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India's Dairy Ecosystem: The Role of Cooperatives, Technology, and Finance

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India's dairy industry has transformed from a milk-scarce sector into the largest dairy producer globally, driven by its extensive livestock resources, robust cooperative network, technological innovation, and supportive government policies. This article examines the structural foundations of India's dairy ecosystem, including livestock resources, milk production trends, regional growth patterns, dairy value chains, and the pivotal role of cooperatives such as Amul, Nandini, Aavin, and Milma. The article further explores emerging digital innovations, including Artificial Intelligence, Internet of Things-based cattle monitoring, digital payments, and traceability systems that are transforming dairy operations. International best practices, government initiatives, and sectoral challenges are analysed to identify opportunities for sustainable growth. Particular emphasis is placed on value chain financing, climate-resilient investments, and technology-enabled lending models that can unlock the next phase of India's dairy-led rural transformation and economic prosperity.

"Dairying is not a mere business; it is a tool for social and economic change."

— Dr. Verghese Kurien, Father of the White Revolution

Introduction: The Architecture of India's White Revolution

The growth of India's dairy sector is widely regarded as one of the most significant success stories in the world dairy industry. From a milk-deficient nation in the 1960s, the country has emerged as the world's largest milk producer, contributing nearly one-fourth of global milk output. Milk production increased from 146.3 million tonnes in 2014-15 to 247.9 million tonnes in 2024-25, while per capita milk availability rose from 322 grams per day to about 485 grams per day. The sector supports more than 80 million rural households and provides a dependable source of income, particularly for small and marginal farmers and women. Beyond its contribution to nutrition, dairying acts as a stabilizing force in rural economies by generating daily cash flows and reducing dependence on seasonal crop income. The resilience of this ecosystem stems from the effective convergence of livestock resources, cooperative networks, technological innovations, infrastructure development, supportive policies, and financial services.

Livestock Resources and Milk Production Landscape

India possesses the world's largest bovine population and accounts for nearly 13 percent of global cattle resources.

Table 1: India's Livestock Population

Animal Category	Share in Livestock Population (%)
Cattle	36.1
Buffalo	20.5
Goat	27.8
Sheep	13.8

Animal Category	Share in Livestock Population (%)
Others (Pig, Horse, Camel, Mule, Donkey)	1.9

(Source: GAIN-India Livestock and Products Annual; Animal Husbandry Statistics)

Buffaloes play a particularly significant role by contributing nearly half of the country's milk production despite their smaller population share. Indigenous breeds such as Gir, Sahiwal, Red Sindhi, Tharparkar, Murrah, Mehsana, and Jaffarabadi continue to form the backbone of sustainable dairy development.

Milk Production and Per Capita Availability

Table 2: Growth in Milk Production and Availability

Year	Milk Production (Million Tonnes)	Per Capita Availability (g/day)
2014-15	146.31	322
2019-20	198.44	406
2023-24	239.3	471
2024-25	247.87	485

(Source: Basic Animal Husbandry Statistics (BAHS) 2025, DAHD)

India's milk production growth has consistently outpaced global averages. Over the last decade, milk production has recorded a compound annual growth rate exceeding 5 percent. Simultaneously, per capita milk availability has increased substantially, reflecting improvements in both production and distribution networks.

State-Wise Milk Production: Regional Drivers of India's Dairy Growth

Table 3: Leading Milk Producing States

State	Share in National Milk Production (%)
Uttar Pradesh	15.66
Rajasthan	14.82
Madhya Pradesh	9.12
Gujarat	7.78
Maharashtra	6.71
Andhra Pradesh	4.5
Karnataka	4
Tamil Nadu	3.8

(Source: Dept of Animal Husbandry and Dairying (DAHD), GOI)

Milk production in India is concentrated in a few leading states, with Uttar Pradesh, Rajasthan, Madhya Pradesh, Gujarat, and Maharashtra together contributing more than half of the country's total output. Their dominance is supported by favourable agro-climatic conditions, large milch animal populations, strong cooperative networks, well-developed veterinary services, and efficient milk procurement systems. Uttar Pradesh leads national production, while Rajasthan and Madhya Pradesh have expanded rapidly through breed improvement, organized milk collection, and growing dairy infrastructure. Gujarat remains a model for cooperative-led dairy development through the success of the Amul network, whereas Maharashtra benefits from a combination of cooperative and private sector investments in processing and value-added products. Southern states such as Karnataka, Andhra Pradesh, and Tamil Nadu have also strengthened their position through efficient dairy federations, modern processing facilities, chilling infrastructure, and digital procurement systems, resulting in higher productivity and greater farmer participation. Despite this progress, significant interstate disparities persist in milk productivity, per capita availability, breed quality, fodder resources, and infrastructure. States with better veterinary support, scientific feeding practices, crossbred cattle penetration, and organized marketing channels generally achieve higher yields and farmer incomes. In contrast, several eastern and northeastern states continue to face challenges related to low productivity, inadequate fodder availability, weak market linkages, and limited processing facilities. These variations

highlight the need for region-specific strategies to achieve balanced and inclusive growth in the dairy sector.

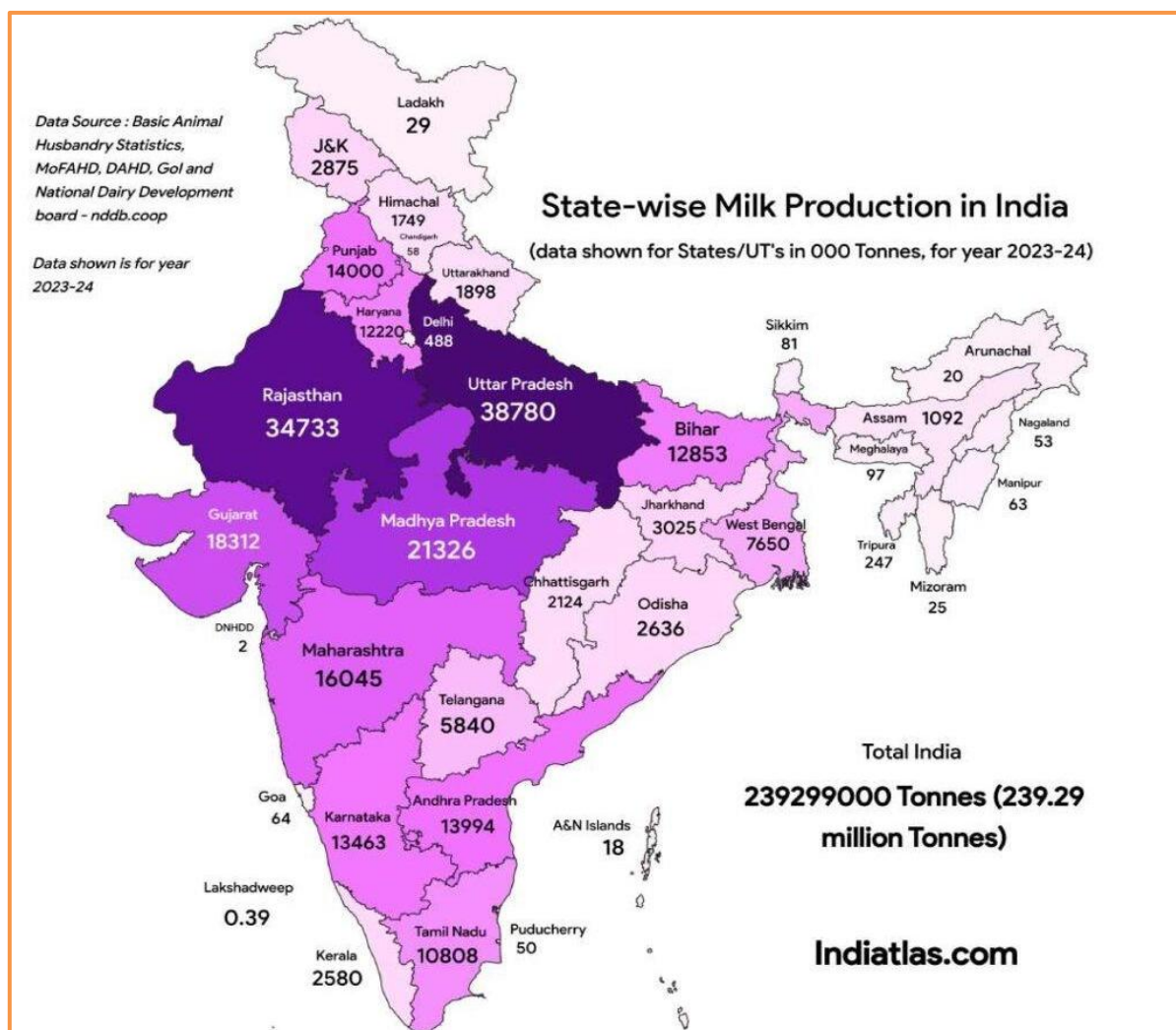


Figure 1: India's State-wise Milk Production Map
(Source: Dept of Animal Husbandry and Dairying (DAHD), GOI)

Dairy Value Chain and Value Addition Ecosystem



Figure 2: Indian Dairy Industry Value Chain
(Source: Dairy Industry in India 2026-2034 Edition: Market Statistics)

The dairy value chain functions as an interconnected and ongoing network that brings together milk producers, cooperatives, processing units, logistics operators, retailers, and end consumers. Unlike seasonal agricultural activities, dairying generates daily income and employment, making it one of the most resilient rural economic activities. The value chain begins with input support such as breeding services, artificial insemination, feed and fodder supply, veterinary healthcare, livestock insurance, and scientific farm management. Milk production is primarily undertaken by smallholder farmers, dairy cooperatives, self-help groups, and commercial dairy farms. Milk is collected through Village Dairy Cooperative Societies (VDCS), milk collection centres, and private procurement networks. Bulk Milk Coolers (BMCs), chilling centres, and refrigerated transport systems preserve milk quality and maintain critical parameters such as fat and Solids-Not-Fat (SNF) content. Increasing use of automated milk collection systems, digital payments, and quality-testing equipment has improved transparency and efficiency across the procurement network.

Table 4: Major Stages of the Dairy Value Chain

Stage	Key Activities
Input Supply	Breeding, feed, fodder, veterinary services, insurance
Production	Milk production by farmers, cooperatives and dairy farms
Collection & Aggregation	Milk collection centres, BMCs, chilling infrastructure
Processing	Pasteurization, homogenization, packaging, value addition
Distribution & Marketing	Cold-chain logistics, retail, institutions, e-commerce
Consumption	Households, food industry, hospitality and export markets

Processing transforms raw milk into a diverse range of products including liquid milk, curd, yoghurt, paneer, butter, ghee, cheese, milk powder, flavoured milk, Ultra-High Temperature (UHT) milk, and ice cream. Growing consumer demand is driving expansion of premium segments such as probiotic products, lactose-free milk, organic dairy products, A2 milk, functional foods, and whey-based nutrition products, which offer significantly higher value realization than liquid milk.

Dairy Cooperatives: The Institutional Backbone of the Sector

The transformation of India's dairy sector is closely linked to the success of the cooperative movement. The three-tier cooperative structure consisting of village dairy cooperative societies, district milk unions, and state federations enabled millions of small producers to participate in organized markets. Cooperatives eliminated multiple layers of intermediaries, ensured transparent milk testing and pricing, and created a stable procurement system that encouraged production growth.



Figure 3: Major Dairy Cooperatives in India
(Source: National Dairy Development Board)

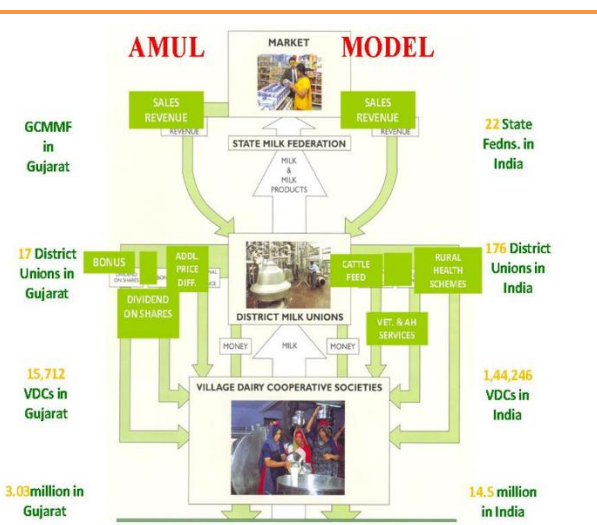


Figure 4: AMUL Dairy Cooperative Model
(Source: AI Generated Image)

Collectively, the National Cooperative Dairy Federation of India (NCDFI) commands a vast network comprising approximately 28 State/UT Apex Cooperatives, 240 District Milk Unions, and over 2,30,000 Village Milk Societies, bringing more than 18 million dairy farmers into formal economic channels.

Profile of Top Institutional Dairy Cooperatives

Amul (Gujarat Cooperative Milk Marketing Federation - GCMMF): The global golden standard for dairy cooperation, processing millions of litres daily. It operates on complete transparency, utilizing automated fat-testing and instant digital payments.

Gujarat – SUMUL Dairy (Surat District Cooperative Milk Producers' Union Ltd.): A leading dairy cooperative in South Gujarat, empowering milk producers through procurement, processing, and value-added dairy products.

Gujarat – Mahisagar Dairy: A district milk cooperative serving Mahisagar region, strengthening rural livelihoods through milk collection, dairy development, and farmer-centric services.

Gujarat – Sabar Dairy (Sabarkantha District Cooperative Milk Producers' Union Ltd.): One of Gujarat's largest dairy cooperatives, supporting farmers through extensive milk processing, marketing, and export-oriented dairy operations.

Nandini (Karnataka Cooperative Milk Producers Federation – KMF): The second-largest dairy cooperative network in India, linking thousands of village societies through robust cold-chain logistics.

Aavin (Tamil Nadu Cooperative Milk Producers Federation): Manages widespread district-level unions, focusing on providing affordable fluid milk and expanding traditional product portfolios.

Milma (Kerala Cooperative Milk Marketing Federation): Noted for its high procurement pricing models that directly benefit smallholders across topography-challenged terrain.

Verka (Punjab Cooperatives) & Sudha (Bihar Cooperatives): Dominant regional players that have successfully transitioned traditional milk belts into organized, commercial value chains.

Delhi (National Capital Region) – Mother Dairy: A major dairy enterprise established under the National Dairy Development Board, providing milk, dairy products, fruits, and vegetables while supporting millions of dairy farmers through an efficient procurement and distribution network.

Digitalization of Indian Dairy: Bottlenecks and Structural Solutions

Unlike Western nations where over 90% of surplus milk moves through consolidated corporate farmlands, 60% of India's dairy trade remains unorganized and highly fragmented. This fragmentation limits uniform technology penetration, resulting in distinct developmental bottlenecks.

Primary Digital Bottlenecks

Inconsistent Quality and Wastage: Due to inadequate cold-chain access at remote collection boundaries, approximately 3% of nationally produced milk undergoes souring or spoilage annually.

Low Average Yield Proportions: The average milk yield of an indigenous cow in India stands at 1,248 kg per year, compared to over 10,000 kg per year in industrial Western dairy configurations.

Fragmented Transaction Channels: Traditional cash payouts limit credit tracing, excluding rural farmers from mainstream banking systems.

Structural Solutions

Digitalisation is gradually transforming India's dairy sector by improving productivity, reducing wastage, and enhancing value chain efficiency. Technologies based on Artificial Intelligence (AI), the Internet of Things (IoT), and advanced analytics are enabling real-time monitoring of cattle health, feeding behaviour, breeding cycles, rumination patterns, and herd performance.

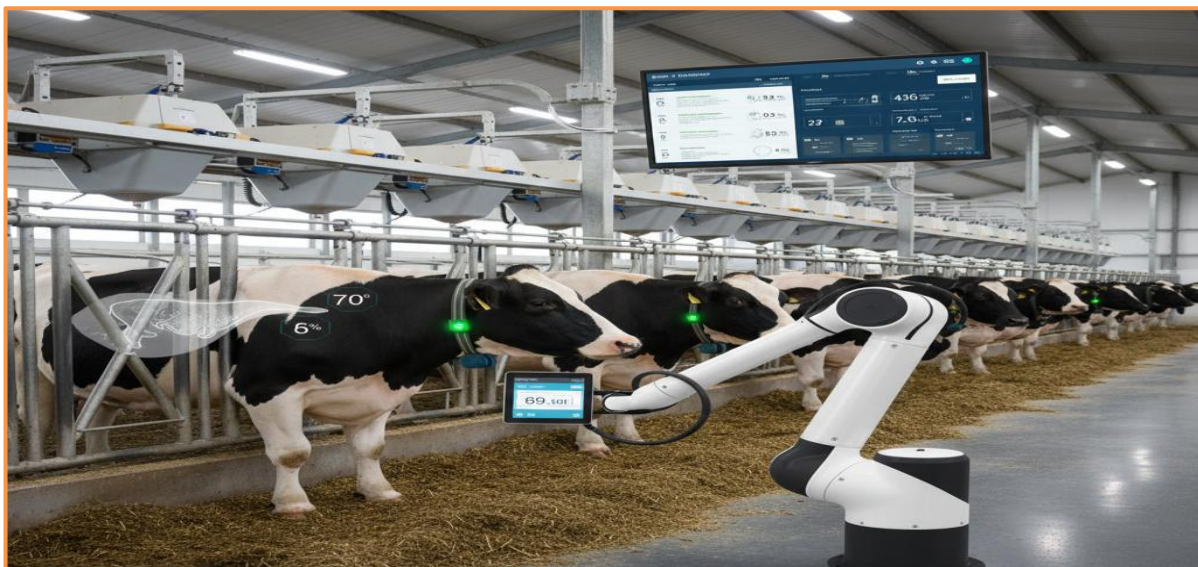


Figure 5: Digitalization in Dairy Farming (Source: AI Generated Image)

AgriTech firms such as Prompt Equipments, in collaboration with the Indian Institute of Technology Bombay, have developed the wearable cattle belt **BovSmart**, which provides alerts on breeding, health conditions, and thermal stress. Similarly, **Stellapps Technologies** has introduced the **mooOn™** platform, which combines wearable sensors and mobile-based analytics to improve herd management, increase milk yields, and reduce animal healthcare costs. More than 4.5 lakh cattle are reportedly monitored through Stellapps' digital ecosystem. Beyond farm-level operations, digital technologies are strengthening dairy supply chains by enabling real-time tracking of milk quality, quantity, transportation, inventory, and sales. Startups such as **Stellapps**, **Mr. Milkman**, and **Trinetra Wireless** are leveraging IoT-enabled monitoring systems and data analytics to improve traceability, reduce spoilage, automate inventory management, and support informed business decisions. Dairy cooperatives and milk unions are also promoting digital payment systems to ensure faster and more transparent transfer of milk proceeds to farmers. The initiatives implemented by institutions like Amul, Mother Dairy, Gokul Dairy, and Fino Payments Bank have contributed to greater financial inclusion by promoting seamless benefit disbursement and expanding financial service access for dairy farming communities. Collectively, these innovations are modernizing India's fragmented dairy ecosystem and creating a more efficient, transparent, and technology-driven value chain.

International Lessons for Building a Resilient Dairy Sector

New Zealand: Demonstrates the effectiveness of producer-owned cooperatives, pasture-based production systems, and export-oriented dairy development that maximize farmer participation and operational efficiency.

Netherlands: Showcases the advantages of precision livestock farming, robotic milking systems, automation, data-driven herd management, and advanced traceability mechanisms to improve productivity and quality.

Denmark: Leads in climate-smart dairy production through renewable energy integration, low-emission livestock systems, resource-efficient practices, and circular economy models that enhance environmental sustainability.

United States: Highlights the importance of advanced genetics, scientific breeding programmes, comprehensive cold-chain infrastructure, risk management mechanisms, and large-scale commercial dairy operations.

Global Dairy Leaders: Such as Nestlé, Fonterra, and Arla Foods demonstrate how farmer-centric cooperatives, advanced processing technologies, strong quality standards, product diversification, and global market integration can build a resilient dairy sector.

Key Takeaways for India

- Key lessons for India include strengthening cooperatives, promoting innovation, enhancing value addition, and expanding export competitiveness to build a resilient and globally competitive dairy sector.
- Adopt digital animal identification and traceability systems to improve herd management, disease control, and quality assurance.
- Promote precision feeding and technology-driven dairy management to enhance productivity and resource efficiency.
- Invest in climate-resilient dairy infrastructure and strengthen milk quality and traceability standards.
- Expand cooperative-led value addition, producer-owned processing enterprises, and livestock insurance mechanisms to improve farmer incomes and reduce risks.

Government Policy Interventions Driving Dairy Development

The Government of India has introduced several fiscal policies and developmental schemes to modernize the national dairy infrastructure. The Union Budget 2026–27 provided a significant impetus to the livestock and dairy sector by earmarking ₹6,153.46 crore for the Department of Animal Husbandry and Dairying (DAHD), marking a 27% increase over the previous year's allocation.

Comprehensive Framework of Key Schemes

- ❖ **Rashtriya Gokul Mission (RGM):** Funded at ₹800 crore to promote indigenous breed development, genetic mapping, and the setup of Breed Multiplication Farms.
- ❖ **National Programme for Dairy Development (NPDD):** Receives ₹1,055 crore to strengthen quality testing networks and install village-level Bulk Milk Coolers.
- ❖ **Animal Husbandry Infrastructure Development Fund (AHIDF):** Operating with a total fund outlay extended up to 2025–26, this scheme provides a 3% interest subvention and credit guarantee coverage to incentivize private and cooperative investments in mega-processing plants and value-added byproduct facilities.
- ❖ **Integrated Scheme for Entrepreneurship Development:** A new initiative backed by ₹500 crore designed to offer capital subsidies to FPOs, startups, and rural youth for establishing veterinary clinics and feed production units.
- ❖ **Dairy Processing and Infrastructure Development Fund (DIDF):** Focus on capital infusions for upgrading outdated cooperative processing units.
- ❖ **National Cooperative Dairy Federation of India (NCDFI):** Works directly with central ministries to manage e-market portals, ensuring transparent institutional trade of bulk dairy commodities.
- ❖ **National Dairy Plan (NDP):** Enhances milk productivity through scientific breeding, balanced feeding, and producer institution development.
- ❖ **Dairy Entrepreneurship Development Scheme (DEDS):** Promotes dairy enterprises, self-employment opportunities, and rural entrepreneurship through financial assistance.
- ❖ **National Livestock Mission (NLM):** Improves fodder availability, livestock productivity, breed development, and sustainable animal husbandry practices.
- ❖ **Galvanizing Organic Bio-Agro Resources Dhan (GOBARdhan) Scheme:** Converts cattle waste into biogas, compressed biogas, and organic fertilizers for sustainability.
- ❖ **National Dairy Development Board (NDDB):** Supports dairy development through research, capacity building, infrastructure creation, and policy support.
- ❖ **National Cooperative Dairy Federation of India (NCDFI):** Strengthens dairy cooperatives through market development, coordination, advocacy, and institutional support.
- ❖ **Indian Dairy Association (IDA):** Promotes dairy research, training, innovation, knowledge dissemination, and industry-academia collaboration.

Challenges and Emerging Risks

- Low animal productivity, disease outbreaks, and heat stress continue to constrain milk production growth.
- Feed and fodder shortages, coupled with rising input costs, significantly reduce farmer profitability.
- Seasonal fluctuations in milk production create supply imbalances and irregular cash flows.
- Milk price volatility and changing consumer preferences increase market uncertainty for producers.
- Inadequate cold-chain infrastructure and informal marketing channels lead to quality losses and inefficiencies.
- Limited access to formal credit, livestock insurance, and risk mitigation mechanisms restrict sectoral expansion.
- Lack of animal traceability and medical records increases lending and insurance risks.
- Water scarcity, extreme weather events, and declining fodder resources pose long-term sustainability challenges.

Financing Opportunities for Banks for Sustainable Dairy Sector Growth

Strengthening dairy value chains requires innovative financing, technology adoption, infrastructure development, and climate-resilient investments.

1. Value Chain Financing Through Cooperative-Linked Milk Procurement and Repayment Mechanisms: Promote Value Chain Financing by linking loans to verified milk procurement records and cooperative payment systems, enabling automatic repayment deductions, reducing credit risk, and improving loan performance.

2. Financing Productivity Enhancement Through Breed Improvement and Scientific Dairy Management Practices: Support investments in high-yielding animals, scientific feeding, precision livestock farming, fodder cultivation, and veterinary services to improve productivity, profitability, and resilience of dairy enterprises.

3. Leveraging Digital Technologies for Risk-Based Lending and Faster Credit Delivery: Integrate digital milk procurement data, IoT-based cattle monitoring, electronic herd records, and digital loan platforms to improve credit assessment, risk pricing, and loan turnaround times.

4. Expanding Credit Support for Dairy Infrastructure and Cold-Chain Development: Finance milk collection centres, bulk milk coolers, chilling plants, processing facilities, logistics networks, and technology-enabled procurement systems to reduce wastage and strengthen value chains.

5. Promoting Climate-Resilient and Circular Economy-Based Dairy Investments: Support financing for biogas, compressed biogas, organic fertilizers, water-efficient systems, climate-smart housing, and waste-to-wealth projects under GOBARdhan and related initiatives.

6. Encouraging Value Addition, Dairy Entrepreneurship, and Emerging Growth Segments: Provide credit for value-added dairy products, nutraceuticals, functional foods, organic dairy ventures, producer-owned enterprises, and export-oriented processing units to enhance farmer incomes.

Conclusion

India's dairy ecosystem stands at the intersection of agricultural transformation, rural development, technological innovation, and sustainable growth. The cooperative movement laid the foundation for the first White Revolution by integrating millions of small producers into organized markets. The next phase of growth will depend on productivity enhancement, digital transformation, climate resilience, value addition, and innovative financing models. A stronger convergence of cooperatives, technology providers, financial institutions, research organizations, and government agencies will be essential for building a globally competitive dairy sector. With abundant livestock resources, expanding domestic demand, supportive

policy frameworks, and growing technological capabilities, India is well positioned to lead the next generation of dairy development while ensuring prosperity for millions of rural households.

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