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Volume 1 | Issue 6 | Sep-Oct 2025

bi-monthly

Keys to Success in Mini Dairy Farming

Dr. T. M. Gowrisankar

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Published by

BENISON Media

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Karnal-132001, Haryana

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In association with

JORDBRUKARE

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SUBSCRIPTION INFORMATION

	Simple Post	Courier	Overseas
One Year	: INR 1200	INR 1800	USD 300
Three Year	: INR 3300	INR 4800	USD 900
Five Year	: INR 5200	INR 6500	USD 1500

Printed by: Noni Printer | Published by: Prachi Arora | On behalf of: BENISON Media |
 Printed at: Model Town, Karnal-132001, Haryana | Published at: SCO-17, 2nd Floor, Mugal
 Canal Market, Karnal-132001, Haryana | Editor: Prachi Arora

Dairy Dimension is a bi-monthly magazine published by BENISON Media at its office in Karnal in association with Jordbrukare. Editorial policy is independent. Views expressed by authors are not necessarily those held by the editors. The data/information provided in the magazine is sourced through various sources and the publisher considers its sources reliable and verifies as much data as possible. However, the publisher accepts no liability for the material herein and consequently readers using this information do so at their own risk.

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Keys to Success in Mini Dairy Farming

by **Dr. T. M. Gowrisankar**, Independent Animal Nutritionist & Animal Feed Consultant



Dr. T. M. Gowrisankar

Practical Guidelines for Sustainable and Profitable Operation

Mini dairy farms are increasingly being recognized as a viable model for small and medium-scale dairy entrepreneurs in India. When managed well, they offer a balance between profitability, sustainability, and manageable operational scale. However, to succeed, farmers must adhere to key principles involving land use, animal management, feed production, health care, and overall farm planning.

This article outlines essential components for building and running a successful mini dairy farm, drawing on best practices adapted to Indian conditions.

Foundational Requirements

Two baseline conditions are necessary for the long-term success and viability of a commercial mini dairy farm:

- Minimum 3 acres of land with reliable water access to grow adequate green fodder.
- Minimum daily milk production of 300 litres per farm to achieve economies of scale.



Farm Size and Labour Considerations

- An optimal herd size is either:
20 cows in milk, each producing ~15 litres/day, or
15 cows in milk, each producing ~20 litres/day
- Family labour involvement is highly recommended to reduce costs and ensure hands-on supervision.
- Ideally, the farm owner should reside on the farm for close monitoring of animal health, feeding, and productivity.
- High-yielding cows (>20 litres/day) are generally not recommended for mini farms due to increased risk of metabolic disorders, mastitis, and fertility issues.

Cow Induction Strategy

Introducing animals into the farm should follow a staggered, sustainable process:

- Begin with 1/3 or 1/4 of the total planned herd, preferably first-lactation heifer cows.
- Introduce the 2nd and 3rd batches at 3–4 month intervals.
- Once established, focus on raising your own heifer calves with good genetics. Target:

Average daily weight gain of 400g or more.

First conception by ~18 months of age.

This reduces reliance on external cow purchases and

improves long-term herd quality.

Maintain a system where old or low-yielding cows (4th/5th lactation or problem cows) are sold and replaced with in-farm raised pregnant heifers.

If external purchase is necessary, buy first-lactation cows at a price equivalent to what was received from selling 4th-lactation cows.

Green Fodder Cultivation

Green fodder is the backbone of economical and efficient dairy production.

- 1 acre of land with adequate water can support 5–7 crossbred cows producing 15–20 litres of milk/day.
- Based on this, land allocation for a 20-cow herd should ensure fodder self-sufficiency to minimize feed costs and improve:

Milk yield and quality

Cow fertility and health

Suggested land division per acre for fodder cultivation:

- 25 cents – CO4/CO 5 (Cumbu Napier hybrid)
- 25 cents – Super Napier (hybrid grass)
- 25 cents – COFS 29 (Multicut Fodder Sorghum)
- 25 cents – Desmanthus (leguminous fodder)

Tip: Begin silage making for year-round green fodder availability.

Essential Equipment for Daily Operations

- Brush cutter
- Chaff cutter
- Milking machines
- Cow mats
- Foggers and sprinklers
- Jet sprayers

These tools ensure efficiency, hygiene, and better cow comfort.

Animal Health Management

A robust health protocol is non-negotiable for any dairy operation:

- Foot-and-Mouth Disease (FMD) vaccination every 4 months for all cows, including pregnant animals.
- Calf deworming: Monthly up to 6 months of age, then every 2–3 months.
- Cow deworming: Immediately post-calving.

Reproductive Management and Calving

- Focus on timely heat detection and artificial insemination using quality semen from proven sires.

- Adopt modern, non-invasive pregnancy diagnosis techniques (e.g., IDEXX kits).
- Pay close attention during calving, feeding, and milking times to reduce stress and improve outcomes.
- Milking machines, used twice a day, improve efficiency. Start milking with the highest yielding cows and end with the lowest.

Mastitis Prevention

- Prevent cows from lying down for at least 30–60 minutes post-milking.
- Use antiseptic spray and teat dip solutions after milking.
- Dry teats using a clean cloth or tissue.
- Buy cows only from farms with no history of mastitis.

Mineral Nutrition

Daily supplementation with quality mineral mixtures containing calcium, phosphorus, and trace elements is essential for:

- Higher milk yield
- Improved milk quality
- Stronger immunity
- Enhanced reproductive performance

Recommended dose: 30–50 grams per cow per day

Feeding Management

- Feed 30–40 kg of green fodder per cow per day to reduce production costs.
- Use balanced compound cattle feed, rather than individual raw ingredients.

Feeding recommendations

1 kg of concentrate for maintenance

400 g of concentrate per litre of milk produced

Adjust feed quantity based on body weight, milk yield, fat %, pregnancy status, and quality/availability of green and dry fodder—preferably under the guidance of a veterinarian or dairy nutritionist.

This precision feeding approach optimizes costs and improves sustainability.

Record Keeping and Performance Goals

- Maintain daily records of milk yield, feeding, and calving.
- Set targets:

One calf per cow every 12–14 months

Use sexed semen for better female calf ratio

Maintain 60–70% cows in milk and pregnant at all times

Aim for at least 1/3 of cows in advanced pregnancy (7th–9th month) at any time

Limit herd size to 30–35 milking cows to ensure manageable labour needs given the current shortage of skilled workers.

Silage Making: Preserving Fodder for Year-Round Feeding

Silage is a practical solution for ensuring year-round green fodder availability.

Silage Process (using fodder maize as an example):

1. Harvest maize at dough stage (30–35% dry matter).
2. Chop the crop into small pieces.
3. Wilt to reduce moisture content to ~30–40%.
4. Pack tightly in airtight conditions (silo, pit, or bag).
5. Allow anaerobic fermentation to preserve nutrients.
6. Seal thoroughly to prevent spoilage.

Benefits of Silage:

- Nutrient preservation
- Year-round availability
- Improved milk production and quality

Best Practices:

- Monitor moisture content and prevent contamination.
- Maintain airtight storage conditions.
- Conduct regular quality checks.

Challenges in Silage Making

While silage offers numerous benefits for year-round green fodder availability and improved dairy productivity, successful silage making requires careful attention to certain key challenges. Addressing these proactively ensures high-quality silage and reduces losses.

Moisture Management

- Challenge: Excess moisture leads to poor fermentation, while too little can result in dry, unpalatable silage.
- Best Practice: Ensure the crop is wilted properly to maintain optimal moisture content (30–40%) before ensiling.

Contamination Risk

- Challenge: Soil, water, or organic debris contamination can introduce harmful bacteria and molds.

- Best Practice: Chop and handle fodder on clean surfaces and avoid contact with soil during harvesting and filling.

Inadequate Compaction

- Challenge: Poor packing leads to air pockets, which disrupt anaerobic fermentation and cause spoilage.
- Best Practice: Compact the silage tightly during filling to eliminate air and promote proper fermentation.

Improper Sealing

- Challenge: Incomplete sealing allows oxygen to enter, encouraging mold growth and nutrient loss.
- Best Practice: Use durable, airtight covers or bags and ensure edges are well-sealed with weights (like tires or sandbags) or soil.

Storage Conditions

- Challenge: Exposure to moisture, pests, or fluctuating temperatures can degrade silage quality.
- Best Practice: Store silage in shaded, protected areas and regularly inspect for leaks or damage.

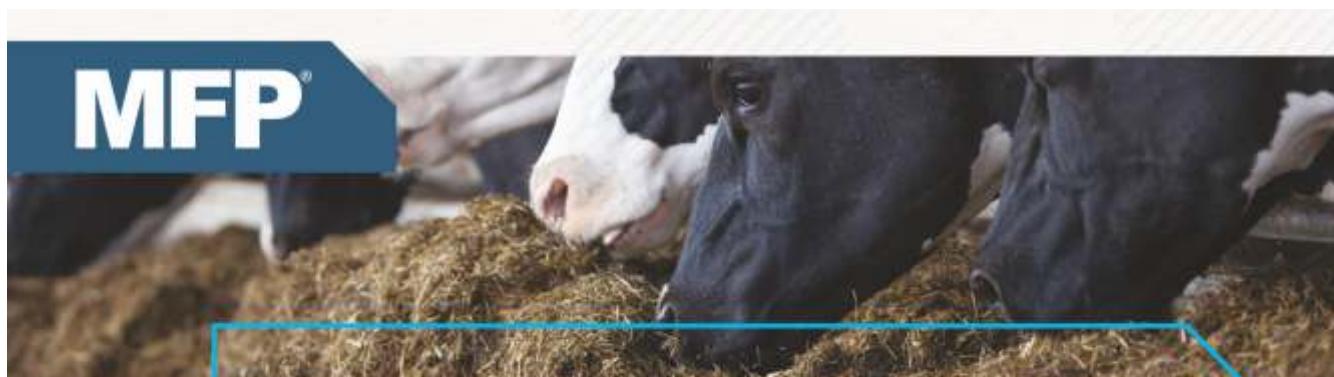
Lack of Monitoring

- Challenge: Farmers often skip regular quality checks, leading to undetected spoilage or nutrient degradation.
- Best Practice: Periodically open small sections to assess silage smell, texture, and color; test nutrient content if possible.

Final Thoughts

Mini dairy farms can be profitable and sustainable if managed with attention to detail, proper planning, and commitment to best practices. However, one growing concern among farmers is the lack of skilled labour, which hinders scaling up operations. This challenge calls for collective action and innovation across stakeholders to support the government's goal of doubling farmer incomes.

By following these practical guidelines, dairy farmers can enhance productivity, animal welfare, and long-term profitability in mini dairy operations across India.



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Mastitis and Metabolism: The Overlooked Connection

“During mastitis, immune cells accelerate glycolysis to support defence, while invading bacteria exploit host metabolism to drive their growth.”

by **Sundram Singh** and **Swati Sangolgi**, Master's (Animal Biochemistry), ICAR-NDRI, Karnal

Abstract

Mastitis, one of the costliest diseases in dairy herds, is increasingly recognized not only as an infectious disorder but also as a metabolic one. During infection, mammary and immune cells undergo profound metabolic reprogramming that fuels both defence and inflammation. Glycolysis is rapidly upregulated, driven by key enzymes such as hexokinase (HK), phosphofructokinase (PFK), and pyruvate kinase (PK), which amplify inflammatory signalling through HIF-1 α -mediated cytokine production. At the same time, disruption of the tricarboxylic acid (TCA) cycle leads to the accumulation of succinate—a pro-inflammatory metabolite—and itaconate, which exerts antibacterial

and anti-inflammatory effects.

The pentose phosphate pathway (PPP) is also redirected to produce NADPH, sustaining reactive oxygen species (ROS) generation that contributes to pathogen clearance but also causes tissue damage. These interconnected pathways highlight the immune metabolic basis of bovine infectious diseases. Integrating these insights with epitope mapping for diagnostic development, along with the design of potential inhibitors using *in silico* docking, could further advance both detection and therapeutic strategies. Emerging evidence on these enzymes in mastitis and sepsis highlights their potential as targets for innovative diagnostic and metabolic interventions, offering new opportunities for earlier

disease detection, reduced dependence on antibiotics, and more sustainable approaches to udder health management.

Introduction

Mastitis has long been seen as an infectious disease. New research shows it is also a metabolic disorder. During infection, immune and mammary epithelial cells shift from oxidative metabolism to aerobic glycolysis —a rapid but less efficient method of generating energy. This is similar to the Warburg effect described in cancer cells (O'Neill et al., 2016).

Glycolysis on overdrive: HKII, PFKP, and PKM2

Glycolysis is initiated by hexokinase (HK), which phosphorylates glucose and thereby traps it within the cell. In the context of mastitis, HK functions as the critical gateway enzyme that secures a continuous energy supply. Its expression and activity are closely regulated by signalling pathways such as PI3K/Akt/mTOR, which are activated by insulin and growth factors. This regulation enhances HK transcription and promotes its association with mitochondria, thereby supporting elevated glycolytic flux in proliferating or metabolically active cells. In mastitis, HK activity is increased to secure a continuous supply of metabolic fuel.

Phosphofructokinase (PFK) catalyzes the key commitment step of glycolysis. Increased PFK activity drives glucose deeper into the pathway, sustaining rapid energy production. Under stress conditions such as hypoxia or oxidative stress, upregulation of PFK activity promotes a metabolic shift toward anaerobic glycolysis, ensuring continued ATP production when mitochondrial oxidative phosphorylation is impaired. This metabolic plasticity is particularly important in rapidly dividing cells, including tumour cells and proliferating follicular cells.

A central regulator of this step is PFKB3, which produces fructose-2,6-bisphosphate, a potent allosteric activator of PFK. In mastitis, PFKB3 expression in mammary cells is elevated, and its inhibition has been shown to reduce reactive oxygen species generation, suppress HIF-1 α signalling, and alleviate *Staphylococcus aureus*-induced inflammation, underscoring its importance as both a metabolic driver and a potential therapeutic target (Gao et al., 2024), as shown in Fig.1. Targeting glycolytic regulators has therefore emerged as a promising strategy to control this metabolic overactivation.

Pyruvate kinase (PK), produced downstream of PFK, plays a special role. Instead of only working in the cytoplasm, PK can translocate into the nucleus, where it

binds to hypoxia-inducible factor 1-alpha (HIF-1 α). This complex enhances transcription of pro-inflammatory cytokines, particularly interleukin-1 β (IL-1 β) (Krawczyk et al., 2010; Rodríguez-Prados et al., 2010; Liu et al., 2022).

The TCA Cycle Stalls and Makes Trouble

Under normal conditions, pyruvate from glycolysis is fed into the TCA cycle, producing a steady supply of energy. But mastitis disrupts this cycle, leading to metabolic bottlenecks that generate inflammatory metabolites. Succinate accumulates when the cycle is impaired. Succinate acts as a pro-inflammatory metabolite, stabilizing HIF-1 α and promoting sustained IL-1 β production (Tannahill et al., 2013; Mills & O'Neill, 2014). Itaconate is produced as an alternative pathway product. Itaconate has direct antibacterial effects against pathogens such as *Mycobacterium tuberculosis* and also reduces inflammation by activating the Nrf2 pathway and restraining type I interferon responses (Michelucci et al., 2013; Mills et al., 2018). Thus, the TCA cycle doesn't just slow down in mastitis but also actively shapes whether the immune response escalates or resolves.

The Pentose Phosphate Pathway: Fuelling ROS and Inflammation

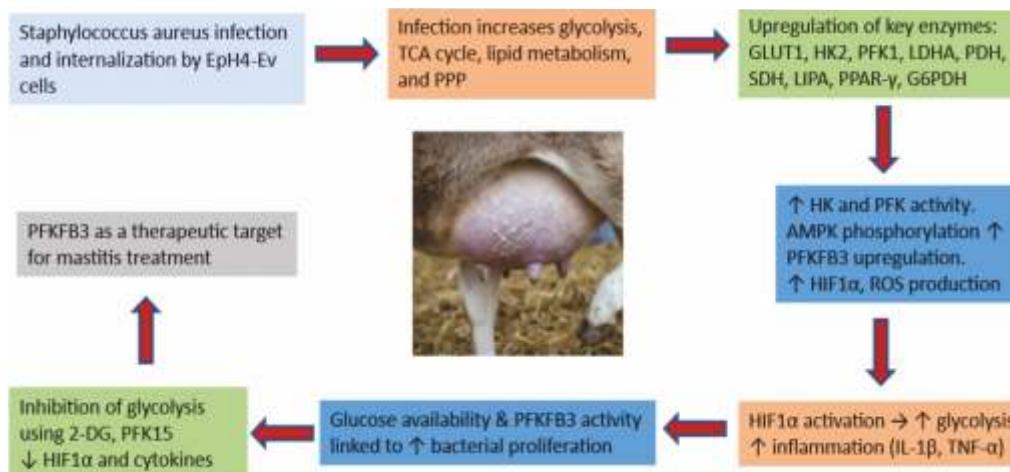
The pentose phosphate pathway (PPP), which branches off from glycolysis, is also reprogrammed in mastitis. In activated macrophages, PPP activity increases, producing NADPH (Yu et al., 2019). NADPH drives NADPH oxidases, which generate reactive oxygen species (ROS). While ROS are essential for bacterial killing, their overproduction damages mammary tissue and prolongs inflammation (Saito et al., 2021; Ushio-Fukai et al., 2021).

Dysbiosis in the gut has similarly been associated with PPP upregulation, linking gastrointestinal microbial imbalance to mastitis at the immune-metabolic interface (Horst et al., 2021; Kheirandish et al., 2022).

At the same time, the PPP contributes to antioxidant defence. Sedoheptulose kinase (Shpk), a unique enzyme of this pathway, generates sedoheptulose-7-phosphate, which supports NADH production and enhances cellular antioxidant capacity (Haschemi et al., 2012; Nagy & Haschemi, 2015). These findings emphasize the dual nature of the PPP: depending on context, it can exacerbate oxidative stress and inflammation or help restore redox balance and limit tissue injury.

Linking Infection and Metabolism: The TLR4-NF- κ B Axis

Pathogen-associated signals are key drivers of the metabolic rewiring observed during mastitis. In

Fig. 1. Metabolic reprogramming during mastitis and the role of PFKFB3.

particular, Gram-negative bacteria release lipopolysaccharide (LPS), which is recognized by Toll-like receptor 4 (TLR4) on mammary epithelial and immune cells.

LPS binds to LPS-binding protein and CD14, then activates the TLR4-MD2 complex. This recruits MyD88 and activates NF- κ B, which enters the nucleus and switches on genes for cytokines such as TNF- α and IL-6 (Chow et al., 1999; Medzhitov, 2009; Akhtar et al., 2020). Beyond its role in cytokine production, NF- κ B also stimulates glycolysis, establishing a feed-forward loop in which infection amplifies metabolism and heightened metabolism further sustains inflammation (Sordillo, 2018; Zhao et al., 2022a, 2022b). This tight coupling of immune signalling and metabolic flux highlights why mastitis should be viewed not merely as a localized udder infection but as a systemic metabolic-immune disorder.

From Computational Leads to Farm Solutions

Epitope mapping of HK and PFK isoforms (HK II and PFKP) expressed in mammary epithelial cells offers a promising route to designing multi-epitope vaccines and diagnostic constructs that specifically target key glycolytic enzymes in cattle, forming the basis of affordable diagnostic strips or ELISA kits for early mastitis detection.

Parallel computational docking has highlighted small molecules such as 2-deoxy-D-glucose, Lonidamide, Metformin, and sugar analogs as potential metabolic inhibitors with strong predicted binding affinities. These leads resonate with experimental findings showing that inhibition of PFKFB3, for example with PFK15, can reduce both inflammation and bacterial burden in mastitis (Gao et al., 2024) and in sepsis (Xiao et al., 2023).

Together, these strategies suggest that metabolic enzymes may serve dual purposes: as diagnostic biomarkers for subclinical mastitis and as therapeutic targets for precision interventions. This approach paves the way toward farm-ready solutions that move beyond antibiotics, combining early detection with therapies designed to fine-tune glycolysis and restore immune-metabolic balance.

Conclusion

Mastitis should be understood not only as a bacterial infection but as a metabolic disease. During infection, glycolysis intensifies, with HK, PFK, and PKM fuelling both energy supply and inflammatory signalling. At the same time, the TCA cycle becomes disrupted, releasing metabolites such as succinate, which amplifies inflammation, and itaconate, which tempers it. The pentose phosphate pathway (PPP) accelerates to generate NADPH, feeding both antimicrobial defences and damaging bursts of ROS. Among various regulators, PFKFB3 stands out as a central switch that links infection-driven metabolic rewiring to inflammation. Emerging tools such as epitope mapping and in silico docking provide a foundation for translating these molecular insights into practice, designing diagnostics that detect disease earlier and metabolic interventions that reduce reliance on antibiotics. Taken together, this integrated view of infection and metabolism points toward a new paradigm in mastitis management: shifting from symptom control to proactive monitoring and metabolic modulation, enabling earlier detection, more precise therapies, and sustainable improvement in udder health.

References are available upon request.

BRIDGING INDIAN DAIRY WITH THE WORLD

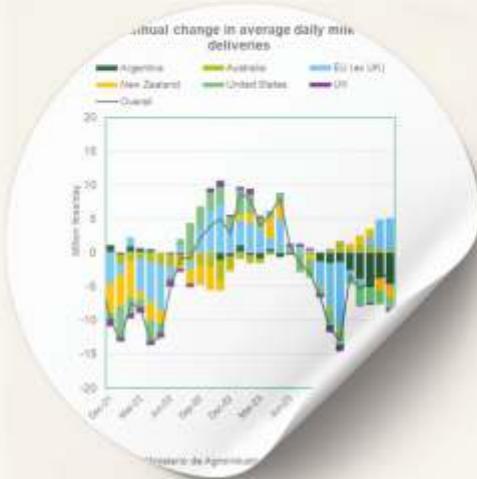


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Cheese as India's Next Value-Added Dairy Frontier

By **Prashant Tripathi**



Prashant Tripathi

Introduction

India's cheese industry is undergoing a structural shift. What was once a small, urban-concentrated indulgence category is now gaining strategic significance within the dairy economy. The rise of food-service formats such as pizza chains, burger QSRs, bakery cafés and modern retail stores has transformed how cheese is perceived and consumed. A new generation of consumers sees cheese less as a Western novelty and more as an everyday protein that improves meal convenience, taste and nutrition.

For dairy processors seeking higher margins and insulation from volatile liquid milk economics, cheese represents a clear path to stronger value capture — but one that demands tight integration of milk quality, processing efficiency, market positioning and logistics discipline.

"Cheese is fast becoming the most powerful value-add story emerging from Indian milk."

Market Growth and Evolving Consumption

Urbanisation and the rapid expansion of organised food service have created a robust demand engine for mozzarella and processed cheese. Pizzas, burgers, sandwiches, and bakery preparations — once limited to metros — now drive mainstream consumption across India's Tier-II and Tier-III towns. At the household level, cheese spreads, slices and snack formats are increasingly part of routine shopping baskets, particularly for young families who value fast-to-prepare meal components with better protein density.

As disposable incomes increase and palates evolve, premium cheese experiences are also emerging. Small artisanal producers and established brands are experimenting with localised products, region-inspired flavours, and cleaner labels, signalling a market diversifying beyond commodity formats.

Production Efficiency and Milk Quality — Unlocking Yield

Cheese manufacturing economics are fundamentally driven by yield and repeatability. India faces structural barriers on both fronts. Milk quality can vary significantly by season and geography, with shifts in fat and protein affecting consistency and curd recovery. Somatic cell count (SCC) management is inconsistent, and antibiotic residues — even at low frequency — pose compliance risks and potential batch rejections.

Process plants also grapple with high energy utilisation, labour dependence, and shrinkage caused by manual intervention. Without automation in key steps such as curd cutting, whey handling and ripening control, cost per kilogram remains elevated. To build competitive unit economics, processors must implement tighter upstream QA, invest in modernisation, and cultivate a strong hygiene-based culture across the value chain.

"Yield, hygiene and temperature discipline are worth more than stainless steel — if upstream QA is weak, downstream capex won't save margins."

Export Potential — Execution-Heavy but Promising

India has a credibility and price advantage in select export markets, particularly the GCC and parts of Southeast Asia, where food-service mozzarella and processed cheese are in steady demand. However,

global buyers expect

- Strict consistency in baking and melting performance
- Robust packaging integrity to prevent moisture loss
- Certified compliance with microbiological and chemical standards
- Traceability documentation that protects against origin risks

Indian processors must demonstrate repeatability across multiple production cycles, provide tight service-level agreements, and invest in shelf-life validation through real-world transport simulations. Those who strengthen logistics and regulatory readiness will find a growing export opportunity that complements domestic growth.

Technological Upgrading and Valorisation

Modern cheese plants that succeed in competitive markets treat whey not as a by-product but as a monetisable ingredient stream. Membrane filtration technologies, such as ultrafiltration, improve standardisation and yield while enabling the conversion of whey into whey protein concentrates (WPC), lactose, and beverage bases. Automated curd handling reduces variability and labour intensity. Precision ripening under controlled humidity and temperature enhances product performance and customer satisfaction.

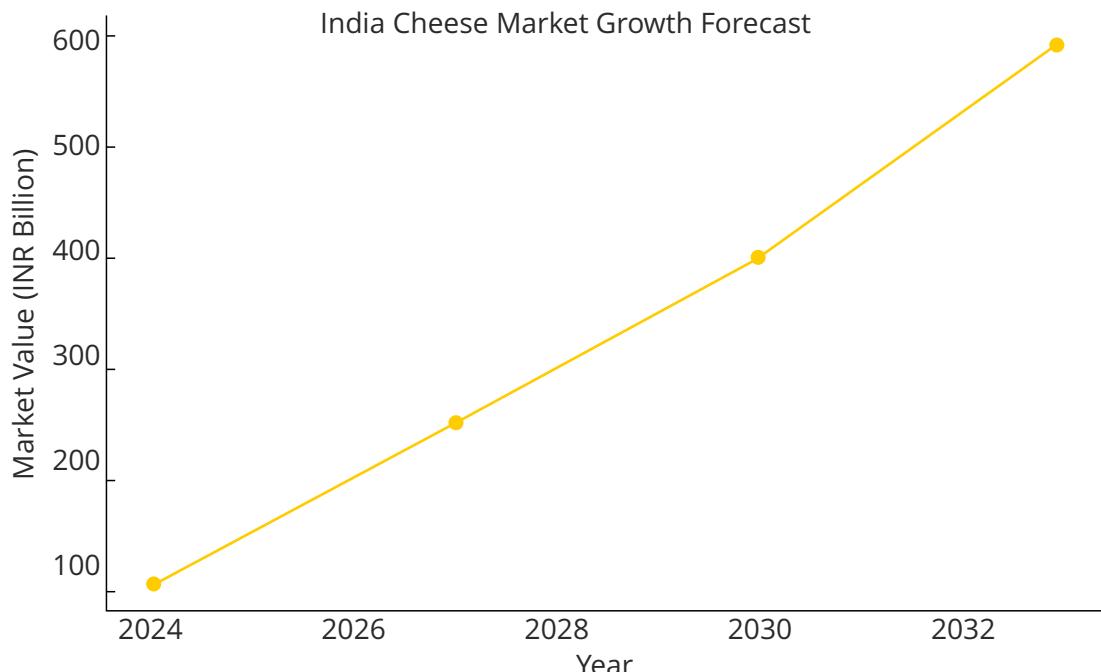
Investments in energy-efficient utilities further reduce the cost per kilogram. For India to unlock global competitiveness, such process innovations must move from isolated capex decisions to systematic production planning.

Quality-Linked Sourcing — A Win-Win Model

Sourcing programmes that pay farmers for measurable quality improvements have demonstrated excellent payback in cheese processing worldwide. When SCC and antibiotic residues are adequately controlled, yields improve, shrinkage reduces, and complaint rates drop. This creates a self-reinforcing cycle: processors recycle margin gains into farm-level incentives, while producers gradually invest in better hygiene, feed management, and veterinary oversight. Transparent communication of incentives and long-term procurement contracts helps stabilise seasonal supply fluctuations and reduce dependence on spot procurement markets.

"Premiums tied to measurable QA unlock win-wins — higher farm incomes and repeatable plant yields."

Mass Versus Premium — Portfolio Strategy



India's cheese market will bifurcate into two clear paths. The mass-market will continue to grow through processed cheese and mozzarella, supplying QSRs and institutional kitchens where consistency and cost leadership are key. The premium segment — small but rapidly evolving — will focus on cheeses with local identity, artisanal craftsmanship or functional benefits such as higher protein or cleaner labels. Brand trust will

increasingly depend on transparency around sourcing, origin and process discipline. Traceability, farmer-share stories and antibiotic-free claims will drive differentiation.

Enabling Ecosystem and Policy Support

For India to accelerate cheese competitiveness, stakeholders need stronger cold-chain linkages, validated export corridors, and access to targeted

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Dairy Dimension — December 2025 Edition: Editorial Focus

- Launching December 2025, the edition will spotlight Balanced Sustainability — Environmental, Economic, and Social dimensions of dairy.
- Examines how India can scale sustainably while retaining its smallholder-driven production model.
- Investigates methane reduction, fodder efficiency, and water-smart dairying aligned with global climate imperatives.
- Highlights product integrity and compliance — antibiotic stewardship, aflatoxin control, somatic cell counts, and traceability frameworks.
- Features digitisation and automation in farm-to-plant workflows enabling cost-efficient quality improvements.
- Focus on women-led and youth-led dairy entrepreneurship, preserving community livelihoods and intergenerational succession.
- Analyses policy direction, incentives, and India's positioning in global trade and sustainability standards.
- Showcases impactful case studies from cooperatives and private dairies demonstrating commercial and environmental wins.
- Explores circular economy solutions — manure-to-energy, feed optimisation, waste valorisation.
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financing for technology upgradation. Regulatory clarity around cheese grades and compositional requirements tailored to Indian conditions would provide manufacturers with a more precise roadmap.

Investment in local testing infrastructure — including SCC, antibiotic, and microbial monitoring — would standardise quality assurance and enhance both safety and profitability. Policy incentives encouraging dairy clusters that combine processing, packaging and logistics would reduce transaction costs and encourage scale.

A Sequenced Roadmap for 12-18 Months

Cheese ambitions must be matched with disciplined execution.

First 6 months: baseline QA parameters across catchments, launch a pilot premium sourcing programme with selected farms, and run energy and yield audits to identify technological priorities.

Mid-cycle: implement partial automation and launch a dual-tier portfolio—food-service core plus one premium

SKU—to build brand presence.

Final phase: expand farmer onboarding, secure GCC buyer agreements, document traceability success stories, and reinvest margin gains into both brand building and farm improvement.

This phased transformation ensures both upstream and downstream capabilities strengthen in tandem.

Conclusion

Cheese is India's clearest pathway to sustained value-added growth in dairy. When processors secure cheese-grade milk, drive efficiency through automation and whey monetisation, and communicate trust through traceability and performance, they unlock superior returns across the chain.

The winners will be those who build integrated systems that connect farm-level QA, efficient processing, disciplined cold chain, and differentiated market positioning. In doing so, Indian dairy will not only serve domestic aspirations but also compete credibly on the global stage.



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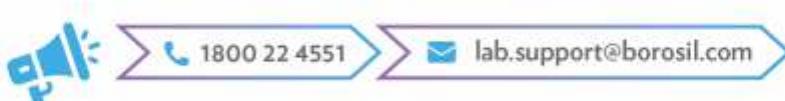
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The Rise of Automation in Dairy Equipment: Reducing Human Error, Increasing Hygiene

by Mr. Shreesh Kashyap, Neologic Engineers

The dairy industry is undergoing a significant transformation driven by technological advancements in automation. As global demand for high-quality dairy products continues to rise, producers are increasingly adopting automated systems to enhance operational efficiency, ensure product quality, and maintain stringent hygiene standards.

This shift is particularly critical in addressing persistent challenges such as human error, labor shortages, and contamination risks. The integration of automation in dairy equipment is not merely a trend but a strategic response to evolving regulatory requirements and consumer expectations.

Overview of Automation in Dairy Operations

Automation in dairy refers to the deployment of technologies that perform tasks with minimal human intervention. These technologies include robotic milking systems, PLC program driven processes, automated

cleaning protocols, sensor-based monitoring, and data-driven management tools. The primary objectives of automation in this context are to:

- Improve consistency and accuracy in operations
- Enhance hygiene and food safety
- Reduce dependency on manual labor
- Optimize resource utilization
- Facilitate compliance with industry standards

Automation spans across various stages of dairy production, from milking and storage to processing and packaging. Dairy equipment manufacturers offer comprehensive automated solutions that mitigate the risks and enhance the product quality.

Mitigating Human Error Through Automation

Human error remains a major concern in dairy operations, often resulting in compromised product quality, equipment malfunctions or breakdowns.

Automation in dairy processing addresses these issues through the following mechanisms:

1. Standardized Milking Procedures

Robotic milking systems ensure uniformity in milking practices using programmed routines and sensor-guided mechanisms. These systems detect udder position, assess cleanliness, and apply consistent suction pressure, thereby eliminating variability associated with manual milking.

2. PLC Program driven plant operations and processes

Both continuous and batch processes are now controlled by programmable logic controllers (PLCs). Critical operations such as thermal treatment in pasteurizers or sterilizers, heating or cooling steps, and batch mixing are managed through PLC programs. This ensures process accuracy, enhances product safety, and eliminates manual intervention prone to error.

3. Real-Time Monitoring and Control

Automated systems incorporate sensors and control units that continuously monitor parameters such as milk temperature, flow rate, and equipment performance. Deviations from predefined thresholds trigger alerts or corrective actions, minimizing oversight or delayed responses.

4. Automated Data Logging

Digital platforms record operational data in real time, reducing reliance on manual entries. This enhances the accuracy of records related to milk yield, cleaning cycles, which are essential for traceability and audit readiness.

5. Predictive Maintenance

IoT-enabled equipment can identify early signs of wear and tear, enabling timely maintenance before failures occur. This proactive approach reduces downtime and prevents errors resulting from equipment breakdowns.

Enhancing Hygiene Standards Through Automation

Maintaining high levels of hygiene is imperative in dairy production to prevent contamination and ensure consumer safety. Automation enhances hygiene in several ways:

1. Clean-in-Place (CIP) Systems

CIP systems automate the cleaning of tanks, pipelines, and milking equipment without disassembly. These systems follow precise cleaning protocols involving controlled cycles of water, detergent, and sanitizers. The consistency of CIP systems significantly reduces microbial risks.

2. Reduction of Human Contact

Automated milking and packaging systems minimize direct human interaction with milk and equipment, lowering the risk of contamination from external sources such as skin, clothing, or airborne particles.

3. Environmental Control

Automation also extends to climate regulation within dairy facilities. Systems manage temperature, humidity, and ventilation to create optimal conditions for milk storage and animal welfare. Controlled environments inhibit bacterial growth and preserve product integrity.

4. Hygiene Documentation and Compliance

Automated systems maintain detailed logs of cleaning activities, equipment sterilization, and environmental conditions. These records support compliance with food safety regulations and facilitate internal quality audits.

Environmental and Sustainability Considerations

Dairy automation also supports sustainability initiatives within the industry by promoting resource efficiency and reducing waste

1. Water and Energy Conservation: CIP systems and smart climate control technologies help minimize resource consumption.
2. Waste Reduction: Automated feeding and milking systems reduce product spoilage and prevent overuse of raw materials.
3. Emission Monitoring: IoT devices track energy usage and emissions, enabling farms to adopt more environmentally responsible practices.

These measures align with global efforts to reduce the environmental footprint of agricultural operations.

Future Outlook

The future of dairy automation is shaped by emerging technologies such as artificial intelligence, blockchain, and remote monitoring platforms. These innovations are expected to:

- Enhance supply chain transparency and product traceability
- Enable remote management and autonomous operations
- Provide 24/7 remote support and troubleshooting capabilities
- As these technologies mature, they will further improve the efficiency, hygiene, and resilience of dairy operations.

Conclusion

Automation in dairy equipment represents a strategic advancement in addressing the industry's longstanding challenges related to human error and hygiene. By standardizing operations, enabling real-time monitoring, and reducing contamination risks, automated systems contribute to safer, more efficient, and sustainable dairy production. While implementation requires thoughtful planning and investment, the long-term benefits in quality assurance, regulatory compliance, and operational efficiency make automation an essential component of modern dairy management.



De Heus Brings Global Expertise to India's Dairy Sector



Rutger Oudejans

With a rich heritage spanning over three centuries, Royal De Heus has become one of the world's most respected names in animal nutrition. Headquartered in the Netherlands, this family-owned company operates over 100 production sites across 20 countries, supplying feed, premixes, and nutritional solutions to farmers in 75 markets.

India, with its growing population and dynamic livestock sector, has become a key focus for De Heus. On October 1, 2025, the company inaugurated a state-of-the-art USD 17 million feed plant in Rajpura, Punjab, with an annual production capacity of 180,000 metric tons and employment for over 300 people.

In an exclusive conversation with Think Grain Think Feed & Dairy Dimension, Mr. Rutger Oudejans, Managing Director of De Heus India, discusses the company's legacy, its Rajpura facility, and the transformative role of quality feed in India's dairy sector.

Could you briefly introduce De Heus and its global



De Heus Opens New Animal Feed Factory in Punjab, India

footprint, and explain how De Heus India fits into the company's broader vision?

De Heus is a family-owned company with a legacy that dates back more than 300 years, starting from milling operations in the Netherlands. Today, we are a fully integrated global animal nutrition group, offering compound feed, premixes, concentrates, and feed specialties across multiple species.

What makes us unique is the combination of entrepreneurial agility, short decision lines, and technical expertise that comes with being a family-run business. Our mission is to support independent farmers worldwide by improving animal health, productivity, and food security.

Globally, we operate over 100 production facilities in more than 20 countries, employing 13,000 people, and producing over 13.5 million tons of feed annually. Our products reach farmers in 75 countries, serving poultry, ruminants, swine, and aquaculture sectors.

De Heus India is a strategic chapter in this global story. We began operations in 2017 in Rajpura with a small rented plant and have gradually expanded through partnerships in Assam and Maharashtra, culminating in our new greenfield facility in Rajpura. India's growing

protein demand, rising incomes, and government focus on modernizing agriculture make it a natural fit for our long-term vision of sustainable livestock farming.

Why did De Heus India decide to invest in a new feed manufacturing facility in Rajpura?

India is central to our global growth strategy, being one of the world's fastest-growing economies with a population exceeding 1.4 billion. The country is already the eighth-largest animal feed market globally, with feed demand forecasted to grow at 6.3% CAGR to 2030.

We see enormous potential in the dairy sector, particularly among medium and large farms that are increasingly adopting commercial compound feed to improve yield, fertility, and animal health. North India—Punjab, Haryana, Uttar Pradesh, and Rajasthan—offers excellent agricultural infrastructure, strong logistics, and a large dairy farmer base that is open to innovation.

The Rajpura facility allows us to localize production, source raw materials domestically, and deliver high-quality feed efficiently across the region. With a population of over 350 million in North India, the market is both diverse and dynamic, providing opportunities to serve smallholders transitioning to professional dairy operations as well as larger commercial farms.

How do you assess the current scope and potential of India's dairy feed market? Which trends are most significant?

India's dairy sector is undergoing a profound transformation. While smallholders still dominate, the adoption of commercial feed is steadily increasing, particularly among medium and large farms. The drivers are clear: rising milk prices, increased awareness of animal health and nutrition, and government initiatives promoting dairy modernization.

Key trends in dairy feed adoption:

- Rising demand for milk and dairy products: Per capita milk consumption is increasing steadily, and urbanization is driving higher protein intake.
- Shift toward professionalization: Farmers are moving from traditional fodder to compound and customized feed, improving yield and efficiency.
- Focus on animal health: Nutritionally balanced feed reduces fertility issues, improves lactation, and minimizes disease risk.
- Technological adoption: Precision feeding, automated feed delivery systems, and on-farm monitoring are growing among larger operations.
- Sustainability and quality: There's increasing interest in feed efficiency, traceability, and safe ingredients, reflecting global standards.

While poultry and aquaculture also present opportunities, the dairy segment leads in growth, particularly in North and West India. Medium and large dairy farms are the primary users of commercial compound feed, with smallholders gradually transitioning.

What is the production capacity of the Rajpura facility, and what technologies ensure feed quality and safety?

Our Rajpura plant has an installed capacity of 180,000 metric tons per year, expandable to 240,000 tons. It features two dedicated production lines—one for monogastrics (poultry and swine) and one for ruminants (cattle and buffalo).

We have invested in European equipment and automation from leading suppliers such as Van Aarsen, PTN, and Prado. Key features include:

- Precision dosing and pre-grinding systems
- Hammer and pellet mills
- Micro-ingredient bins and premix dosing
- Advanced quality monitoring and process control

Automation ensures minimal human error, uniform product consistency, and adherence to strict hygiene standards. Real-time monitoring guarantees that every batch meets both international and Indian quality requirements, providing farmers with safe, nutritionally balanced feed.

How does De Heus ensure quality assurance and feed safety at the new plant?

Quality and safety are non-negotiable. Our Rajpura plant follows global De Heus protocols adapted for local conditions. The facility includes:

- World-class laboratory instruments such as Dumas and NIR analyzers for testing mycotoxins, minerals, and nutritional parameters
- Physical quality checks for pellet durability, hardness, and stability
- Hygiene protocols including fumigation, sanitation routines, and premix dosing control
- Standard Operating Procedures (SOPs), vendor audits, workflow management, and non-conformity tracking

We operate under GMP, HACCP, and PRP/OPRP standards, and are preparing for full ISO certification covering 26 processes. These measures ensure traceability from raw materials to the farmer's feed bag, guaranteeing the highest level of safety and consistency.

What is De Heus India's strategic vision for the next five years?

Our strategy is multi-tiered:

1. Consolidate and expand in North India using the Rajpura facility to serve dairy farmers across Punjab, Haryana, and Uttar Pradesh.
2. Scale operations in the Northeast, particularly Assam, through toll-milling and feed distribution.
3. Expand across West and South India through brownfield and greenfield projects, aiming for a pan-India network of modern feed plants.

Beyond feed production, we are exploring value-chain opportunities including breeding, genetics, and dairy farm advisory services, leveraging international expertise to strengthen the entire ecosystem.

How does De Heus India contribute to farmer support and sustainable dairy development?

We view farmers as partners, not just customers. De Heus India provides:

- Nutritional advice and farm management support
- Customized feed solutions for different farm sizes and production goals
- Training programs to improve herd management, fertility, and milk yield

Sustainability is integral. Our feed formulations aim to optimize feed conversion, reduce environmental impact, and improve animal welfare. By supporting professionalization in dairy farming, we help farmers increase income while maintaining ecological balance.

How does De Heus' regional expansion in Asia benefit Indian operations?

On the day we inaugurated the Rajpura facility, we also signed an agreement to acquire CJ Feed & Care's operations in Vietnam, Indonesia, South Korea, the Philippines, and Cambodia.

This adds 17 feed mills and breeding operations to our portfolio, strengthening our Asian presence and technical expertise. For India, it means we can share best practices, advanced nutritional solutions, and operational efficiencies with our local team, ultimately benefiting Indian dairy farmers.

What message would you like to convey to Indian stakeholders?

Our message is simple: De Heus is here to stay. India is a strategic market, and we are committed to long-term partnerships with farmers, distributors, and industry stakeholders.

With the Rajpura facility, we aim to deliver high-quality feed consistently, support farm productivity, and help shape a sustainable and prosperous dairy sector. By combining Dutch expertise with Indian opportunity, De Heus is helping India's dairy sector achieve its full potential.

Prices: Firm Through Early 2025; Gradual Easing with Supply Recovery

Global price signals remain firm for butter and cheddar on tightness from EU/Oceania and steady Asian demand. Incremental supply growth in the US and New Zealand is expected to nudge balances looser later in the year, contingent on biosecurity stability and feed/weather conditions. For processors, margin defence hinges on mix agility: leaning into cheese/whey during strength, protecting fresh portfolios through pack-price architecture and private-label collaboration where necessary. Retailers continue to push value tiers, but premium health propositions, such as protein, probiotics, and lactose-managed, sustain elasticity among higher-income cohorts. Export flows are robust, though geopolitics and freight can whipsaw spot availability. Expect cautious optimism: no collapse, modest softening as supply normalises, with volatility spikes around disease headlines and weather.

Spain: Live Cattle Export Ban Highlights Biosecurity Risk

Spain's temporary halt on live-cattle exports following Lumpy Skin Disease cases spotlights Europe's biosecurity vulnerabilities. Immediate effects include throughput disruptions for exporters serving the Middle East/North Africa and precautionary controls that ripple through transport and markets. Dairy-specific impacts are indirect but notable: farm movement restrictions complicate herd management and replacement planning; stress and logistics adjustments can dent yields in the short term. Authorities are accelerating vaccine procurement, surveillance and harmonised movement protocols, while insurers reassess risk exposure and terms. For processors, the episode reinforces the need for scenario plans around raw-milk balancing, contingency procurement, and contract clauses addressing disease force majeure. Long-term, the EU will likely tighten cross-border animal movement rules and data reporting, raising compliance burdens but improving system resilience. The takeaway: invest in

Australia: Weather Volatility Tests a Leaner Industry

Australian dairy faces a pincer of drought in the south and flooding in the east, squeezing pastures, raising purchased-feed costs and forcing herd rationalisation. Production guidance points modestly lower, with farmgate prices supportive but unevenly so across regions. The strategic response is multi-pronged: irrigation upgrades, on-farm water efficiency, drought-resilient forages, and risk-transfer products (index insurance) to smooth cash flows. Export orientation, roughly a third of output remains intact, with Asia as the destination, but buyers are increasingly sensitive to supply reliability and sustainability credentials. Consolidation continues as scale advantages in procurement and processing offset volatility. Policy asks include targeted infrastructure funding and extension services to spread best practices. The long view: resilience through systems change, better water economics, genetics tuned to heat tolerance, and business models that accommodate climate variance without sacrificing animal welfare or product quality.

Scotland: 'Farm-Twin' Puts Digital Twins on the Dairy Map

Scotland's Rural College has rolled out "farm-twin", an AI-enabled digital twin platform that ingests real-time farm data, including feeding, activity, milk meters, and weather, to simulate and optimise decisions. Early pilots report double-digit yield gains, earlier mastitis detection, and lower emission intensity via ration tweaks and heat-stress interventions. The model helps managers test "what-ifs" before spending: ration reformulations, grouping strategies, milking schedules, and ventilation upgrades. Initial costs, while meaningful, are expected to decline with scale and as vendors move to subscription bundles. Lenders and insurers are watching closely; demonstrable risk reduction and performance stability could translate into better terms. For regions battling labour constraints, the digital twin serves as a force multiplier, codifying SOPs and proactively alerting rather than reacting. The broader implication: as MRV frameworks for sustainability tighten, decision-support systems that quantify outcomes will become essential—not optional—in temperate dairy regions and beyond.



Global Innovation in Dairy Shines: Highlights of the International Dairy Federation (IDF) Dairy Innovation Awards 2025 with India's Pioneering Wins

The 2025 edition of the IDF World Dairy Summit (held in Santiago, Chile, from 20 to 23 October) provided a global stage for dairy innovation, where the International Dairy Federation (IDF) honoured cutting-edge projects with the fourth annual Dairy Innovation Awards. With over 130 entries spanning continents, the awards underscore how the dairy sector is advancing in sustainability, processing, nutrition and social inclusion.

Why this matters for the Indian dairy industry

India, long recognised as the world's largest milk producer, is facing new challenges—rising input costs, environmental pressures, evolving consumer demands,

and the need for innovation in value-added dairy products. For stakeholders in the Indian dairy sector (co-operatives, private dairies, farmer-producer organisations, and technology providers), the IDF awards highlight best-in-class models of sustainable dairy farming, processing efficiencies, and socio-economic impact. For example:

- They align closely with "sustainable dairy farming", "dairy technology India", and "dairy methane emissions".
- They reflect market drivers such as "value-added dairy products", "milk supply shortage", and "milk prices 2025".

- They underscore cooperative strengths, "Dairy Cooperative News" and "India Dairy Trends".

Highlighting Indian winners signals that Indian dairy innovation is being recognised globally, which can boost reputation, open up collaboration opportunities, and support investment in new technologies or sustainability practices.

Global winners – Snapshot

While the complete list of winners is available on the IDF site, a few standouts across categories include:

- In the "Climate action in the dairy sector" category, NDDB (India) won for its Carbon Credits from Biogas Plants initiative – a manure management programme generating clean fuel and carbon credits for smallholder farmers.
- In "Sustainable processing innovation", the Indian entry by SARAS Cooperative Milk Producers' Union (ZLD plant) was recognised.
- Other global winners include major players across New Zealand, the USA, China and Chile in categories spanning product innovation, packaging transparency and women's empowerment.

India's Winning Innovations – In Focus

Here we spotlight the Indian initiatives recognised at the 2025 Awards.

1. NDDB – Carbon Credits from Biogas Plants

The initiative by the National Dairy Development Board (NDDB) addresses manure management among dairy farmers, especially smallholders. By setting up biogas plants and generating carbon credits, the model delivers multiple outcomes:

- Reduces methane emissions from manure decomposition – tackling "dairy methane emissions" and advancing "dairy climate solutions".
- Provides clean fuel (biogas) replacing fossil or wood fuel for on-farm or village usage – contributing to "eco-friendly dairy India".
- Delivers an additional revenue stream to smallholder farmers via carbon credit sales – strengthening "socio-economic sustainability in farming".

In winning this category, the model demonstrates how the Indian dairy sector can link GHG reduction with farmer income, making it a compelling example for the "Indian dairy industry".

2. Jaipur Dairy (via Rajasthan Co op) – Zero Liquid

Discharge (ZLD) Plant

Jaipur Dairy has been selected for the Award in the category of "sustainable processing innovation" for its ZLD plant. Key features:

- The plant reportedly saves ~660,000 litres (6.6 lakh litres) of water per day by recycling wastewater in dairy operations.
- It demonstrates high water efficiency and wastewater reuse, aligning with "green dairy practices" and "sustainable dairy farming".
- As a first-of-its-kind in the Indian dairy sector (within the Rajasthan co-operatives), it sets a precedent for processing units across India aiming for zero liquid discharge.

For Indian dairy producers facing water scarcity, regulatory pressure, and sustainability goals, this innovation offers a replicable model.

3. NITARA – AI-Enabled Mobile Platform for Smallholder Dairy Farmers

In the "Socio-economic sustainability in farming" category, the Indian entry, NITARA (an AI-enabled mobile platform for smallholder farmers), reached finalist status. While it may not have won the top prize, its recognition is significant:

- Provides virtual advisory, dairy management tools and offline access for farmers – promoting "precision dairy farming" and "dairy technology India".
- Its focus on smallholder farmers aligns with efforts to mitigate "milk supply shortage" by improving efficiency at the base of the value chain.

Implications for the Indian Dairy Sector

- Replicability and Scale:** The recognised models from India demonstrate that innovation need not come only from large multinationals; Indian co-ops and institutions are developing scalable, farm-friendly solutions. Implementing ZLD or biogas pathways at scale can transform processing units and farms across India.
- Sustainability Credentials:** For Indian dairies engaging with ESG investors, export markets or global value chain partners, these wins strengthen the case that "Indian dairy trends" are moving towards sustainable, innovation-led growth.
- Technology Adoption:** Technologies such as AI-enabled platforms for smallholders, manure-to-

biogas systems, and water-recycling plants underscore that the “Indian dairy industry” needs to integrate digital, green, and process innovations to maintain competitiveness.

- Policy Alignment: These initiatives align well with India's broader dairy policy ambitions: supporting smallholder livelihoods, reducing the environmental footprint of milk production, adding value via processing, and meeting global standards.

Branding & Recognition: Winning or being a finalist in global awards increases visibility for Indian dairy organisations, boosting the broader narrative of “the Indian dairy industry” as innovation-oriented—not just volume-focused.

Expert Quote

"Recognition at the IDF Dairy Innovation Awards reinforces that innovation in the Indian dairy sector is not only about increasing volume but about increasing value, sustainability and technological adoption," says Dr Meenesh Shah, Chairman of NDDB.

Looking Ahead: Key Takeaways for Stakeholders

- Processing units need to accelerate the adoption of water-efficient, waste recycling (ZLD) systems and energy-efficient technologies.
- Dairy co-operatives and farmer networks must focus

on manure management, methane reduction, and linking to carbon credit markets.

- Smallholders adopting digital tools (mobile apps, AI-based advisory) are increasingly critical for improving productivity and traceability.
- International recognition matters: actively participating in global benchmarking, awards, and networks helps lift Indian dairy best practices and opens up export and partnership ecosystems.
- The Indian industry can use these innovations to position itself in conversations around “dairy industry forecast”, “dairy export news” and “organic dairy India” by emphasising not just scale but sustainability and value.

Conclusion

The 2025 IDF Dairy Innovation Awards shine a spotlight on how the global dairy industry is pivoting towards sustainability, processing efficiency, climate action and socio-economic inclusion. For the Indian dairy sector, the wins and high placements from NDDB's biogas-to-credits initiative to Jaipur Dairy's ZLD plant mark a decisive shift: from the White Revolution era of volume focus to a future of smart dairying, value creation, and global benchmarking. As India moves forward in the "dairy market growth" journey, these innovations will be key anchors for industry transformation.



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IDF World Dairy Summit: Agenda for a Low-Emission, High-Nutrition Future

The IDF's global convening in Chile brought regulators, scientists and industry together around three imperatives: cutting emission intensity, advancing nutrition through fermented/fortified products, and de-risking trade with interoperable standards. Discussions treated precision fermentation and plant-based lines as adjacencies rather than existential threats, highlighting regions where ruminant systems are ecologically optimal versus where alternatives add value. Biosecurity was front-and-centre after recent HPAI and LSD episodes; the community called for faster vaccine access, movement protocols and data sharing. On measurement, delegates pushed for standard baselines and MRV frameworks that enable comparability without crushing small farms in paperwork. Procurement signals are shifting: buyers want verifiable water/energy gains, animal-health metrics, and residue stewardship. The opportunity space spans digital twins, selective breeding, feed additives, and waste-to-energy. The summit's subtext was pragmatic: dairy must demonstrate public-good outcomes —nutrition, livelihoods, and climate —backed by data. Expect updated guidance on sustainability indicators, strong emphasis on fermented dairy for affordable nutrition, and more cooperation across blocs to avoid technical trade barriers dressed up as climate policy.

Global Dairy & Alternatives: Modest Volume, Value-Led Growth

Fresh market outlooks point to value growth of roughly 2 per cent annually over the decade, with modest volume gains as mature markets plateau. APAC will drive absolute expansion driven by urbanisation and income effects; MEA and LATAM will contribute dynamism despite inflation headwinds. Cheese and cultured products are the workhorses, helped by foodservice recovery and at-home cooking habits that stuck post-pandemic. Price architecture matters: private labels keep pressure on mainstream tiers, while premium niches —high-protein, lactose-managed, probiotics — sustain the mix. Plant-based remains faster-growing but from smaller bases, with taste/textural and price narrowing the gap. Sustainability pivots from messaging to procurement: retailers increasingly require verifiable water/energy reductions and animal-health outcomes,

favouring suppliers with robust MRV. Risks include disease shocks, food volatility, and geopolitics. Yet diversified portfolios, stronger cold-chains, and smarter hedging are improving resilience. The strategy for incumbents: defend core dairy, expand hybrids and fortified offerings, and de-risk supply with multi-region sourcing.

Belarus-Kazakhstan: EAEU Trade Corridor Strengthens

Belarus has deepened dairy shipments into Kazakhstan, showcasing how regional frameworks here, the Eurasian Economic Union, can re-route supply under sanctions and logistics constraints. The mix is classic: SMP/WMP for recombination and bakery, plus cheeses tuned to mass-market price points. Belarus's edge lies in cost-efficient cooperatives, scale processing, and shelf-life technologies that support long-haul logistics. Kazakhstan's urban demand, rising incomes and foodservice expansion create a receptive market, while EAEU rules smooth customs frictions. The lesson for global players: certification agility, predictable service levels, and risk-managed currency logistics can outweigh distance. For Kazakhstan, dependency risks exist; diversified sourcing and quality labs will be prudent. Environmentally, the corridor will face the same scrutiny as EU exporters: residue standards, animal-health declarations, and sustainability signalling. Expect Belarus to target incremental value capture via cheese maturation and private-label partnerships, even as it keeps powder volumes steady to anchor plant utilisation.

Nestlé Restructuring: Leaner Overheads, Focus on Premium & Innovation

Nestlé is executing a multi-year restructuring to simplify overheads and reallocate resources toward premiumisation, functional nutrition and automation. Dairy adjacencies, ready-to-drink coffee/dairy mixes, fortified yoghurts, specialised pediatric/senior nutrition, are prioritised where the company has brand equity and pricing power. Portfolio pruning continues in categories without scale or clear differentiation, freeing capital for R&D and digital operations. Labour transitions are significant and closely watched by unions, especially in high-cost geographies; management frames reskilling and redeployment as pillars of competitiveness. Input costs, disease events, and competition from both private labels and insurgent brands tighten margins. The strategic bet: elevate mix, improve factory OEE with

automation/AI, and use data to sharpen innovation cycles. For suppliers, this means heightened performance expectations on quality, sustainability metrics and delivery reliability. For rivals, near-term shelf opportunities may open up as assets are divested; in the long term, a leaner Nestlé could be more formidable in chosen battlegrounds.

United States: Labour Scarcity Accelerates Automation

US dairy is grappling with chronic labour shortages as immigration uncertainty and rising wages collide with 24/7 operations. Medium-to-large farms are fast-tracking robotic milking, sensor-rich parlours, and herd-management platforms to stabilise throughput and animal health. Capital intensity is the hurdle; lenders are increasingly supportive where farms present disciplined cash flows, maintenance SOPs, and ROI models grounded in labour savings and yield consistency. Policy ambiguity around visa pathways remains the wild card, affecting regional labour markets unevenly.

Downstream, processors are recalibrating plant schedules and mix to cope with variable milk flows, while foodservice recovery keeps cheese demand firm. The net effect is a bifurcation: tech-enabled operations consolidate advantages; smaller farms without access to capital face exit pressures. Vendors of robotics, analysers and advisory services are beneficiaries, but must deliver measurable outcomes and reliable after-sales support to sustain adoption.

Feed Additives: Probiotics and Enzymes Go Mainstream

Speciality feed additives have moved from trial to mainstream as farms chase the twin goals of higher yields and lower emission intensity. Probiotics modulate gut health and stabilise performance under heat stress; enzymes enhance fibre and starch utilisation, improving FPCM and feed conversion. Methane-mitigating additives, still under varied regulatory regimes, show promise in specific ration contexts. The market is consolidating around players who marry science with field validation and transparent data, moving beyond one-size-fits-all claims. Precision nutrition stacks, combining additives with ration design, mineral balance and management SOPs, are replacing “add a bag and hope” approaches. Regulatory scrutiny is sharpening on antibiotic substitution claims and label integrity, favouring companies with robust dossiers. For emerging markets, affordability and last-mile advisory remain adoption bottlenecks; partnerships with processors and cooperatives can bridge that gap through outcome-based incentives.

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India-New Zealand FTA Talks: Dairy Is the Red Line

India and New Zealand have re-engaged on a comprehensive FTA, but dairy remains the non-negotiable fault line. New Zealand's export-reliant industry seeks preferential access to the fast-growing Indian market for powders, butterfat, and cheese. India's position is anchored in protecting ~80 million smallholders, most operating 2-5 animals, and the cooperative model that underwrites rural livelihoods, women's participation and nutritional security. The technical sticking points are tariff peaks, tariff-rate quotas (TRQs), feed declarations (concerns around animal-byproduct feeds), SPS equivalence, and enforceable traceability. Delhi could consider narrow, tariff-paid carve-outs for speciality or non-competing cheeses with robust labelling and origin controls, but will resist broad SMP/butter concessions that risk price discovery and farmgate stability. A "landing zone" would likely include longer phase-downs, snap-back safeguards, seasonality triggers, and joint working groups on quality, feed and animal welfare. The political economy matters: India's liquid milk balance, festival-season demand, and state cooperative priorities argue for caution. Expect a drawn-out timetable mirroring Australia-India talks, with real progress occurring only if both sides accept dairy ring-fencing while deepening cooperation in agritech, logistics, services and investment. Net effect: incrementalism over big-bang access, with India prioritising resilience over import-led efficiency gains.

Uttar Pradesh-NDDB MoU: Professionalising State Dairy Assets

Uttar Pradesh has mandated NDDB to professionally manage three state-owned dairies, aiming to convert legacy capacity into competitive, quality-assured throughput. The programme bundles capex for modernisation (HTST/UHT lines, automated CIP), quality/reliability upgrades (BIS/ISO-compliant labs, rapid antibiotic/adulterant screens), and cold-chain reinforcement (ATPs, reefer nodes, data-logged distribution). On the farm side, it layers in structured procurement with women's SHG inclusion, breed/health advisory, and fodder support (silage hubs, azolla/napi initiatives). Power stability, often the Achilles heel, is addressed through solar rooftops and hybrid backup to

contain opex and curtail quality losses. Digitisation of milk records, route optimisation, and QR-enabled traceability connect procurement to plant-to-shelf, improving price transmission and export readiness for GCC/South-East Asia buyers. Execution risks persist: fodder inflation, last-mile leakages, and skill gaps in plant operations. NDDB's playbook village collection discipline, chilling coverage, quality-linked pricing, mitigates these while catalysing local employment. Expect measurable gains in SNF/fat recovery, lower wastage, and improved farmer realisations. Strategically, the state builds a platform for VAP expansion (fermented lines, butterfat, mozzarella), positioning UP as a northern dairy hub aligned to White Revolution 2.0 priorities of safety, traceability and sustainability.

Brand Finance: Amul Extends Lead as India's #1 Food Brand

Amul retains its position as India's most valuable food brand, powered by a unique blend of cultural resonance and infrastructural muscle. A 3.6-million-farmer cooperative engine secures milk-pool depth, while disciplined procurement and village-level chilling underpin leadership in liquid milk. In market terms, Amul dominates butter, ghee and pouch milk, with strong positions in cheese, ice-cream and beverages. The brand's distinctive communications, led by the Amul Girls, sustain top-of-mind relevance across generations. Still, the growth engine is increasingly value-added: probiotic and high-protein yoghurts, lactose-managed offerings, and premium frozen novelties. The capex path focuses on capacity, cold-chain, and sustainability (water/energy efficiency; zero-waste aspirations). Challenges are real: private labels nibble at price points, regional champions innovate rapidly, and climate variability stresses milk availability. Yet Amul's depth in distribution, farmer payouts tied to quality, and a fast iterating R&D pipeline create a defendable moat. Looking forward, the strategic arc is clear: protect liquid milk economics, steepen the value-added mix, professionalise export adjacencies (butterfat, cheese) and keep farmer incomes competitive to sustain quality. Expect mid-teens revenue ambition with mix-led margin expansion and continued investments in traceable, safe dairy.

India's Dairy Footprint Up ~70% in a Decade: Co-ops Double Down

India's dairy economy has expanded by roughly 70% over the past decade, with per capita availability now comfortably above global averages. The system's strength remains decentralised procurement: village collection centres, primary chilling, and cooperative governance that channels value back to producers, significantly women. Industrially, capacity has pivoted beyond table milk into fermented products, butterfat and mozzarella, aligning with urban convenience and foodservice growth. Productivity, however, is still the frontier: average yields trail global benchmarks due to genetics, feed quality, heat stress and animal-health gaps. The policy-market playbook is converging: sexed semen adoption, better heifer rearing, mastitis control (SCC targets), rapid residue tests, and precision feeding to lift FPCM while cutting emission intensity. Co-ops and private processors alike are scaling accredited labs, antibiotic stewardship, and digital traceability. Risks, such as fodder inflation, Lumpy Skin Disease shocks, and climate volatility, necessitate insurance products, fodder banks and resilient supply chains. Export potential exists in butterfat and select cheeses, but domestic demand will dominate. The next decade will be defined by measurable quality, verified safety and carbon-aware productivity, keeping the smallholder at the centre while industrial capacity delivers consistency.

India-US Trade: Dairy Safeguards Take Centre Stage

As India and the US configure a broader trade understanding, dairy sits at the intersection of economics, culture and politics. The Indian side seeks binding safeguards: tariff integrity, carefully sized TRQs, seasonality triggers, and stringent feed declarations to filter products linked to animal-byproduct feeds. SPS equivalence must include residue protocols, pathogen standards and interoperable documentation. A pragmatic compromise could open limited lanes for speciality cheeses at tariffs that reflect consumer choice without crushing local value chains; in return, India would expect space in categories where it is competitive,

plus cooperation on cold-chain, testing and genomics. The broader calculus: prevent subsidised inflows from destabilising farmgate prices across an unsubsidised smallholder ecosystem. Implementation discipline will be critical, customs risk engines, QR traceability, retail labelling, and any access must be reversible via snap-backs if import surges distort markets. Done well, the deal could modernise quality frameworks and consumer offering; done poorly, it risks eroding producer confidence. The default Indian posture is cautious liberalisation tethered to enforceable safeguards.

Climate Resilience: Why Smallholders Matter

India's path to low-emission, high-productivity dairy runs through its smallholders. Precision feeding (balanced rations, mineral mixtures, protected fats), heifer management, and targeted genetics can lift yields materially while trimming methane per litre. Add to that mastitis control, heat-stress mitigation (shade, water, sprinklers), and vaccination protocols, and you get a step-change in both productivity and resilience. Financing is the bridge: micro-capex for sheds and cooling, embedded insurance, and carbon-credit monetisation for measurable reductions. Women who form the backbone of daily operations must be central: extension tailored to their schedules, digital advisory in local languages, and governance roles in cooperatives. Private processors and co-ops can mainstream outcome-based incentives, such as paying for quality, SCC thresholds, and residue-free milk. The policy synthesis is clear: village-level advisory and diagnostics, interoperable data standards, and carbon MRV that small farms can actually use. Done right, India can decouple dairy growth from emissions while deepening rural incomes.

Hatsun Agro: Double-Digit Growth on Protein and VAP

Hatsun Agro's growth algorithm is clear: deepen value-added penetration, expand a tightly run retail footprint, and strengthen procurement in core southern basins. Product-market fit spans curd, flavoured milk, shakes, and indulgent novelties, increasingly layered with protein-forward propositions. GST rationalisation in select dairy lines supports affordability, while farmer

programmes (quality-linked bonuses, advisory on feed and animal health) stabilise milk quality and volumes. The distribution thesis emphasises density and cold-chain reliability, crucial for fresh and frozen portfolios. Risks, such as inflation, weather swings, and festival-season demand spikes, are mitigated through agile procurement and disciplined working capital management. Upside optionality includes export adjacencies in butterfat and cheeses, as well as foodservice and modern trade partnerships. Expect continued premiumisation, SKU architecture tuned to price ladders, and selective automation in plants to defend margins. The strategic watch-outs: balancing brand-led pricing power with competitive regional players and managing capex cadence without overextending the cash conversion cycle.

World Food India: Dairy Draws Big-Ticket Commitments

Large investment intents announced around India's food-processing ecosystem have a decisive dairy tilt, spanning powders, butterfat, cheese and cold-chain infrastructure. The rationale is straightforward: reduce post-harvest losses, normalise quality variability, and capture higher unit economics through value-added products. Projects emphasise lab capacity (residues, Aflatoxin M1, SCC), modern packaging, and digitisation of the route-to-market. Cooperative anchors like NDDDB and leading private processors provide the operating spine; logistics partners bring ATPs, reefers and cross-docking nodes. If executed to plan, the result is measurable recovery gains, lower wastage, and better price transmission to producers, particularly women-led SHGs. The headwinds, land and utility clearances, subsidy disbursals, and skilled manpower are real and must be de-risked with programmatic PMU support. Export-fit design for GCC/ASEAN, harmonised with SPS regimes, can lift India's butterfat and select cheese exports while stabilising domestic balancing during flush. Bottom line: the capex wave can professionalise the chain end to end, but delivery discipline will separate intent from impact.

Milk Output: CAGR Near 6% Over the Last Decade

India's milk pool has compounded at roughly 5–6% annually over the last decade, driven by breed improvement, better animal health services, and expansion of organised procurement. Per-capita availability has surged, reflecting both supply and an urbanising diet. The next stage is quality-and-carbon: cutting emission intensity via precision nutrition (protected fats, bypass protein, feed additives), improving reproductive efficiency, and reducing disease burdens, especially mastitis, through SCC targets and hygiene SOPs. Digital traceability from farm to pack, rapid antibiotic/adulterant testing, and a calibrated cold chain are moving from "nice-to-have" to market-access prerequisites, including for institutional buyers. Productivity headroom remains significant as average yields trail global leaders. With increments in genetics (sexed semen, genomic selection) and feed/fodder (silage culture, multi-cut green), a 25–30% productivity uplift is feasible over the medium term, lifting farmer incomes while moderating the carbon footprint per litre. Exports will play a balancing role; domestic demand stays the fulcrum.

GST on Ghee: Reform to Tame Adulteration and Formalise Supply

Industry stakeholders are pressing for a GST cut on ghee to improve affordability, expand the formal-sector share, and attack adulteration incentives. A lower rate can nudge consumers towards tested, traceable packs, compressing the grey market where quality is inconsistent and residue risks rise. For producers, higher offtake through organised channels tends to lift farmgate realisations, particularly when quality-linked premiums are passed down. The public-finance counterpoint near-term revenue loss must be weighed against downstream health savings, tax buoyancy from formalisation, and export competitiveness in nearby markets. Reform should be twinned with tighter enforcement: randomised market testing, public dashboards, QR-based pack traceability, and deterrent penalties for repeat violators. Retail education matters too, clean labelling, clarity on bilona/traditional claims, and nutrition communication. If executed cohesively, GST rationalisation plus enforcement can reshape the ghee aisle toward safety, authenticity and better returns to farmers.



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