GLOBAL DAIRY PLATFORM

Perspective Paper

Beyond the Farm Gate: Dairy Processing Efficiency and Climate Performance

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KEY TAKEAWAYS:

- Dairy processing represents a significant and under-addressed opportunity to improve emissions performance, operational efficiency, and resource productivity.
- A recent industry analysis suggests that commercially available technologies could reduce emissions from liquid dairy processing lines by up to 49%, while also reducing water use and product loss.
- Modernizing existing processing infrastructure may offer one of the more practical near-term opportunities to support both climate goals and operational resilience across the dairy sector.

The global dairy sector is increasingly recognized for its role in advancing sustainable and resilient food systems. Much of the climate discussion around dairy has historically focused on agricultural production and on-farm emissions, particularly methane, where the sector has demonstrated **measurable progress**.[1] Increasingly, however, attention is expanding beyond the farm gate to include the broader systems that support dairy production, processing, distribution, and delivery to consumers.

Within this broader value chain, dairy processing represents an important and often under-recognized opportunity to improve both environmental performance and operational efficiency. As companies across the food sector navigate rising energy costs, resource constraints, infrastructure pressures, and evolving climate expectations, processing modernization is emerging as one of the areas where sustainability objectives and business performance align.

Processing sits within what many researchers and policymakers describe as the “hidden middle” of food systems: the infrastructure, manufacturing, transportation, storage, and distribution systems that connect agricultural production to consumers. These systems influence food availability, affordability, safety, efficiency, and environmental performance. As climate and food system strategies continue to evolve, improving the efficiency and resilience of food processing systems will become increasingly important.

The **Dairy Processing Impact Assessment**, a recent report from Tetra Pak, independently reviewed by the **Carbon Trust**, highlights the potential contribution that processing modernization can make within dairy manufacturing systems.[2] The assessment evaluated advanced dairy processing technologies against a 2019 baseline of conventional processing systems and identified opportunities to reduce energy demand, heat use, electricity consumption, and product loss across liquid dairy operations.

The analysis estimated that deploying available decarbonization and resource-efficiency technologies could reduce greenhouse gas (GHG) emissions from processing lines by up to 49%,

alongside substantial reductions in water use and product loss. The findings are significant not only because they demonstrate the emissions-reduction potential of processing improvements, but because they reinforce a broader industry reality: many operational improvemnets that strengthen efficiency and resilience can also contribute meaningfully to climate performance.

Expanding Climate Conversations Beyond the Farm

For many years, sustainability discussions in dairy have concentrated heavily on farm-level emissions. Agricultural emissions remain critically important, and continued progress in areas such as feed efficiency, manure management, genetics, and methane mitigation will remain essential; however, reducing the environmental footprint of dairy systems cannot depend on a single intervention point alone.

Food systems are interconnected, and progress depends on coordinated improvements across production, processing, transportation, packaging, refrigeration, and distribution. This broader systems perspective is becoming increasingly important as the dairy sector shifts from climate ambition toward implementation.

Processing facilities are inherently energy-intensive operations. Heat generation, refrigeration, drying, pasteurization, and cleaning systems all contribute to operational emissions and resource consumption. While these activities may receive less public attention than agricultural methane emissions, they represent meaningful opportunities for practical improvement. Many processing-related interventions are implementation-ready today; however, technology deployment alone does not determine outcomes. Real-world improvement depends on the ability to identify opportunities, prioritize investments, implement effectively, measure results, and sustain performance improvements over time.

In practice, this means processing efficiency should be viewed as the development of operational systems capable of continuously identifying and capturing efficiency opportunities. Technologies matter, but so do measurement systems, operational discipline, and implementation capability.

From Incremental Improvement to System Efficiency

There is growing recognition that operational efficiency and climate performance are interconnected. Reducing heat demand, minimizing product loss, improving energy recovery, optimizing cleaning systems, and modernizing processing equipment can simultaneously lower GHG emissions, improve operational resilience, reduce resource consumption, support cost efficiencies, and strengthen long-term competitiveness.

These types of improvements are important in an operating environment shaped by energy price volatility, water constraints, infrastructure pressures, supply chain disruptions, and evolving expectations from governments, customers, and financial institutions. As the dairy sector continues to evolve, Scope 1 emissions reductions are likely to come not from one transformative solution, but from the cumulative impact of multiple improvements implemented across the value chain.

This is particularly relevant for processing because improvements often deliver co-benefits beyond emissions reductions. Efficiency gains can improve resource efficiency, reduce operational losses, strengthen manufacturing performance, and support broader business resilience and profitability. In this sense, processing modernization can be viewed not only as a sustainability initiative but also as an operational and strategic opportunity.

As processing assets often operate for decades, investment decisions made today shape future operating costs, emissions trajectories, water use, infrastructure flexibility, and exposure to future resource constraints. Relying on short-term payback logic alone can systematically mis-rank projects, undervaluing solutions that deliver greater value across the asset life by reducing operational risk, avoiding retrofit costs, and limiting stranded-asset exposure. Decision quality increasingly depends on applying life-cycle capital logic to ensure that investments made today do not become liabilities tomorrow.

The Role of Collaboration in Scaling Progress

One of the most important lessons emerging from climate work across agriculture and food systems is that collaboration accelerates implementation. Shared frameworks, aligned methodologies, open technical dialogue, and cross-sector engagement help translate innovation into practical adoption. This is one reason why collaborative initiatives focused on dairy processing are critically important. Through the **Pathways to Dairy Net Zero Dairy Processing Task Force**, dairy processors, technical experts, and sector partners are working together to identify practical opportunities for improving emissions performance and operational efficiency within dairy manufacturing systems.

Insights from these discussions have already contributed to implementation-focused work in several processing areas, including **direct** and **indirect UHT milk**, **pasteurized milk**, and **yogurt**. The value of these efforts lies not only in the technical findings themselves, but also in the creation of shared learning across the sector. Collaborative approaches help identify solutions that are technically feasible, economically realistic, and adaptable across different regions and operational contexts.

These initiatives reinforce that sustainability progress in dairy is not solely about setting targets. It is about building practical pathways that enable implementation. Scaling progress also requires strong measurement and verification capabilities. Organizations must build the operational capabilities needed to establish baselines, prioritize interventions, verify outcomes, and continuously improve performance. This requires governance structures, measurement infrastructure, decision frameworks, and operational accountability that allow organizations to move from isolated projects toward systematic improvement programs.

Processing and Operational Emissions

The growing attention to processing efficiency also reflects the importance of operational emissions strategies across the food sector. As climate reporting frameworks contiunue to evolve, companies are under increasing pressure to demonstrate measurable progress across direct operational emissions while maintaining competitiveness and financial performance. For dairy processors, this creates a need to identify solutions that can deliver meaningful reductions while maintaining food safety, product quality, operational reliability, and affordability.

This challenge is particularly important because dairy processing systems operate within complex manufacturing environments. Facilities must simultaneously balance food safety requirements, product quality standards, energy reliability, operational continuity, cost pressures, and environmental expectations.

This is where both operational improvements and equipment innovation can play important roles. Many efficiency gains can be achieved through improved controls, scheduling optimization, system integration, operational discipline, and better use of existing assets, alongside investments in new technologies and equipment. In many manufacturing environments, avoiding unnecessary energy, water, and resource consumption through improved operational management can represent one of the most immediate and scalable opportunities for improving performance and one of the most compelling arguments for building the organzations systems to sustain it.

Ultimately, processing efficiency is not only a sustainability initiative, it is a pathway to operational excellence. When organizations build the systems to continuously identify, prioritize, and verify efficiency improvements, they are not adding complexity; they are reducing it. They are sharpening focus, building capability and creating the confidence and organizational capability to do more with less.

Sustainable Dairy Requires System Thinking

Policymakers, researchers, and industry leaders recognize that sustainability cannot be evaluated through isolated metrics or individual interventions. Environmental performance, nutrition, affordability, resilience, and economic viability are deeply interconnected. Long-term progress will require integrated approaches that strengthen environmental performance while maintaining dairy's important contributions to nutrition, livelihoods, food security, and rural economies. Within this broader context, dairy processing represents a critical opportunity.

Processing improvements are essential components of credible, long-term climate and operational strategies. They also reinforce a broader message for the dairy sector: meaningful progress will depend not only on future technological breakthroughs, but also on the implementation of practical solutions that are already available today.

DAIRY LEADERSHIP: A CALL TO ACTION

The dairy sector has an opportunity to move from ambition to implementation by modernizing existing processing infrastructure and accelerating the adoption of technologies that improve both environmental and operational performance.

Many processing improvements deliver benefits beyond emissions reductions that support lower operating costs, improved resource productivity, and greater operational resilience.

The priority now is enabling implementation at scale, which requires measurement systems, governance structures, and operational discipline that enable continuous improvement toward more capable and resilient manufacturing systems.

For more information on the Global Dairy Platform's Perspective Papers, please reach out to Dr. Beth Bradley at beth.bradley@globaldairyplatform.com.

References

1. Dairy Sustainability Framework. 2025. DSF Annual Sustainability Progress. 2024 Calendar Year Reporting. https://www.dairysustainabilityframework.org/wp-content/uploads/2025/11/DSF-2024-Reporting.pdf.
2. Tetra Pak. 2026. Dairy Processing Impact Assessment. https://www.tetrapak.com/insights/case-articles/improve-dairy-lines Specifically, the assessment covering greenhouse gas emissions was reviewed by the Carbon Trust using best-practice avoided emissions guidance and includes solution emissions in the calculation of net impact.