243 122 (Uttar Pradesh).

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decades have witnessed radical shift in dietary patterns in favour of animal based food products on account of increasing trends in urbanisation, income growth and globalisation. These trends are robust and will sustain in the near future in developing countries like India, thus presenting substantial opportunities for demand-driven growth in the livestock sector, including poultry and fisheries.

In hilly regions of India, the dairy sector assumes greater importance on account of limited livelihood options for rural households with rainfed subsistence agriculture and limited irrigation facilities, low input-output production system, small and fragmented landholdings with uneven terrain, low risk bearing ability of farmers and out migration of males in search of off-farm employment. In Uttarakhand, where 11 out of the total 13 districts are hilly, cattle constitute the major share of livestock population (44.6 per cent) and milk constitutes the major livestock produce accounting for 77 per cent of the total value of output from the livestock sector. Dairy husbandry forms a source of livelihood for almost all the households in the state, with each household possessing 1-2 milch animals. Over 80 per cent of all livestock species are owned by small holders (Singh and Rawat, 2006). Dairying is thus considered to have high prospects to enhance the level of living of the poorest of the poor.

The cost of milk production is an important economic indicator for policy makers in regard to providing remunerative price for milk and assessing the farm household efficiency in milk production. A number of studies on costs and returns from milk production have been carried out in different agro-climatic regions of India (Raju *et al.*, 2005; Sirohi *et al.*, 2007; Bhangaroo, 2007; Singh *et al.*, 2009; Meena *et al.*, 2010). However, scant research attention has been given on identifying typical milk producing households and in examining how profitability in dairy farming varies across these households.

It is well recognised that economic viability in milk production may vary across different dairy systems categorised on the basis of relevant socio-economic and farm characteristics of milk producing households. It thus becomes important to typify different dairy systems based upon these characteristics. Typology constitutes an essential step in any realistic evaluation of the constraints and opportunities that exist within farm households and also targeting efforts and investment by policy makers (Bidogeza *et al.*, 2007). Typological studies can therefore be of great importance for exploring factors explaining economic viability and efficiency in milk production. In the above context, the present study was carried out with the objectives of assessing profitability in milk production of various dairy systems and identify the factors influencing profitability in dairy farming.

II

METHODOLOGY

Sampling and Data

The study was carried out in Uttarakhand state. Multistage purposive and stratified random sampling were followed in the selection of division, districts, Tehsils, villages and respondents for the study. Uttarakhand has two administrative divisions, viz., Kumaon and Garhwal. Kumaon division was selected for the study on account of higher livestock density and greater economic dependence of rural people on livestock. Livestock per sq. km. geographic area and livestock per 1000 rural population are higher in Kumaon division (114 and 840, respectively) than in Garhwal (78 and 795, respectively) (Bardhan *et al.*, 2010).

Two districts, viz., Nainital and Almora from Kumaon region were chosen, purposively. Both the districts are rich in livestock resources. Nainital district accounts for about 9.55 per cent and 9.53 per cent of total milch cattle and buffalo population of the state while Almora district accounts for 10.74 per cent and 10.81 per cent, respectively. Both the districts have highest bovine composition in the total livestock population among all the hill districts in the Kumaon division. The net sown area per capita in Almora and Nainital districts is 0.15 and 0.10 hectares, respectively. Density of rural population in both the districts is highest among all the hill districts in the state (124 and 122 per square kilometre, respectively for Almora and Nainital). Marginal farming is more prevalent in Almora than in Nainital (59305 and 24377 landholdings being less than 0.5 hectare in Almora and Nainital districts, respectively). From each of the two districts, two tehsils having highest population of dairy animals were chosen, viz., Betalghat and Bhimtal from Nainital district and Hawalbagh and Chaukhutiya from Almora district. From each selected tehsil in each district, three villages were selected, randomly. Thus, a total of 12 villages were selected for the study from the two districts. From each selected village, 10 households having at least one milch animal were selected randomly for the study. Thus, the ultimate sampling units comprised 120 milk producing households.

The data were collected through personal interview method with the help of a well-structured, comprehensive and pre-tested interview schedule. The respondents comprised of the heads of the sample households surveyed. Data were collected on parameters like demographic particulars of households, farm inventories, technical characteristics of dairy enterprise, cost of feeding, veterinary and miscellaneous expenses, hired and family labour and prevailing wage rates, prevailing prices of milk, feed inputs etc.

Multivariate Typology of Milk Producing Households

A farm typology study was used to classify groups of farm households with similar farm and socio-economic characteristics as typology constitutes an essential

step in any realistic evaluation of the constraints and opportunities that exist within farm households. For this purpose, the methodology described by Bidogeza *et al.* (2007) and Garcia *et al.* (2012) were used. Farm household typologies were constructed by using two multivariate statistical techniques, viz., Principal Component Analysis (PCA) and Cluster Analysis (CA). PCA was used to transform linearly an original set of variables, representing farm and socio-economic characteristics, into a smaller set of uncorrelated variables (factors) that represent most of the information in the original set. A small set of uncorrelated variables is much easier to understand and use in cluster analysis than a larger set of correlated variables. Table 1 presents the variables which were used to construct factors using PCA. Bartlett's sphericity test was carried out to address the question of whether the data set was appropriate to be factored. The decision regarding number of factors to be retained was based on Kaiser's criterion that suggests retaining all factors with eigen values greater than 1.

TABLE 1. VARIABLES CONSIDERED FOR CONSTRUCTING FACTORS USING PRINCIPAL COMPONENT ANALYSIS

S.No. (1)	Variables (2)	Descriptions (3)
1.	Household size	No. of members in Household
2.	Social group	ST=1, SC=2, OBC=3, GEN=4
3.	Dwelling structure	Kuccha=1, Semi-pucca=2, Pucca=3
4.	Gender of household head	Female=0, Male=1
5.	Age household head	Age in No. of years
6.	Education household head	No. of years of formal schooling
7.	Household education index	Average formal schooling years of the household members
8.	HH income	Annual income in Rs.
9.	Family labour employment in farming	No. of family members involved in farming
10.	Non-farm income	Presence of NFI=1, Absence=0
11.	Number of earning members	No. of earning members of the Household
12.	Landholding	Total land holding size of Household (acres)
13.	Proportion of irrigated land	Proportion of irrigated to total land
14.	Land under fodder	Area of land under fodder cultivation
15.	No. of lactating animals	No. of lactating animals in the herd at the time of survey
16.	Herd size	Total no. of dairy animals owned by household (measured in SAU)
17.	CB animal	Presence=1, Absence=0
18	Milk production	Fat corrected total milk in litres
19.	Milk sold	Fat corrected total milk sold in litres
20.	Milk yield	Fat corrected total milk / SAU
21.	Vaccination	Whether animals were vaccinated in last one year: Yes=1, Otherwise=0
22.	Artificial insemination	Whether AI is followed? Yes=1, Otherwise=0
23.	Concentrate usage	Whether concentrate is fed to animals: Yes=1, No=0

The factors retained from the PCA were used for cluster analysis. Cluster analysis seeks to typify entities (in this case milk producing households) M = (M1, M2, M3 ….) according to their (dis)similarity in terms of their attributes represented by the variables chosen N1, N2, N3, ….ϵ M. Entities within a certain group (cluster) should be very similar to each other and entities belonging to different classes should be very

dissimilar (Bidogeza *et al.* 2007). A hierarchical cluster analysis using Ward's method and Euclidean distance was carried out to classify the farm households using the main factors obtained in the PCA.

Cost and Returns in Milk Production

The cost of rearing milch animals included expenditures incurred on feeds (include dry and green fodder and concentrates), labour, veterinary expenses, miscellaneous expenses, interest on fixed capital and depreciation on animals and capital assets minus the income from dung. Depreciation on cattle shed and dairy equipments was worked out using straight line method taking into account the useful life of the asset concerned. Based on the assumption of 10 years of productive life of dairy animals, the depreciation rate was worked out as 10 per cent per annum. Similarly, the depreciation rate for other fixed assets were taken as 5 per cent for pucca buildings and 10 per cent for chaff cutter based upon appropriate assumptions regarding their productive lives (20 years for pucca buildings and 10 years for chaff cutter). The interest on fixed capital like value of animal, cattle shed, store and equipments was calculated at 12 per cent per annum. The value of hired labour was taken as the wage rates prevailing in the study area. The value of family labour was imputed upon the prevailing wage rate in the study area. Maintenance cost of milk production was computed both inclusive and exclusive of family labour cost.

The objective of the present investigation was to compare the profitability of milk production for the farm households belonging to typical clusters. Therefore, it was very important to consider the effect of various species/breed of milch animals kept by farm households. For this purpose, Standard Animal Units (SAU) of the bovine stock was derived for each farm household as per specification given by Kumbhare *et al.* (1983).[1] The standard animal unit was derived to standardise output of different farms with different species of dairy animals.

The milk of different species was converted into fat corrected milk (FCM) per SAU per day in litres based on the following formula as prescribed by Hemme (2000), considering 4 per cent level of fat correction:

FCM milk = (milk production x fat in per cent x 0.15) + (milk production x 0.4)

The fat percentage in milk from different breeds/species was collected village wise, from the respective milk co-operative societies. As such, the average fat percentages in milk of indigenous cattle, crossbred cattle and buffaloes, which were considered in the study were 4.5 per cent, 4 per cent and 6 per cent, respectively.

Factors Influencing Profitability (Net returns/SAU) in Milk Production

A multiple regression equation as given below was fitted to identify the factors significantly influencing profitability in milk production (net returns/SAU).

$$P = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, D_1, D_2, C_1, C_2, C_3, C_4)$$

where,

- P = net returns/SAU per day
- X_1 = Age of household head
- X_2 = Education level of household head (Number of years of schooling/education completed)
- X_3 = Herd size (measured in terms of SAU)
- X_4 = Operational landholding size (acres)
- X_5 = Proportion of milk output that is sold (per cent)
- X_6 = Price of fat corrected milk (Rs./litre)
- X_7 = Imputed value of family labour charges per SAU (Rs.)
- X_8 = Feeding costs/SAU (Rs.)
- D_1 = Dummy for Non-farm Income ($D_1 = 1$ if household has non-farm income source, $D_1 = 0$, otherwise)
- D_2 = Dummy to capture the effect of Dairy Co-operative Membership ($D_2 = 1$ if the household was a member of Dairy Co-operative Society, $D_2 = 0$, otherwise)
- C_1 = Dummy to represent Cluster-1 ($C_1 = 1$ if the household was small dairy farm with low family labour use, = 0, otherwise)
- C_2 = Dummy to represent Cluster-2 ($C_2 = 1$ for female headed farm households = 0, otherwise)
- C_3 = Dummy to represent Cluster-3 ($C_3 = 1$ for market oriented dairy farm households, = 0, otherwise)
- C_4 = Dummy to represent Cluster-4 ($C_4 = 1$ for low income farm households, = 0, otherwise)

The fitted function was estimated through OLS technique.

III

RESULTS AND DISCUSSION

Multivariate Typology of Milk Producing Households

The results of the Principal Component Analysis (PCA) test showed that Bartlett's sphericity was highly significant ($P<0.01$). This means that the use of PCA towards dimension reduction in this case is justified. The PCA identified 1 out of total 120 observations as outlier and this observation was ignored in the final PCA. Thus, further analyses were carried out on 119 households which constituted the ultimate sample size for the study. A total of eight principal components (factors) emerged with eigen values greater than one. These eight factors explained 71.32 per cent of total original variability. Based on the loadings of the original variables on each of the factors, they were identified as household income; scale of production and

intensity of market participation, crossbreeding technology, herd size, gender and education of household-head, family labour use, area under fodder, and concentrate feed'.

In the next step, in the typology study, CA was carried out with the above eight factors. Five clusters emerged from this analysis. In order to name each of the identified cluster, one-way ANOVA was conducted to determine which classifying factors are significantly different between the clusters. The in-between groups mean were all significant indicating that each of the identified factors reliably distinguished between the 5 clusters. With a significant ANOVA and 5 clusters, a Tukey *post-hoc* test was conducted to determine where exactly the differences existed.

Cluster 4 and cluster 5 scored significantly low on 'household income' as compared to other clusters; 'scale of production and intensity of market participation' significantly differentiated cluster 3 from other clusters. Cluster 4 scored significantly low on 'crossbreeding technology adoption', while cluster 3 scored significantly more on the same factor. Cluster 3 scored significantly more on 'lactating animal strength', while cluster 2 scored significantly low on 'gender and education profile of household head'. Cluster 1 scored significantly low on 'family labour employment in farm', while cluster 3 scored significantly high on the same factor. Cluster 5 scored significantly higher on 'area under fodder', while cluster 4 scored significantly higher on 'use of concentrate feed'. The significant differences between factors for the clusters suggest the ways in which the clusters differ or on which they are based. From the above results (Tukey *post-hoc* test), the 5 clusters were named as under:

Cluster 1	small dairy farms with low family labour use.
Cluster 2	female dairy farmers.
Cluster 3	market oriented milk production.
Cluster 4	low income households with high incidence of concentrate feeding.
Cluster 5	low income households with high land area under fodder cultivation.

Cluster 5 only had 4 households within its fold and since the main differentiating factor between cluster 4 and cluster 5 from other clusters was low income level, cluster 4 and cluster 5 were merged into one cluster which was characterised as low income households. Thus, subsequent analyses in regard to profitability estimation were carried out for 4 clusters. Table 2 presents the distribution of sample households across different identified clusters. Thus, it can be seen from the table that cluster 1 and cluster 4 comprised majority of sample households (37 per cent and 39 per cent, respectively).

Socio-Economic Profile

Table 3 elicits the socio-economic profile of respondents belonging to different clusters of households, as identified in the typology study. The average age of heads

TABLE 2. DISTRIBUTION OF SAMPLE HOUSEHOLDS ACROSS DIFFERENT CLUSTERS

Cluster (1)	Cluster Name (2)	Number of sample households (3)	Per cent of sample households (4)
Cluster 1	Small herd size owning households with low farm family labour involvement	44	36.97
Cluster 2	Female headed households with low education level	14	11.76
Cluster 3	Full farm households with market oriented milk production	15	12.61
Cluster 4	Low income households	46	38.66

TABLE 3. SOCIO-ECONOMIC PROFILE OF RESPONDENTS BELONGING TO DIFFERENT CLUSTERS

Sr No. (1)	Particulars (2)	Cluster 1 (Small herd-size owning HHs) (3)	Cluster 2 (Female headed HHs) (4)	Cluster 3 (Market oriented HHs) (5)	Cluster 4 (Low income HHs) (6)	Overall (7)
A.	Respondent specific characteristics					
1.	Age (years)	57.34[a]	58.79[a]	54.80[a]	47.13[b]	53.24
		(11.21)	(7.52)	(11.07)	(10.23)	(11.55)
2.	Education[#]	9.84[a]	3.07[b]	9.13[a]	8.48[a]	8.43
		(2.07)	(2.63)	(3.56)	(3.29)	(3.56)
3.	Caste (per cent of total respondents)					
3.a	SC	0.00[c]	14.29[ac]	6.67[b]	36.96[a]	36.96
3.b	OBC	13.64[c]	21.43[bc]	0.00[b]	8.70[a]	8.70
3.c	General	86.36[cb]	64.29[ac]	93.33[b]	54.35[a]	54.35
4.	Occupational profile (per cent)					
4.a	Agriculture + AH	45.45[a]	14.29[b]	53.33[a]	32.61	36.97
4.b	Agriculture	22.73	28.57	20.00	17.39	21.01
4.c	Agriculture + other	15.91	35.71	13.33	21.74	21.01
4.d	AH	9.09	14.29	6.67	17.39	12.61
4.e	Government service	2.27	0.00	0.00	4.35	2.52
4.f	Pensioner	4.55	7.14	6.67	6.52	5.88
B.	Household specific characteristics					
1.	Family size[##]	4.66	5.64	8.47	5.80	5.70
		(1.41)	(1.11)	(2.39)	(1.61)	(2.01)
2.	Percentage of households having non farm income	88.64[a]	71.43[a]	86.67[a]	41.30[b]	68.07
3.	Annual household income (Rs.)	172523[a]	135357	161733[a]	93391[b]	136202
		(106135)	(84513)	(76707)	(53394)	(90597)
4.	Dwelling structure (per cent)					
a	Kuccha	9.09[a]	0.00[b]	6.67	8.70[a]	7.56
b	Semi-Pucca	13.64[a]	42.86[b]	40.00[b]	52.17[b]	35.29
c	Pucca	77.27[a]	57.14	53.33	39.13[b]	57.14
C.	Farm specific characteristics					
1.	Herd size (SAU)	3.31	3.29	5.12	2.56	3.25
		(1.09)	(2.24)	(1.24)	(1.14)	(1.53)
2.	Percentage of FCM sold	23.59[a]	28.63	56.94[b]	34.41	32.57
3.	Land Total (acres)	1.41[b]	0.61[ab]	1.40[b]	0.69[a]	1.03
		(0.31)	(0.26)	(0.33)	(0.25)	(0.33)
4.	Percentage of irrigated land	44.52	21.43	51.21	32.93	38.17
5.	Per cent of households as dairy society members	47.73[a]	35.71	66.67[a]	10.87[b]	34.45

Figures having different superscripts across clusters are significantly different up to 5 per cent level of significance between them.

Figures in parentheses indicate the standard error of corresponding values.

[#] Level of education given as number of years of formal education;

[##] Family size measured in terms of Adult Male Equivalents (4 children=3 adult women=2 adult men).

of low-income households was significantly lower than that of other clusters. The education level of female headed households was significantly lower as compared to other clusters. Majority of the respondents in case of all the clusters belonged to general caste category. A significantly higher proportion of respondents from female headed households belonged to Other Backward Class (OBC) category than other typical household categories. A significantly higher proportion (37 per cent) of respondents from low-income households belonged to Scheduled Caste (SC) category as compared to other clusters.

Six major occupational profiles of the household heads were observed in the study area, viz., agriculture + animal husbandry (AH), agriculture only, agriculture + other, AH only, government service and pensioner. The highest proportion of households had agriculture + AH as their principal occupation in case of all clusters except female headed households. For female headed households, majority (29 per cent) of the respondents pursued agriculture solely as their principal occupation. Significantly, a higher proportion of market-oriented households had agriculture + AH as their main occupation than that of other clusters. Relatively, a lower proportion of respondents from all clusters pursued AH as their principal occupation (9 per cent, 14 per cent, 7 per cent and 17 per cent in case of small herd-size owning households, female headed households, market-oriented households and low-income households, respectively). The above results indicate that farmers prefer to maintain dairy animals for sustainable income and livelihood security throughout the year.

Significantly lower proportion of low-income households had non-farm income source than other clusters. The average annual income per household for low-income households was significantly lower than the corresponding figures for other clusters. The dwelling structure of the respondents was observed under three categories, viz., kuccha, semi-pucca and pucca. A significantly higher proportion of respondents from small herd-size owning households and low-income households lived in kuccha houses than their counterparts from other clusters. No significant differences in herd size holdings (SAUs) were observed across different clusters. Overall, dairy animal holding, across all clusters was 3.25 SAU. The average land holding per household was significantly lower for female-headed households and low-income households as compared to the corresponding figures for small herd-size owning households and market-oriented households. No significant difference was found among different clusters in regard to the proportion of land that is irrigated. Overall, 38 per cent of land was irrigated across all clusters. Low-income households had lowest membership in dairy co-operative societies as compared to other clusters. Overall, 34 per cent of all respondents were members of dairy co-operative societies. The above findings regarding farm and socio-economic characteristics of selected households revealed that the multivariate analytical techniques used in the typology study have correctly identified the typical household categories in the study area.

Investment Patterns in Dairying

Investment patterns comprising expenditures made in constructing animal sheds, and purchase of animals and equipment, in dairying across different clusters are presented in Table 4. The average household investment in dairying for low-income households was significantly lower than that for other clusters. Investment made by market-oriented households was significantly higher than that for other clusters.

TABLE 4. INVESTMENT PATTERN IN DAIRYING ACROSS DIFFERENT CLUSTERS

(Rs.)

Clusters	Investment / HH	Investment / SAU
(1)	(2)	(3)
Cl-1	193960[bc]	129218
Cl-2	164989[ab]	110961
Cl-3	263155[c]	91886
Cl-4	141716[a]	104280
Overall	179079	112724

Figures having different superscripts across clusters are significantly different up to 5 per cent level of significance.

In regard to investment per SAU, lowest investment was observed in case of market-oriented households, while small herd-size owning households recorded highest investment. However, the differences in investment per SAU across all the four clusters were statistically not significant.

Cost and Income Measures per Standard Animal Unit (SAU)

The maintenance costs per SAU for different clusters are presented in Table 5. Cost per SAU was lowest for market-oriented households. This category of households also maintained the largest herd size among all clusters. The lower cost per SAU thus imply realisation of genuine economies of scale for these households. Overall, the net cost per SAU across all clusters was Rs. 96.74. Disaggregation of cost of milk production into its various components revealed that fixed and variable costs for overall category constituted 21 per cent and 79 per cent of total cost, respectively. Similar observations regarding share of fixed cost in total cost of milk production (15-20 per cent) were reported in earlier studies (Meena *et al*., 2010; Mahajan *et al*., 2010 and Bardhan and Sharma, 2012).

Within the variable cost component, feed and fodder cost contributed the highest share, which is in consonance with the findings of earlier studies carried out on cost of milk production (Meena *et al*., 2010; Khoveio *et al*., 2012; Bardhan and Sharma, 2012). The share of feed and fodder for overall category constituted 44.53 per cent of gross cost. This finding is in consonance with that of Rajendran and Prabhahran (1993) who reported 42 per cent share of feed and fodder cost to total milk production cost. Market-oriented households had the highest proportion of feed and fodder cost to total cost of milk production, while low-income households had the

TABLE 5. COST PER SAU ACROSS DIFFERENT CLUSTERS

(*Rs./SAU/day*)

	Clusters									
Particulars	Cluster 1 N = 44	Per cent share	Cluster 2 N = 14	Per cent share	Cluster 3 N = 15	Per cent share	Cluster 4 N = 46	Per cent share	Overall N = 119	Per cent share
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Fixed cost										
Interest on fixed	2.15		1.86		1.66		1.76		1.90	
capital	(0.80)	2.06	(0.88)	1.86	(0.40)	1.72	(0.97)	1.79	(0.86)	1.89
Depreciation	21.49		18.60		16.64		17.60		19.03	
	(8.04)	20.61	(8.89)	18.60	(4.05)	17.25	(9.73)	17.94	(8.67)	18.96
Variable cost										
Green fodder	23.93		21.22		22.44		18.21		21.21	
	(6.02)	22.95	(6.89)	21.23	(5.66)	23.27	(6.98)	18.57	(6.44)	21.13
Dry fodder	14.43		8.53		7.79		11.57	11.80	11.79	
	(3.54)	13.84	(3.99)	8.53	(3.01)	8.08	(3.65)		(3.47)	11.75
Concentrate	13.36		14.42		17.66		10.95	11.16	13.09	
	(2.86)	12.82	(2.95)	14.43	(2.11)	18.31	(2.59)		(2.47)	13.04
Feed and fodder	48.22		44.17		47.05		40.73		44.70	
cost	(16.38)	46.25	(18.95)	44.19	(15.41)	48.78	(18.56)	41.53	(17.52)	44.53
Total labour	27.98		31.76		27.00		34.31		30.75	30.63
	(26.84)	26.84	(10.64)	31.77	(7.29)	27.99	(13.38)	34.98	(13.01)	
Veterinary	2.70		2.17		2.70		2.33		2.50	
expenses	(2.59)	2.59	(1.01)	2.17	(1.93)	2.80	(3.18)	2.38	(2.29)	2.49
Miscellaneous	1.71		1.40		1.40		1.35		1.50	
expenses	(1.05)	1.64	(0.59)	1.40	(1.44)	1.45	(0.78)	1.38	(0.98)	1.49
Gross costs	104.25		99.96		96.45		98.08		100.38	
	(25.24)	100.00	(21.43)	100.00	(20.06)	100.00	(20.45)	100.00	(24.31)	100.00
Returns from dung	3.63		3.68		3.63		3.64		3.64	
	(0.22)		(0.28)		(0.23)		(0.21)		(0.40)	
Net cost	100.62		96.28		92.82		94.44		96.74	
	(25.29)		(21.27)		(20.07)		(20.41)		(24.18)	
Milk production	5.15		5.41		11.58		5.15		5.99	
	(2.56)		(3.73)		(4.99)		(3.47)		(4.03)	
Milk yield	4.41		3.87		5.26		4.65		4.55	
	(2.40)		(2.01)		(2.67)		(2.91)		(2.64)	
Milk production	32.07		33.34		20.51		26.78		28.72	
cost (Rs./litre)	(23.15)		(19.21)		(7.61)		(12.53)		(18.17)	

Figures in parentheses indicate standard errors.

Figures in per cent share column indicate share of each cost component in gross cost

lowest proportion. This implies that the share of feed and fodder cost tends to increase with increase in the degree of commercial orientation in milk production. Overall, across all clusters, the proportion of green fodder, dry fodder and concentrate feeding costs accounted for 21.13 per cent, 11.75 per cent and 13.04 per cent of gross cost, respectively. The next important component of variable cost was the cost of labour charges which accounted for 30.63 per cent of the gross cost, for overall category. Dhaka *et al*. (1998) had reported from West Bengal that labour cost accounted for about 36 per cent of total cost of milk production. Bardhan and Sharma (2012) had also reported that share of labour in gross cost was over 30 per cent in both plains and hills of Uttarakhand. The share of labour cost to gross cost was lowest for small herd-size owning households. This is understandable as one of the important criteria for typology of this category of households was low farm family

labour involvement. The other components of variable costs, viz., veterinary expenses and miscellaneous expenses accounted for minor shares (2.49 per cent and 1.49 per cent, respectively) of the total cost for overall category.

Per day milk production per household was highest for market-oriented households (11.58) among all clusters. Milk yield (milk produced per SAU) was also highest in case of this category of households (5.26 litres/SAU) as compared to other clusters. Overall, per litre cost of milk production, across all clusters, was Rs. 28.72. The per litre cost of milk production was lowest for market-oriented households and highest for female headed households. It thus becomes evident that households with high degree of market oriented milk production were also the ones which produced milk at lowest cost. This is understandable as households with commercial orientation are expected to manage their enterprises more efficiently so as to lower down the cost of production.

Income Measures

Various income measures across different clusters are presented in Table 6. Market-oriented households were most profitable followed by low income households Small herd-size owning households had negligible net income, while female-headed households were not profitable. Several earlier studies have reported positive net returns from milk production (Sirohi *et al*., 2007 and Meena *et al.*, 2010). On the other hand, few studies have reported negative net returns from milk production, especially in case of indigenous cows (Kalra *et al*., 1995 and Manbhekar *et al.*, 1995). Market-oriented households had the highest milk yield per SAU and produced milk at the lowest cost. It is thus obvious that higher degree of market orientation also brought in greater efficiency in milk production, which explains the high level of profitability for this cluster. Low-income households had no non-farm income source and hence their dependence on farm income, especially income from dairying, was high. Thus, this category of households gave more care in maintaining their dairy animals which probably explains the higher level of profitability for this cluster. The negligible level of profits for small herd-size owning households and

TABLE 6. INCOME MEASURES ACROSS DIFFERENT CLUSTERS

(*Rs./SAU/day*)

Items of Cost / Income	Clusters				
	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Overall
(1)	(2)	(3)	(4)	(5)	(6)
Gross Income	104.67	88.14	126.39	113.93	109.04
	(55.81)	(40.76)	(60.47)	(69.57)	(62.08)
Family Labour Income (Gross Income - Cost A)	28.41	19.94	56.94	50.16	39.42
	(50.96)	(31.97)	(56.18)	(62.23)	(57.57)
Net Income (Gross Income - Cost B)	0.43	-11.82	29.94	15.85	8.67

Figures in parentheses indicate standard errors.

Cost A = Expenditures on feed and fodder + veterinary expenditures + misc. expenditures + hired labour charges + depreciation on fixed assets + Interest on fixed capital.

Cost B = Cost A + Imputed value of family labour charges.

losses incurred by female headed households point towards their relative inefficiency in milk production as compared to other two clusters. However, when cost of milk production was calculated by excluding imputed value of family labour charges from gross costs, the net returns (family labour income) turned positive for all clusters. Thus, milk production becomes profitable for all clusters when family labour charges are not included in the cost of milk production. Similar findings were reported by Bardhan and Sharma (2012) from Almora district of Uttarakhand.

Factors Influencing Profitability in Milk Production

The results of the multiple regression analysis carried out to identify the factors significantly influencing profitability in milk production are presented in Table 7. During the course of multiple regression, the software calculates 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 to avoid perfect collinearity in the data set, the software automatically dropped one dummy variable from the data set. The dummy variable dropped was that of cluster 1, i.e., small dairy farms with low family labour use. The inferences in regard to other dummy variables, thus, have to be drawn in relation to the excluded variable.

TABLE 7. FACTORS AFFECTING PROFITABILITY IN MILK PRODUCTION

Sl. No.	Variables	β – Values	Standard Error	"t" Value
(1)	(2)	(3)	(4)	(5)
1.	INTERCEPT	-163.156**	74.877	-2.179
2.	Age of HH head	0.42	0.509	0.824
3.	Education	1.139	1.983	0.574
4.	Non-farm income (Y=1, N=0)	-8.655	13.02	-0.665
5.	Total SAU	4.223	5.076	0.832
6.	Land holding	-0.534	0.326	-1.64
7.	Proportion of FCM sold	0.499***	0.172	2.905
8.	Price FCM	6.217**	2.422	2.567
9.	Dairy society membership (Y=1, N=0)	-11.348	14.616	-0.776
10.	Labour cost	-0.624	0.504	-1.237
11.	Feeding cost	0.117	0.351	0.333
	Cluster 2 (Y=1, N=0)	-36.062	22.101	-1.632
13.	Cluster 3 (Y=1, N=0)	4.508	18.965	0.238
14.	Cluster 4 (Y=1, N=0)	3.26	15.101	0.216
	R^2	0.52		
	F-value	2.116***		

Significant at ***1 and **5 per cent level of significance.

Overall the factors significantly affecting the profitability were proportion of FCM sold ($P<0.001$) and price of milk ($P<0.01$). The other variables are namely age of the household head, level of education in family, presence of non-farm income, total animal holding, total land holding, dairy society membership, labour cost and

feed cost. This implies that the profitability in milk production increased with increase in price received for milk and increase in intensity of market participation. This finding is consistent with the earlier finding in this study which revealed that households belonging to cluster 3 (households with market oriented milk production) have lower per litre cost of milk production, higher milk yield and thus higher rate of return. Price being a policy variable, positive effect of price on net return implies that profitability in milk production would increase if adequately remunerative price for milk is guaranteed to producers. None of the three dummy variables, representing different clusters, was significant. However, the signs and the magnitude of the regression coefficients provide some implications regarding their extent and direction of influence on profitability in milk production. The magnitude of regression coefficient was the highest for cluster 2. The negative sign associated with this coefficient implies that female dairy farmers were also the ones with low income from dairying. This finding is consistent with the earlier finding that female-headed farm households were least profitable.

IV

CONCLUSION

Significant heterogeneity of small-scale dairy farms was observed in the study area in regard to socio-economic and farm characteristics. Multivariate statistical techniques like Principal Component Analysis (PCA) and Cluster Analysis (CA) proved to be adequate tools in identifying the important socio-economic characteristics of typical milk producing households. Four homogenous groups (clusters) were obtained., viz., small herd size owning households with low farm family labour involvement (37 per cent), female headed households (12 per cent), full farm households with market oriented milk production (13 per cent) and low income households (39 per cent). Government policies regarding dairy development are likely to be more effective if they consider the heterogeneity of farms in the design and delivery of extension approaches and interventions. Approaches that work with farmers that are considered to be representative of the groups in terms of characteristics may be most effective.

Households with market oriented milk production owned high-yielding species/breeds of dairy animals, produced milk at lowest cost of production and were most profitable. These households also operated at higher scale of production. It thus implies that there is scope for realising genuine economies of scale in dairy farming in the study area by increasing scale of production. Female headed households with low education level were least profitable. It thus becomes imperative to give greater focus on training female workforce in dairying in order to enhance their competitiveness.

Profitability in milk production increased with increase in price received for milk. Price is a very important factor to consider as it often acts as an incentive for farmers

to scale up their production. It is imperative that factors other than fat and SNF be considered for fixing of milk price by the co-operatives. For this, price based upon the total cost of milk production (including imputed value of family labour charges) rather than only fat and SNF can go a long way in offering remunerative prices to member farmers. However, cognizance needs to be taken regarding quality of milk (as denoted by fat and SNF content) that is produced by the farmers. Thus, a model needs to be developed so as to standardise milk production costs as per the specified quality levels of milk. This would enable linking of milk production cost with the quality of milk and hence guarantee remunerative price to the producers as well as provide enough incentives to them in producing milk of adequate quality. Area specific cost of production is also advisable in making dairy production economically sustainable.

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NOTE

1. The following standards were used to standardize herd size of the farm households:

Milch Buffalo	1.30
Milch Crossbred cow	1.40
Milch Indigenous cow	1.00

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