INTERNATIONAL JOURNAL OF RESEARCH CULTURE SOCIETY
Monthly Peer-Reviewed, Refereed, Indexed Journal
Volume - 9, Issue - 7, July - 2025
ISSN(O): 2456-6683
[Impact Factor: 9.241]
IJRCS

DOIs:10.2017/IJRCS/202507034 --:-- Research Paper / Article / Review

India's Dairy Revolution: From Cooperative Innovation to Global Leadership in Sustainable Rural Development

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Abstract: *India's dairy sector represents one of the most significant agricultural transformation stories of the modern era. This comprehensive analysis examines the multifaceted dimensions of India's dairy industry, from its humble beginnings to its current status as the world's largest milk-producing nation. The sector has evolved from traditional subsistence farming to a sophisticated network of cooperatives, processing facilities, and distribution systems that collectively generate employment for millions while ensuring food security for over 1.4 billion people. This study explores the sector's economic impact, technological advancement, cooperative structure, market dynamics, challenges, and future prospects, providing insights into how India's dairy industry serves as a model for sustainable agricultural development in emerging economies.*

1. INTRODUCTION

The Indian dairy sector stands as a testament to the transformative power of cooperative movements, technological innovation, and farmer empowerment. What began as scattered, subsistence-level milk production has metamorphosed into a sophisticated industry that not only meets domestic demand but also positions India as a potential global dairy powerhouse. The journey from milk scarcity in the 1950s to surplus production today represents more than statistical achievement; it embodies a socio-economic revolution that has fundamentally altered rural India's landscape.

The significance of this transformation extends beyond production metrics. The dairy sector has become a cornerstone of rural economic development, providing sustainable livelihoods to millions of farming families, particularly small and marginal farmers who constitute the backbone of Indian agriculture. The sector's inclusive growth model has demonstrated how agricultural development can be both economically viable and socially equitable, offering valuable lessons for other developing nations grappling with similar challenges.

2. Literature Review and Historical Context

The body of literature on India's dairy sector consistently underscores its dual identity as both the world's largest milk producer and a sector with modest global trade participation. Foundational studies such as Miranda and Ramachandran (2014) and Ohlan (2016) highlight how domestic consumption absorbs nearly all production, leaving limited export surpluses despite structural improvements introduced by Operation Flood. These early studies establish the sector's transformation from an import-dependent market to a self-reliant and net-exporting system, yet caution that infrastructural and regulatory inefficiencies continue to hinder competitiveness.

Several studies adopt macroeconomic perspectives, linking dairy growth to national development. Basaragi and Kadam (2025) and Ramani et al. (2023) emphasize dairy's 4–5% contribution to GDP and its role in providing livelihoods for over 80 million farmers, particularly women, positioning it as central to rural development and food

security. Khongsai (2020) and Reddy and Padmavathi (2016) further confirm dairy's pivotal role in dietary improvement and employment generation, projecting sustained growth driven by income elasticity and urbanization.

3. Pre-Independence Era and Early Challenges

The foundations of India's modern dairy sector can be traced back to the colonial era, when milk production was largely unorganized and confined to meeting local needs. During this period, the dairy sector was characterized by subsistence farming, with most farmers keeping one or two animals primarily for household consumption. The lack of proper storage, transportation, and processing facilities meant that surplus milk often went to waste, particularly during peak production seasons.

The colonial administration's focus on cash crops for export meant that livestock development received minimal attention. This neglect resulted in a sector that was technologically backward, economically unviable for most farmers, and unable to meet the growing urban demand for milk and dairy products. The exploitative practices of middlemen further marginalized milk producers, who received minimal compensation for their produce while consumers paid exorbitant prices.

4. The White Revolution and Cooperative Genesis

The post-independence period marked the beginning of systematic efforts to develop India's dairy sector. The government recognized the potential of dairying as a means of improving rural incomes and ensuring nutritional security. However, the real transformation began with the establishment of the first farmers' integrated dairy cooperative in Anand, Gujarat, in 1946, under the leadership of Sardar Vallabhbhai Patel and the guidance of Verghese Kurien.

Operation Flood, launched in 1970 and implemented in three phases until 1996, represents the most significant intervention in India's dairy sector development. Conceived and led by Dr. Verghese Kurien, this program aimed to replicate the Anand Pattern across the country, creating a national network of dairy cooperatives. The program's objectives were ambitious: increase milk production, improve productivity, enhance farmer incomes, and ensure fair prices for consumers.

5. Current Market Dynamics and Production Statistics

- **Market Size and Growth Trajectory**

The contemporary Indian dairy market presents impressive statistics that reflect its robust growth and potential. Recent market analysis indicates that the Indian dairy market reached a valuation of INR 18,975 billion in 2024, with projections suggesting growth to INR 57,001.81 billion by 2033, representing a compound annual growth rate (CAGR) of 12.35% during the forecast period (IMARC Group, 2025). Alternative assessments place the market value at USD 146.80 billion in 2025, with expectations of reaching USD 274.09 billion by 2032, exhibiting a CAGR of 9.33% (Fortune Business Insights, 2025).

These growth projections are supported by several fundamental drivers. India's expanding population, currently exceeding 1.4 billion, creates a massive domestic market for dairy products. Rising disposable incomes, particularly in urban areas, are driving demand for premium dairy products and value-added items. Additionally, increasing health consciousness among consumers is fueling demand for protein-rich dairy products, organic milk, and functional dairy foods.

- **Production Excellence and Global Leadership**

India's position as the world's largest milk producer is well-established and continues to strengthen with each passing year. The country's milk production reached approximately 211.7 million metric tons in 2024-25, representing an increase of roughly 2.2% over the previous year (Edairy, 2025). This production level significantly exceeds that of other major dairy-producing nations, with India accounting for nearly 23% of global milk production.

Cow milk production is expected to reach 103.2 million metric tons in 2025, up from 101 million metric tons in 2024 (The Dairy Site, 2025). Buffalo milk continues to play a crucial role in India's dairy sector, contributing approximately 48% of total milk production. Buffalo milk is particularly valued for its higher fat content, making it suitable for traditional dairy products like ghee, khoa, and paneer.

- **Product Diversification and Market Segmentation**

The Indian dairy market exhibits distinct product segmentation patterns that reflect consumption preferences and dietary habits. Liquid milk stands as the leading product type with a market share of 65.3% in 2024, attributed to its critical role in daily consumption and high nutritional value as a staple food (IMARC Group, 2025). Beyond liquid milk, the market encompasses a diverse range of products including yogurt, cheese, butter, ghee, milk powder, and ice cream.

Traditional products like ghee and paneer continue to hold significant market shares due to their cultural significance and culinary applications. Meanwhile, modern dairy products such as flavored milk, probiotic yogurt, and specialty cheeses are gaining traction, particularly among urban consumers. The product diversification reflects the sector's evolution from a commodity-focused industry to one that caters to sophisticated consumer preferences.

6. The Cooperative Movement: Foundation of Success

- **Structural Innovation and Democratic Governance**

The cooperative movement in India's dairy sector represents one of the most successful examples of grassroots economic organization in the developing world. The movement's philosophical foundation rests on the principles of collective action, equitable benefit distribution, and farmer empowerment. The dairy cooperative structure in India follows a three-tier system: village-level primary cooperatives, district-level unions, and state-level federations.

The governance structure emphasizes democratic participation, with farmers electing representatives at each level. This democratic framework ensures that decision-making processes remain transparent and accountable to the membership. Professional management complements the democratic governance structure, ensuring that commercial objectives are achieved while maintaining cooperative principles.

- **Economic Impact and Farmer Empowerment**

The economic impact of dairy cooperatives extends far beyond milk procurement and processing. Dairy cooperatives generate employment opportunities for approximately 15 million farm families (NDDB, 2025), making it one of the largest sources of rural employment in the country. This employment is particularly significant for small and marginal farmers, women, and landless laborers who find sustainable livelihood opportunities within the cooperative network.

The cooperative model has demonstrated its effectiveness in improving farmer incomes through multiple mechanisms. Fair pricing policies ensure that farmers receive remunerative prices for their milk, often higher than those offered by private traders. Regular payment systems, typically on a weekly or bi-weekly basis, provide farmers with steady cash flow, crucial for meeting household expenses and farm investments.

7. Technological Innovation and Digital Transformation

- **Automation and Smart Farming**

The Indian dairy sector has embraced automation and advanced process technology to enhance efficiency, improve product quality, and ensure food safety. Technologies like automation, Internet of Things (IoT), and artificial intelligence (AI) are being employed to enhance efficiency, improve product quality, and ensure safety (IMARC Group, 2025). These technological interventions are transforming traditional dairy operations into modern, efficient systems.

IoT applications in dairy farming are revolutionizing animal husbandry practices through real-time monitoring and data-driven decision making. Smart sensors attached to animals monitor health parameters, activity levels, and reproductive status. Environmental monitoring systems track barn conditions including temperature, humidity, and air quality. Automated climate control systems maintain optimal conditions for animal comfort and productivity.

- **Digital Platforms and Market Access**

Digital start-ups like Stellapps, Promethean Power, and Inficold are working on transforming Indian dairy farming through innovative solutions (Pashudhan Praharee, 2023). These companies are developing comprehensive solutions that address various aspects of dairy farming including milk collection, quality testing, cold chain management, and farmer services.

ISSN(O): 2456-6683
[Impact Factor: 9.241]

Digital platforms are transforming the way farmers interact with cooperatives, access services, and manage their operations. Mobile applications provide farmers with real-time information about milk prices, payment status, and cooperative services. Farm management applications help farmers maintain detailed records of animal performance, health treatments, breeding activities, and feed consumption.

8. Economic Impact and Employment Generation

- **Contribution to National Development**

The dairy sector's contribution to India's economy extends far beyond direct production values, encompassing multiple layers of economic activity that support millions of livelihoods. The estimated annual value of India's milk production has grown substantially from ₹2,900 billion in 2012-13 (NDDB, 2025) to much higher levels today, reflecting both increased production volumes and improved pricing mechanisms.

The livestock sector, of which dairy forms a major component, is the backbone of Indian agriculture and plays a crucial role in rural economy development, with more than one-fifth (23%) of agricultural households with area less than 0.01 hectare reporting livestock as their principal source of income (SpringerLink, 2025). This statistic underscores the sector's critical role in supporting marginalized farming communities who have limited access to land resources.

- **Women's Empowerment and Social Impact**

Women's participation in dairy farming is notably high, with women traditionally responsible for animal care, milking, and milk processing activities. The cooperative model has recognized and leveraged this involvement, creating women-only cooperatives and leadership roles for women within mixed cooperatives. This approach has contributed to women's economic empowerment and improved household welfare.

The sector's contribution to financial inclusion extends beyond direct participants. Successful dairy farmers often become community leaders and entrepreneurs, establishing ancillary businesses and providing informal credit to other community members. This ripple effect contributes to broader rural economic development and financial deepening.

9. Value Chain Analysis and Processing Infrastructure

- **Modern Processing and Quality Management**

The dairy value chain in India begins at the farm level with milk production and extends through collection, processing, distribution, and retail. Most processing capacity comes from the organized segment (Sathguru Management Consultants, 2021), reflecting significant investments in infrastructure and technology over the past few decades.

Milk collection systems have been modernized to ensure efficiency and quality maintenance. Village-level collection centers are equipped with electronic weighing scales, fat testing equipment, and basic quality assessment tools. Refrigerated transportation connects collection centers to processing facilities, maintaining the cold chain essential for quality preservation.

Secondary processing encompasses the transformation of milk into various dairy products including yogurt, cheese, butter, ghee, milk powder, and ice cream. Traditional dairy products continue to dominate the secondary processing segment, while modern dairy products are gaining market share, particularly in urban areas.

- **Distribution Networks and Market Reach**

The distribution network for dairy products in India encompasses multiple channels, each serving specific market segments and geographical areas. Cooperative networks maintain extensive distribution systems that reach even remote rural areas, ensuring product availability and affordability. Modern retail channels, including supermarkets, hypermarkets, and organized retail chains, serve urban consumers seeking convenience and variety.

E-commerce platforms are emerging as significant distribution channels, particularly for premium and specialty dairy products. India's e-commerce platforms achieved a gross merchandise value of USD 60 billion in fiscal year 2023, marking a 22% increase from the previous year (IMARC Group, 2025). This growth provides opportunities for dairy companies to reach consumers directly and offer specialized products.

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10. Regional Performance and State-wise Analysis

- **Leading Dairy States and Models**

The geographical distribution of dairy production in India reflects variations in agro-climatic conditions, infrastructure development, and policy support. Uttar Pradesh leads in absolute milk production, accounting for approximately 16% of national output. Rajasthan ranks second in milk production, with its arid climate being well-suited to buffalo rearing.

Different states have developed unique cooperative models that reflect local conditions and policy priorities. Gujarat's AMUL model remains the benchmark for cooperative success, with its focus on farmer ownership, professional management, and market-driven operations. Tamil Nadu's Aavin cooperative network demonstrates how state government support can complement cooperative principles to achieve sector development.

- **Emerging Opportunities in Eastern States**

Eastern and northeastern states represent emerging opportunities for dairy sector development. West Bengal has shown significant growth in milk production through focused government programs and cooperative development. Odisha and Bihar have implemented state-specific dairy development programs that address local challenges including infrastructure deficits, limited technical knowledge, and fragmented production systems.

11. Challenges and Strategic Responses

- **Infrastructure and Quality Concerns**

Despite significant progress, the Indian dairy sector continues to face substantial infrastructure challenges that limit its efficiency and growth potential. About 60 percent of surplus milk in India's dairy industry remains unorganized (Pashudhan Praharee, 2023), which presents challenges for maintaining consistent quality standards and ensuring food safety compliance.

Cold chain infrastructure, while improved, remains inadequate for the sector's scale and geographical spread. Rural areas, where most milk production occurs, often lack reliable electricity supply and refrigeration facilities, leading to quality deterioration and economic losses. Investment in rural infrastructure development is essential for sector growth and farmer welfare.

- **Environmental Sustainability**

Environmental sustainability has emerged as a critical challenge for the dairy sector globally, and India faces similar concerns. Livestock farming contributes to greenhouse gas emissions through methane production, requiring attention to climate change mitigation strategies. Water resource management represents another significant challenge, with dairy farming requiring substantial water resources for drinking, cleaning, and processing activities.

12. Export Potential and Global Opportunities

- **Current Export Performance and Future Prospects**

India's dairy export performance, while modest compared to domestic production, shows potential for significant expansion. India exported 67,572.99 metric tonnes of dairy products worth $284.65 million in 2022-23 (Invest UP, 2025). Though modest compared to domestic production, these exports demonstrate the sector's potential for international market participation.

The future of Indian dairy exports will see greater demand for organic dairy, A2 milk, and specialty cheese varieties as global consumers shift towards premium, health-conscious choices (Kabilai Farm, 2025). Cross-border e-commerce platforms including Amazon, Flipkart, and Alibaba are becoming key channels for dairy exports, enabling Indian brands to sell directly to global consumers (Kabilai Farm, 2025).

- **Market Access and Certification Requirements**

International market access requires compliance with stringent quality and safety standards. Hazard Analysis and Critical Control Points (HACCP) certification, ISO standards, and country-specific requirements must be met for

export authorization. Many countries are imposing sustainability and environmental compliance norms on dairy imports, requiring Indian exporters to remain competitive through environmental standards.

13. Innovation and Future Prospects

- **Product Innovation and Market Development**

Indian dairy industry's strength lies in its rich heritage of traditional dairy products that have sustained nutritional needs for millennia. Modern processing techniques are being applied to these traditional products to improve shelf life, ensure consistency, and meet contemporary packaging and distribution requirements.

The growing awareness of health benefits associated with dairy consumption has driven innovation in functional dairy products. Probiotic yogurts containing beneficial bacteria strains support digestive health and immune function. Protein-enriched milk and dairy products cater to fitness enthusiasts and health-conscious consumers seeking convenient protein sources.

- **Technology Integration and Industry 4.0**

The dairy sector's future will be increasingly shaped by advanced technologies including artificial intelligence, machine learning, robotics, and biotechnology. Smart farming systems will optimize animal management, feed efficiency, and environmental control. Biotechnology applications will enhance animal breeding, develop improved feed additives, and create innovative dairy products.

14. Government Policies and Strategic Support

- **National Programs and State Initiatives**

The Government of India has implemented various programs to support dairy sector development, building upon the success of Operation Flood. The National Programme for Dairy Development (NPDD) focuses on increasing productivity through genetic improvement, feed optimization, and infrastructure development. The Dairy Processing and Infrastructure Development Fund (DIDF) provides financial support for establishing and expanding processing facilities. State governments have implemented complementary programs that address local conditions and priorities. Some states provide subsidies for animal purchase, feed supplements, and veterinary services. Skill development programs focus on training farmers in modern dairy farming practices, animal husbandry techniques, and business management.

15. Conclusion

India's dairy sector represents one of the most remarkable agricultural transformation stories of the modern era. From a nation struggling with milk shortages in the 1950s to becoming the world's largest milk producer today, the sector's journey exemplifies how well-designed policies, cooperative movements, and technological innovation can create inclusive and sustainable growth. The sector's success rests on several foundational pillars: the cooperative movement that empowered farmers and eliminated exploitative intermediaries; technological advancement that improved productivity and quality; government support that provided enabling infrastructure and policies; and market development that created viable economic opportunities throughout the value chain.

The cooperative model, pioneered by the Anand Pattern and scaled through Operation Flood, remains the sector's greatest strength. This model demonstrated how farmer ownership, professional management, and market orientation could be successfully combined to create economically viable and socially equitable enterprises. The cooperative network's reach to 15 million farm families represents not just an economic achievement but a social revolution that transformed rural India. With a market valuation projected to reach INR 57,001.81 billion by 2033, the dairy sector represents a major economic engine that supports millions of livelihoods while contributing significantly to India's GDP. The sector's inclusive nature ensures that benefits reach small farmers, women, and marginalized communities, supporting broader development objectives. Looking ahead, the dairy sector faces both opportunities and challenges. Growing domestic demand, export potential, and technological possibilities create significant growth opportunities. However, climate change, sustainability concerns, and market competition require strategic responses and adaptive capabilities. The sector's future success will depend on its ability to embrace innovation while maintaining its cooperative foundations.

India's dairy sector serves as a model for agricultural development in emerging economies. Its demonstration that small farmers can be organized into efficient economic systems while maintaining social equity provides valuable lessons for other sectors and countries. The sector's continued evolution and adaptation will undoubtedly contribute to India's aspirations of becoming a developed economy while ensuring food security and rural prosperity. The story of India's dairy sector is ultimately one of human empowerment and institutional innovation. It shows how collective action, supported by appropriate technology and policies, can transform traditional agriculture into modern, efficient systems that serve both economic and social objectives. As the sector continues to evolve, it remains a testament to the potential of cooperative enterprise and the power of farmer empowerment in creating sustainable and inclusive growth.

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