An Empirical Study on the Challenges Faced by Sheep Owners in Sheep Wool Processing and Value Addition in Himachal Pradesh

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Abstract

Wool processing and value addition play a critical role in enhancing the income, employment, and livelihood security of sheep-rearing households, particularly in hilly and pastoral regions of India. Despite its potential, sheep owners continue to face multiple challenges that limit effective wool processing and value realisation. The present study aims to identify the key dimensions of challenges faced by sheep owners in sheep wool processing and value addition in Himachal Pradesh. Primary data were collected through a structured questionnaire from 440 sheep owners across the Chamba and Kangra districts, and the responses were analysed using descriptive statistics and exploratory factor analysis. The results reveal seven major challenge dimensions encompassing climatic and environmental stress, disruption of pastoral routes and grazing resources, disease-related issues, transportation and logistics constraints, socio-cultural barriers, living and occupational vulnerabilities, and extreme weather events. These factors together explain a substantial proportion of the total variance, highlighting the multidimensional nature of constraints in wool processing. The findings underscore the need for targeted policy interventions, improved processing infrastructure, skill development and training programmes, and stronger institutional and market linkages to promote wool value addition and enhance the economic resilience of sheep owners in hilly regions.

Keywords: Sheep owners, Wool processing, Value addition, Factor analysis, Livestock sector, Himachal Pradesh

1. Introduction

Sheep wool forms an important by-product of sheep rearing and plays a significant role in supporting the livelihoods of pastoral and hill-based communities by providing an additional source of income beyond meat production (Doyle et al., 2021; Bhateshwar et al., 2022). In India, and particularly in Himalayan regions such as Himachal Pradesh, wool processing has traditionally been carried out at the household or community level, contributing to rural employment, craft-based activities, and livelihood diversification (Indian wool industry and prospects, 2022; Srivastava, 2022). Value addition through processes such as cleaning, grading, sorting, spinning, and conversion into woollen products has the potential to enhance income, reduce vulnerability to price fluctuations, and strengthen the economic resilience of sheep owners (Prathibha & Yogish, 2021; Marais et al., 2024). However, sheep owners in hilly and pastoral regions face multiple challenges in wool processing, including poor quality raw wool, lack of modern processing facilities, limited technical skills, high processing costs, weak market access, and inadequate institutional and policy support, which constrain effective value addition (Allafi et al., 2021; Manzoor et al., 2022; Kumar et al., 2025). The absence of organised wool processing units, cooperatives, and formal linkages with markets further compels sheep owners to sell raw wool

at low prices, limiting their share in the value chain (Shubham et al., 2025; Rawat, 2025). While existing studies have largely focused on wool production, quality characteristics, and broader sectoral trends (Allafi et al., 2022; Broda et al., 2023), empirical research examining the challenges faced by sheep owners in wool processing and value addition using multivariate, factor-based approaches remains limited, particularly in the context of Himachal Pradesh. In this backdrop, the present study seeks to systematically analyse the challenges faced by sheep owners in sheep wool processing and value addition in Himachal Pradesh using field-based evidence, with the following objectives:

- **RO1:** To identify and examine the major challenges faced by sheep owners in sheep wool processing and value addition in Himachal Pradesh.
- **RO2:** To analyse the underlying dimensions of wool processing and value addition challenges using exploratory factor analysis.
- **RO3:** To derive policy- and practice-oriented insights for strengthening wool processing systems and enhancing value addition for sheep owners in hilly regions.

2. Review of Literature

2.1 Sheep Wool Production and Processing in India

Sheep wool production constitutes an important component of India's livestock sector, contributing to rural livelihoods through wool, meat, manure, and allied activities, particularly in hill, arid, and pastoral regions (Bhateshwar et al., 2022; Dinesh et al., 2023). The Indian wool sector is characterised by low productivity, coarse wool quality, and dominance of traditional breeds, which limits competitiveness in both domestic and international markets (Indian wool industry and prospects, 2022; Kumar et al., 2025). Wool processing in India is largely unorganised and carried out through traditional methods such as manual shearing, washing, and spinning at household or community levels, especially among pastoral communities (Srivastava, 2022; Sharma, 2023). While modern processing technologies offer opportunities for improving quality, efficiency, and value realisation, their adoption remains limited due to infrastructural and institutional constraints, resulting in continued reliance on low-value raw wool sales (Allafi et al., 2021; Shubham et al., 2025).

2.2 Value Addition in Sheep Wool and Rural Livelihoods

Value addition in sheep wool through processes such as grading, cleaning, sorting, spinning, and conversion into finished or semi-finished products plays a critical role in enhancing income and employment opportunities for rural and pastoral households (Doyle et al., 2021; Marais et al., 2024). Studies highlight that proper grading and cleaning of wool significantly improve its market value and usability in textile and non-textile applications, thereby strengthening producers' participation in value chains (Allafi et al., 2022; Broda et al., 2023). In hill regions, wool-based value-added activities such as handloom products and artisanal crafts also contribute to livelihood diversification and preservation of traditional skills (Rawat, 2025; Sharma, 2024). However, limited access to processing facilities, skill development, and organised markets restricts the ability of sheep owners to fully capture the benefits of value addition, resulting in continued dependence on low-margin raw wool marketing (Prathibha & Yogish, 2021; Shubham et al., 2025).

2.3 Challenges in Sheep Wool Processing

Sheep wool processing in pastoral and hilly regions is constrained by multiple interrelated challenges encompassing technological, financial, infrastructural, and skill-related dimensions. Studies indicate that poor wool quality, contamination with impurities, lack of modern cleaning and processing equipment, and absence of standardised grading systems adversely affect processing efficiency and market acceptance (Allafi et al., 2021; Allafi et al., 2022). Financial constraints such as limited access to credit, high cost of processing machinery, and low returns from raw wool discourage investment in value addition activities (Manzoor et al., 2022; Bibi, 2024). Infrastructural deficiencies, including inadequate processing units, storage facilities, and transport connectivity, further exacerbate marketing and processing inefficiencies in hilly terrains (Bhateshwar et al., 2022; Rawat, 2025). Additionally, lack of technical knowledge, training, and exposure to improved processing practices limits the capacity of sheep owners to adopt modern wool processing technologies, reinforcing traditional and low-productivity systems (Triveni & Sharma, 2023; Favilli et al., 2025).

2.4 Use of Factor Analysis in Agricultural and Livestock Studies

Factor analysis has been extensively used in agricultural and livestock research to identify latent dimensions underlying complex and interrelated variables related to production practices, socio-economic conditions, risk perception, and adoption behaviour. Prior studies have successfully applied multivariate techniques to reduce data complexity and reveal key factors influencing farmers' decisions and constraints in livestock systems (Channappa et al., 2021; Li et al., 2021). Research on sheep rearing and allied activities demonstrates that factor analysis is effective in capturing multidimensional challenges related to management, marketing, and institutional support, thereby providing a structured understanding of farmers' perceptions (Kanakaraja et al., 2024; G, N. K. M. et al., 2024). Given the multifaceted nature of wool processing and value addition challenges, the application of exploratory factor analysis is particularly suitable for identifying dominant constraint dimensions and informing targeted interventions.

2.5 Research Gap

The review of literature indicates that while considerable research has been undertaken on sheep production, wool characteristics, and sectoral trends in India (Doyle et al., 2021; Kumar et al., 2025), empirical studies focusing specifically on the challenges faced by sheep owners in wool processing and value addition remain limited. Existing studies largely emphasise technical aspects of wool quality, industrial processing, or macro-level sector analysis, with relatively less attention to farmers' perceptions and field-level constraints (Allafi et al., 2022; Shubham et al., 2025). Moreover, studies in the context of Himachal Pradesh have predominantly addressed pastoral livelihoods, cultural dimensions, and socio-economic conditions, without systematically examining wool processing challenges using multivariate, factor-based approaches (Srivastava, 2022; RajKumar et al., 2025). This gap underscores the need for field-based empirical research employing exploratory factor analysis to identify the underlying dimensions of wool processing and value addition challenges faced by sheep owners, which the present study seeks to address.

3. Research Methodology

3.1 Study Area

The study was conducted in the Chamba and Kangra districts of Himachal Pradesh, which were purposively selected due to their significant sheep-rearing activity and the prevalence of traditional wool production and processing practices among pastoral and hill-based communities. These districts represent important wool-producing regions where sheep owners are actively engaged in shearing, primary wool handling, and limited value addition under challenging geographic and infrastructural conditions. The selection of Chamba and Kangra enables the study to capture region-specific realities of wool processing in hilly terrains, where institutional support and access to organised processing facilities remain limited, thereby enhancing the relevance of the findings to policy and development interventions.

3.2 Sample Design and Size

A total of 440 sheep owners constituted the sample for the study, selected through a multistage sampling technique to ensure adequate representation and reliability of results. In the first stage, the study districts were selected purposively based on their importance in sheep rearing and wool production, followed by the random selection of sheep owners at the village level. The individual sheep owner was considered the unit of analysis, as decisions related to wool shearing, processing, storage, and value addition are primarily undertaken at the household level. The sample size of 440 respondents is statistically sufficient for the application of exploratory factor analysis, meeting recommended sample adequacy criteria for multivariate analysis.

3.3 Data Collection

Primary data were collected using a structured questionnaire designed to capture sheep owners' perceptions of challenges related to wool processing and value addition. Responses were measured using a five-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree," which is appropriate for assessing attitudinal and perceptual variables and facilitates multivariate statistical analysis. The questionnaire included statements covering key aspects of wool processing and value addition, such as wool quality, cleaning and grading practices, access to processing equipment, skill availability, cost constraints, market access, and institutional support, enabling a comprehensive assessment of the challenges faced by sheep owners in the study area.

3.4 Analytical Tools

The collected data were analysed using descriptive statistics and exploratory factor analysis (EFA) to achieve the objectives of the study. Descriptive statistics were employed to summarise respondents' characteristics and provide an initial overview of wool processing and value addition challenges. Exploratory factor analysis was used as the primary analytical technique to reduce a large set of interrelated variables into a smaller number of underlying factors, thereby identifying the key dimensions of challenges faced by sheep owners. The use of EFA is justified given the exploratory nature of the study and its focus on uncovering latent constraint patterns in an under-researched, field-based context.

4. Results and Discussion

4.1 Descriptive Profile of Respondents

Table 1: Descriptive Profile of Sheep Owners (n = 440)

Particulars	Category	Frequency	Percentage
Age	Up to 35 years	102	23.2
	36–50 years	198	45.0
	Above 50 years	140	31.8
Education Level	Illiterate	96	21.8
	Primary	154	35.0
	Secondary	132	30.0
	Graduate & above	58	13.2
Experience in Sheep Rearing	Up to 10 years	118	26.8
	11–20 years	176	40.0
	Above 20 years	146	33.2
Flock Size	Up to 50 sheep	164	37.3
	51–100 sheep	186	42.3
	Above 100 sheep	90	20.4
District	Chamba	170	38.6
	Kangra	270	61.4

Source: Author(s) Compilation

Table 1 shows that sheep rearing in the study area is primarily undertaken by middle-aged and experienced respondents, with 45.0 per cent belonging to the 36–50 years age group and more than 73 per cent having over ten years of experience, indicating substantial practical exposure to sheep rearing and wool-related activities. Educational attainment is modest, as the majority of respondents have primary or secondary education, which may influence their awareness of improved wool processing techniques and value addition practices. Most sheep owners operate at a small to medium scale, with nearly 80 per cent maintaining flocks of up to 100 sheep, reflecting the dominance of smallholder systems in Himachal Pradesh. The higher share of respondents from Kangra district corresponds with its relatively larger sheep population compared to Chamba. Overall, the demographic profile suggests that wool processing decisions are shaped by experience-based knowledge within small-scale production systems, underscoring the relevance of examining processing and value addition challenges faced by sheep owners.

4.2 Descriptive Statistical Analysis of Driving Factors

Table 2: Descriptive Statistical Analysis of Driving Factors

Variables	Mean	Std. Deviation	N
Pneumonia (Bacterial & Parasitic)	3.3773	1.10226	440
Diarrhea	3.3000	1.30567	440
Sheep Pox	3.3500	1.26644	440
Haemonchosis	3.3795	1.30324	440
Uneven Rainfall	3.4068	1.32625	440
Soaring Temperature	3.7068	1.10618	440
Intense Monsoon	3.6409	1.05137	440

Severe Drought	3.5023	1.03029	440
Melting Glacier	3.6364	1.04981	440
Grazing Resources	3.6182	1.14332	440
Water Scarcity	3.6500	1.06090	440
Hamper the Sheep Husbandry Activities	3.4818	1.21105	440
Change of Nomadic Route	3.2886	1.29863	440
Sheep Diseases	3.3841	1.24466	440
Language and Cultural Obstacles	3.4114	.99948	440
Cultural Differences	3.3523	.99931	440
Occupational Syndromes	3.1568	1.06741	440
Caste / Tribal Factor	3.4909	1.25910	440
Identity Threat	2.2659	.71094	440
Non-Dignified and Unsafe Living Conditions	3.5386	1.11660	440
Non-Cooperation on the Part of Transport Owner	3.7205	1.34199	440
Incompatible Transportable Vehicle	3.6545	1.39597	440
Overcrowded Animal	3.7250	1.33101	440
High Transportation Cost	3.7568	1.26183	440
Floods	2.9159	1.35153	440

Source: Author(s) Compilation

Table 2 presents the descriptive statistics of the driving factors related to challenges faced by sheep owners and indicates that respondents perceive a wide range of environmental, disease-related, socio-cultural, and logistical issues at moderate to high levels. Climatic and environmental factors such as soaring temperature (Mean = 3.71), intense monsoon (Mean = 3.64), melting glaciers (Mean = 3.64), water scarcity (Mean = 3.65), and severe drought (Mean = 3.50) emerge as prominent concerns, reflecting the growing vulnerability of sheep husbandry to climate variability in hilly regions. Disease-related challenges, including pneumonia, haemonchosis, sheep pox, and diarrhea, also record moderate mean values, indicating their persistent impact on flock health and productivity. Grazing resource scarcity and disruptions to sheep husbandry activities further underline pressures on traditional pastoral systems. Transport-related constraints such as high transportation cost (Mean = 3.76), overcrowding of animals (Mean = 3.73), non-cooperation of transport owners, and unsuitable vehicles show relatively higher mean scores, highlighting serious logistical difficulties faced by sheep owners. Socio-cultural factors, including caste or tribal issues and non-dignified living conditions, are perceived as moderate challenges, while identity threat records a comparatively lower mean value. Overall, the variability in mean scores and standard deviations suggests heterogeneous experiences among respondents, supporting the suitability of applying exploratory factor analysis to identify underlying dimensions of these multifaceted challenges.

4.3 Reliability Statistics for Driving Factors

Table 3: Reliability Statistics for Driving Factors

Cronbach's Alpha	No. of Items
.884	25

Source: Author(s) Compilation

Table 3 presents the reliability statistics for the set of driving factors used to examine the challenges faced by sheep owners. The Cronbach's alpha value of 0.884 indicates a high level of internal consistency among the 25 items included in the scale. This value exceeds the commonly accepted threshold of 0.70, confirming that the items reliably measure the underlying construct of challenges related to sheep husbandry and associated conditions. The strong reliability of the scale provides statistical justification for proceeding with exploratory factor analysis and supports the robustness and consistency of the responses obtained from the surveyed sheep owners.

4.4 KMO and Bartlett's Test of Sampling Adequacy

Table 4: KMO and Bartlett's Test Value for Driving Factors

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.821
Bartlett's Test of Sphericity	Approx. Chi-Square	8409.813
	df	300
	Sig.	.000

Source: Author(s) Compilation

Table 4 reports the results of the Kaiser–Meyer–Olkin measure and Bartlett's Test of Sphericity conducted to assess the suitability of the data for exploratory factor analysis. The KMO value of 0.821 indicates a high level of sampling adequacy, suggesting that the correlations among the variables are sufficiently strong and appropriate for factor extraction. Bartlett's Test of Sphericity is statistically significant ($\chi^2 = 8409.813$, $df = 300$, $p < 0.001$), rejecting the null hypothesis that the correlation matrix is an identity matrix and confirming the existence of meaningful interrelationships among the driving factors. These results collectively validate the application of exploratory factor analysis for identifying the underlying dimensions of challenges faced by sheep owners.

4.5 Communality Estimates for Driving Factors

Table 5: Communality for Driving Factors

Variable	Initial	Extraction
Pneumonia (Bacterial & Parasitic)	1.000	0.711
Diarrhea	1.000	0.752
Sheep Pox	1.000	0.795
Haemonchosis	1.000	0.779
Uneven Rainfall	1.000	0.674
Soaring Temperature	1.000	0.800
Intense Monsoon	1.000	0.936
Severe Drought	1.000	0.807
Melting Glacier	1.000	0.934
Grazing Resources	1.000	0.745
Water Scarcity	1.000	0.691
Hamper the Sheep Husbandry Activities	1.000	0.809
Change of Nomadic Route	1.000	0.784

Sheep Diseases	1.000	0.734
Language and Cultural Obstacles	1.000	0.633
Cultural Differences	1.000	0.842
Occupational Syndromes	1.000	0.721
Caste / Tribal Factor	1.000	0.692
Identity Threat	1.000	0.342
Non-Dignified and Unsafe Living Conditions	1.000	0.796
Non-cooperation on the Part of Transport Owner	1.000	0.697
Incompatible Transportable Vehicle	1.000	0.670
Overcrowded Animal	1.000	0.678
High Transportation Cost	1.000	0.682
Floods	1.000	0.614

Extraction Method: Principal Component Analysis
Source: Author(s) Compilation

Table 5 presents the communality values for the driving factors considered in the exploratory factor analysis, indicating the proportion of variance in each variable explained by the extracted factors. The extraction communalities are generally high, with most variables recording values well above the acceptable threshold of 0.50, suggesting that the factor solution adequately explains the variance in the majority of indicators. Climatic and environmental factors such as intense monsoon (0.936), melting glacier (0.934), severe drought (0.807), and soaring temperature (0.800) show very high communalities, highlighting their strong representation in the underlying factor structure. Disease-related variables and constraints affecting sheep husbandry activities also exhibit satisfactory communalities, confirming their relevance in explaining the challenges faced by sheep owners. Transport-related and socio-cultural variables demonstrate moderate to high communalities, indicating their meaningful contribution to the extracted factors. However, identity threat shows a relatively low communality (0.342), suggesting that this variable is less strongly explained by the factor model compared to others. Overall, the communality results confirm the adequacy of the selected variables and support the robustness of the factor analysis in capturing the multidimensional challenges faced by sheep owners.

4.6 Total Variance Explained by Driving Factors

Table 6: Total Variance Explained by Driving Factors

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.184	32.736	32.736	8.184	32.736	32.736	3.359	13.437	13.437
2	2.737	10.948	43.684	2.737	10.948	43.684	3.299	13.196	26.633
3	2.143	8.572	52.256	2.143	8.572	52.256	2.789	11.154	37.787
4	1.876	7.504	59.760	1.876	7.504	59.760	2.722	10.886	48.674
5	1.266	5.066	64.825	1.266	5.066	64.825	2.485	9.939	58.612
6	1.077	4.310	69.135	1.077	4.310	69.135	1.862	7.446	66.059
7	1.034	4.136	73.271	1.034	4.136	73.271	1.803	7.212	73.271
8	0.980	3.919	77.190						
9	0.727	2.909	80.098						
10	0.654	2.615	82.713						
11	0.572	2.287	85.000						
12	0.502	2.009	87.009						
13	0.492	1.968	88.978						

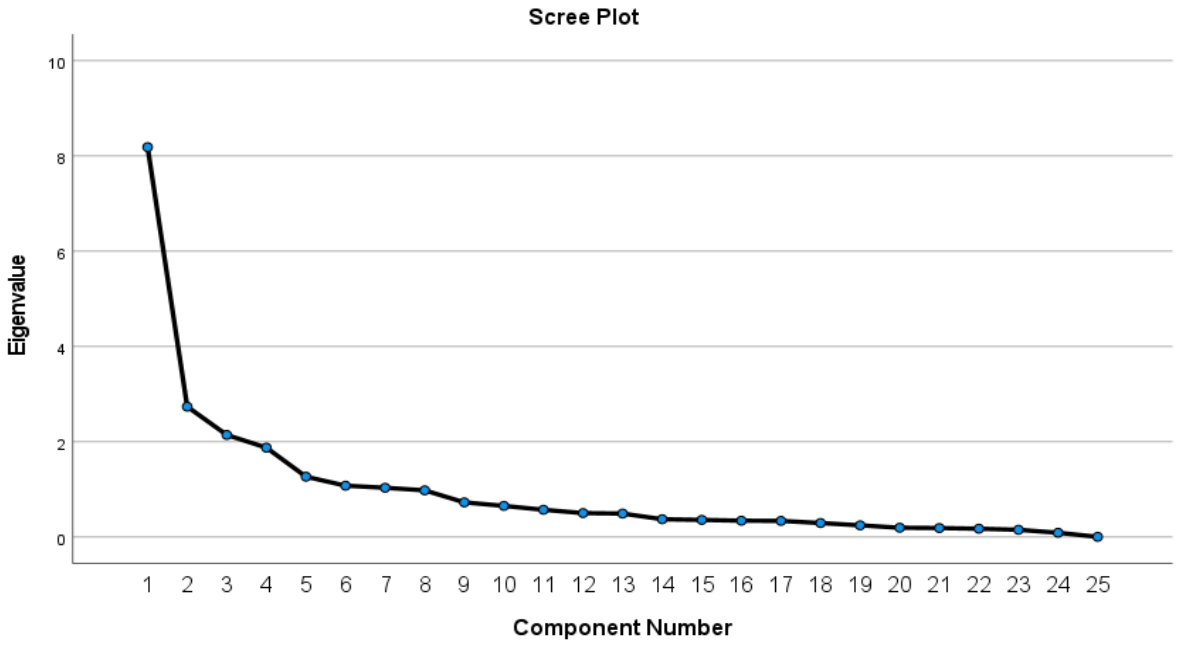
14	0.373	1.494	90.472						
15	0.359	1.437	91.908						
16	0.343	1.370	93.279						
17	0.338	1.354	94.632						
18	0.294	1.174	95.807						
19	0.245	0.980	96.787						
20	0.195	0.780	97.567						
21	0.188	0.754	98.321						
22	0.174	0.698	99.018						
23	0.152	0.607	99.626						
24	0.090	0.359	99.984						
25	0.004	0.016	100.000						

Extraction Method: Principal Component Analysis
Source: Author(s) Compilation

Table 6 presents the total variance explained by the extracted components using Principal Component Analysis and indicates the underlying structure of challenges faced by sheep owners. Based on the eigenvalue-greater-than-one criterion, seven components were retained, collectively explaining 73.271 per cent of the total variance, which is considered satisfactory for social science and livestock-related research. The first component accounts for the highest proportion of variance (32.736%), suggesting the presence of a dominant challenge dimension influencing sheep husbandry and wool-related activities. The second and third components explain 10.948 per cent and 8.572 per cent of the variance, respectively, while the remaining components contribute progressively smaller but meaningful shares, reflecting the multidimensional nature of challenges faced by sheep owners. After Varimax rotation, the variance is more evenly distributed across the seven factors, with rotated variance contributions ranging from 13.437 per cent to 7.212 per cent, thereby improving interpretability and reducing factor dominance. The cumulative rotated variance of 73.271 per cent indicates that the extracted factors adequately capture the major dimensions of environmental, disease-related, socio-cultural, and logistical challenges experienced by sheep owners, justifying the robustness and suitability of the factor solution.

4.7 Scree Plot Analysis

Figure 1: Scree Plot Analysis



Source: Author(s) Compilation

The scree plot in Figure 1 illustrates a steep decline in eigenvalues from the first to the second component, followed by a gradual flattening of the curve after the seventh component. The clear "elbow" observed around the seventh component indicates that components beyond this point contribute marginally to explaining the variance and largely represent random noise rather than meaningful underlying dimensions. The first seven components have eigenvalues greater than one and together account for a substantial proportion of the total variance, while subsequent components show only minor incremental contributions. This visual evidence from the scree plot supports the eigenvalue criterion and the total variance results, thereby justifying the retention of seven factors for further interpretation. Overall, the scree plot confirms that a seven-factor solution is appropriate and sufficient to capture the key dimensions of challenges faced by sheep owners in wool processing and related activities.

4.8 Unrotated Component Matrix for Driving Factors

Table 7: Unrotated Component Matrix for Driving Factors

Variables	Component						
	1	2	3	4	5	6	7
Melting Glacier	.748	-.018	-.268	-.442	.196	-.048	-.259
Intense Monsoon	.746	-.022	-.267	-.442	.197	-.052	-.265
Severe Drought	.746	-.004	-.270	-.312	.264	.087	.054
Haemonchosis	.724	.013	-.082	.150	-.474	.032	.011
Water scarcity	.723	-.017	-.052	.386	.113	.049	.016
Diarrhea	.710	-.033	-.394	.134	-.185	-.152	.127
Grazing resources	.708	.001	.234	.343	.082	-.102	-.233
Sheep Pox	.708	.007	-.162	.074	-.494	.057	.124
Pneumonia (Bacterial & Parasitic)	.658	.062	.173	-.152	-.369	.289	.030
Non-Dignified and Unsafe Living Conditions	.648	.112	.393	.089	-.086	-.433	-.079
Occupational Syndromes	.626	.076	.429	-.025	.092	.270	.240
Hamper The Sheep Husbandry Activities	.624	-.048	-.016	.577	.113	.045	-.263
Uneven Rainfall	.619	-.120	-.399	.041	-.126	-.049	.312
Soaring Temperature	.606	.035	-.077	-.513	-.229	.093	-.317
Sheep Diseases	.602	-.066	-.086	-.030	.526	.206	.199
Change of Nomadic Route	.599	-.061	-.079	.551	.204	.133	-.230
Non - Cooperation on the Part of Transport Owner	-.023	.830	-.075	-.014	.007	.027	.042
High Transportation Cost	-.013	.816	-.084	-.006	.017	.026	-.093
Incompatible Transportable Vehicle	.020	.811	-.062	.065	.045	-.019	.033
Overcrowded Animal	-.002	.805	-.141	.058	.031	.036	.067
Cultural Differences	.534	.033	.589	-.106	.110	.287	.319
Caste/Tribal Factor	.474	.142	.576	-.017	.056	-.333	-.022

Language and Cultural Obstacles	.432	.006	.546	-.345	-.018	-.164	.048
Identity Threat	-.117	-.034	.036	.052	-.075	.554	-.104
Floods	.374	-.068	-.345	.015	.149	-.278	.501

Extraction Method: Principal Component Analysis
Source: Author(s) Compilation

Table 7 presents the unrotated component matrix extracted using Principal Component Analysis and indicates how the driving factors load across seven components. The first component shows strong loadings for climatic, environmental, and disease-related variables such as melting glaciers, intense monsoon, drought, water scarcity, grazing resources, and major sheep diseases, suggesting a dominant climate–environment–health-related challenge. The second component is clearly associated with transportation-related constraints, including high transportation costs, non-cooperation of transport owners, incompatible vehicles, and overcrowding of animals. The third component captures socio-cultural factors such as cultural differences, caste or tribal factors, and language barriers. The fourth component reflects challenges related to the disruption of traditional sheep husbandry practices, including changes in nomadic routes and hampering of sheep husbandry activities. The remaining components represent comparatively smaller but meaningful dimensions related to disease severity, occupational stress, identity-related concerns, and extreme events such as floods. Overall, the unrotated solution confirms the multidimensional nature of challenges faced by sheep owners; however, due to overlapping loadings, rotation is required to achieve clearer and more interpretable factor structures.

4.9: Rotated Component Factor Analysis

Table 8: Rotated Component Matrix for Driving Factors

Variables	Component						
	1	2	3	4	5	6	7
Intense Monsoon	**.902**	.195	.167	-.009	.077	.149	.170
Melting Glacier	**.900**	.193	.170	-.005	.080	.146	.174
Soaring Temperature	**.734**	-.028	.448	.007	.122	.132	-.161
Severe Drought	**.717**	.217	.161	.029	.270	-.007	.382
Hamper the Sheep Husbandry Activities	.088	**.864**	.202	-.022	.053	.092	.036
Change of Nomadic Route	.128	**.858**	.133	-.021	.080	-.025	.077
Grazing Resources	.174	**.691**	.208	-.020	.219	.380	-.015
Water Scarcity	.162	**.681**	.273	.011	.223	.086	.265
Sheep Pox	.189	.233	**.799**	.012	.133	.070	.208
Haemonchosis	.172	.336	**.768**	.009	.120	.140	.110
Pneumonia (Bacterial & Parasitic)	.287	.119	**.627**	.027	.456	.063	-.092
Diarrhea	.291	.356	**.549**	.010	-.059	.095	.476
Non - Cooperation on the Part of Transport Owner	-.004	-.064	.010	**.832**	.022	.011	-.012
Overcrowded Animal	-.022	.002	.016	**.820**	-.005	-.037	.052
High Transportation Cost	.056	-.004	-.004	**.817**	-.039	.021	-.099
Incompatible Transportable Vehicle	-.026	.027	-.006	**.815**	.014	.057	.018
Cultural Differences	.074	.123	.125	-.024	**.879**	.180	.021

Occupational Syndromes	.144	.251	.202	.038	**.755**	.144	.065
Sheep Diseases	.424	.389	-.120	-.025	**.453**	-.105	.414
Non-Dignified and Unsafe Living Conditions	.131	.335	.270	.046	.224	**.735**	.047
Caste / Tribal Factor	.074	.195	.052	.060	.392	**.698**	-.047
Language and Cultural Obstacles	.238	-.091	.109	-.081	.498	**.543**	-.080
Identity Threat	-.050	.044	.057	-.024	.169	**-.451**	-.320
Floods	.113	.061	.114	-.017	.032	.082	**.759**
Uneven Rainfall	.256	.211	.480	-.070	.054	-.038	**.570**

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalisation
Source: Author(s) Compilation

Table 8 presents the Varimax-rotated component matrix, which clearly groups the driving factors into seven distinct and interpretable dimensions of challenges faced by sheep owners. The first factor is dominated by climatic stress variables such as intense monsoon, melting glaciers, soaring temperature, and severe drought, indicating climate-induced environmental challenges. The second factor loads highly on hampering sheep husbandry activities, change of nomadic routes, grazing resource constraints, and water scarcity, representing resource and livelihood disruption challenges. The third factor is characterised by high loadings of sheep pox, haemonchosis, pneumonia, and diarrhea, reflecting animal health and disease-related challenges. The fourth factor shows strong loadings for non-cooperation of transport owners, overcrowding of animals, high transportation costs, and incompatible vehicles, indicating transportation and logistics constraints. The fifth factor is associated with cultural differences, occupational syndromes, and sheep diseases, highlighting socio-cultural and occupational challenges. The sixth factor loads on non-dignified and unsafe living conditions, caste/tribal factors, and language obstacles, representing social vulnerability and marginalisation issues. The seventh factor, dominated by floods and uneven rainfall, captures extreme weather and disaster-related challenges. Overall, the rotated factor structure provides a clear and meaningful classification of multidimensional challenges faced by sheep owners, facilitating focused discussion and policy interventions.

5. Interpretation of Factors

The exploratory factor analysis identified seven distinct dimensions representing the major challenges faced by sheep owners in wool processing and value addition. The first factor represents climatic and environmental stress, driven by intense monsoon, melting glaciers, soaring temperatures, and severe drought, highlighting the increasing vulnerability of wool production to climate variability in hilly regions, as also reported in studies on pastoral systems and Himalayan livestock livelihoods (Bhateshwar et al., 2022; Dinesh et al., 2023). The second factor reflects resource and livelihood disruption challenges, characterised by water scarcity, declining grazing resources, changes in nomadic routes, and hampered sheep husbandry activities, indicating pressure on traditional pastoral practices and mobility patterns (Srivastava, 2022; Singh & Ashwani, 2023). The third factor captures animal health and disease-related challenges, including sheep pox, haemonchosis, pneumonia, and diarrhea, which directly affect wool quality, productivity, and processing outcomes, consistent with findings from sheep health and management studies (Manzoor et al., 2022; Birhanu et al., 2022). The fourth factor represents transport and logistical constraints, reflected by high transportation costs, unsuitable vehicles, overcrowding, and non-cooperation of transport owners, underscoring infrastructural bottlenecks in hilly regions (Bhateshwar et al., 2022; Das et al., 2024). The fifth factor denotes socio-cultural and occupational

challenges, including cultural differences, occupational syndromes, and caste or tribal factors, highlighting social barriers that influence participation in wool processing and market activities (Gautam, 2022; RajKumar et al., 2025). The sixth factor reflects living conditions and social vulnerability issues, such as non-dignified and unsafe living conditions and language barriers, which indirectly affect labour availability, processing efficiency, and market engagement (Bibi, 2024; Sharma, 2024). The seventh factor represents extreme weather shocks, dominated by floods and uneven rainfall, indicating episodic but severe disruptions to wool processing and value addition activities. Collectively, these factors demonstrate that challenges in sheep wool processing are multidimensional, extending beyond technical issues to include environmental, social, and infrastructural constraints, reinforcing observations from earlier livestock and wool sector studies (Allafi et al., 2022; Kumar et al., 2025).

6. Implications of the Study

6.1 Managerial Implications

The findings of the study offer important managerial insights for sheep owners, cooperatives, processors, and artisans engaged in wool-based activities. For sheep owners, the dominance of climate, disease, and resource-related challenges highlights the need for adaptive management practices, including improved flock health management, better shearing and storage practices, and collective action to reduce processing and transport costs. Cooperatives and wool processors can play a crucial role by aggregating wool, facilitating access to basic cleaning and grading facilities, and linking producers with organised buyers to enhance value realisation. Artisans and small-scale processors can benefit from improved coordination with sheep owners to ensure consistent quality and supply of wool, thereby strengthening local value chains and reducing dependence on informal intermediaries, as suggested in earlier studies on livestock value chains and wool-based livelihoods (Prathibha & Yogish, 2021; Marais et al., 2024).

6.2 Policy Implications

From a policy perspective, the study underscores the need to strengthen wool processing infrastructure in hilly and pastoral regions through the establishment of decentralised cleaning, grading, and primary processing units accessible to sheep owners (Indian wool industry and prospects, 2022; Rawat, 2025). Skill development and training programmes focusing on improved wool handling, disease management, and value addition techniques are essential to enhance processing efficiency and income generation (Channappa et al., 2021; Triveni & Sharma, 2023). Additionally, policies aimed at strengthening institutional and market linkages—such as promoting cooperatives, integrating wool producers with handloom and textile clusters, and facilitating access to government-supported schemes—can help sheep owners move up the value chain and reduce vulnerability associated with raw wool sales (Shubham et al., 2025; Kumar et al., 2025).

7. Conclusion

The study provides empirical evidence on the multifaceted challenges faced by sheep owners in sheep wool processing and value addition in Himachal Pradesh by identifying seven underlying dimensions through exploratory factor analysis. The findings reveal that wool processing constraints are not limited to technical or processing-related issues but are strongly influenced by climatic stress, animal health problems, infrastructural bottlenecks, and socio-cultural vulnerabilities. By shifting the analytical focus from wool production to

processing and value addition challenges, the study contributes to the existing literature on the livestock and wool sector, particularly in the context of hilly and pastoral regions. From a practical standpoint, the results offer valuable insights for sheep owners, cooperatives, processors, and policymakers by highlighting priority areas for intervention, including infrastructure development, skill enhancement, and institutional support, to strengthen wool-based livelihoods and improve income sustainability.

8. Limitations and Future Research

Despite its contributions, the study has certain limitations that provide scope for future research. The analysis is confined to two districts of Himachal Pradesh, which may limit the generalisability of the findings to other wool-producing regions with different ecological and institutional contexts. Moreover, the study relies solely on exploratory factor analysis to identify challenge dimensions and does not examine causal relationships or their impact on income and value addition outcomes. Future research may employ advanced techniques such as structural equation modelling (SEM) to test relationships among identified factors, undertake value-chain analysis to capture interactions among stakeholders, and adopt longitudinal designs to assess changes in wool processing challenges over time in response to policy interventions and climatic shifts.

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