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The Next Phase of Dairy Growth: Quality Consolidation, and Opportunity

The Milk India Forgot to Measure

Featuring: Nicholas Tomkins and Pankaj Navani

Lameness in India's Dairy Cows

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Precision Nutrition: Redefining Dairying

With evolving dairy industry in India, the focus is steadily shifting from conventional feeding practices to more scientific, data-driven approaches. With rising feed costs, increasing pressure on productivity, and the need to improve reproductive efficiency, precision nutrition is emerging as a game changer for dairy farmers and feed manufacturers alike.

In an e-interaction, Dr Manish Pathak, a seasoned industry expert from Carus Laboratories shared insights into the evolving dynamics of dairy nutrition, the growing importance of amino acid balancing, and how technology-driven solutions—including AI—are shaping the future of the sector. The discussion also highlights practical strategies to address on-ground challenges such as heat stress, fragmented farm structures, and the need for sustainable profitability.


Dr Manish Pathak

Could you briefly share your professional journey and elaborate on your current role?

With over 11 years of experience in the livestock and dairy nutrition sector, my journey has been focused on integrating technical expertise with commercial strategy. I began my career with a strong emphasis on precision nutrition, feed formulation, and amino acid balancing, and gradually transitioned into techno-commercial leadership roles.

Currently, as General Manager at Carus Laboratories, I oversee strategic marketing and business development. My role involves delivering performance-driven, cost-optimised nutritional solutions for dairy producers and feed manufacturers. Our core focus is on precision dairy nutrition—enabling farmers to enhance milk yield and reproductive efficiency while maintaining profitability.

With over a decade of experience in the livestock sector, how do you view the industry structure and key farmer challenges?

The livestock industry in India and South Asia remains highly fragmented, with a significant proportion of smallholder farmers.

Unlike Western markets, herd sizes are smaller, and decision-making is often driven by cost considerations rather than data-led nutritional planning.

Key challenges include:

- Fluctuating feed costs
- Limited awareness of precision nutrition
- Mineral deficiencies leading to reproductive and metabolic disorders
- Heat stress management
- Inconsistent milk pricing structures

Farmers often prioritise short-term milk output over long-term herd health and reproductive efficiency. The need of the hour is a balanced nutritional approach that supports both productivity and fertility.

Precision nutrition and amino acid balancing are relatively new concepts in India. What benefits do they offer?

Precision nutrition focuses on feeding animals according to their actual nutritional requirements rather than relying on assumptions. Amino acid balancing plays a key role in this approach by optimising limiting amino acids such as methionine and lysine, instead of simply increasing crude protein levels. This leads to multiple benefits, including improved milk protein percentage, enhanced nitrogen utilisation, reduced feed cost per litre of milk, lower metabolic stress, and better reproductive performance. Rather than increasing protein indiscriminately, the emphasis shifts toward improving protein efficiency, resulting in superior milk quality, greater cost efficiency, and improved environmental sustainability.

With summer approaching, what nutritional strategies can help mitigate heat stress?

Heat stress is one of the most significant, yet often underestimated, factors affecting dairy productivity. Effective nutritional strategies to mitigate its impact include increasing dietary energy density, maintaining electrolyte balance through DCAD management, supplementing rumen-protected amino acids, providing adequate antioxidant support, and ensuring optimal mineral balance. Additionally, adjusting feeding schedules to cooler hours of the day can help sustain feed intake. Maintaining rumen health is particularly critical during summer, as intake typically declines, making precision nutrition even more important under such conditions.

What is the ideal feeding strategy for medium- to high-performing dairy farms?

An effective feeding programme should be closely aligned with the animal's stage of lactation to ensure optimal productivity and health outcomes. During early lactation (0–70 days), the primary focus should be on minimising negative energy balance, supporting metabolic stability through rumen-protected amino acids, ensuring proper DCAD management, and maintaining an optimal body condition score of 2.75 to 3.25.

In mid-lactation, the objective shifts toward sustaining peak milk production by optimising the protein-to-energy ratio while closely monitoring fertility parameters. As cows move into late lactation, feeding strategies should aim to prepare them for the dry period while preventing over-conditioning.

The dry period itself is critical and requires controlled energy intake, effective DCAD balancing, and a strong mineral programme, with particular emphasis on transition cow management. Overall, feeding strategies must be carefully aligned with both production targets and reproductive goals to achieve long-term herd performance and profitability.

How does Carus differentiate itself in a highly competitive nutritional market?

While the market offers a wide range of products, meaningful differentiation remains limited. Strength in this space lies in adopting science-based formulations, precise nutrient balancing, and a clear focus on nutrient bioavailability rather than mere inclusion levels. Equally important are cost-optimised ration design and robust technical advisory support. The emphasis is increasingly shifting from product offerings to delivering measurable, outcome-driven solutions that enhance milk yield, improve milk composition, and support overall reproductive performance.

How is Carus integrating AI-driven innovations into its approach?

Artificial intelligence is rapidly transforming dairy management, with increasing adoption of data-driven nutrition models, ration optimisation tools, and predictive performance analytics. The integration of AI enables more precise feed formulation, improved nutrient efficiency, better prediction of production trends, and more informed decision-making at the farm level. Looking ahead, the future of dairy nutrition will depend on effectively combining field expertise with digital intelligence to drive sustainable and efficient outcomes.

What is your message for feed manufacturers?

The future of dairy nutrition lies in precision rather than volume. Feed manufacturers need to shift their focus toward the use of highly bioavailable mineral sources, effective amino acid balancing, and the adoption of rumen-protected technologies, supported by strong scientific validation. Equally important is the emphasis on enhancing long-term farmer profitability. The objective should not be to increase input costs, but to maximise returns per rupee invested. Ultimately, when farmers prosper, the entire industry grows.

Lameness in India's Dairy Cows: A Major Challenge and Pathways to Prevention

by **Sukhjeet Singh Kahlon**, Intracare India

Lameness continues to be one of the most significant and costly health challenges faced by dairy farmers in India. With the sector increasingly shifting toward high-yielding crossbred cattle—particularly those derived from indigenous breeds with exotic genetics such as Holstein Friesian and Jersey—the incidence of lameness is on the rise across both smallholder and commercial dairy systems.

A lame cow experiences pain with every step. This not only affects her mobility but also leads to reduced feed intake, lower milk production, delayed conception, loss of body condition, and increased veterinary costs. In many cases, affected animals are culled prematurely or suffer reduced longevity. Beyond animal welfare concerns, lameness has a direct and substantial economic impact on farm profitability. It also predisposes animals to secondary health complications, making it the third most critical issue in dairy farming—after mastitis and reproductive disorders.

Prevalence and Risk Factors in India

The prevalence of lameness in India varies widely depending on farm management, housing systems, and geographical conditions. Recent studies indicate that between 8% and 30% of crossbred dairy cows are affected nationwide.

A 2024 study conducted in Karnataka reported lameness prevalence of approximately 22% in large commercial farms, compared to around 5% in smallholder systems. This disparity is largely attributed to differences in housing conditions, including hard flooring, higher stocking densities, and limited preventive care in intensive operations.

In high-production states such as Punjab, front limb lesions account for nearly 29% of cases, while hind limb issues contribute to over 54%. A broader review of tropical Asian studies places the average prevalence at approximately 15%, though many farms report herd-level incidence of 20–25%, closely aligned with global averages of 22–23%.

Key risk factors include:

- Advancing age (particularly cows beyond 3–4 lactations)

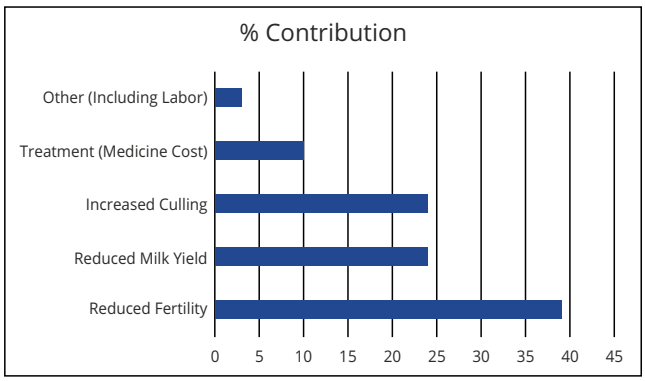
Sukhjeet Singh Kahlon

- Poor body condition
- Hard or poorly designed flooring
- Wet and unhygienic housing conditions
- Lack of routine hoof trimming

Economic Impact

The financial implications of lameness extend well beyond treatment costs. Farmers face losses due to reduced milk yield, lower reproductive efficiency, increased labour, premature culling, and often the indiscriminate use of antibiotics.

Estimates from institutions such as Guru Angad Dev



Veterinary and Animal Sciences University (GADVASU), along with government livestock reports (BAHS 2024) and veterinary studies, suggest annual losses of approximately INR 25,000–30,000 per affected cow. This represents a substantial and recurring economic burden for dairy operations.

Understanding the Causes

Lameness in dairy cattle broadly falls into two categories:

1. Infectious Causes (~31%)

These include conditions such as digital dermatitis (Mortellaro disease), interdigital infections, and foot rot. Such issues are commonly associated with wet, unhygienic, and manure-laden environments.

2. Non-Infectious Causes (~69%)

These include sole ulcers, white line disease, laminitis, and overgrown or imbalanced hooves. Prolonged standing on hard concrete surfaces is a major contributing factor, leading to hoof damage and uneven weight distribution.

3. Nutritional and Management Factors

- High-concentrate diets leading to sub-acute ruminal acidosis (SARA)
- Abrupt dietary transitions, especially around calving
- Deficiencies in minerals essential for hoof strength

Hoof Structure and Its Importance

The bovine hoof is a robust, keratinised structure comparable to a natural protective boot. Each foot comprises two primary claws, supported by additional structures such as the hoof wall, sole, coronary band, and heel bulbs.

Most lameness originates within the hoof rather than the upper limb. Pain and discomfort trigger stress responses, disrupt hormonal balance, reduce feed intake, impair reproductive cycles, and ultimately lower milk yield. Even a small proportion of lame animals can significantly impact overall herd performance.

Prevention and Control Strategies

The encouraging aspect is that lameness can largely be prevented and managed through consistent and well-implemented practices:

1. Regular Hoof Trimming

Routine professional hoof trimming is the most effective preventive measure. It ensures proper weight distribution, removes excess horn, and prevents lesion development. Techniques such as the Dutch five-step method are widely recommended. Ideally:

- Heifers should be assessed before first calving
- Lactating cows should be trimmed at least twice a year
- High-risk animals may require trimming every 3–4 months

2. Skilled Workforce Development

The availability of trained hoof trimmers remains limited. Proper training or engagement of certified professionals is essential, as poor trimming practices can exacerbate problems. Larger farms may benefit from in-house expertise, while smaller farms can adopt cooperative models.

3. Improved Housing and Flooring

Hard concrete surfaces should be modified with grooves or covered with rubber mats to improve traction. Providing soft bedding (sand or straw) encourages cows to rest adequately (12+ hours daily), reducing stress on hooves. Overcrowding should be avoided.

4. Hygiene and Footbath Management

Maintaining clean, dry housing conditions is critical. Regular manure removal and the use of footbaths help control infectious agents. Structured hoof care programmes, when implemented in coordination with veterinarians and trained personnel, have demonstrated significant reductions in lameness incidence.

5. Balanced Nutrition

Feeding strategies should aim to prevent ruminal acidosis, ensure gradual dietary transitions, and maintain optimal body condition. Adequate mineral supplementation supports hoof integrity.

6. Early Detection and Monitoring

Routine observation of animal movement is essential. Mobility scoring systems can help identify early signs of lameness, allowing timely intervention and reducing severity.

7. Holistic Management

Attention to transition cow management, adequate space allowance, and the specific needs of high-yielding crossbred animals can further reduce risk.

Conclusion

With the adoption of these measures—particularly regular hoof care, improved housing, and proactive monitoring—lameness prevalence can be reduced to below 5% in well-managed herds. The benefits are multifold: improved animal welfare, enhanced productivity, better reproductive performance, and significant cost savings.

In India's rapidly evolving dairy sector, where intensification and crossbreeding are becoming the norm, investing in hoof health is no longer optional—it is essential.

Healthy hooves are the foundation of dairy productivity. Simply put: hooves carry the milk.

References are available upon request.

The Milk India Forgot to Measure

NICHOLAS TOMKINS PANKAJ NAVANI

How Frontrunner Farms is turning the world's largest dairy sector's quality blind spot into a farmer income opportunity — THROUGH THE "HERD INTELLIGENCE PROGRAM" — one 10-day cycle at a time.

Pankaj Navani
Chief Data Architect & CEO, FFIN

The Shift from Farming to System-Building

Pankaj Navani did not set out to build a data company. His early years at Binsar Farms were spent at the sharp end of Indian dairying—managing herds, building a brand, and watching the challenges of scaling compound as demand grew. The lesson came gradually, then all at once: India's dairy sector does not have a supply problem; it has quality issues.

"We were producing more milk every year, but nobody could tell a farmer exactly what that milk was worth beyond Fat and SNF," Navani recalls. "Antimicrobial resistance, aflatoxin contamination, somatic cell counts — these were invisible costs draining farmer income. The system simply wasn't designed to see them."

That insight became the founding thesis of Frontrunner Farms India Pvt Ltd (FFIN): milk quality, not milk volume, is India's real bottleneck. Fixing it would require not better cows or bigger sheds, but better information—delivered continuously, at farm level, in a language that translates directly into rupees per litre.

The transition from farmer to system-builder was not a pivot so much as an expansion of scope. Navani's years

managing herds had taught him that the information asymmetry in Indian dairying was not incidental—it was structural. Processors had no economic incentive to test beyond fat and SNF, while farmers had little visibility into the hidden costs eroding their margins. The entire value chain was optimised for throughput, not quality.

FFIN was built to turn that equation on its head. Quality is not a cost imposed on the farmer; it is income already being produced and silently forfeited—recoverable through better data, faster correction, and a system designed to make clean milk pay.

Nicholas Tomkins

COO & Commercial Strategy Lead

A Global Lens on an Indian System

Nicholas Tomkins brought a different vantage point. With years of exposure to dairy systems across Europe, and the Americas, his first impression of India's dairy ecosystem was one of paradox: a country that is the world's largest milk producer, yet one where the vast majority of output moves through value chains that neither measure nor reward quality at the farm gate.

"In mature dairy markets, quality is baked into the price signal. A farmer in England or the Netherlands knows exactly how somatic cell count (SCC), bacterial counts, and residue status affect their cheque," Tomkins explains. "In India, the price signal is almost entirely blind to these parameters. The result is a system where a farmer producing genuinely clean milk receives the same rate as one whose milk carries hidden liabilities."

The disconnect, in Tomkins' analysis, is not one of capability but of architecture. Indian farmers—particularly those running progressive, purebred Holstein Friesian operations in states like Punjab—possess the genetics, the infrastructure, and the technical know-how required to produce high-quality milk.

Why Quality Never Became the Default

Ambition. What they lack is a feedback loop that connects what happens in the parlour to what shows up in the payment.

India has discussed milk quality for decades. The Food Safety and Standards Authority of India (FSSAI) has set thresholds. Export ambitions have been articulated in policy document after policy document. Yet the procurement system still operates, in the main, on two parameters: fat percentage and solids-not-fat.

The reasons are structural. Testing for a wider panel—SCC, aflatoxin AT-M1, antibiotic residues, bacterial counts—requires laboratory infrastructure, cold-chain discipline, and analytical capacity that most collection points lack. More fundamentally, it demands an economic model in which quality measurement pays for itself. Without a price premium that flows back to the farmer, testing becomes a cost centre rather than a value driver.

There is also a coordination challenge. For most large processors, shifting to a higher-quality procurement model introduces immediate cost and potential supply risk, while the commercial upside remains uncertain and uneven across the market. In a highly competitive procurement environment, no single player can easily move first without risking margin or volume. As a result, the system tends to stabilize around what is acceptable and scalable, rather than what is optimal.

A related gap is the absence of a structured, outcome-linked extension system. In many mature dairy markets, processors invest heavily in upstream technical support—nutrition, herd health, milking practices—because their profitability is directly linked to milk quality. In India, that linkage is weaker. Extension is often fragmented across multiple actors—feed companies, veterinarians, local advisors—each addressing a part of the problem but without a unified view of milk quality outcomes at the farm level. As a result, interventions can be inconsistent, reactive, and difficult to measure in economic terms. Without a feedback loop connecting farm practices to milk quality and income, extension remains advisory rather than performance-driven.

This is the gap FFIN identified: not the absence of standards, but the absence of a continuous, farm-level intelligence system that converts quality data into actionable economics—and does so frequently enough to change behaviour.

That system design flaw lies at the heart of the "quality as default" conundrum. The system does not actively discourage quality, but neither meaningfully reward it. Over time, that has created a stable equilibrium where "acceptable" becomes the default.

Inside the Herd Intelligence Program

The Herd Intelligence Program (HIP) positions itself not as a testing service but as an intelligence layer for the dairy value chain — one designed to generate a verified quality record against every litre it touches, continuously and without exception. The distinction matters. A testing service produces a certificate; HIP produces a decision framework for its farmers.

The operating unit is a 10-day cycle, repeated 36 times a year. Each cycle begins with daily bulk-tank sample collection from enrolled farms, maintaining cold-chain integrity from parlour to laboratory. Samples pass through a three-lab architecture. PDS Lab handles primary screening (fat, SNF, temperature, methylene

blue reduction time); FFIN's in-house laboratory performs Certificate of Analysis grading and classification; and GADVASU—the state veterinary university in Ludhiana—provides confirmatory testing, calibration, and scientific oversight.

Across these three nodes, each sample is assessed against 7–10 parameters, including SCC, aflatoxin M1 (measured via competitive ELISA and validated against NABL-accredited LC-MS reference), antibiotic residues, and compositional markers. On day ten, a compiled scorecard is delivered to the farmer with RAG (red, amber, green) status indicators, trend lines, identified blockers, and a prioritised action plan.

The three-lab design is deliberate: no single point of failure while adding a governance layer that strengthens scientific credibility. Between August 2025 and March 2026, the system generated 3,619 lab records, 2,356 daily SCC readings, and 2,400 daily M1 readings across 50 purebred Holstein Friesian farms in five districts of Punjab.

Turning Data into Farmer Income

Farmers adopt what pays. Navani is unequivocal on this point. HIP's design philosophy rests on translating every technical parameter into a rupee value that a farmer can act on within a defined time window.

The economics are revealing. Across a 13-farm subset, HIP identified approximately INR 3.77 crore in annual revenue at risk—income lost to invisible quality gaps. The composition gap alone—the difference between actual and achievable fat and SNF levels—accounts for INR 55–70 lakh annually, validated against processor payment records.

Then come the hidden losses. Elevated SCC reduce yield even when fat percentages appear acceptable—what FFIN terms the "fat percentage paradox." A farm may appear healthy on a processor's ledger while losing litres per cow per day to subclinical mastitis. Aflatoxin M1 contamination, often driven by mycotoxin-laden feed, creates rejection risk and, in export markets, outright exclusion. Antibiotic residues, when detected, result in blocked milk days—entire consignments diverted or discarded.

HIP's intervention model is built around the 72–96 hour recovery window for aflatoxin M1: the time required for contamination to clear once the feed source is corrected. Frequent testing and rapid reporting give farmers a critical window to act before losses compound.

Baseline data underscores the scale of the opportunity. Across the study period, 63% of SCC readings exceeded 600,000 cells per millilitre, and 51% of M1 readings breached the FSSAI action limit of 500 parts per trillion. These are not marginal farms but some of Punjab's most progressive operations—suggesting that sector-wide exposure is significantly larger.

The Discipline of Data Integrity

With multiple collection points, three laboratories, and 36 testing cycles per year, maintaining data integrity is non-trivial. FFIN addresses this through end-to-end traceability—every sample tagged from bulk tank to lab result—and a tiered quality assurance protocol that includes cross-validation and periodic calibration audits overseen by GADVASU.

The methodology paper underpinning HIP, currently under peer review and targeted at journals such as the Indian Journal of Dairy Science and Tropical Animal Health and Production, applies the Hortet and Seegers (1998) meta-analysis framework with a deliberate conservative bias. HIP's loss coefficients are 5–32% below published central estimates—ensuring that revenue impact claims remain defensible.

"If we overstate the numbers, farmers lose trust in the first cycle," Navani notes. "We would rather understate and let the data surprise them."

Creating a Market for Gem-Quality Milk

FFIN's downstream ambition extends beyond farm optimisation. Under the PureGEM ingredient brand—Pure Goodness Ensured Milk—the company aims to create a new category: assured, traceable, premium-quality milk with a defined specification.

PureGEM-grade milk must meet strict thresholds, including SCC below 400,000 cells per millilitre, aflatoxin M1 below 500 parts per trillion (FSSAI limit), zero antibiotic residues, and full traceability to farm and feed source.

The commercial logic is straightforward: buyers—whether export-oriented processors or institutional purchasers—will pay a premium for milk backed by a Certificate of Analysis rather than assumption. India's dairy export performance supports this thesis: exports reached $662 million in 2024, up 80% year-on-year, with a shift toward value-added fats. The Gulf Cooperation Council region alone accounts for roughly 45% of export value, where quality assurance is a prerequisite for market access.

Why Punjab, Why Now

Launching HIP at GADVASU in Ludhiana on 4 April 2026, in collaboration with the Punjab Dairy Farmers Association (PDFA), is a strategic move. Punjab hosts some of India's most advanced dairy farms—high-yielding Holstein herds, mechanised milking, TMR feeding, and sexed semen adoption exceeding 60%.

GADVASU provides scientific credibility, while PDFA

offers grassroots linkage—together forming the institutional backbone needed to build trust.

"We deliberately chose the hardest geography first," Tomkins explains. "Punjab's farms are large, capital-intensive, and data-literate. If the model works here, it works anywhere in India."

Scaling the Model: Friction Points

The challenges ahead are clear. Logistics—particularly cold-chain maintenance and sample collection—remain immediate constraints. At scale, the cost of daily testing must be absorbed by value chain participants through premium pricing, reduced losses, or both.

Farmer behaviour is the deeper variable. Even with clear economic signals, changes in feed, hygiene, or infrastructure require both conviction and capital. HIP's four-tier architecture—Insight, Foundation, Shield, and Advantage—addresses this by building adoption progressively, driven by data rather than sales.

The roadmap reflects this pragmatism:

- Phase 1: Validate methodology across 50+ farms
- Phase 2: Expand to 100–150 farms within 12 months
- Phase 3: Scale to 50,000 litres/day of export-grade milk

Redefining How Milk Is Valued

"We are not building a premium milk brand," Navani says. "We are building quality infrastructure. Any brand outcome is incidental."

Tomkins reinforces the point: India does not lack dairy brands—it lacks a system that verifies quality at origin, continuously.

If HIP succeeds, it will establish something fundamentally new: a real-time, farm-level intelligence system that makes milk quality both visible and economically relevant.

Whether this scales nationally or remains a regional model will depend on execution and value chain alignment. But the underlying insight is difficult to ignore: quality becomes the default only when it pays.

For an industry long anchored in fat and SNF, HIP signals a shift—from commodity milk to intelligent milk. And if that shift holds, it will not be driven by policy or aspiration, but by a farmer reading a 10-day report and recognising a simple truth: clean milk pays better.

INDIA
Dairy Protein Balance
& 2030 Protein Gap Outlook

Executive Summary

India presents the world's most striking dairy protein paradox. As the world's largest milk producer — contributing 24% of global output at 239 million tonnes (MT) in 2023-24, India should theoretically be a major source of whey protein. Instead, it produces less than 20% of its national whey protein requirement domestically, with over 80% of demand across all segments — sports nutrition, pharmaceuticals, nutraceuticals, infant formula, geriatric nutrition, and food ingredients — met by imports of sweet whey powder and bulk WPC concentrate from the EU, New Zealand, and the United States.

The root cause is structural: Indian dairy is overwhelmingly organised around acid-coagulated products — paneer, chhana, dahi — which generate low-pH acid whey unsuitable for mainstream WPC/WPI processing. Western cheese production is larger than commonly reported, but processing infrastructure to convert the resulting sweet whey into WPC/WPI remains underdeveloped. Demand is accelerating, driven by a fitness boom, rapid QSR expansion, and

239 MMT Milk production 2023-24	**#1 Global** World's largest producer	**~USD 200-250M** Total whey demand 2024 (all segments)	**>80%** Import dependency (WPC/WPI)

1. India's Dairy Landscape

1.1 Milk Production Scale & Growth

India's total milk production reached 239.30 MMT in 2023-24, representing a CAGR of approximately 5.6% over the past decade from 146.3 MMT in 2014-15. Notably, the growth rate has been decelerating: 5.7% Þ 5.3% Þ 4.4% Þ 3.7% in successive years. Production is forecast to reach ~247–252 MMT by 2025-26, consistent with this trend — earlier estimates of 255–265 MMT implied implausible 8%+ growth and have been revised.

Year	Production (MMT)	Growth YoY	Per Capita (g/day)
2019-20	198.4	+5.7%	407
2020-21	209.9	+5.8%	427
2021-22	221.1	+5.3%	444
2022-23	230.8	+4.4%	453
2023-24	239.3	+3.7%	459
2025-26f	~247-252	~4.0-4.5%	~475f

1.2 Milk Utilization by Product Category

The utilization structure of Indian milk differs fundamentally from western dairy nations. Approximately 46% is consumed as fluid milk, 35% goes into traditional products (paneer, curd, khoa, dairy beverages, ghee — ghee is a premium traditional product and India's largest dairy export, not a commodity), 15% into commodity dairy (butter, SMP, and western-style cheese), and only 4% into specialised processing — WPC, casein, and infant formula.

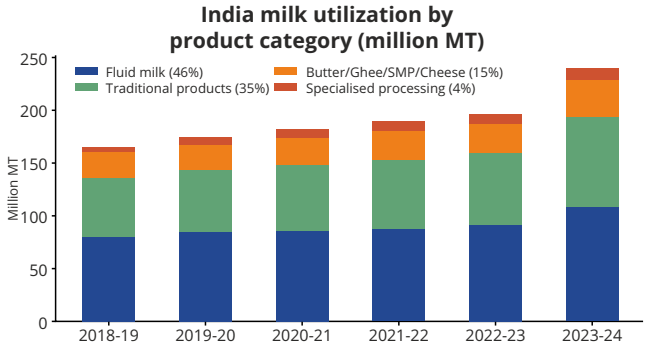


Figure 1: India milk utilization by product category (MMT) — 2018-19 to 2023-24

Traditional Products (~35% of milk)

- Paneer - acid coagulated fresh cheese
- Curd / dahi - fermented milk
- Khoa / mawa - heat-evaporated milk
- Chhana - acid precipitated curd
- Dairy beverages (lassi, chaas, etc.)
- Ghee - premium clarified butter

Specialised Processing (~4% of milk)

- WPC35 / WPC80 - ultrafiltration
- WPI - ion exchange / MF
- Casein & caseinates
- SMP & WMP
- Infant formula ingredients

2. Western Cheese Production & Sweet Whey

2.1 Western Cheese: Scale Significantly Larger Than Published Estimates

Published FAO statistics place India's western cheese production at approximately 3,000 MT/yr — a figure that is substantially incorrect. Amul alone operates a 120 MT/day cheese facility (~43,800 MT/yr from a single plant). Parag Milk Foods, Mother Dairy, Karnataka Milk Federation, and other large cooperatives and private processors add significant additional volume. Organised sector production across all major players is estimated at 80,000–120,000 MT/yr, with the true figure pending verification against National Dairy Development Board and Ministry of Animal Husbandry data.

INR 128.9 Bn Cheese market value 2025	**19.1% CAGR** Market growth to 2034
120 MT/day Amul cheese facility (single plant)	**~80–120k MT** Est. organised sector production/yr

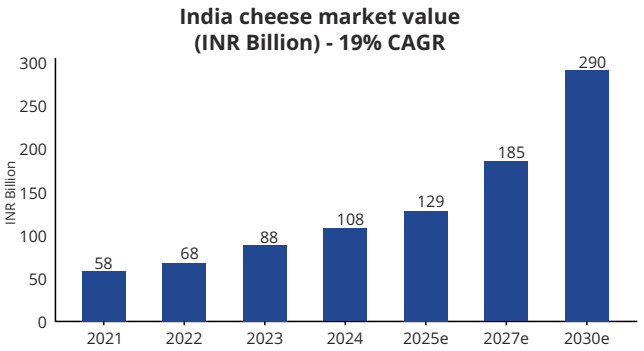


Figure 2: India cheese market value (INR Billion) 2021–2030e

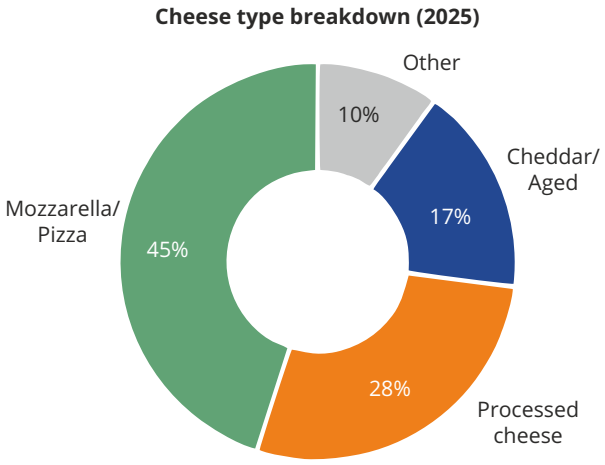


Figure 3: Cheese type breakdown by application 2025

2.2 Sweet Whey Generation — Revised Estimates

Western (rennet-based) cheese generates sweet whey at approximately 9 litres per kilogram of cheese. With revised production estimates, India's domestic sweet

whey stream is far larger than previously understood, and with appropriate UF/MF processing investment, could supply a meaningful share of domestic WPC80 demand.

Parameter	Published estimates (MT/yr)	Revised analysis (MT/yr)
Western cheese production	~3,000-5,000	~80,000-120,000
Sweet whey liquor (9:1 ratio)	~27,000-45,000	~720,000-1,080,000
Recoverable protein (WPC80)	~270-450	~7,200-10,800
Implied WPC80	~215-360	~5,760-8,640

Strategic implication - revised

At 80,000-120,000 MT/yr of western cheese, India is already generating ~720,000-1,080,000 MT of sweet whey liquor annually.

This implies ~7,000-10,000 MT of recoverable protein - enough to supply a significant share of domestic WPC35 and WPC80 demand across food ingredients, nutraceuticals, and sports nutrition segments.

The bottleneck is NOT feedstock availability. It is the absence of ultrafiltration and membrane filtration capacity to convert this sweet whey stream into sweet whey powder and bulk WPC concentrate rather than discharging it.

Priority investment: UF/MF processing co-located at existing large cheese plants rather than new cheese capacity - the raw material is already being generated and largely going to waste.

3. Paneer Whey: The Dominant But Challenging Stream

3.1 Scale of Acid Whey Generation

India generates approximately 3 MT of liquid whey annually from paneer and chhana production alone. At a conservative estimate of 3 MT of paneer produced annually (paneer market valued at INR 648 billion in 2024), roughly 9 litres of acid whey is generated per kilogram — yielding ~27 MT of acid whey liquor per year, most of which is discarded or used as animal feed at near-zero value.

3.2 Acid vs Sweet Whey — Why Chemistry Matters

Property	Acid Whey - India dominant	Sweet Whey - EU/US/NZ
pH	4.4-4.8 (highly acidic)	5.8-6.5 (near-neutral)
Protein content	0.45-0.62%	0.70-0.90%
Lactose	~4.5%	~4.8%
Mineral / ash content	High - difficult demineralisation	Low - easily processed
Source	Paneer, chhana, dahi	Cheddar, mozzarella, gouda
WPC/WPI suitability	Low - requires costly pre-treatment	High - direct UF/MF applicable

3.3 Valorization Pathways for Acid Whey

While acid whey cannot be directly processed into WPC80/WPI at commercial scale, it holds significant value through alternative routes:

- RTD dairy beverages — whey-based lassi, chaas, flavoured whey drinks. Growing consumer acceptance of functional dairy beverages creates a direct high-volume outlet. NDDB actively promoting cooperative-level bottling.
- Fermentation substrate — acid whey's lactose and peptide content makes it suitable for yeast and bacterial fermentation, producing bioethanol, lactic acid, and single-cell protein for animal feed.
- Lactose crystallisation — demineralisation followed by evaporation and crystallisation can yield food-grade lactose at USD 800–1,200/tonne for pharmaceutical and infant formula markets.
- Biogas generation — lowest-value pathway but widespread in cooperative dairies; reduces effluent BOD/COD load and generates on-site energy.

4. Protein Supply-Demand Gap

4.1 Total Whey Market — Segmented View

India's whey protein demand spans six distinct end-use segments, each with different product specifications, price points, and growth dynamics. A common error is to size the market only around the sports nutrition and consumer supplement channel — this substantially understates total demand. The full market encompasses:

> "India does not have a whey shortage problem; it has a processing problem. The country is already generating significant volumes of sweet whey, but without ultrafiltration capacity, this value is literally being washed away."

Segment	Key whey form	Est. demand 2024 (MT)	Est. value 2024 (USD)	CAGR 2024 –30
Sports & active nutrition	WPC80, WPI, WPH	8,000– 10,000	~60–75M	8–10%
Pharmaceuticals	WPI, hydrolysates	3,000–4,000	~35–45M	7–9%
Nutraceuticals & functional food	WPC35, WPC80	5,000–7,000	~30–40M	9–12%
Infant formula	Demineralised whey, WPC35	4,000–5,000	~40–55M	6–8%
Geriatric & clinical nutrition	WPI, WPH	2,000–3,000	~20–30M	10–13%
Food ingredients (bakery, dairy, beverages)	WPC35, sweet whey powder	6,000–8,000	~20 –30M	6–8%
Total (all segments)	Mixed	28,000–37,000	~205–275M	8–10%

Market sizing note

The ~USD 205–275M total whey demand estimate for 2024 is based on volume estimates by segment multiplied by prevailing import price equivalents for each whey grade.

Sweet whey powder and bulk WPC concentrate (WPC35) account for the largest volume share, primarily consumed in food ingredients and infant formula.

WPC80, WPI, and hydrolysates command significantly higher per-kg values and dominate the sports, pharmaceutical, and clinical segments.

Domestic production (primarily WPC35 from a small number of processors) accounts for less than 20% of total national requirement. Over 80% is imported as sweet whey powder, bulk WPC, or finished WPC80/WPI.

4.2 Import Dependency — The Sweet Whey & Bulk WPC Gap

India's domestic whey processing capacity is nascent. The country produces less than 20% of its national whey protein requirement domestically. What is being produced is primarily WPC35, with limited WPC80 output from a handful of processors (Amul, Parag Milk Foods, and a small number of cooperative plants).

India whey protein - supply vs demand gap (USD million, indicative)

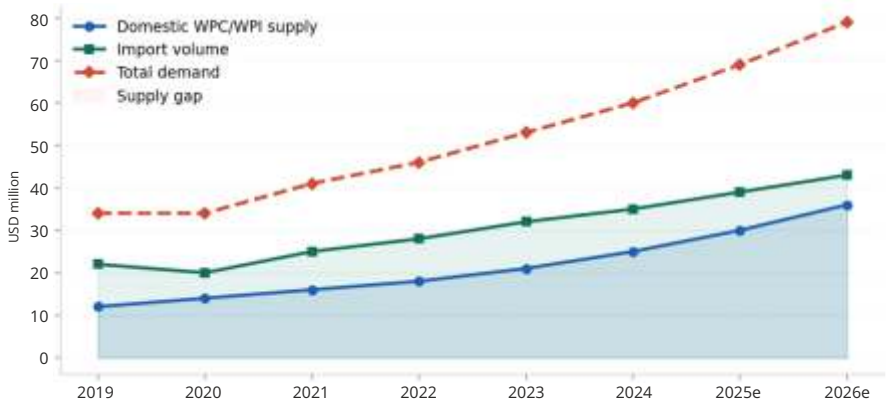


Figure 4: India whey protein — domestic supply vs imports (all segments combined, USD million, indicative)

The remaining 80%+ of demand is met by imports — predominantly sweet whey powder and bulk WPC concentrate — sourced from:

- European Union (France, Germany, Netherlands, Ireland) — largest source, approximately 55–60% of import volumes
- New Zealand and Australia — approximately 20–25% of imports, strong in WPI and infant-grade ingredients

> "India is emerging as one of the world's largest demand centres for dairy protein, yet it remains structurally dependent on imports. Bridging this gap will define the next decade of value creation in the Indian dairy sector."

- United States — historically ~15–20% of imports; access disrupted since November 2024 by veterinary health certificate requirements

It is important to note that when considering waste and underutilisation of India's whey opportunity, the reference is specifically to sweet whey and sweet whey-derived products — sweet whey powder and bulk WPC concentrate generated as a co-product of western cheese manufacturing. This sweet whey stream is either being underprocessed into low-value liquid discharge or not captured at all. The acid whey from paneer is a separate, compositionally distinct stream with different valorisation pathways.

4.3 Supply Constraints

Barrier	Description	Mitigation pathway
Processing infrastructure gap	Insufficient UF/MF/IE at cheese plants; sweet whey mostly discarded despite large volumes	Co-locate UF/MF at existing cheese plants highest-leverage action
Acid whey chemistry	Paneer whey pH 4.4–4.8 — costly pre-treatment before protein recovery	Dairy beverages, lactose recovery, biogas — not WPC
Import tariff complexity	30–40% duty; Nov 2024 VHC requirement cut US supply access	Domestic substitution via UF investment; bilateral trade
Scale fragmentation	Paneer production across millions of small producers	Cooperative aggregation; cluster processing hubs
Cheese-type mix	Mozzarella dominates; cheddar (higher-protein whey) is minor	Expand aged cheese varieties for higher-quality whey stream

Supply barrier severity - India whey protein (assessed)

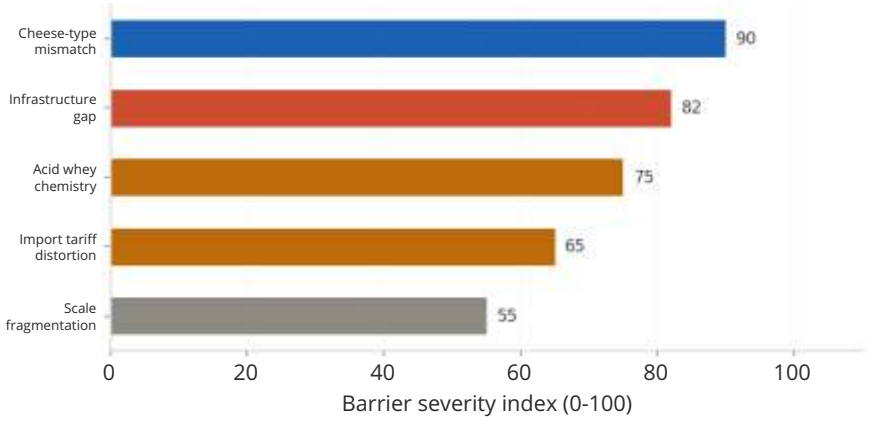


Figure 5: Supply barrier severity index — India whey protein market (assessed, 0–100 scale)

4.4 Quantified Gap — 2022 to 2030

The table below reflects total whey demand across all segments. Domestic production (primarily WPC35) remains below 20% of national requirement through the forecast period under base-case assumptions.

Year	Domestic supply (USD M)	Imports (USD M)	Total market (USD M)	Domestic share
2022	25	130	155	~16%
2023	30	155	185	~16%
2024e	38	192	230	~17%
2025f	48	212	260	~18%
2027f	70	255	325	~22%
2030f	110	310	420	~26%

India whey protein balance: supply components vs demand (USD M) through 2030

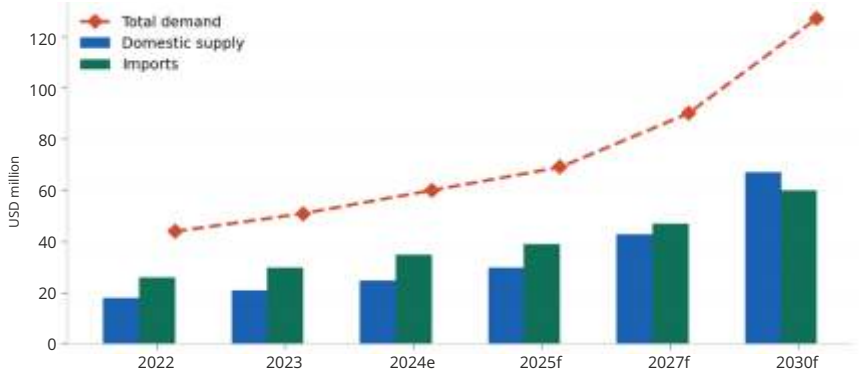


Figure 6: India whey protein — domestic supply vs imports vs total demand through 2030 (USD M, revised estimates)

5. Industry Response & Key Players

5.1 Cooperative Sector

Amul (GCMMF) operates India's largest cheese manufacturing facility at 120 MT/day and has launched a comprehensive high-protein product range including whey protein powder priced at approximately INR 2.5 per gram. The scale of Amul's cheese operation means it generates the largest single sweet whey stream in India. Installing UF/MF processing at this facility to produce sweet whey powder and bulk WPC concentrate rather than discharging the liquid stream represents the single largest domestic whey protein production opportunity in the country.

NDDB is actively promoting co-product valorisation at the cooperative level, including acid whey-based dairy beverage programmes and lactose recovery pilot projects. NDDB's mandate to improve farmer returns is a structural driver for whey monetisation beyond the animal feed route.

5.2 Private Sector

Parag Milk Foods has established a dedicated whey processing facility in Maharashtra and integrates WPC into both B2C consumer products (Avvatar brand) and B2B ingredient supply. The company expects whey to contribute 15% of revenues within three years — a significant pivot for a traditionally commodity-focused dairy processor.

Godrej Agrovet announced an INR 15,000 million (USD 180 million) dairy processing facility in Telangana in December 2025, signalling major private-sector commitment to fractionation capacity. The scale of this investment implies a protein-centric revenue model.

5.3 Government Policy Support

- PLI (Production Linked Incentive) scheme: reimburses up to 50% of qualifying CapEx for dairy processing investments — directly reduces economics of building UF/MF/WPC plants.
- National Programme for Dairy Development (NPDD): funds cold chain, processing, and quality testing infrastructure at cooperative level.
- Veterinary health certificate (VHC) requirements: from November 2024, US-origin whey requires VHC clearance — creating market space for domestic producers to substitute imports.

6. Strategic Outlook to 2030

6.1 Market Trajectory

India whey protein - stacked supply vs demand trajectory 2022-2030

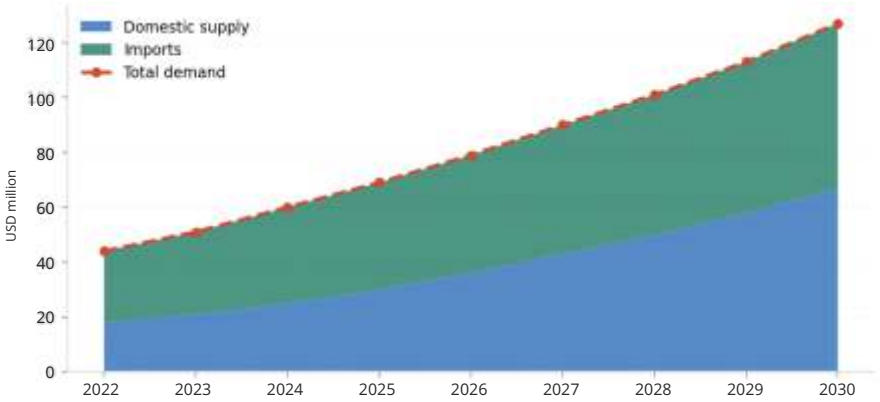


Figure 7: India whey protein — stacked domestic supply + imports vs total demand trajectory 2022–2030 (USD M, revised)

6.2 Scenario Analysis — Base, Upside, Risk

Dimension	Base case	Upside scenario	Risk scenario
Total market CAGR	8-10%	12-14% (all segments grow)	5-6% (slowdown)
Import dependency 2030	~74%	~60% (UF investment scales)	~82% (slow build)
Domestic WPC output	~8,000-12,000 MT	~18,000-25,000 MT	~3,000-5,000 MT
UF at cheese plants	3-5 major plants	8-10 plants by 2028	1-2 plants only
Acid whey valorised	10-15% of stream	25-30% of stream	<5% of stream

6.3 Recommended Strategic Priorities

Priority 1: Install UF/MF at existing large cheese plants (immediate, highest ROI)

Amul's 120 MT/day facility alone generates ~394 MT/day of sweet whey liquor — ~143,000 MT/yr of liquid sweet whey currently being discharged rather than valorised.

At 0.8% protein and 80% UF recovery, this single plant could yield ~1,150 MT WPC80/year plus sweet whey powder — directly substituting for imported bulk concentrate.

This is the fastest route to reducing India's >80% import dependency on sweet whey powder and bulk WPC concentrate.

Same logic applies to Parag, KMF Nandini, Mother Dairy, and all other large cheese operators — each is a stranded whey asset.

Priority 2 : Valorise paneer acid whey at cooperative scale

Launch RTD dairy beverage programmes through NDDB cooperative network (whey-based chaas/lassi at ~INR 15–20/unit).

Install lactose crystallisation at 5–10 large cooperative facilities; target pharmaceutical-grade lactose for infant formula at USD 800–1,200/tonne.

Biogas from remaining acid whey as a transitional step — reduces effluent treatment costs immediately.

Priority 3: Policy: mandate whey capture at cheese facilities above threshold size

Operators of cheese facilities above 10 MT/day should be required to capture liquid whey rather than discharge it — an environmental and economic win.

PLI scheme should explicitly incentivise integrated cheese + UF/WPC co-located facilities.

FSSAI to fast-track WPC35/WPC80 standards for domestic food fortification applications.

Conclusions

Six revised key conclusions for India's dairy protein trajectory through 2030:

1. Western cheese production is far larger than published data suggests. Amul's 120 MT/day facility alone generates more cheese annually than the entire FAO-reported national figure. Organised sector production is ~80,000–120,000 MT/yr, generating a sweet whey stream of ~720,000–1,080,000 MT/yr. Without UF/MF processing infrastructure, this sweet whey — the feedstock for sweet whey powder and bulk WPC concentrate — is largely being discharged rather than valorised.

2. The bottleneck is processing, not feedstock. India has sufficient sweet whey liquor to be largely self-sufficient in WPC35 and a meaningful WPC80 producer. The gap is ultrafiltration and membrane filtration capacity at cheese plants — a capital investment problem, not a raw material problem.
3. Domestic production is less than 20% of national requirement. India currently produces below one-fifth of its total whey protein need across all segments. Over 80% is imported as sweet whey powder and bulk WPC concentrate. This creates acute vulnerability to global price shocks, trade disruptions (as seen with the US VHC requirements in November 2024), and currency depreciation.
4. Acid whey valorisation remains India's unique co-product challenge. The ~27 MT/yr of paneer acid whey cannot be processed into sweet whey-grade WPC, but represents a major opportunity for dairy beverages, lactose recovery, and fermentation. This is a separate stream from the sweet whey generated by western cheese — the latter is where the WPC35 and WPC80 opportunity lies.
5. Ghee is a strategic traditional product, not a commodity. It is India's largest dairy export category and should be recognised as a premium value-added product rather than grouped with commodity dairy outputs.
6. India is a major amplifier of the global protein gap. As a large, fast-growing import market drawing on global WPC/WPI supply while not yet contributing to it, India is a critical variable in the Gira 2030 protein gap analysis — and the country with the largest single investment opportunity in dairy protein processing.

SUSTAINABILITY INITIATIVE

Gujarat Allocates INR 60 Crore for Bio-CNG Projects Through Dairy Cooperatives

Gujarat's budget allocation of INR 60 crore to set up new bio-CNG plants through milk cooperative societies is relevant because it extends dairy thinking beyond milk and into circular-economy infrastructure. The plan to develop bio-CNG projects using the cooperative network shows how dairy institutions are increasingly being viewed not only as milk aggregation systems but also as platforms for energy, waste utilisation and additional farmer-linked revenue streams. In a state where the cooperative dairy model is deeply embedded, that is a strategically significant direction.

The move matters for several reasons. First, it can help create value from dung and related waste streams that are often under-monetised. Second, it aligns with broader policy efforts around sustainability, renewable energy and rural income diversification. Third, by routing such projects through dairy cooperatives, the state may improve execution chances because the organisational base, farmer touchpoints and governance structures already exist. Rather than building a new rural platform from scratch, the government is leveraging an existing network.

For the dairy industry, the development is important because it points to a future in which dairy competitiveness may include environmental and energy dimensions alongside milk productivity and product innovation. Bio-CNG projects can potentially lower waste

burdens, support local energy generation and strengthen the long-term economics of cooperative ecosystems. They also create a more attractive policy narrative for dairy at a time when climate scrutiny is rising globally. This is why the announcement deserves attention beyond Gujarat. It signals that dairy cooperatives may increasingly be positioned as rural bio-economy anchors, not merely as milk buyers and marketers. That has implications for investment priorities, ESG positioning and the next phase of cooperative modernisation in India.

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Science, Sustainability, and the Next Phase of Livestock Growth

Capt. (Dr.) A.Y. Rajendra

On the occasion of National Farm Animals Day, the spotlight turns to the indispensable role of livestock in shaping India's agricultural and economic landscape. From ensuring nutritional security to sustaining millions of rural livelihoods, farm animals remain at the heart of the country's agri-food ecosystem. As India navigates rising demand for protein-rich food and the need for more efficient, sustainable farming practices, the livestock sector stands at a critical juncture. In this context, Godrej Agrovet Limited continues to play a pivotal role in advancing science-led nutrition, improving productivity, and promoting responsible livestock management. In an interaction with Think Grain Think Feed, Capt. (Dr.) A.Y. Rajendra, CEO – Animal & Aqua Feed Business, shares insights on strengthening the sector for a more resilient and future-ready India.

On National Farm Animals Day, how would you describe the role of farm animals in India's food security and rural economy?

Farm animals play a very important role in India's agri-food system, contributing not only to food security but also to rural livelihoods. Over time, livestock has evolved from being a supplementary activity into a core pillar of the agricultural economy, supporting both nutrition and income for millions of households. As demand for protein-rich food continues to rise, the importance of livestock will increase further, making it essential to strengthen the sector

through more efficient and science-led practices.

India's position as the world's largest milk producer highlights this significance, with strong domestic supply ensuring access to nutrition. At the same time, livestock remains a critical economic asset, contributing nearly 30 percent of agricultural Gross Value Added and supporting millions of dairy farmers, many of whom are small and marginal.

However, despite its scale, the sector continues to face productivity constraints. Per-animal output remains below global benchmarks, with feed and fodder gaps affecting efficiency. Going forward, improving productivity through better nutrition, genetic improvement, and animal health management will be key to meeting rising demand, while strengthening rural incomes and long-term food security.

How is Godrej Agrovet Limited contributing to sustainable and responsible livestock practices?

At Godrej Agrovet Limited, our livestock approach focuses on improving productivity through science-led nutrition, efficient management, and technology adoption, while ensuring sustainability and farmer profitability. Lifecycle-based, stage-specific feed solutions enable precise nutrient delivery, improving biological efficiency and overall output—particularly important in India, where quality feed gaps persist.

By shifting from unstructured feeding to balanced, scientifically formulated feed, we help improve consistency, reduce inefficiencies, and lower production costs. Our solutions, including Pride Hog for pigs, have demonstrated gains in growth and reduced mortality. Through strong farmer engagement, training, and advisory programmes, we enable the adoption of scientific practices, driving more efficient, sustainable livestock systems and better farmer incomes.

What role do animal nutrition and health play in enhancing livestock productivity?

Animal nutrition and health are central to livestock productivity, directly impacting output, efficiency, and farmer profitability. In India, where growth has largely been scale-driven, strengthening nutrition and preventive healthcare is key to improving per-animal productivity and building a more sustainable ecosystem. Balanced, scientifically formulated feed enhances feed conversion efficiency, translating inputs into higher milk yield, weight gain, and better reproductive performance—making it critical in addressing persistent feed and fodder gaps.

At Godrej Agrovet Limited, our feed portfolio—including Doodh Vriddhi, Samrudhi, and Dhanalaxmi—delivers precise nutrition to improve yield quality, lactation, and animal health, while solutions like Summer Kool help manage heat stress. Alongside nutrition, preventive healthcare—covering vaccination, hygiene, and biosecurity—reduces disease risk and economic losses. Together, these enable a shift towards efficiency-led growth, boosting farmer incomes while promoting sustainable livestock farming.

How can the industry ensure ethical treatment and welfare of farm animals alongside productivity?

Ensuring the ethical treatment and welfare of farm animals is not just a moral responsibility but also a key driver of productivity, efficiency, and long-term sustainability. Improved welfare practices are increasingly linked to better health outcomes, higher output, and stronger farm profitability, with studies indicating productivity gains of 9–15%, along with improved feed efficiency and reduced disease incidence. Animals that are well-managed and free from stress deliver better milk yield, growth, and reproductive performance, while factors such as heat stress, poor housing, and inadequate nutrition can significantly reduce output.

Balanced nutrition, continuous access to clean water, and sound genetics play a critical role in improving animal health and resilience. At Godrej Agrovet Ltd, our solutions are designed to support both productivity and animal health, complemented by strong biosecurity practices that improve resilience in high-risk segments. A proactive approach to preventive healthcare through vaccination, hygiene, and biosecurity helps reduce mortality, minimise economic losses, and ensure more stable productivity outcomes. Strengthening farmer awareness and leveraging technology for monitoring and data-driven decisions will be key to advancing welfare outcomes. Ultimately, a balanced approach that combines productivity with responsible animal care is essential for sustainable growth and improved farmer incomes.

Could you share insights into its current organizational structure, the scale of its farmer network, and its market reach?

At Godrej Agrovet Limited, our approach is anchored in a strong, integrated feed ecosystem that operates at scale while staying closely connected to farmers. Our Animal Feed business is among India's leading organised players, supported by over 30 manufacturing plants and a diverse portfolio spanning cattle, poultry, aqua, and specialty feed. At the core of our innovation is the Nadir Godrej Centre for Animal Research & Development (NGCARD), where advanced research is focused on improving livestock productivity through scientifically developed, high-impact nutrition solutions. This scientific foundation ensures that what reaches the farmer is not just a product, but a well-researched solution built for real-world impact.

Farmer engagement is central to our model. We work directly with over 10,000 dairy farmers through structured advisory programmes, driving the adoption of scientific practices. Initiatives like the Krishnagiri dairy

programme reflect this approach, that supported more than 6500 farmers and more than 21000 animals through 250+ veterinary camps, combining capacity building with veterinary outreach. We also promote inclusive sourcing by procuring grains locally, integrating smallholders into our supply chain. Supported by strong last-mile advisory, ration balancing, and multilingual customer care, our focus remains on expanding reach, strengthening farmer partnerships, and scaling sustainable, high-efficiency livestock systems.

What more can corporates and policymakers do to strengthen support for small and marginal livestock farmers?

Smallholders are the backbone of India's livestock sector, owning nearly 80% of the livestock and playing a vital role in rural livelihoods and food security. However, gaps in access to quality feed, veterinary care, and scientific knowledge persist. Bridging the nutrition gap is critical, as feed accounts for nearly 70% of input costs yet remains imbalanced in a fragmented ecosystem. Scaling the adoption of balanced compound feed can significantly improve productivity, reduce inefficiencies, and enhance farmer incomes.

Stronger collaboration between industry and policymakers is essential—through a National Feed Security roadmap, improved last-mile veterinary services, and expanded public-private partnerships for training. Digital advisory tools, along with continuous on-ground awareness, can drive better decision-making. Strengthening extension systems, scaling initiatives like digital animal IDs, and promoting agri-tech solutions such as mobile vet services and IoT tools—along with targeted support for women farmers—will be key to building a more inclusive and future-ready livestock ecosystem.

What piece of advice would you give to young entrepreneurs entering the livestock/agri sector?

For young entrepreneurs, the key shift is that livestock is moving from scale-led to efficiency-led growth. Despite having the world's largest livestock population, per-animal productivity in India remains low—creating a significant opportunity to improve output per unit of input rather than simply expanding herd size. Nutrition-led value creation is central to this, as feed is the single largest lever impacting productivity, animal health, and sustainability.

The future is increasingly science- and technology-driven, with a growing focus on precision nutrition, specialised formulations, and performance-enhancing additives. On farms, technologies such as automated feeders, IoT systems, and sensors are enabling real-time monitoring and smarter decision-making. For entrepreneurs, leveraging AI and IoT for solutions like ration balancing, disease alerts, and digital advisory platforms offers strong potential. Ultimately, success will depend on improving feed efficiency, enhancing animal health, and delivering consistent, sustainable productivity gains.

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Global Dairy Enters Q1 2026 With Strong Milk Flows and Weaker Prices

DairyReporter's Q1 2026 global outlook is one of the most important recent reference points for the world dairy industry because it captures the dominant market reality of the moment: milk supply has remained elevated while commodity prices have come under sustained pressure. The report notes that the first quarter saw steady milk flows from most major exporters, which continued to weigh on prices, especially in fat and whole milk powder markets. That combination of strong production and weaker pricing sets the tone for much of the industry's current strategic thinking.

The relevance of the story lies in its breadth. Oversupply is not just a single-country issue; it influences export competitiveness, farmgate prices, processing margins, inventory strategy and capital spending decisions across multiple regions at once. The fact that fat markets and WMP were among the hardest hit is particularly significant because these product streams are central to the earnings profile of many exporters. Meanwhile, protein-oriented categories such as whey, cheese and SMP appear more resilient, but they too have softened.

For dairy companies, the report reinforces a familiar but increasingly urgent theme: scale alone will not protect margins in a soft commodity environment. Businesses need mix discipline, stronger positioning in proteins or functional categories, and careful management of farmgate expectations. For farmers and cooperatives, the outlook suggests that milk growth cannot be assumed to translate into income growth. In practical terms, this is one of the month's most relevant stories because it frames nearly every other development - processor pricing, farmer pressure, retail promotions and investment caution. It is the macro backdrop against which much of the global dairy sector is now operating.

Lactalis Warns the Iran War Could Force New Dairy Price Increases

Lactalis warning that the Iran war is driving up costs and could force fresh dairy price increases is highly relevant because it links one of the world's biggest dairy companies directly to the latest geopolitical shock. According to Reuters, the disruption has affected energy, transport and packaging, while the near-closure of the Strait of Hormuz has created delays for perishable cargoes including butter and cream. When a company of Lactalis' scale says conflict is beginning to affect the movement and economics of dairy products, the industry has to pay attention.

The importance of this story extends beyond one processor. Dairy is often seen as a local farm-to-fridge business, but large processors depend on a global network of shipping routes, packaging materials, ingredients and energy-intensive manufacturing. When those inputs become unstable, the impact can move quickly from supply chain stress to price decisions. Lactalis signalled that any 2026 consumer price increase would likely be smaller than the huge hikes seen during the last energy crisis, but the warning itself matters because it shows how fragile the margin environment remains.

Strategically, the development is important for exporters, importers and branded dairy businesses alike. It raises questions about freight reliability, product mix, regional inventory strategies and the ability of companies to pass on higher costs in a softer demand climate. It also reinforces the idea that dairy inflation does not always originate at farm level. Processing and logistics shocks can be just as influential. In that sense, the Lactalis warning is not simply another conflict headline. It is a reminder that dairy remains deeply exposed to geopolitical volatility, even when the immediate conflict is far from the farm.

Fonterra Lifts Earnings and Milk Price Outlook Despite Middle East Risks

Fonterra raising both its earnings outlook and its forecast milk price range is one of the month's most relevant dairy stories because the cooperative remains one of the most important signals in global traded dairy. Reuters reported that Fonterra lifted its annual guidance and increased the forecast range for the farmgate milk price to NZ$9.40-NZ$10.00 per kilogram of milk solids. That is important not only for New Zealand farmers, but for anyone trying to understand the direction of export-market confidence, processor margins and the resilience of dairy demand despite broader uncertainty.

What makes the story especially noteworthy is the contrast between stronger internal performance and rising external risk. Fonterra cited robust milk flows and operational discipline, yet also flagged potential disruptions linked to the Middle East situation. That combination captures the current state of global dairy rather well: near-term business performance can still

look solid, even while logistics, freight and input risks remain elevated.

The wider relevance lies in Fonterra's role as a bellwether. When it adjusts payout expectations upward, market participants across Asia-Pacific and beyond pay attention because the cooperative sits at the centre of major global product flows. Its guidance can influence sentiment around milk supply growth, export competitiveness and the confidence with which farmers continue investing into the season.

The story also matters because it complicates the simple "oversupply equals weakness" narrative. Fonterra's update suggests that even in a softer overall market, strong product execution and disciplined operations can preserve earnings. For the global industry, the takeaway is that 2026 is shaping up to be a year of mixed signals - price pressure in some commodity areas, but still meaningful upside for well-positioned exporters.

EU Moves Toward Emergency Support for Farmers as War Lifts Input Costs

The European Commission's move toward grants, subsidies and tax relief to offset the impact of the Iran war on farming and transport is highly relevant for dairy because European milk production is deeply sensitive to fuel and fertiliser costs. Reuters reported that Brussels was considering temporary support measures to help sectors facing cost inflation as the Strait of Hormuz disruption pushed up pressure on critical agricultural inputs. Even though the proposal is broader than dairy, the dairy industry is one of the clearest downstream channels through which such cost increases are felt.

The reason this story matters is straightforward: dairy margins can tighten sharply when energy and fertiliser costs spike, even if milk prices or demand look stable on the surface. Fertiliser affects feed and forage economics; fuel affects milk collection, processing and distribution; transport volatility raises uncertainty for exports and cross-border flows. The Commission's consideration of targeted aid therefore signals that policymakers see the pressure as serious enough to threaten competitiveness if left unaddressed.

For dairy companies and cooperatives, the development is relevant because it may influence how aggressively producers hold milk output, whether processors can avoid severe cost pass-through, and how Europe positions itself against lower-cost exporters. For farmers, any support that cushions fertiliser or energy bills could help preserve production incentives at a delicate moment.

More broadly, the proposal highlights a recurring pattern in modern dairy economics: geopolitical shocks increasingly affect dairy indirectly through inputs, not only through direct market access issues. That is why this item deserves a place among the most relevant dairy developments of the month. It shows that governments are already being forced to think about dairy resilience through the lens of energy security, transport vulnerability and strategic agricultural support.

Coles Offers Direct Relief to Australian Dairy Farmers as Costs Surge

Coles' decision to provide a A$1 million relief payment and a temporary special milk payment to directly contracted dairy farmers is notable because it shows a major retailer stepping in more visibly as cost pressure intensifies. The support is tied to production volumes and is designed to help farmers cope with surging fuel, fertiliser and packaging costs. In an industry where the relationship between supermarkets and milk producers is often tense, the announcement stands out as a significant commercial and political signal.

The story matters because Australia's dairy sector has been under pressure from a difficult mix of weather shocks, cost inflation and margin stress. Retailer behaviour is therefore closely watched. When a large supermarket acknowledges the squeeze by adding direct support, it can influence expectations across the supply chain - including how rival retailers respond, how processors position their own milk price offers and how farmer groups frame negotiations.

There is also a broader industry lesson here. Dairy often sits at the intersection of agriculture and retail politics more visibly than many other food categories. Milk is a staple, highly price-sensitive for consumers and symbolically important for farmers. As a result, support measures from supermarkets carry significance beyond their immediate monetary value. They signal whether the burden of inflation is being shared or simply passed downstream.

From a global perspective, the Coles move deserves attention because it reflects how dairy stress is being managed in real time in one exporting region. It shows that cost shocks are not abstract macro forces; they are now producing concrete interventions at the farm-retail interface. That makes this one of the more relevant dairy developments of the past month, especially for anyone tracking producer sustainability under volatile market conditions.

Ornua Says Milk Prices Could Stay Under Pressure for the Rest of 2026

Ornua's warning that milk prices may remain under pressure for the rest of 2026 is relevant because the Irish dairy system is one of the world's most export-oriented, and its market signals often reflect wider global conditions. Speaking around the publication of Ornua's financial results, chief executive Conor Galvin indicated that although some stabilisation could emerge later in the year, the expected turn now appears slower than previously hoped. That message matters because it tempers optimism at a time when some market participants were looking for a clearer second-half recovery.

The story is significant for both farmers and processors. For producers, prolonged pressure means another period in which cost discipline and cash-flow management will remain critical. For processors and cooperatives, it suggests limited room to expand milk prices materially unless product market returns improve. That tension is especially important in seasonal milk systems, where peak production months can amplify the consequences of weak pricing.

What makes the Ornua view important beyond Ireland is that it aligns with the broader global picture of strong supply and uneven demand support. Ornua is closely tied to export market realities across butter, cheese and other dairy products, so its assessment carries weight for the wider trade environment. If one of the most internationally exposed dairy organisations is cautioning that price pressure may persist, that is a useful read-through for others.

In short, this is not just another processor comment on prices. It is a strategic signal from a major export-market participant that the dairy recovery may be slower, patchier and more fragile than some in the industry had expected only a few months earlier.

Tirlan Commits to Hold Milk Price Through Peak Supply Months

Tirlan's announcement that it would maintain a committed milk price for March and signal continuity into April and May is relevant because it addresses one of the most sensitive points in dairy markets: price confidence during peak supply. In seasonal systems, producers often fear that milk price weakness will intensify precisely when volumes rise. A processor's decision to provide a short-term commitment therefore has value beyond the nominal price itself. It helps reduce uncertainty and offers farmers a clearer basis for managing feed, labour and working capital decisions.

The importance of the move lies in timing. Spring and early summer milk flows can quickly expose the gap between farm expectations and market realities. By stating a clearer near-term position, Tirlan is trying to balance market caution with supplier stability. That can be commercially important for a cooperative because milk loyalty is not simply ideological; it depends on whether farmers believe their processor is providing a fair and predictable return.

The story also matters at a wider level because it illustrates how processors are reacting in a difficult global environment. With international dairy prices under pressure and input volatility still present, every milk price signal becomes a test of confidence. A commitment through multiple months suggests a desire to stabilise sentiment even when the broader market outlook remains uncertain.

For the international dairy industry, the relevance is not that Tirlan alone can change the market, but that such moves show how cooperatives are trying to manage producer psychology during a soft phase. In that sense, this is one of the month's useful operational stories: it reveals how price communication itself has become an important management tool in a volatile dairy cycle.

Kerry Dairy Ireland Lifts Base Milk Price for March Supplies

Kerry Dairy Ireland's increase in its base milk price for March supplies is relevant because it shows that even in a market widely described as under pressure, processors are still making selective upward adjustments to support suppliers. That matters in a season when farmers are watching every cent closely and trying to judge whether the worst of the price slide has passed. While the increase does not signal a full market recovery, it does indicate that processors are not responding in a uniform way to current conditions.

The strategic significance lies in the nuances. Milk price announcements are never purely technical; they reflect a processor's reading of market returns, competitive procurement dynamics and the need to preserve supplier trust. In Ireland's export-driven system, price decisions also send a message about how confident processors are in near-term product performance.

Kerry's move therefore deserves attention because it suggests at least some capacity to share value back to farmers despite continuing caution in broader dairy

markets.

This story also matters in conjunction with other recent Irish processor announcements. When several companies make adjustments around the same time, the pattern helps shape farmer expectations and influences procurement behaviour. A single increase may not transform the income outlook, but it can still affect sentiment and relative supplier loyalty.

For the global dairy sector, developments like this are useful because they show how local milk price mechanisms respond in a soft but not uniformly collapsing market. There is still room for tactical support and processor differentiation. Kerry's announcement is therefore one of the month's relevant developments, not because it changes the global balance sheet on its own, but because it helps reveal how exporters are trying to navigate a fragile pricing environment without losing farm-level confidence.

Lakeland Dairies Raises March Milk Price as Processors Jostle for Supplier Confidence

Lakeland Dairies increasing its base price for March milk supplies is another relevant signal from the Irish dairy market because it reinforces that processors remain under pressure to keep suppliers engaged even while broader international conditions stay challenging. In practice, these price decisions are about more than one month's return. They influence how farmers assess cooperative alignment, what they expect from competing processors and how much confidence they carry into the peak production period.

The move matters because Lakeland operates across a cross-border milk pool, making its announcements closely watched in both the Republic of Ireland and Northern Ireland. When a processor serving multiple jurisdictions chooses to lift price, it reflects a calculation that supplier retention and near-term support outweigh the risks of standing still. That is particularly important in a year when many farmers have been unsettled by the pace of milk price decline since late 2025.

This development should also be read as part of a wider pattern. Several Irish processors have recently made upward adjustments or support moves, suggesting the market is not in free fall even though underlying pressures remain. That does not remove the structural issue of weaker global returns, but it shows that processors are trying to smooth the landing for producers where possible.

For global dairy observers, Lakeland's move is relevant because milk price behaviour in export regions often reveals more than formal market outlook reports. It shows how companies are actually choosing to distribute risk and maintain procurement relationships on the ground. In that sense, the announcement is not merely a local board decision. It is one more indicator of how the industry is managing farmgate tension during a period of oversupply, volatility and fragile confidence.

Dairygold Says Milk Supply Is Still Growing Despite Price Headwinds

Dairygold's statement that milk supply has continued to increase in 2026 is a notable global dairy story because it underlines one of the market's biggest tensions: production growth has not backed off as quickly as prices might have suggested. The co-op reported that milk supply had risen in 2025 and that volumes and milk solids continued to strengthen into the current year. That matters because sustained supply growth in a major European exporter helps explain why commodity markets remain under pressure even as processors try to support farmers.

The significance of the development is not confined to Dairygold itself. Exporting regions such as Ireland play an outsized role in shaping global butter, cheese and milk powder balances. If supply keeps expanding there, the industry has to assume that price recovery will be harder won unless demand improves or output growth eases elsewhere. Rising milk solids are especially relevant because they amplify the product impact of volume growth, giving processors more fat and protein to sell into already competitive markets.

This is why the story belongs among the most relevant recent dairy developments. It offers a real-world confirmation of the oversupply narrative seen in broader market reports. Rather than merely forecasting strong milk flows, Dairygold is reporting that the pattern is actually continuing.

For farmers, the message is mixed: production performance remains robust, but that success can feed the very pressure that weighs on prices. For processors and traders, it reinforces the need for disciplined sales strategy and realistic expectations about market recovery. In short, Dairygold's update is an important reminder that the current dairy cycle is being driven as much by stubborn supply strength as by any single demand-side weakness.

Amul Crosses the INR 1 Lakh Crore Sales Mark

Amul crossing the INR 1 lakh crore sales milestone is one of the clearest signals that India's dairy story is entering a new scale bracket. The achievement matters not simply because of its size, but because it reflects the durability of the cooperative model in a market where milk remains both a mass staple and a high-frequency consumer purchase. According to Managing Director Jayen Mehta, the federation has moved from a small cooperative origin to processing roughly 350 lakh litres a day, and the milestone strengthens the argument that India can now think beyond self-sufficiency toward a more ambitious global dairy role.

Strategically, the story is relevant for three reasons. First, it reinforces that value-added dairy - not just liquid milk - will increasingly drive growth. As margins in plain milk remain structurally tight, large players such as Amul are expected to invest more in higher-value categories where brand, innovation and shelf presence matter more. Second, the milestone highlights the centrality of farmer-linked procurement systems. Amul's scale rests on a distributed milk collection base that private processors still struggle to match in depth and resilience. Third, management linked the growth story to policy changes such as the GST reduction on dairy, suggesting the demand environment may become more supportive for packaged and value-added products.

For the wider industry, this is not just a company success story. It is a marker of consolidation, formalisation and brand-led expansion in Indian dairy. It also raises the competitive bar for every other processor, cooperative and premium challenger that now has to define where it can differentiate in a market increasingly dominated by scale, reach and farmer integration.

Akshayakalpa Bets INR 200 Crore on Mumbai and Pune Expansion

Akshayakalpa's decision to enter Mumbai and Pune with a planned investment of around INR 200 crore is significant because it shows how India's premium dairy market is moving from a niche urban proposition to a more deliberate regional scale-up play. The company is not competing on mass affordability; it is positioning milk at roughly INR 100-110 per litre, well above mainstream brands. That price point makes the story important for anyone tracking consumer premiumisation, clean-label demand and the willingness of affluent Indian households to pay for differentiated sourcing narratives.

The move also underlines a structural shift in the Indian dairy sector. For years, premium dairy was often discussed in terms of organic, farm-fresh or subscription-led concepts, but scale remained limited and geography narrow. Akshayakalpa's expansion suggests that a branded premium proposition can now justify meaningful capital deployment outside its core southern stronghold. This is particularly relevant in western India, where modern retail, high-income catchments and digital grocery channels can support a differentiated milk and protein portfolio.

From an industry perspective, the story matters because it tests whether India's future dairy growth will come only from mass volume or also from premium value pools. If Akshayakalpa succeeds, it will strengthen the case for higher-margin categories built around origin assurance, animal-care narratives, residue-free claims and protein-led innovation. That could push other processors - especially those serving metros - to sharpen their offerings. In that sense, this is not merely a city expansion announcement. It is a live market experiment in whether India's premium dairy ceiling is much higher than the sector previously assumed.

Uttar Pradesh Secures INR 3,000 Crore of Dairy Investment Commitments

Uttar Pradesh signing MoUs worth roughly INR 3,000 crore for dairy investment is relevant because it points to the next phase of state-level dairy development: larger, infrastructure-led expansion supported by policy signalling and private participation. UP is already one of India's most important milk-producing states, so new investment commitments there are not marginal additions. They have the potential to influence procurement systems, chilling capacity, processing footprints, employment generation and the pace of organised-sector growth in one of the country's biggest milk belts.

The importance of the announcement lies in the combination of size and location. In India, dairy growth is often discussed nationally, but competitiveness is still shaped state by state through infrastructure, logistics, cooperative strength, power availability and farmer access. A fresh investment pipeline in UP suggests stronger competition for milk, more downstream processing opportunity and potentially better routes for formalisation. If executed well, such projects could help reduce losses, improve milk handling, encourage local value addition and deepen linkages between farmers and organised processors.

For the industry, this is also a political signal. States are increasingly using dairy as an employment, rural income

and food-processing lever rather than seeing it only as an agricultural activity. That matters because dairy investment tends to spill over into cold chain, transport, feed, packaging and local services. It also helps create the conditions for differentiated products, not just raw milk handling. While MoUs are not the same as commissioned plants, the scale of the commitment makes the development noteworthy. It suggests that state governments still see dairy as one of the most dependable channels for inclusive rural growth and industrial expansion at the same time.

Punjab Raises Milk Procurement Rates for Verka-Linked Farmers

Punjab's decision to raise milk procurement rates for farmers linked to Milkfed and Verka is important because it goes straight to the heart of dairy economics: what the producer gets paid. The announcement, which increases rates by around INR 10-15 per kilogram of fat with effect from April 1, is expected to benefit a large cooperative-linked farmer base and could also influence private-sector pricing behaviour in the state. In a dairy market where farmer retention and milk loyalty are increasingly contested, procurement price revisions are never just administrative actions; they are strategic market signals.

The move matters for at least three reasons. First, it supports rural incomes in a state where dairy remains a critical supplementary cash-flow source. Second, it helps Verka defend milk procurement in a competitive environment where private players and local collection agents may try to attract better suppliers. Third, it illustrates the political sensitivity of dairy procurement. When states choose to intervene or support producer returns, they often shape the commercial room available to both cooperatives and private processors.

For the wider Indian dairy industry, the development is relevant because procurement costs remain one of the biggest pressures on processor margins. Any upward move in one region can trigger local competition, affect milk pooling patterns and alter price discipline in adjacent markets. It also reminds the market that dairy is not only about brands and consumers; it is equally about farmer confidence and supply-side trust. Punjab's rate hike therefore represents more than farmer relief. It is a reminder that procurement economics remain the foundation on which every downstream dairy strategy - from liquid milk to premium ingredients - ultimately rests.

Purabi Dairy Reports 33% Turnover Growth in Assam

Purabi Dairy's reported 33% rise in turnover to INR 400 crore is a meaningful regional dairy story because it shows that organised dairy growth in India is not confined to traditional western and southern strongholds. Operated by the West Assam Milk Producers' Cooperative Union, Purabi's performance suggests that the northeast can support more substantial cooperative-led dairy development when procurement networks, farmer participation and brand distribution expand in step. For a sector that often focuses on Gujarat, Karnataka, Tamil Nadu or the National Capital Region, this is an important reminder that new growth corridors are emerging.

The cooperative's expansion has reportedly been supported by a growing farmer base of more than 58,000 dairy farmers. That number matters because dairy scale is difficult to build without procurement trust and steady farmer onboarding. Turnover growth in such a context is not only a demand story; it is also a collection, processing and institution-building story. If the underlying supply system continues to strengthen, Purabi could become one of the more interesting regional dairy models in India.

The broader relevance is strategic. India's dairy future will depend not just on large national brands but also on the ability of regional players to organise milk, create local value addition and defend market share. A successful northeastern cooperative can reshape expectations around what is possible in geographies historically considered logistically difficult or commercially fragmented. It may also encourage more investment in chilling, feed support, breed improvement and local processing. In short, Purabi's performance is not merely a turnover update. It signals that the map of organised dairy growth in India may be broadening faster than many industry observers assumed.

Himachal Pradesh Signs NDDB MoUs to Build Dairy Infrastructure

Himachal Pradesh's set of MoUs with the National Dairy Development Board is relevant because it combines institution-building, processing capacity and rural economic strategy in a relatively under-scaled dairy geography. The agreements cover formation of the Kangra Milk Union, development of processing plants and chilling centres, and ERP implementation in the state federation. The most ambitious element is a milk processing plant in Dhagwar, Kangra, with an initial capacity of 1.5 lakh litres per day and room for expansion. Taken together, the package signals that

Himachal wants to move from scattered production support toward a more integrated dairy system.

The story matters because dairy development in hill states has distinctive constraints: terrain, logistics, dispersed milk pools and smaller market density. That makes infrastructure choices especially consequential. Chilling centres and processing plants are not generic investments in such regions; they determine whether milk can move reliably into formal channels. The ERP element is also important because it suggests the state is trying to combine physical expansion with governance and data improvements.

For the wider industry, the Himachal move illustrates how NDDB continues to shape dairy development beyond the major producing states. If the projects are executed well, they could strengthen local procurement, support farmer incomes, expand the “Him” dairy brand and reduce wastage. They may also encourage more state-led thinking on how to use dairy as a tool for rural employment and decentralised value addition. In strategic terms, the significance of the announcement lies less in immediate volume and more in model-building: it shows how smaller states can still construct viable, formal dairy ecosystems through targeted infrastructure, cooperative design and institutional support.

Madhya Pradesh Dairy Federation Rolls Out Digital Systems Across 17 Plants

The Madhya Pradesh State Cooperative Dairy Federation's rollout of a digital system and mobile app across 17 dairy plants is one of the more relevant operational stories of the month because it tackles a chronic weakness in Indian dairy: fragmented data flows between farmer, society, plant and management. The reform, being implemented through NDDB's enterprise resource planning platform, aims to improve procurement transparency, reduce losses in storage and transport, and centralise information across multiple functions including milk collection, inventory, marketing and finance.

This matters because digitalisation in dairy is often discussed in abstract terms, while the actual bottlenecks remain basic and expensive - delayed information, inconsistent quality records, poor traceability and weak visibility on plant-level performance. A system that sends immediate SMS updates to milk suppliers about fat and related metrics can improve trust at the village level. That may sound operational, but in dairy, operational trust directly influences milk loyalty and cooperative credibility.

The scale of the implementation also makes it relevant. Extending the platform across 17 plants means the effort is not a small pilot; it is a network-level management upgrade. If successful, it can improve decision-making speed, reduce leakages and create a more consistent basis for quality-linked procurement and plant optimisation. For the broader Indian dairy sector, the story is important because digital backbone systems will increasingly separate efficient federations from those that struggle with accountability and profitability. In that sense, MP's move is not just a software deployment. It is an attempt to modernise the governance architecture of cooperative dairy at a time when data quality is becoming as important as milk quality.

Bemul Reports Record Profit as Regional Cooperative Expansion Gains Pace

The Belagavi District Cooperative Milk Producers' Union, or Bemul, reporting a record profit of about INR 12.5 crore for FY2025-26 is a relevant story because it reflects the continuing resilience of regional dairy cooperatives in India's competitive market. With turnover of roughly INR 510 crore, average daily procurement of around 2.5 lakh kg and visible expansion in franchise presence and value-added products, Bemul's performance suggests that well-run district unions can still grow meaningfully without being national giants.

The significance lies in the combination of operational and market-side progress. The union reportedly added new cooperative societies, expanded production of products such as ghee, paneer and peda, and broadened reach into markets including Goa and Pune. That indicates a gradual but important shift from being only a milk handling institution toward becoming a stronger branded dairy operator. In India, that transition is crucial because long-term viability increasingly depends on value addition rather than pure liquid milk dependence.

Bemul's result also matters for policy and cooperative observers because it highlights what district-level institutions can achieve when they retain farmer engagement and pursue commercial discipline. Many discussions about the future of Indian dairy are dominated by either national brands or startup-led premium models. Regional cooperatives like Bemul show there is still another path: strengthening local procurement, building modest but durable branded presence, and broadening product mix step by step.

In strategic terms, this is more than a local profit announcement. It is evidence that second-tier cooperatives can remain relevant engines of rural income and organised dairy growth, especially when they combine procurement depth with focused expansion into higher-margin product segments and nearby urban markets.

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