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Multivariate Typology of Osmanabadi Goat Farming in its Home Tract: A Cluster Analysis

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ABSTRACT

The study was conducted to identify the typology of the Osmanabadi goat-keeping households and farms in a home tract of the breed during 2020-21. Hierarchical and K-mean clustering techniques were used to classify 107 households into three homogenous clusters. In extensively large flock keeping households with large landholdings (C1, n=25, 23%), the respondents were using scientific practices to a great extent than the households with extensively keeping small flock with small landholdings (C3, n=59, 55%). Goat rearing was being the sole farm activity of relatively more households in C3, where primarily women had control over farm decisions and returns than the households who semi-intensively kept medium flock with medium landholding (C2, n=23, 22%). Households in C3 were mostly using open sheds, had lower goat income than the rest of the clusters. Households in C2 were higher in employment generation than households in C3. The typologies of Osmanabadi goat-keeping households showed significant heterogeneity in clusters and critical points which need to be considered to find sustainable solutions. Government policies and extension approaches are likely to be more effective if they consider the heterogeneity in the planning and delivery of extension interventions.

INTRODUCTION

In India, goats are the second largest (27.74%) species in the livestock category and showed an increase of 10.1 per cent over the previous (19th) livestock census. The goat sector shares 14 and three percent of total meat and milk production. Out of 148.88 million goats in the country, the pure and graded Osmanabadi goat breed constitutes a share of 2.4 per cent (GOI, 2019). Maharashtra's goat population is 10.60 million, 7.11 per cent of the country, and ranks sixth (Das, 2022). Maharashtra had the highest (15.2 lacs) of pure Osmanabadi goats (GOI, 2019). Osmanabad and Latur districts are the breeding tract of Osmanabadi goats (Acharya, 1982; Das, 2022). This goat breed is hardy, dual-purpose, adaptable under adverse climatic conditions, and generally reared for meat purposes (Raskar et al., 2018) and reared under extensive (open grazing), semi-intensive (grazing and closed enclosure) and intensive systems (Wakchaure et al., 2021).

The productivity of goats under the traditional extensive system is low (Singh & Kumar, 2007), mainly because of feed scarcity and the lack of adoption of improved technologies and management practices. Livestock technology use may vary among farm households because of differences in socioeconomic characteristics (Somda et al., 2005; Milan et al., 2006). Smallholder farming systems are highly complex and heterogeneous in their characteristics (Pal et al., 2017; Kumar et al., 2019; Panda et al., 2022). The productivity and profitability of the existing goat rearing system need to be improved substantially by harnessing the potential of goat rearing activity. Goats are increasingly the

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subject of special attention in livestock research and the government's various schemes to generate rural livelihood.

In such circumstances, developing unique recommendations, technologies, educational programs and policy interventions for each household is complex. A more objective classification of livestock enterprises is needed to reveal the main factors that dictate the level of intensity in their production system (Gelasakis et al., 2012). Multivariate analysis may be a valuable tool in planning extension activities and using communication channels effectively for the target farmers with varied needs, constraints, and motivations for change (García et al., 2015). More in-depth characterization of goat-keeping households would help to improve regional goat farming. It would also help in technology transfer programs depending on differences between their socioeconomic and farm-specific characteristics. It is necessary to define Osmanabadi goat-keeping households into specific clusters based upon similarities in farm and households' characteristics for comparative evaluation, which would help develop suitable recommendations and effective interventions. In this context, the current study was conducted to identify the typology of the Osmanabadi goat-keeping households and farms in a home tract of the breed.

METHODOLOGY

A descriptive and cross-sectional study purposively was conducted in the home tract of Osmanabadi goat, i.e., Osmanabad and Latur districts of Maharashtra state. One hundred twenty households keeping at least two adult Osmanabadi goats were selected randomly from 20 villages equally distributed across every two talukas in both districts. The respondents were persons belonging to the Osmanabadi goat-keeping household who had control over farm decisions and goat returns. A field survey was conducted in 2020-21 using a pre-tested interview schedule. Through personal contact, the investigator asked each respondent about personal, family, and farm-specific characteristics and recorded the responses on the interview schedule. Collected data was edited, coded and tabulated. Quantitative variables were classified using the cumulative square root frequency rule (Dalenius & Hodges, 1957). Outliers were removed using boxplots and finally the retained 107 respondents were the sample size considered for further analysis.

Normalized (z score) farm-specific variables, *i.e.*, landholding, flock size, and goat rearing system were used to construct clusters. A typology was constructed applying multivariate statistical techniques, i.e., hierarchical and K-mean cluster analysis (CA), to classify groups of Osmanabadi goat-keeping households with similar farm characteristics into homogenous clusters. The hierarchical cluster analysis based on Ward's method was applied to decide the ideal number of clusters. Euclidean distance as a clustering measure was employed in this analysis. After that, Osmanabadi goat-keeping households were partitioned into three predefined clusters using K-mean clustering. Finally, a one-way ANOVA and post-hoc Tukey HSD tests were applied to examine the existence of statistically significant differences between these clusters. The three clusters were named as C1, C2 and C3 with 25, 23 and 59 respondents respectively. The flock size for C1, C2 and C3 were extensively large with large landholdings, semi-intensively medium goat flock with medium landholdings and extensively small goat flock with small landholdings respectively.

RESULTS AND DISCUSSION

The maximum proportion of extensive Osmanabadi goat-keeping households had high agricultural landholding (3 to 6 acres) in C1, moderate (1.5 – 3 acres) in C2, and low (<1.5 acres) in C3 (Table 1). The average landholding of households in C1 was significantly higher and significantly lower in C3 than in the rest of the clusters.

The majority of goat keeping households in C1 owned large to medium flock, small to medium flock by the plurality in C3 and were rearing goats exclusively under an extensive system. A greater extent of semi-intensive goat-keeping households in C2 also possessed large to medium flock. Under an extensive goat rearing system, high landholding households had a significantly higher average flock (8.16 SGU) than those extensively rearing small flock with lower landholding, except for semi-intensive goat keeping households in C2.

Most semi-intensive goat-keeping households had moderate landholdings and medium size (4.6-8.5 SGU) flock. In contrast,

Table 1. Farm specific variables considered for cluster formation

Variables	Class interval	C1	C2	C3	Pooled	SD	F	*p*
Land holding (acre)	Low (Below 1.5)	0.0	17.4	59.3	36.4			
	Moderate (1.5 to 3)	16.0	52.2	33.9	33.6			
	High (3 to 6)	84.0	30.4	6.8	29.9			
	Mean	3.52[a]	2.30[b]	0.97[c]	1.85	1.52	50.139**	0.000
Goat flock size (SGU)	Small (2 to 4.60)	12.0	4.3	33.9	22.4			
	Medium (4.60 to 8.50)	48.0	60.9	50.8	52.3			
	Large (8.50 to 15.00)	40.0	34.8	15.3	25.2			
	Mean	8.16[a]	7.65[a]	5.69[b]	6.69	2.71	10.789**	0.000
Goat rearing system	Extensive (1)[#]	100.0	0.0	100.0	78.5			
	Semi-intensive (2)[#]	0.0	100.0	0.0	21.5			
	Mean	1.00	2.00	1.00	1.21	0.41	2.7E+16**	0.000

Values in the same row with different superscript are significantly different

**Indicate significant difference at 1 % level (p<0.01)

SGU – Standard Goat Unit (Adult=1 SGU, Kid age 3 - 6 months= ½ SGU, & Kid age < 3 months=¼ SGU)

[#]Code used for qualitative traits

about one-third of the extensive goat-keeping households with small landholdings had a small flock. In Rajasthan, Kumar et al. (2009) found that goat rearing was an important economic activity across all landholding categories.

Farm specific characteristics

In extensive goat-keeping households both in C1 and C3, mostly women took farm decisions and had control over farm returns (Table 2). Kumar et al., (2011) found less role of women in farm decisions and less control over returns in a large category than small category households in Rajasthan and Uttar Pradesh. Control over farm decisions and returns in Osmanabadi goat-keeping households varied significantly across all clusters. A post-hoc test revealed that men were significantly more dominant in semi-intensive goat-keeping households (C2) related to their control over farm decisions and farm returns than in households in C3. The significant mean difference between C2 and C3 indicates that the control over farm decisions and farm returns was primarily a domain of women in extensively small flock keeping households (C3) than the households in C2.

Goat rearing was the sole farm activity of around 20 percent of the households in C3. Most households across all clusters were doing goat husbandry as a farm activity well integrated with crop cultivation. Production systems adopted by households across all

Table 2. Frequency and mean distribution of farm specific characteristics of Osmanabadi goat keeping households

Characteristic	Class interval	C1	C2	C3	Pooled	SD	F	*p*
Control over farm decision & goat return	Men (1)#	36.0	56.5	23.7	33.6			
	Women (2)#	44.0	39.1	69.5	57.0			
	Both (3)#	20.0	4.3	6.8	9.3			
	Mean	1.84^{ab}	1.48^{a}	1.83^{b}	1.76	0.61	3.167*	0.046
Production system	Goat rearing only (8)#	0.0	0.0	20.3	11.2			
	Goat + Crop (7)#	36.0	43.5	35.6	37.4			
	Goat + Cattle /Buffalo (6)#	0.0	0.0	6.8	3.7			
	Goat + Sheep (5)#	4.0	0.0	1.7	1.9			
	Goat + Poultry birds (4)#	0.0	13.0	20.3	14.0			
	Goat + Crop + Cattle/Buffalo (3)#	16.0	30.4	1.7	11.2			
	Goat + Crop + Cattle/Buffalo+Poultry (2)#	16.0	8.7	3.4	7.5			
	Goat + Crop + Poultry (1)#	28.0	4.3	10.2	13.1			
	Mean	3.80^{a}	4.70^{ab}	5.64^{b}	5.01	2.44	5.727**	0.004
Shed type	No separate shed (within house) (1)#	4.0	0.0	16.9	10.3			
	Covered shed (inside house) (2)#	0.0	0.0	5.1	2.8			
	Open shed (inside house) (3)#	0.0	0.0	6.8	3.7			
	Open shed (attached to house) (4)#	32.0	17.4	57.6	43.0			
	Thatched shed (attached to house) (5)#	64.0	82.6	13.6	40.2			
	Mean	4.52^{a}	4.83^{a}	3.46^{b}	4.00	1.22	17.516**	0.000
Labour utilization	Family (1)#	96.0	21.7	93.2	78.5			
	Hired (2)#	4.0	78.3	6.8	21.5			
	Mean	1.04^{a}	1.78^{b}	1.07^{a}	1.21	0.41	57.153**	0.000
Employment generation (man-days/annum)	Low (55.85 to 80)	40.0	13.0	52.5	41.1			
	Medium (80 to 95)	32.0	39.1	18.6	26.2			
	High (95 to 149.27)	28.0	47.8	28.8	32.7			
	Mean	87.16^{ab}	99.07^{a}	82.40^{b}	87.10	18.74	7.335**	0.001
Adoption of scientific practices (score)	Low (31.67 to 46)	16.0	21.7	33.9	27.1			
	Medium (46 to 52)	44.0	47.8	35.6	40.2			
	High (52 to 70)	40.0	30.4	30.5	32.7			
	Mean	52.07^{a}	52.17^{ab}	47.68^{b}	49.67	7.94	4.395*	0.015
Goat marketing channel	Local butcher only (1)#	60.0	43.5	33.9	42.1			
	Local butcher + Traders (2)#	16.0	34.8	20.3	22.4			
	Fellow farmers + local butchers (3)#	12.0	4.3	22.0	15.9			
	Traders only (4)#	12.0	17.4	23.7	19.6			
	Mean	1.76	1.96	2.36	2.13	1.17	2.704	0.072
Goat selling purpose	Expected expenses (1)#	44.0	34.8	47.5	43.9			
	Unexpected expenses (2)#	56.0	65.2	52.5	56.1			
	Mean	1.56	1.65	1.53	1.56	0.50	0.530	0.590
Gross goat income (Rs./annum)	Poor (Rs. 14000 to 26000)	4.0	8.7	32.2	20.6			
	Medium (Rs. 26000 to 44000)	60.0	43.5	50.8	51.4			
	High (Rs. 44000 to 78000)	36.0	47.8	16.9	28.0			
	Mean	40920^{a}	43522^{a}	31720^{b}	36407	13929	8.775**	0.000
Goat share to family income (%)	Low (5.95 to 15)	28.0	30.4	23.7	26.2			
	Medium (15 to 25)	52.0	52.2	50.8	51.4			
	High (25 to 53.44)	20.0	17.4	25.4	22.4			
	Mean	18.71	20.97	21.97	20.99	9.47	1.039	0.357

Values in the same row with different superscript are significantly different (p<0.05); * and ** Significance at 5 % and 1% levels, respectively.
#Code used for qualitative traits

clusters showed a significant difference that implied relatively less proportionate diversification of farm activities among households with small flock under the extensive system in C3. The mean difference between C1 and C3 was significantly high, implying more dependency of households in C3 for household income over goat husbandry. Across all clusters, the usage of shed type was significantly different. The maximum proportion of goat-keeping households in C1 and C2 used a thatched type of shed attached to their dwelling. Around 17 percent of households in C3 had no separate shed and maximum kept goats in an open shed attached to their house. Agossou et al., (2017) in West Africa also observed poor housing for goats in an extensive sedentary system. Post hoc test revealed the highly significant mean differences between C1 and C3 and between C2 and C3, indicating that extensive goat-keeping households in C1 and semi-intensive goat-keeping households in C2 had better goat sheds than households in C3. Shelters for goats were a part of farmers' residences in one-third of households (Gokhale et al., 2002).

Semi-intensive goat-keeping households (C2) were significantly higher in their use of hired labourers in goat farming than extensive goat-keeping households in C1 and C3. Pathade et al., (2022) found that the hired labours were mostly utilized by the households with small landholding, small dairy herd and large flock. Extensive goat-keeping households were primarily depended on family labours. Semi-intensive goat-keeping households had an average of 99 man-days employment generation. Average annual employment generation in semi-intensive goat-keeping households (C2) was significantly higher than the households with small flock under extensive system and small landholding (C3), except for extensive goat-keeping households with large flock and large landholding (C1). Pathade et al., (2022) found a positive correlation between landholding, flock size and technology adoption with employment generation. Most goat-keeping households across all clusters used a medium extent of scientific practices. Osmanabadi goat-keeping households were significantly different across all clusters related to their use of scientific practices. The use of scientific practices in extensive goat-keeping households with large flock and large landholding (C1) showed a significantly higher average use of scientific practices than the households who extensively reared small flock and had small landholding (C3). Bidogeza et al., (2008) & Agossou et al., (2017) noticed that the limited resources of female-headed and small farmers limit their ability to adopt animal husbandry technologies which needed monetary and technical support.

Maximum goat-keeping households across all clusters were selling goats to local butchers. The sale of goats was maximum to traders/butchers (Ssewannyana et al., 2004; Kumar et al., 2009) and middlemen (Sabapara, 2016). Mostly they sold goats to meet unexpected expenses like crop failure, health expenses etc. The finding contradicts Homann et al., (2007), who reported that the selling purpose of most goat farmers was to cover expected expenses in the Semi-Arid region of Zimbabwe. Most extensive goat-keeping households in C1 and C3 had a medium extent of annual goat income, while semi-intensive goat-keeping households (C2) had generated an average of Rs 43522 annual gross income from goat husbandry. Khode et al., (2021) noticed that net annual income of dairy owners positively and directly affected with herd size. Gelasakis et al., (2017) noticed that more profitable clusters had more variation in profit, suggesting they are riskier. Semi-intensive goat-keeping households in C2 and extensive goat-keeping households in C1 had generated significantly higher average annual gross income from goat husbandry than households in C3, those rearing small flock under an extensive system with small landholding. Raghavendra et al., (2022) reported that diversified farms with both livestock and crop sectors were reaping better income. Baral & Bardhan (2016) reported that low-income households and small herd-size owning households had negligible net income, while female-headed households were not profitable. Rodriguez et al., (2015) stated that the management aspects determined profitability, and family labour-intensive producers were the most profitable. The average goat share in the family income was about 21 per cent across all clusters. Singh et al., (2013), in the Bundelkhand region, noticed the contribution of goat rearing to household income was between 14-15 percent. About one-fourth of small flock-keeping households in C3 had a high goat share in family income which might be due to their sole dependency on goat husbandry. Baral & Bardhan (2016) also reported that the low-income households had no non-farm income source, hence their dependence on farm income.

CONCLUSION

Significant heterogeneity in Osmanabadi goat-keeping households was observed in the study area. Households extensively rearing small flock prominently had more representation of women. Semi-intensive goat-keeping households primarily deploy hired labours with higher employment generation than extensive small flock-keeping households. Extensively large flock-keeping households had better adoption of scientific practices than small flock-keeping households. Small flock-keeping households depended more on goats for livelihood but generated lower income from goats. Government policies and extension approaches are likely to be more effective if they consider the heterogeneity of Osmanabadi goat-keeping households in the planning and delivery of extension interventions. Women-dominated cluster implied a need for empowerment through proper training and enhanced institutional support.

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