



A Comprehensive Analysis of the Wool Supply Chain in Bikaner District of Rajasthan

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ABSTRACT

The study, conducted in the year 2023, investigates the wool supply chain in Rajasthan's Bikaner district, focusing on marketing methods, challenges, financial viability, and potential improvements. It examines the preferred marketing channels of local farmers, highlights persistent problems, conducts a cost-benefit analysis, and suggests a more efficient supply chain model. Through surveys and interviews, utilizing a multistage sampling technique, data was collected from key stakeholders, including wool producers, traders, processors, and government officials. The findings show that most farmers prefer to sell their wool at wool markets, where they have direct access to buyers. However, challenges such as price fluctuations, delayed payments, and complicated middleman processes continue to affect their earnings. The cost-benefit analysis confirms that wool production in the region is financially sound, with a benefit-cost ratio of 1.38 and a quick payback period of around 1.09 years. To address these issues, a proposed supply chain model, "Producers-Cooperatives-Online Marketplace-Processors-Retailer-Consumer," was developed, which aims to simplify intermediary problems, strengthen farmers' bargaining power, open new markets, and increase transparency.

INTRODUCTION

Wool, a natural fibre sourced from animals like sheep, goats, llamas, and alpacas, is among the oldest known textiles, dating back over 10,000 years. Sheep domestication, crucial for wool production, traces back to around 9000 BCE in what is now Iran (Brown, 2001). Valued for its warmth, durability, and versatility, wool has been employed in clothing, blankets, and carpets, particularly in cold climates. In India, the wool industry significantly contributes to the economy, supporting millions of livelihoods, primarily in rural areas. This industry has substantial potential but faces challenges, including marketing issues, low profitability, and a lack of technological advancement (Sethi et al., 2015).

India's wool industry is divided into organized and decentralized sectors, collectively worth Rs. 12444.45 Crores (Ministry of Textiles, Government of India, 2020-21). It's the world's 3rd largest sheep population country and 6th largest wool producer. However, average wool yield per sheep in India is lower than the global average. The wool industry supports millions of jobs in both organized and decentralized sectors (Ministry of Textiles, Government of India).

India boasts diverse sheep breeds classified as fine wool, medium wool, and carpet wool. These breeds cater to specific textile needs. For instance, Magra sheep in Rajasthan produce high-quality wool ideal for fine textiles, while Chokla sheep in the

same region yield wool suitable for carpets and blankets (Kumar & Singh, 2018). Supplementing lambs with concentrate has been shown to significantly enhance both weight gain and wool yield, with an increase in staple length observed as supplementation levels rise, highlighting the impact of nutritional strategies on wool production (Singh et al., 2003). In exploring the decision-making factors within the New Zealand wool supply chain, the psychological and social aspects were taken into account, underscoring the complexity of the industry (Bradford, 2009). The role of middlemen in agricultural supply chains, including wool, is essential yet often contentious. These intermediaries help farmers access markets but can also capture a disproportionate share of the economic returns, suggesting the need for strategies to ensure a fairer distribution of value within the supply chain (Helen & Shammugasundaram, 2010).

Furthermore, addressing communication challenges and the need for better coordination in the wool industry are critical for improving supply chain efficiency (Champion & Fearn, 2011). The complexities and alignment between product and supply chain strategies in the Indian garment sector were also explored, highlighting the intricate dynamics of the industry (Giri & Rai, 2013). The volatility of prices and the inefficiency of intermediaries, prevalent across agricultural sectors, pose significant challenges. A model integrating online marketplaces and cooperatives is recommended to enhance market access and empower farmers with greater bargaining power, proposing a universally applicable strategy intended to improve the resilience and profitability of agricultural supply chains, including wool (Kumar et al., 2023; Rajavardhan et al., 2020).

METHODOLOGY

The research followed a descriptive approach to analyse the wool supply chain in Bikaner District, Rajasthan. Data was collected through interviews with key stakeholders, including wool producers, traders, processors, and government officials, along with surveys to gather quantitative data on wool production, supply, and demand. A combination of structured schedules and questionnaires served as the research instruments for data collection. Structured questionnaires guided interviews, enabling detailed responses. Both primary and secondary data collection methods were used. Primary data involved interviews and questionnaires, while secondary data was obtained from existing literature, government reports, and industry databases.

Sampling was conducted using a multi-stage sampling method. The sampling unit included individuals and organizations in the wool supply chain. Village selection was based on population size, and 10 villages were chosen. Within these villages, a random sample of 10 sheep-rearing farmers was selected, resulting in a total sample size of 100 farmers. Sampling methods varied for traders, processors, and scientists based on convenience and expertise.

The analytical framework consisted of stages like wool production, trading, processing, and exports. Data collected at each stage was analysed using techniques such as RBQ ranking method, cost-benefit analysis, pie charts, and tables. Descriptive statistics were employed to examine marketing channels, while

Ranking Based Quotient (RBQ) analysis helped investigate problems within these channels (Radhika et al., n.d.). Cost-benefit analysis assessed the economic aspects of wool production in the study area.

$$RBQ = (n + 1) - R / n$$

Where, n = Total number of responses, R = Rank of the response, The RBQ provides a value between 0 and 1, with 1 representing the highest rank and 0 representing the lowest rank.

$$CBA = (\text{Total Benefits} / \text{Total Costs})$$

Where, Total Benefits = Sum of all the benefits associated with the project or investment

Total Costs = Sum of all the costs associated with the project or investment

The result of the CBA formula provided a benefit-cost ratio (BCR). If the BCR is greater than 1, it indicates that the benefits outweigh the costs, signifying financial feasibility. If the BCR is less than 1, the costs outweigh the benefits, suggesting the project or investment is not financially feasible. To recommend a suitable supply chain model for sheep-rearing farmers, input from scientists and stakeholders was incorporated. The research aimed to provide a comprehensive analysis of the wool supply chain and offer practical recommendations for improvement.

RESULTS

Examine various marketing channels chosen by sheep rearing farmers for marketing of wool

There were three major marketing channels chosen by sheep rearing farmer,

- a) Producer- Traders- Market-Processor-Retailer-Consumer - In this marketing channel, wool producers sell their wool to local traders, who then sell it to processors. This channel lacks direct communication between producers and manufacturers, relying on intermediaries. It provides broader market access but incurs higher transaction costs due to multiple middlemen.
- b) Producer- Processors-Retailers-Consumer- In this marketing channel, wool producers sell their wool directly to processors, who transform it into finished products. These products are then distributed to retailers or wholesalers and eventually reach consumers. This channel emphasizes strong coordination between producers and manufacturers. While it offers better profit margins for producers, it restricts their market access since they rely on processors to sell their products, and
- c) Producer- Market-Processor -Retailers-Consumer- In this marketing channel, wool producers directly sell their wool to the market, where it undergoes auctioning and is subsequently purchased by wool buyers. These buyers then supply the wool to processors or manufacturers who transform it into finished wool products. This channel lacks direct coordination between producers and manufacturers, and the wool price is determined by market forces. Producers have limited control over the final price. Channel 3 involves producers selling their

wool directly to the market, from where it is directed to processors. Processed products are then sold to retailers, who, in turn, reach the end consumers. This channel strikes a balance between market access and transaction costs.

The market-based marketing channel was identified as the best and most preferred by wool producers. This channel enables producers to sell their wool directly to the market, establishing a direct link with buyers and the potential for better prices. Subsequently, processors transform the wool into various products, which are then sold to retailers for distribution to consumers.

Marketing channels chosen by sheep rearing farmers for selling of wool

In Bikaner, the preferred marketing channel chosen by sheep rearing farmers for selling their wool is the wool mandi (market), with 83 per cent of farmers utilizing this channel. The wool mandi serves as a central marketplace for wool transactions, allowing farmers to directly sell their wool to buyers. This channel is favoured by farmers seeking to sell wool in bulk and secure fair prices. Selling to wool merchants is the second most favoured channel, chosen by 12 percent of farmers. Wool merchants act as intermediaries, purchasing wool from farmers and selling it to consumers. This channel is preferred by farmers who cannot sell their wool in bulk and seek equitable prices. Selling to processors is the least preferred channel, selected by only 5 percent of farmers. It involves selling wool to processors who convert it into yarn or other products. This method suits farmers with substantial wool quantities, enabling them to secure better prices through bulk sales.

As depicted in the Table 1, the wool mandi (market) stands out as the most preferred channel for selling wool among sheep rearing farmers in Bikaner. This channel offers benefits such as fair pricing, bulk selling capabilities, and direct buyer interaction. While bulk selling may pose challenges for small-scale farmers, the overall advantages make the wool mandi the optimal choice for wool sales in Bikaner.

Major problems of marketing channel chosen by the sheep rearing farmers for wool

Some common problems that may arise in each channel are

- I. Producer-Traders-Market-Processor-Retailer: High initial investment cost for producers to set up processing facilities, limited access to capital for small-scale producers to invest in processing equipment and the risk of market saturation if too many producers invest in processing, leading to oversupply and lower prices were prioritised.
- II. Producer-Market-Processor-Retailer: Limited bargaining power for individual producers when selling to the market, dependence on market conditions and demand for wool and limited control over pricing and quality when selling through the market were major problems

Table 2 shows that the price volatility tops the list of critical issues faced by Indian wool producers in the supply chain, with a mean score of 98.3. This volatility severely disrupts their operational planning. Delayed payments come in second, with a mean score of 93.3, leading to cash flow problems and eroding trust between producers and buyers. Dealing with numerous intermediaries ranks third, with a mean score of 68, resulting in added complexity and costs, ultimately lowering prices for producers. Fluctuating demand and the rejection of small quantities follow as the fourth and fifth most significant challenges, with mean scores of 37 and 40, respectively. In summary, the most pressing concerns in the Indian wool supply chain are price volatility and delayed payments, causing financial instability and trust issues among stakeholders.

Economic analysis of woollen production in the study area

Economic analysis has been done for the wool production which includes cost of production, cost benefit analysis. Table 3 outlines the fixed investment needed for sheep rearing, encompassing expenses such as sheep acquisition, shed construction, machinery, and equipment. For a herd of 20 sheep,

Table 1. Comparison table for the three-channels of selling wool in Bikaner

Marketing Channel	Advantages	Disadvantages	Preferred by wool producers (%)
Wool Mandi (Market)	Provides a fair price for wool, Allows selling wool in bulk, Direct interaction with buyers.	Bulk selling can be a disadvantage for small-scale farmers	83
Wool Merchants	Provides a fair price for wool, No need for bulk selling	Limited negotiation opportunity	12
Processors	Offers better prices for bulk wool, Provides employment opportunities in the wool processing industry	May require high-quality wool, Limited negotiation opportunity	5

Table 2. Major problems of supply chain ranked with help of ranking based quotient method

S.No.	Problems	1	2	3	4	5	RBQ value	Rank
1	Fluctuating Demand	6	11	4	5	64	37	4
2	Price volatility	45	23	10	6	4	98.3	1
3	Too many intermediaries	9	37	24	17	15	68	3
4	Buying denial due to Small Quantity	19	12	6	53	10	40	5
5	Delayed payment	21	17	56	19	7	93.3	2

Source: Researcher's own computation from field data.

Table 3. Investment details of sheep rearing

Fixed Investment	Cost/20 sheep/Year (Rs.)
Buying sheep	35,000
Building shed	3,200
Machinery & Equipment	1,000
Total Investment	39,500
Total investment/Sheep	1,975

Source: Researchers own compilation of field data.

the total investment amounts to Rs. 39,500 translating to Rs. 1,975 per sheep.

Table 4 presents the cost breakdown for nurturing a flock of 20 sheep across six years. Fixed costs (A) encompass expenditures like land rent, shed and machinery depreciation, property taxes, and insurance premiums. Variable costs (B) encompass expenses such as feed, labour, veterinary care, shearing, transportation, temporary labour, and miscellaneous costs. The cumulative cost for maintaining 20 sheep for six years commences at Rs. 16,690 in the first year, progressively escalating to Rs. 30,343 in the sixth year.

Table 5 presents revenue generated from diverse income streams within a business, encompassing wool sales, manure, lamb, and milk sales across six distinct periods. The table delineates the revenue accrued from each source in separate columns for each period, also providing the total revenue garnered from all these sources during each period. Across the six periods, the business

accumulated total revenues that ranged from Rs. 1,800 to Rs. 80,200, with lamb sales emerging as the most lucrative revenue source.

Table 6 illustrates the computation of cash outflow present values spanning six years, employing a 10 percent discount rate. The cumulative present value of cash outflows amounts to 156,426. Notably, the initial year exhibits the most substantial cash outflow, totalling 56,190, while subsequent years witness declining outflows.

The computation of cash inflow present values over a six-year timeframe, assuming a 10 percent discount rate. These present value factors are derived from the discount rate and time period, used to calculate each year's cash inflow present value by multiplying the respective cash inflow with its factor. The total present value of cash inflow for the six-year period is 2,17,401.

Net Present Value = Inflows - Outflows = 2,17,401 - 1,56,426 = 60,975

Benefit Cost Ratio = Inflows/Outflow = 2,17,401/1,57,215 = 1.38

Annual Cash Inflows = 217401/6 = 36,233

Pay Back Period = Initial Cost of Investment / Annual Cash Inflows = 39500/36233 = 1.09 year

The Net Present Value, calculated as the difference between inflows and outflows, equals Rs. 60,975, indicating a positive cash flow. The Benefit Cost Ratio is 1.38, implying that for every Rs. 1 spent on wool production, there is a return of Rs. 1.38 in benefits. This ratio signifies the project's worthiness, generating

Table 4: Cost structure for the duration of six years

Cost Attributes	Cost for 20 Sheep (Rs.)					
	1 Year	2 Year	3 Year	4 Year	5 Year	6 Year
Fixed cost (A)						
Land rent or lease	350	370	390	410	430	450
Depreciation on shed (at 5%)	160	152	144	137	130	123
Depreciation of machinery (at 10%)	100	90	81	73	65	59
Property taxes	300	280	320	330	340	360
Insurance premiums	700	710	710	720	730	740
Variable Cost (B)						
Feed cost	9,000	12,000	13,000	14,000	15,000	16,000
Labor cost	4,500	6,500	7,000	7,500	8,000	8,500
Veterinary cost	800	800	850	900	950	1,000
Shearing and wool sorting cost	0	250	280	320	350	370
Transportation cost	0	300	310	320	330	350
Labor costs for temporary workers	280	300	320	350	370	390
Miscellaneous cost	500	1,500	1,600	1,700	1,800	2,000
Total cost (Fixed + Variable)	16,690	23,252	25,165	26,760	28,495	30,343

Source: Researcher's own compilation of field data

Table 5. Revenue earned in the duration of six years

Revenue Sources	Revenue Earned (Rs.)					
	1	2	3	4	5	6
Sale of wool	0	7,500	8,500	10,000	12,000	14,000
Sale of manure	1,800	2,200	2,600	3,000	3,500	4,000
Sale of lamb	0	35,000	40,000	45,000	50,000	55,000
Sale of milk	0	4,500	5,000	5,700	6,500	7,200
Total Revenue	1,800	49,200	56,100	63,700	7,2000	80,200

Source: Researcher's own compilation of field data

Table 6. Calculation of present value of cash outflow

Year	Cash Outflow	Present Value Factor at (10%)	Present Value of Cash Outflow (Rs.)
1	56,190	1	56,110
2	23,252	0.909	21,136
3	25,165	0.826	20,786
4	26,790	0.751	20,119
5	28,495	0.683	19,462
6	30,443	0.618	18,813
Total			1,56,426

Source: Researcher's own compilation of field data.

Table 7. Calculation of present value of cash inflow

Year	Cash Inflow	Present Value Factor at (10%)	Present Value of Cash Outflow (Rs.)
1	1,800	0.909	1,636
2	49,200	0.826	40,639
3	56,100	0.751	42,131
4	63,700	0.683	43,507
5	72,000	0.618	44,496
6	80,200	0.561	44,992
Total			2,17,401

Source: Researcher's own compilation of field data.

more benefits than costs. The Payback Period is 1.09 years, showcasing the project's rapid initial return on investment. In conclusion, wool production remains profitable and sustainable, even though the profit margin may not be exceptionally high.

DISCUSSION

A collaborative effort between scientists from the Central Sheep and Wool Research Institute and various stakeholders, including farmers, traders, and processors, has resulted in an improved supply chain model for wool producers. This model effectively addresses the issue of price volatility and reduces dependence on intermediaries.

In this refined supply chain, producers form cooperatives, engage in both online and offline wool markets, collaborate with processors, work with retailers, and serve consumers directly. This approach empowers producers by establishing direct connections with stakeholders and provides better control over pricing and distribution.

In contrast, the traditional model involves producers selling to traders, who then navigate the market, ultimately reaching retailers. In this traditional approach, producers have limited control over pricing and distribution. The Producers-Cooperatives-Online/Offline Market-Processors-Retailers-Consumers model offers wool producers' greater control, better prices, and improved operational flexibility, which is depicted in Figure 1 above. It enables resource and knowledge sharing through cooperatives, reduces transportation costs, and allows direct sales to processors when needed.

Supply chain preferred by wool producers

Wool producers in the study strongly favoured the supply chain involving cooperatives and online marketplaces as their

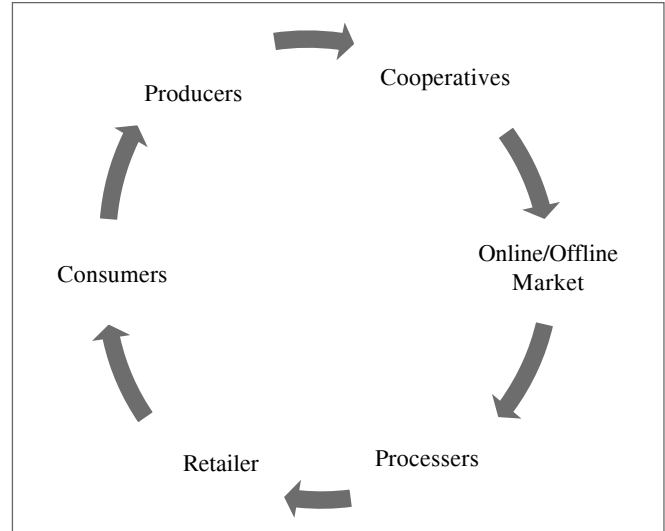


Figure 1. Wool supply chain model developed for wool producers
Source: Researcher's own compilation from field data.

preferred choice. This supply chain, denoted as “Producers-Cooperatives-Online/Offline Market-Processors-Retailers-Consumers,” received the highest preference due to its transparency, accessibility, and enhanced bargaining power for producers. The second most preferred option was “Producer-Market-Processor-Retailers-Consumers,” with fewer respondents selecting it, while “Producer-Processors-Retailers-Consumers” and “Producer-Traders-Market-Processor-Retailers-Consumers” received even lower preferences.

The preference for the cooperatives and online marketplace supply chain stems from the benefits it offers, such as fair pricing for small-scale producers, increased bargaining power when dealing with processors and retailers, and stable incomes. The use of online marketplaces enhances transparency and efficiency in pricing, benefiting both producers and processors. Furthermore, the involvement of processors and retailers ensures product quality and customer satisfaction.

In contrast, other supply chains may involve intermediaries, potentially resulting in lower prices for producers and reduced control over product quality. Additionally, the absence of cooperatives or online marketplaces can limit producers' access to buyers and bargaining power.

CONCLUSION

Sheep-rearing farmers in Bikaner primarily used three marketing channels for wool sales, with the market-based channel being the most preferred. Price volatility, delayed payments, and excessive intermediaries posed significant challenges in the supply chain. Nevertheless, wool production proved economically viable, with a benefit-cost ratio of 1.38 and a short payback period of 1.09 years. The average wool yield per sheep ranged from 0.75 kg to 1.5 kg, and the average price per kilogram varied between 300-550 rupees. Adopting a supply chain model i.e., Producers-Cooperatives-Online Market place-Processors-Retailer-Consumer was deemed suitable, offering increased transparency and bargaining

power for wool producers. Overall, the wool industry was perceived as mostly stable, according to the majority of respondents.

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