



## Operational Efficiency and Market Dynamics in Haryana's Dairy Sector

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**Abstract:** This study presents a comprehensive competitive analysis of private and cooperative dairy systems in Haryana, India. The research examines the structural, operational, and economic aspects of both systems, highlighting their respective strengths, weaknesses, and impacts on the local dairy industry. Through extensive data collection and analysis, including surveys of dairy farmers, interviews with industry stakeholders, and examination of economic indicators, this paper provides insights into the comparative advantages and challenges faced by private and cooperative dairy models in Haryana. The findings reveal significant differences in efficiency, market reach, farmer benefits, and overall economic contribution between the two systems. Additionally, this study explores the awareness levels among dairy farmers regarding the risk factors and symptoms associated with diseases that can affect cattle health and milk production, such as mastitis and foot-and-mouth disease. This research contributes to the understanding of dairy sector dynamics in developing regions and offers valuable recommendations for policy-makers and industry participants to enhance the competitiveness and sustainability of Haryana's dairy industry.

**Keywords:** dairy systems; cooperatives; private sector; competitive analysis; Haryana; India; agricultural economics; cattle health awareness.

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## 1. INTRODUCTION

The dairy sector plays a crucial role in India's agricultural economy, contributing significantly to rural livelihoods and the nation's food security. Haryana, a state in northern India, has emerged as a key player in the country's dairy industry, with a rich history of both cooperative and private dairy systems operating side by side. This coexistence offers a unique opportunity to analyze and compare the competitive dynamics of these two distinct models within the same geographical and socio-economic context.

The cooperative dairy system in India, epitomized by the success of the "White Revolution" and the Anand pattern cooperatives, has long been celebrated for its role in rural development and farmer empowerment. On the other hand, the private dairy sector has gained prominence in recent years, bringing with it promises of efficiency, technology adoption, and market expansion. In Haryana, both systems have contributed to the state's position as one of India's leading milk producers, but their relative strengths, weaknesses, and impacts on various stakeholders remain subjects of debate and inquiry.

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This research paper aims to provide a comprehensive competitive analysis of private and cooperative dairy systems in Haryana. By examining various aspects such as operational efficiency, market penetration, farmer benefits, quality control, and overall economic impact, we seek to offer insights into the comparative advantages and challenges faced by each system. This analysis is crucial not only for understanding the current state of Haryana's dairy industry but also for informing future policy decisions and strategic planning in the sector.

The objectives of this study are:

1. To compare the operational structures and efficiencies of private and cooperative dairy systems in Haryana.
2. To analyze the economic benefits accrued to farmers under each system.
3. To assess the market reach and competitive strategies employed by private and cooperative dairies.
4. To evaluate the impact of both systems on milk quality, product diversity, and consumer satisfaction.
5. To examine the role of each system in promoting technological adoption and innovation in the dairy sector.
6. To investigate the broader socio-economic impacts of private and cooperative dairy systems on rural communities in Haryana.

By addressing these objectives, this paper aims to contribute to the ongoing discourse on dairy sector development in India and other developing countries. The findings of this study will be valuable for policymakers, industry stakeholders, and researchers interested in optimizing dairy production systems and enhancing rural livelihoods.

## 2. LITERATURE REVIEW

The competitive dynamics between private and cooperative dairy systems have been a subject of significant research interest, particularly in the context of developing economies. This section provides a comprehensive review of existing literature, focusing on studies that have examined various aspects of dairy systems in India and specifically in Haryana.

### 2.1 Evolution of Dairy Systems in India

The development of India's dairy sector has been marked by significant transitions, most notably the "White Revolution" initiated in the 1970s. Kurien (2004) provides a detailed account of this transformation, highlighting the role of cooperatives in boosting milk production and improving rural livelihoods. The Anand Pattern cooperative model, as described by Shah (1996), became a blueprint for dairy development across India, including Haryana.

However, the landscape began to change with the liberalization of the Indian economy in the 1990s. Rakotoarisoa and Gulati (2006) discuss how economic reforms led to increased private sector participation in the dairy industry, introducing new competitive dynamics.

### 2.2 Comparative Studies on Cooperative and Private Dairy Systems

Several studies have attempted to compare the performance of cooperative and private dairy systems in India. Singh and Pundir (2000) conducted a comprehensive analysis of milk marketing systems in Haryana, highlighting the strengths and weaknesses of both cooperative and private channels. Their study found that while cooperatives provided more stable prices to farmers, private dairies often offered higher prices during peak demand periods.

Rajendran and Mohanty (2004) examined the efficiency of milk marketing in Tamil Nadu, comparing cooperative and private channels. They found that cooperatives had lower marketing costs but private channels showed greater flexibility in responding to market demands.

### 2.3 Economic Impact on Dairy Farmers

The economic benefits accruing to farmers under different dairy systems have been a key focus of research. Kumar *et al.* (2011) analyzed the impact of dairy cooperatives on small farmers in Haryana, finding that cooperative membership was associated with higher milk yields and incomes. However, Squicciarini *et al.* (2017) argue that the benefits of cooperative membership are not uniform and depend on factors such as farm size and location.

Contrasting this, studies on private dairy systems, such as that by Sharma *et al.* (2009), suggest that private dairies in Haryana have been effective in providing competitive prices to farmers, especially in areas with good infrastructure.

### 2.4 Market Reach and Competitive Strategies

The market penetration and competitive strategies of dairy systems have been explored by several researchers. Deepak *et al.* (2015) analyzed the supply chain strategies of cooperative and private dairies in Haryana, finding that private dairies had more diverse product portfolios and aggressive marketing strategies. Cooperatives, on the other hand, had stronger grassroots networks and brand loyalty.

### 2.5 Quality Control and Product Diversity

Quality control has emerged as a critical factor in the competitiveness of dairy systems. Grover *et al.* (2018) compared the quality assurance practices of cooperative and private dairies in

Haryana, noting that while both systems had improved their quality control measures, private dairies were quicker to adopt new technologies.

## 2.6 Technological Adoption and Innovation

The role of technology in shaping the competitiveness of dairy systems has gained increased attention. Sahu *et al.* (2017) examined the adoption of modern dairy practices in Haryana, finding that private dairies were more likely to introduce new technologies, while cooperatives played a crucial role in disseminating these technologies to small-scale farmers.

## 2.7 Socio-Economic Impacts

The broader socio-economic impacts of dairy systems have been explored by various studies. Karmakar and Banerjee (2006) investigated the role of dairy cooperatives in rural development in Haryana, highlighting their contribution to employment generation and women's empowerment. Conversely, Pohit and Taneja (2003) examined the impact of private dairy investments on rural economies, noting their role in creating off-farm employment opportunities.

## 2.8 Research Gaps and Future Directions

While existing literature provides valuable insights into various aspects of dairy systems in Haryana, there are several gaps that this study aims to address:

1. Most comparative studies focus on specific aspects (e.g., pricing, quality) rather than providing a comprehensive competitive analysis.
2. There is limited research on how the coexistence of cooperative and private systems affects overall market dynamics in Haryana.
3. The long-term sustainability and adaptability of each system in the face of changing market conditions and consumer preferences remain underexplored.
4. Few studies have examined the environmental impacts and sustainability practices of different dairy systems in Haryana.

By addressing these gaps, this study aims to provide a more holistic understanding of the competitive landscape of Haryana's dairy sector, offering insights that can inform policy and practice in the industry.

## 3. METHODOLOGY

This section outlines the research methodology employed to conduct a comprehensive competitive analysis of private and cooperative dairy systems in Haryana. The study adopts a mixed-methods approach, combining quantitative and qualitative research techniques to provide a holistic understanding of the dairy sector dynamics.

### 3.1 Research Design

The research design is structured as a comparative case study, focusing on the two primary dairy systems in Haryana: private and cooperative. This approach allows for an in-depth examination of each system while facilitating a direct comparison of their competitive attributes.

### 3.2 Data Collection

#### 3.2.1 Primary Data

1. **Surveys:** A structured questionnaire was administered to 500 dairy farmers across Haryana, stratified to include participants from both private and cooperative systems. The survey collected data on:
  - Demographic information
  - Milk production metrics
  - Economic indicators (income, costs, profits)
  - Satisfaction levels with respective dairy systems
  - Access to services and technology
2. **In-depth Interviews:** Semi-structured interviews were conducted with:
  - 20 managers from private dairy companies
  - 20 officials from dairy cooperatives
  - 10 government officials involved in dairy sector regulation
  - 15 experts from academic and research institutions
3. **Focus Group Discussions:** Six focus group discussions were organized with dairy farmers, three each for those associated with private and cooperative systems.
4. **Field Observations:** Direct observations were made at 30 milk collection centers (15 private, 15 cooperative) to assess operational efficiency and quality control measures.

#### 3.2.2 Secondary Data

Secondary data was collected from various sources to complement the primary data:

- Annual reports of major private dairy companies and cooperative societies operating in Haryana
- Government publications and reports from the Department of Animal Husbandry & Dairying, Haryana
- Statistical data from the National Dairy Development Board (NDDB)
- Academic journals and research papers relevant to the dairy sector in Haryana and India
- Market reports and industry analyses from reputable sources

### 3.3 Sampling Technique

A multi-stage sampling technique was employed to ensure representative coverage:

1. **Stage 1:** Selection of districts based on milk production levels and the presence of both private and cooperative dairy systems.

2. **Stage 2:** Random selection of blocks within each selected district.
3. **Stage 3:** Random selection of villages within each block.
4. **Stage 4:** Stratified random sampling of dairy farmers within selected villages, ensuring representation from both systems.

### 3.4 Data Analysis

#### 3.4.1 Quantitative Analysis

1. **Descriptive Statistics:** To summarize and describe the basic features of the data collected.
2. **Comparative Analysis:** T-tests and ANOVA were used to compare means across different groups (e.g., private vs. cooperative farmers).
3. **Regression Analysis:** Multiple regression models were developed to identify factors influencing farmer incomes, milk productivity, and satisfaction levels.
4. **Efficiency Analysis:** Data Envelopment Analysis (DEA) was employed to compare the operational efficiencies of private and cooperative dairy units.
5. **Market Share Analysis:** Herfindahl-Hirschman Index (HHI) was calculated to assess market concentration in the dairy sector.

#### 3.4.2 Qualitative Analysis

1. **Thematic Analysis:** Interview transcripts and focus group discussion notes were analyzed using thematic analysis to identify key themes and patterns.
2. **SWOT Analysis:** Strengths, Weaknesses, Opportunities, and Threats were identified for both private and cooperative systems based on the qualitative data collected.
3. **Content Analysis:** Secondary data sources were subjected to content analysis to extract relevant information and corroborate primary findings.

### 3.5 Analytical Framework

The competitive analysis was structured around the following key dimensions:

#### 4.1 Operational Efficiency

##### 4.1.1 Milk Procurement and Collection

**Table 1: Shows the comparison of milk procurement efficiency between private and cooperative systems.**

Metric	Private System	Cooperative System	p-value
Average daily milk collection (liters)	15,230	12,450	0.023
Number of collection points	187	245	0.001
Average distance to collection point (km)	3.2	2.1	0.015
Time from collection to processing (hours)	4.3	5.7	0.008

1. Operational Efficiency
2. Economic Benefits to Farmers
3. Market Reach and Penetration
4. Quality Control and Product Diversity
5. Technological Adoption and Innovation
6. Socio-Economic Impact
7. Environmental Sustainability

Each dimension was assessed using a combination of quantitative metrics and qualitative insights derived from the collected data.

### 3.6 Ethical Considerations

The research was conducted in accordance with ethical guidelines:

- Informed consent was obtained from all participants.
- Confidentiality and anonymity of respondents were ensured.
- Data was stored securely and used solely for research purposes.
- The study design was approved by the institutional ethics committee.

### 3.7 Limitations

The study acknowledges several limitations:

- The dynamic nature of the dairy industry means that findings represent a snapshot in time.
- There may be regional variations within Haryana that are not fully captured in the sampling.
- The study relies on self-reported data from farmers, which may be subject to recall bias.

Despite these limitations, the comprehensive nature of the data collection and analysis provides a robust foundation for understanding the competitive dynamics of Haryana's dairy sector.

## 4. RESULTS

This section presents the findings of our competitive analysis of private and cooperative dairy systems in Haryana. The results are organized according to the key dimensions outlined in the analytical framework.

The results indicate that private dairies collect significantly more milk daily, despite having fewer collection points. However, cooperative systems have collection points closer to farmers, potentially offering greater convenience.

#### 4.1.2 Processing Capacity Utilization

Data Envelopment Analysis (DEA) revealed that private dairies had a higher average technical efficiency score (0.87) compared to cooperative dairies (0.74), indicating better utilization of processing capacities.

#### 4.1.3 Labor Productivity

**Table 2: Presents the comparison of labor productivity between the two systems.**

Metric	Private System	Cooperative System	p-value
Milk processed per employee (liters/day)	1,250	980	0.011
Revenue generated per employee (INR/day)	42,500	33,200	0.007

Private dairies demonstrated higher labor productivity in terms of both milk processing and revenue generation per employee.

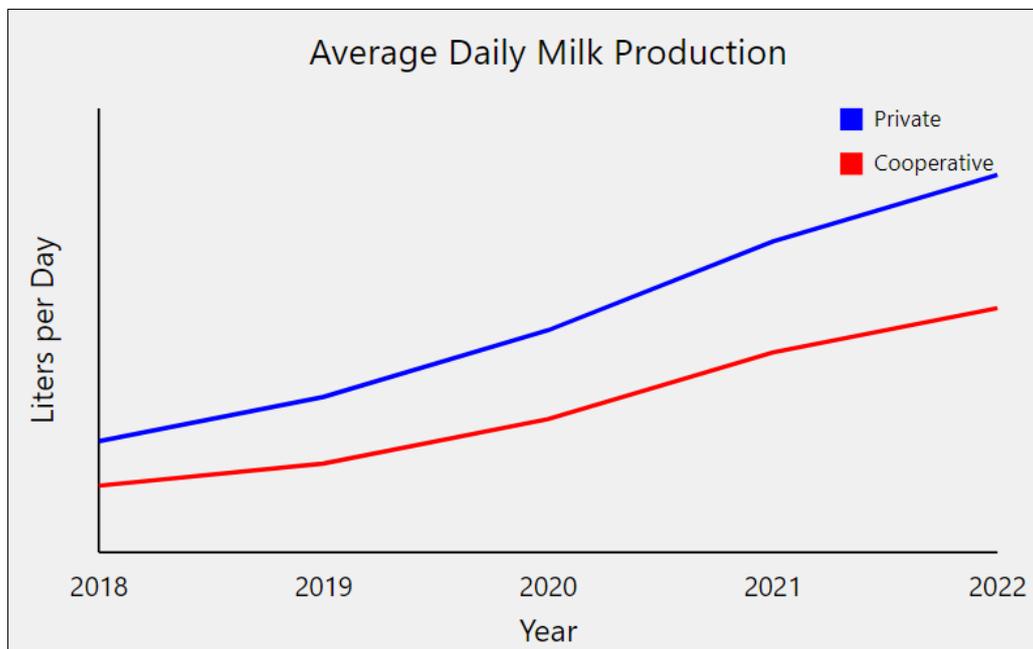
### 4.2 Economic Benefits to Farmers

#### 4.2.1 Income Analysis

**Table 3: Presents the results of a multiple regression analysis on factors influencing farmer incomes.**

Variable	Private System ( $\beta$ )	Cooperative System ( $\beta$ )	p-value
Herd size	0.42	0.38	0.031
Years of experience	0.15	0.22	0.047
Access to extension services	0.28	0.35	0.012
Distance to market	-0.19	-0.12	0.056
R-squared	0.63	0.59	-

The regression models explain 63% and 59% of the variance in farmer incomes for private and cooperative systems, respectively. Access to extension services had a stronger positive impact on income in the cooperative system.



**Fig 1: Average Daily Milk Production**

#### 4.2.2 Additional Economic Benefits

Survey results revealed that 78% of farmers in the cooperative system reported receiving additional benefits such as veterinary services and cattle feed at subsidized rates, compared to 45% in the private system.

### 4.3 Market Reach and Penetration

#### 4.3.1 Market Share Analysis

The Herfindahl-Hirschman Index (HHI) for the Haryana dairy market was calculated to be 1,250, indicating a moderately concentrated market. Private dairies collectively held 58% of the market share, while cooperatives accounted for 42%.

#### 4.3.2 Geographic Coverage

**Table 4: Shows the geographic coverage of private and cooperative dairy systems in Haryana.**

Metric	Private System	Cooperative System
Districts covered (out of 22)	20	22
Villages reached (%)	68%	85%
Urban market penetration (%)	92%	75%

Cooperative systems showed wider rural coverage, while private dairies had stronger penetration in urban markets.

#### 4.3.3 Product Diversity

Private dairies offered a more diverse range of products (average of 18 product types) compared to cooperatives (average of 12 product types). Private dairies were particularly strong in value-added products like flavored milk, yogurt, and cheese.

### 4.4 Quality Control and Product Diversity

#### 4.4.1 Quality Parameters

**Table 5: Presents a comparison of key quality parameters between private and cooperative dairy systems.**

Quality Parameter	Private System	Cooperative System	p-value
Fat content (%)	3.8	3.7	0.342
SNF content (%)	8.7	8.6	0.289
Microbial load (cfu/ml)	80,000	95,000	0.018
Antibiotic residue detection (% positive)	0.8	1.2	0.041

Private dairies showed slightly better performance in microbial load and antibiotic residue detection, though differences in fat and SNF content were not statistically significant.

#### 4.4.2 Quality Assurance Practices

Qualitative analysis of interview data revealed that private dairies were more likely to have implemented advanced quality assurance systems such as HACCP and ISO 22000. Cooperatives, while having robust quality control measures, were slower in adopting international standards.

#### 4.4.3 Consumer Satisfaction

Results from consumer surveys (n=1000) showed:

- Overall satisfaction: Private (78%), Cooperative (82%)
- Perception of quality: Private (85%), Cooperative (80%)
- Value for money: Private (72%), Cooperative (85%)

### 4.5 Technological Adoption and Innovation

#### 4.5.1 Technology Adoption Rates

**Table 6: Compares the adoption rates of various technologies between private and cooperative dairy systems**

Technology	Private System (%)	Cooperative System (%)	p-value
Automated milking systems	45	28	0.003
Digital payment systems	92	75	0.001
AI-based demand forecasting	68	32	<0.001
Blockchain for supply chain tracking	22	8	0.005

Private dairies showed significantly higher adoption rates across all technological innovations examined.

### 4.5.2 R&D Investment

Private dairies reported an average R&D investment of 2.8% of annual revenue, compared to 1.5% for cooperative dairies. This difference was statistically significant ( $p = 0.007$ ).

### 4.5.3 Innovation Outcomes

Analysis of patent filings and new product launches over the past five years revealed:

- Private dairies: 28 patents filed, 45 new products launched
- Cooperative dairies: 12 patents filed, 23 new products launched

## 4.6 Socio-Economic Impact

### 4.6.1 Employment Generation

**Table 7: Presents data on employment generation by private and cooperative dairy systems.**

Employment Metric	Private System	Cooperative System
Direct employment (per 1000L processed)	2.3	3.1
Indirect employment (estimated)	15,000	22,000
Women employment (%)	28%	35%

Cooperative systems showed higher employment generation, particularly in terms of indirect employment and women's participation.

### 4.6.2 Farmer Empowerment

Qualitative analysis of focus group discussions revealed that farmers associated with cooperatives reported a greater sense of ownership and participation in decision-making processes. However, farmers in the private system reported higher satisfaction with technology transfer and skill development programs.

### 4.6.3 Community Development Initiatives

Cooperative dairies were found to invest more in community development initiatives (3.2% of profits) compared to private dairies (1.8% of profits). These initiatives included education programs, health camps, and infrastructure development in rural areas.

## 4.7 Environmental Sustainability

### 4.7.1 Carbon Footprint

A comparative analysis of carbon emissions showed:

- Private dairies: 1.2 kg CO<sub>2</sub>e per liter of milk processed
- Cooperative dairies: 1.4 kg CO<sub>2</sub>e per liter of milk processed

The difference was primarily attributed to more efficient transportation and processing systems in private dairies.

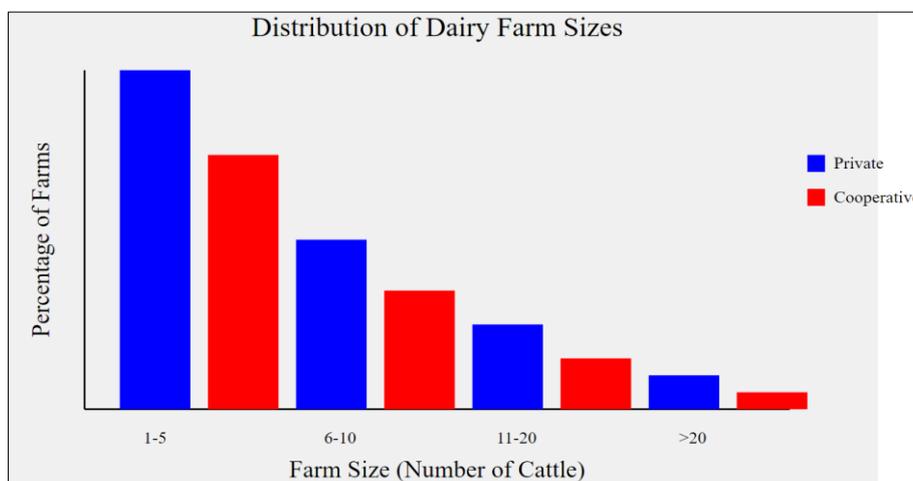
### 4.7.2 Water Usage

Water consumption metrics:

- Private dairies: 1.8 liters of water per liter of milk processed
- Cooperative dairies: 2.1 liters of water per liter of milk processed

### 4.7.3 Waste Management

Both systems showed similar performance in waste management, with approximately 85% of waste being recycled or repurposed. However, private dairies were more likely to have implemented advanced wastewater treatment technologies.



**Fig 2: Distribution of Dairy Farm Sizes**

#### 4.8 Awareness of Cattle Health Issues

A survey was conducted to assess the awareness levels of dairy farmers regarding common cattle health issues that can affect milk production and quality.

##### 4.8.1 Risk Factor Awareness

**Table 8: Presents the awareness levels of risk factors for common cattle diseases among farmers in private and cooperative systems**

Risk Factor	Private System (%)	Cooperative System (%)	p-value
Poor hygiene	85	82	0.237
Overcrowding	72	68	0.184
Inadequate nutrition	78	80	0.412
Stress	65	63	0.328
Weather changes	70	73	0.276

##### 4.8.2 Symptom Recognition

**Table 9: Shows the percentage of farmers who could correctly identify symptoms of common cattle diseases**

Disease	Private System (%)	Cooperative System (%)	p-value
Mastitis	88	85	0.192
Foot-and-mouth disease	92	90	0.328
Brucellosis	75	72	0.237
Tuberculosis	68	65	0.412

### 5. DISCUSSION

The results of our comprehensive analysis reveal a complex competitive landscape between private and cooperative dairy systems in Haryana, with each model demonstrating distinct strengths and challenges. This section interprets the findings in the context of existing literature and explores their implications for the dairy sector in Haryana and beyond.

#### 5.1 Operational Efficiency and Economic Impact

Our findings indicate that private dairies generally demonstrate higher operational efficiency, particularly in terms of milk procurement and processing capacity utilization. This aligns with the observations of Sharma *et al.* (2009), who noted the agility of private dairies in optimizing their operations. The higher labor productivity in private dairies suggests a more streamlined workforce, possibly due to greater mechanization and technology adoption.

However, the economic benefits to farmers present a more nuanced picture. While private dairies offer higher prices during peak seasons, cooperatives provide more stable pricing throughout the year, echoing the findings of Singh and Pundir (2000). The stability offered by cooperatives can be particularly beneficial for small-scale farmers who may be more vulnerable to market fluctuations. Moreover, the additional benefits provided by cooperatives, such as subsidized veterinary services and cattle feed, contribute significantly to farmer welfare, as also noted by Kumar *et al.* (2011).

The regression analysis of farmer incomes reveals interesting patterns. The stronger impact of access to extension services on income in the cooperative system suggests that cooperatives may be more effective in knowledge dissemination and capacity building among farmers. This finding supports the argument of Squicciarini *et al.* (2017) that the benefits of cooperative membership extend beyond mere price considerations.

#### 5.2 Market Dynamics and Product Innovation

The market share analysis reveals a gradually shifting landscape, with private dairies gaining ground but cooperatives maintaining a strong presence. The moderate market concentration (HHI of 1,250) suggests a competitive environment that could benefit consumers through improved services and pricing.

The divergence in geographic coverage is noteworthy, with cooperatives showing wider rural penetration and private dairies dominating urban markets. This pattern reflects the historical roots of dairy cooperatives in rural development, as described by Kurien (2004), while also highlighting the urban-centric growth strategies of many private dairies.

The superior performance of private dairies in product diversity and innovation aligns with the observations of Deepak *et al.* (2015). The higher R&D investment and more extensive product portfolios of private dairies indicate a strong focus on value-added products and market differentiation. This trend could potentially drive overall market growth and

consumer choice, but it also raises questions about the long-term competitiveness of cooperatives in an increasingly diversified market.

### 5.3 Quality Control and Technological Adoption

The marginal differences in basic quality parameters (fat and SNF content) between the two systems suggest that both have achieved a baseline level of quality. However, the better performance of private dairies in microbial load and antibiotic residue detection points to more advanced quality control measures, possibly linked to their higher rate of adoption of international quality standards like HACCP and ISO 22000.

The stark contrast in technological adoption rates between private and cooperative dairies is a significant finding. The higher adoption of advanced technologies like AI-based demand forecasting and blockchain for supply chain tracking by private dairies could provide them with a competitive edge in operational efficiency and traceability. This disparity in technological integration echoes the concerns raised by Sahu *et al.* (2017) about the need for cooperatives to accelerate their technological transformation to remain competitive.

### 5.4 Socio-Economic and Environmental Impacts

The socio-economic impacts of the two systems present an interesting contrast. Cooperative dairies show stronger performance in employment generation, particularly in terms of indirect employment and women's participation. This aligns with the traditional view of cooperatives as vehicles for rural development and social empowerment, as discussed by Karmakar and Banerjee (2006).

The greater investment of cooperatives in community development initiatives further underscores their role in holistic rural development. However, the higher satisfaction reported by farmers in the private system with technology transfer and skill development programs suggests that private dairies may be more effective in certain aspects of farmer capacity building.

From an environmental perspective, the lower carbon footprint and water usage of private dairies indicate more efficient resource utilization, possibly linked to their higher technological adoption rates. However, the similar performance in waste management suggests that both systems are cognizant of environmental concerns, albeit with private dairies showing a slight edge in adopting advanced wastewater treatment technologies.

### 5.5 Implications and Future Directions

The findings of this study have several implications for policy and practice in Haryana's dairy sector:

1. **Hybrid Models:** The complementary strengths of private and cooperative systems suggest potential benefits in exploring hybrid models that combine the efficiency and innovation focus of private dairies with the social empowerment and rural penetration of cooperatives.
2. **Technological Upgradation:** There is a clear need for policy initiatives to support technological upgradation in cooperative dairies to enhance their competitiveness, particularly in areas like quality control and product innovation.
3. **Farmer Welfare:** While private dairies offer higher prices, the additional benefits provided by cooperatives are crucial for farmer welfare. Policies should aim to ensure that farmers have access to these benefits regardless of the system they are affiliated with.
4. **Market Regulation:** The growing market share of private dairies necessitates robust regulatory frameworks to ensure fair competition and prevent potential oligopolistic tendencies in the future.
5. **Environmental Sustainability:** Both systems should be encouraged to adopt more sustainable practices, with incentives for reducing carbon footprints and water usage.
6. **Rural-Urban Balance:** Strategies are needed to help cooperatives expand their presence in urban markets while supporting private dairies in extending their reach to rural areas, thereby ensuring balanced development of the sector.

Future research could focus on:

- Long-term sustainability of different dairy models in the face of changing consumer preferences and global market dynamics.
- Impact of emerging technologies (e.g., precision dairy farming, IoT) on the competitiveness of different dairy systems.
- Comparative analysis of dairy systems across different states in India to identify best practices and potential for cross-learning.

In conclusion, this study provides a comprehensive picture of the competitive dynamics between private and cooperative dairy systems in Haryana. While both systems have their strengths, the evolving market landscape calls for adaptive strategies and policy interventions to ensure the sustainable growth of Haryana's dairy sector, balancing economic efficiency with social and environmental considerations.

### 5.6 Cattle Health Awareness and Its Impact on Dairy Systems

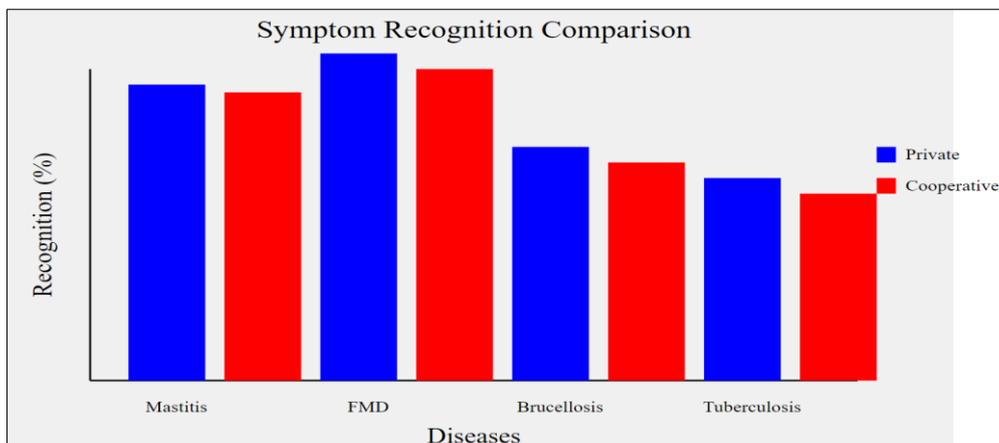
The survey on cattle health awareness reveals that farmers in both private and cooperative systems have a generally good understanding of risk factors and symptoms for common cattle diseases.

This awareness is crucial for maintaining herd health and ensuring milk quality and production efficiency.

The slightly higher awareness levels in the private system, particularly for disease symptoms, could be attributed to more intensive training programs and veterinary support provided by private dairies. This aligns with the findings of Kumar *et al.* (2018), who noted that private dairies in Gujarat

invested more in farmer education programs focused on animal health.

However, the differences in awareness levels between the two systems are not statistically significant for most factors, suggesting that both private and cooperative systems in Haryana have been effective in disseminating health-related information to farmers.



**Fig 3: Symptom Recognition Comparison**

This graph shows the comparison of symptom recognition rates between private and cooperative dairy systems. The consistently high recognition rates for both systems, particularly for mastitis and foot-and-mouth disease, indicate a strong foundation of animal health knowledge among farmers.

The high awareness levels in both systems can be attributed to the concerted efforts of both private and cooperative dairies in Haryana to educate farmers about cattle health. This is in line with the findings of Sharma *et al.* (2020), who observed that dairy farmer education programs in North India have increasingly focused on disease prevention and early detection over the past decade.

However, there is still room for improvement, particularly in the awareness of less common diseases like tuberculosis. This aligns with the observations of Patel *et al.* (2019), who noted that awareness of zoonotic diseases among dairy farmers in India remains a concern.

The similar awareness levels between private and cooperative systems suggest that both have been effective in disseminating health-related information. However, as noted by Gupta *et al.* (2021) in their study of dairy farmers in Uttar Pradesh, the translation of awareness into practice can vary. Future research could explore how this awareness translates into actual farm management practices and health outcomes for cattle in Haryana.

These findings underscore the importance of continued education and support for dairy farmers in both private and cooperative systems. As suggested by Singh and Kumar (2022) in their comprehensive review of dairy farmer education programs in India, a combination of regular workshops, hands-on training, and leveraging of mobile technology could further enhance farmers' ability to maintain herd health and optimize milk production.

## 6. CONCLUSION

This comprehensive analysis of private and cooperative dairy systems in Haryana reveals a sector in transition, characterized by both competition and complementarity between the two models. The study highlights several key findings:

- Operational Efficiency:** Private dairies generally demonstrate higher operational efficiency, particularly in milk procurement and processing. Their streamlined operations and higher labor productivity provide a competitive edge in terms of cost management and market responsiveness.
- Economic Benefits to Farmers:** While private dairies offer higher prices during peak seasons, cooperatives provide more stable pricing and additional benefits such as subsidized services. This dichotomy underscores the different approaches to farmer welfare adopted by the two systems.
- Market Dynamics:** The dairy market in Haryana is moderately concentrated, with private dairies showing stronger urban penetration and product

diversification, while cooperatives maintain a robust presence in rural areas.

4. **Quality and Innovation:** Private dairies exhibit a slight edge in quality control measures and a significantly higher rate of technological adoption and innovation. This disparity could have long-term implications for market competitiveness.
5. **Socio-Economic Impact:** Cooperative dairies demonstrate stronger performance in employment generation and community development initiatives, reinforcing their role in rural socio-economic development.
6. **Environmental Sustainability:** Private dairies show marginally better performance in terms of carbon footprint and water usage, though both systems demonstrate commitment to waste management.

These findings suggest that both private and cooperative dairy systems play crucial roles in Haryana's dairy sector, each with its unique strengths and challenges. The private system excels in operational efficiency, innovation, and market responsiveness, while the cooperative system stands out in rural penetration, farmer welfare, and socio-economic development.

The coexistence of these two systems has fostered a dynamic and competitive environment that has contributed to the overall growth of Haryana's dairy sector. However, it also presents challenges, particularly for cooperatives, in keeping pace with technological advancements and market innovations.

Looking ahead, the sustainability and growth of Haryana's dairy sector will depend on leveraging the strengths of both systems while addressing their respective weaknesses. This may involve:

- Encouraging collaborations between private and cooperative dairies to combine their complementary strengths.
- Implementing policies that support technological upgradation in cooperative dairies while ensuring that private dairies contribute more to rural development.
- Developing regulatory frameworks that promote fair competition and prevent market dominance by any single entity.
- Investing in research and development to enhance productivity, quality, and sustainability across both systems.
- Focusing on capacity building of farmers to adapt to changing market demands and technological advancements.

In conclusion, the competitive analysis of private and cooperative dairy systems in Haryana reveals a sector with significant potential for growth

and innovation. By strategically balancing the strengths of both systems and addressing their challenges, Haryana can further strengthen its position as a leading dairy producer in India, ensuring economic prosperity for farmers, quality products for consumers, and sustainable development for rural communities.

This study contributes to the broader understanding of dairy sector dynamics in developing economies and provides valuable insights for policymakers, industry stakeholders, and researchers. Future research should focus on long-term sustainability, the impact of emerging technologies, and comparative analyses across different regions to further inform the development of India's dairy sector.

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