THE CLIMATE SOURCE

Future-Proofing Carbon Accounting

The Case for Supplier-Provided Product Carbon Footprints

Author: Jessie Deelo, CEO and Co-founder of The Climate Source
Contributors: Maggie Greenberg, Addison Kerwin

INTRODUCTION

Greenhouse gas (GHG) accounting frameworks established the standards by which companies should quantify their emissions inventory, set reduction targets, and report on progress towards emissions reduction goals. To meet these reporting requirements in dairy supply chains, cooperatives, processors, and traders engage annually with their customers to provide bespoke data and reporting to satisfy the disclosure requirements.

Data and reporting requirements are one of the most commonly cited accounting challenges for dairy suppliers. As the pressure on food companies to be more transparent and to reduce their footprint has increased, so have the demands on dairy suppliers to provide more granular data, respond to ever-shifting reporting requirements, and access various data collection platforms. In most cases, there is no additional market value for suppliers. The demands for more data and reporting have become the cost of doing business. However, the success of this approach relies on farmers and their willingness to participate in data collection and reporting. Without their participation, suppliers are unable to provide high quality, granular GHG data that is reflective of the actual performance, including efficiency and productivity metrics.

Dairy suppliers and farmers are beginning to realize that the data required for GHG reporting has significant market value. They are looking to capitalize on their investments in internal capabilities and farmer engagement to generate sustainable and scalable revenue opportunities. Dairy suppliers are now seeking out accounting systems that will enable them to streamline reporting and offer a value-added service to their customers.

At the same time, the risks of carbon accounting continue to negatively affect the return on investment for on-farm project development. The perpetual challenge of integrating project-based reductions with inventory emissions has caused the latest round of proposed changes to the GHG reporting frameworks. The current proposals are attempting to decouple estimated Scope 3 emissions from project-based reductions programs that use primary and traceable data to calculate reductions. Dual and quadruple ledger-based reporting are intended to address interoperability challenges, but they overlook the reporting burden that remains the primary barrier for suppliers. It is hard to imagine that these global accounting frameworks are going to be implemented by suppliers without answering the fundamental question of – what is the market value of carbon accounting for suppliers?

The good news is that there is a potential solution. Product carbon footprints (PCFs) present a future-proofed resolution to supply chain carbon accounting. PCFs allocate the emissions from milk production, transportation, and processing energy to the products that are created at the dairy facility. When led by suppliers using high quality primary data, PCF methodology allows for product-level attributes and flexible reporting capabilities.

This paper explores the current approaches to carbon reporting in dairy value chains and argues that supplier-led, product-level reporting establishes a sustainable and scalable market for decarbonization investments. PCFs address the demands for traceability, data quality, methodology, reporting, and verification providing clarity to farmers and suppliers on the market value for carbon accounting.

CURRENT GHG REPORTING LANDSCAPE

Growing demand for traceability, data quality, reporting, and verified results are being codified in the updated global GHG accounting standards. These standards also outline reporting guidance for buyers calculating Scope 3 emissions inventories. In dairy, where up to 90% of emissions are from the farms, there is a major focus on capturing primary data from suppliers.

More specifically, carbon accounting standards and methodologies provide direction on product-level accounting, physical allocation, and dairy-specific emissions calculation. For dairy, sector-specific accounting rules guide practitioners to standardize volumes to fat-and-protein-corrected milk (FPCM) and use farm-based carbon intensity scores to calculate annual absolute emissions. Buyers may provide assumptions about milk composition, product specifications, or industry-average conversion factors to guide suppliers in how to calculate their unique inventories. This approach produces usable estimates but they are disconnected from actual product flows, facility yields, and co-product relationships causing inaccurate, and often, over-estimated inventory values.

The disconnect between disclosure-based frameworks and the operational realities of dairy supply chains come to a head when the demand for accounting rigor enters the discussion. Suppliers hear from their buyers that they must prevent double counting and free ridership. However, at the same time, the buyers are choosing the data management tools, defining the methodology for estimating Scope 1, 2, and 3 emissions, and determining the metrics for reporting.

This has served the purpose for buyers to calculate their emissions inventories, develop reduction targets, and pilot on-farm interventions. But the approach breaks down when the supplier levels up their data management capabilities to meet the reporting demands for all their customers. When suppliers take the lead in emissions accounting, they are able to calculate the footprints of the farms, transport, and processing energy and allocate those emissions to products based on actual source materials and product manufacturing steps. As a result, they can fully allocate and attribute emissions to product carbon footprints while avoiding double counting, free ridership, and inventory mismanagement.

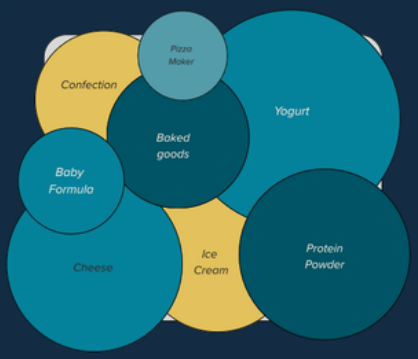
What Buyers Scope 3 Estimates Look Like for Suppliers

When suppliers are responding to buyers demands for GHG accounting using their unique methodologies and software solutions, they estimate allocation based on industry averages.

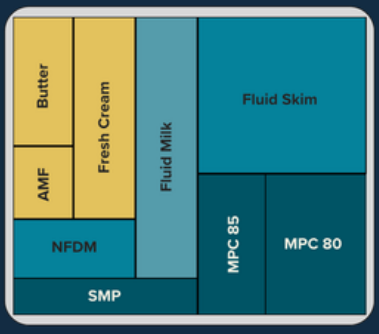
As a result, there is inherent double counting due to lack of visibility in how a gallon of farm milk is produced into multiple intermediary and finished goods.

When suppliers run the calculations, they are able to correctly follow milk solids from farm to products to customers resolving risks of incorrect product allocation.

If suppliers aggregated their buyers' estimated inventories



When suppliers calculate their solids-derived inventory



CURRENT GHG REPORTING LANDSCAPE

Current requirements for carbon accounting in dairy value chains cause three core inconsistencies[4]:

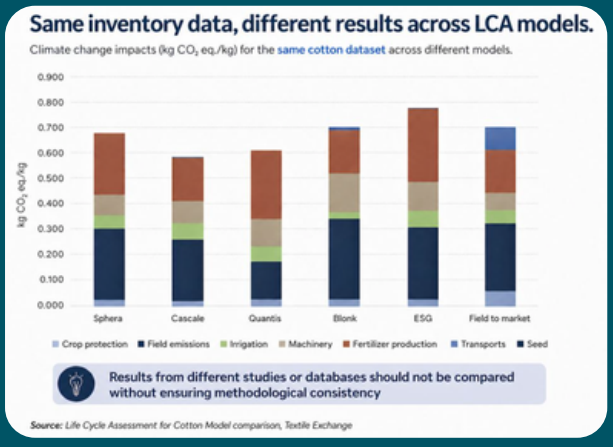
- **Co-product allocation is misestimated** using industry-wide assumptions rather than primary data
- **Emissions assigned to products may not sum to actual total emissions** from farms, transport, and processing energy causing inventory calculations to be out of sync within and across reporting years
- **Mass balance of emissions distributed across products** loses traceability preventing integration for project-based reductions with inventory calculations

For buyers, these inconsistencies create material reporting risk. When emissions are reconstructed using average values rather than supplier-specific data, reported inventories may not reflect production reality. Specifically, the requirements for traceability, data quality, reporting metrics, and verification processes. This can lead to under- or over-attribution of emissions, unstable baselines for tracking reductions, and limited comparability across reporting periods.

These inconsistencies also put suppliers at risk. Suppliers may operate from a single, physically grounded emissions inventory but fragmented customer and platform requirements force them to generate multiple, non-aligned outputs. This increases reporting burden, raises costs, and diverts resources toward translating data rather than improving emissions performance. Critically, it de-values primary data sharing when reporting tools rely on estimates and modeled outputs. Farmers and suppliers alike are seeking clarity on how farm- and facility-level data improves market opportunities and revenue generation.

For the dairy industry, the result is a structural problem: emissions data becomes harder to verify, harder to compare, and harder to rely on for target-setting, procurement, and decarbonization investment. Without a consistent way to allocate and transfer emissions across products, the market cannot fully trust or act on product-level emissions claims.

Supplier-led Reporting Overcomes Inconsistency Across Tools



Life Cycle Assessment for Cotton Models, Textile Exchange, March 26, 2026

There are concerns about the reliability and comparability of outputs if suppliers are creating their own accounting systems and reports. Currently, buyers are using a variety of tools to generate inventory values. As proven by Textile Exchange in their life-cycle assessment for cotton, there are inconsistencies between tool outputs even when the primary data is the same.

For dairy suppliers, they can support their buyers' goals and overcome these risks through three main actions:

- CONSISTENCY. Reduce year-over-year variations by committing to a single, robust tool
- CREDIBILITY. Confirm compliance to international standards required by your sector and customers
- TRANSPARENCY. Engage cross-functional teams to enable actionable insights

SUPPLIER-LED REPORTING FOR TRACEABILITY

The accounting challenges described above have direct market consequences. If emissions are not allocated to products in a way that reflects real-life supply chain operations, dairy stakeholders cannot reliably connect emissions performance to the products being bought and sold. This limits the ability of emissions data to inform procurement, farmer engagement, pricing, contracting, and investment decisions.

As a result, emissions data and reporting do not influence other decision-relevant product attributes, such as service, cost, quality, or composition. Emissions performance may exist in the system, and real reductions may occur through farm or facility projects, but without product-level attribution, those improvements do not consistently influence procurement, supplier selection, pricing, contracting, or co-investment.

> *"Suppliers have critical visibility into all milk solids entering and leaving facilities that buyers lack. We should use this information, rather than have customers make assumptions."*
>
> *Dairy sustainability professional, Interviewed March 2026*

Supplier-led, product-level reporting capabilities resolve the risks associated with traceability and double counting by applying universally-accepted methodology from IDF for the physical allocation of milk solids. With supplier-led allocation, the emissions footprints of all products, co-products, and byproducts are correctly and completely accounted for. Combined with an internal data management system, such as BoundDairy Accounting, suppliers can report to each customer only the emissions associated with the products they actually purchase, allowing buyers to report product-linked emissions without claiming the full raw milk input or duplicating emissions assigned to others.

Without supplier-led allocation and attribution, buyers may reconstruct emissions independently, creating a risk of overlapping or inconsistent claims due to lack of traceability from farm to milk to products to customers.

Supplier-led systems operationalize allocation and attribution

- Maintaining a single, production-based emissions inventory as the source of truth
- Allocating emissions to co-products using physical relationships, such as milk solids
- Assigning and transferring product-level emissions to customers based on actual purchases
- Preserving mass balance across all outputs to ensure complete and non-overlapping accounting

SUPPLIER-LED REPORTING FOR TRACEABILITY

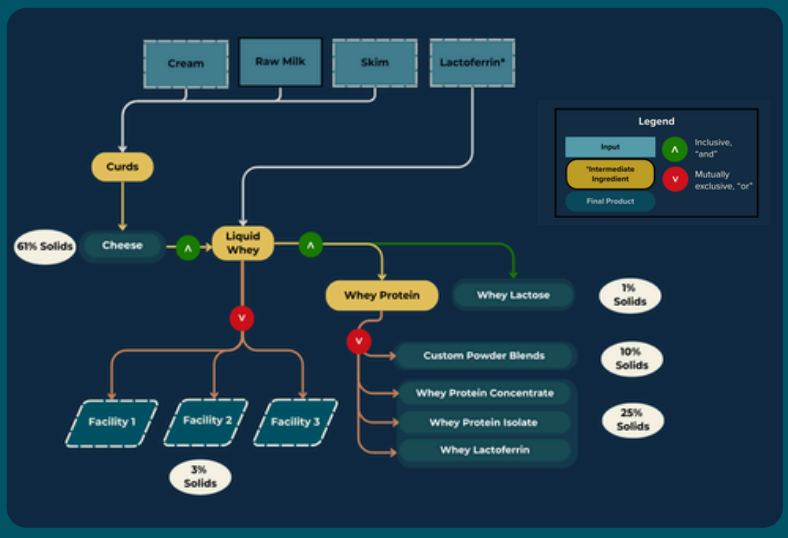
Supplier-led, product-level reporting must do more than provide a single emissions factor or average weighted carbon intensity score for farm milk. To support procurement, Scope 3 reporting, supplier engagement, and investment decisions, reporting must show where emissions occur, how they accumulate across farms and processing, and how they are assigned to the products and customers that move through the supply chain. This aligns with a broader shift in carbon accounting away from static disclosure and toward structured, auditable systems that track both periodic emissions and changes in emissions performance over time. As Stephen Penman argues in Accounting for Carbon, carbon accounting should help users understand not only current emissions, but also where emissions and reductions come from across reporting periods.[8]

Rather than using estimates and industry averages, a supplier-led report connects farm carbon intensity, product volumes, milk solids allocation, product carbon footprints, and customer-specific purchasing activity. This requires traceability and data integrity to ensure emissions are traceable as they move through the supply chain. It ensures that **each product carries the emissions allocated to its production, and that each customer receives the emissions attributed to them based on the products they actually purchased.**

This is only possible when conducted at the facility-basis and led by the processor. This accounting strategy depends on traceability from the point at which farm milk is transformed into products. Raw milk undergoes many transformations from farm to shelf. It is separated, recombined, and converted into multiple intermediate and finished products. These internal production relationships determine how emissions should be assigned, and can only be calculated and reported accurately by the processors.

In practice, reporting is where supplier-led, product-level accounting becomes operational. Suppliers are not just providing a number; they are providing a structured output that connects emissions performance to real products, volumes, and customers. That structure allows emissions data to support procurement, disclosure, supplier engagement, and investment decisions.

Facility-based Process Flow for Cheese & Whey



The diagram illustrates a simple but critical principle: product-level accounting is where emissions, production, product, and sales data can be structured together. At each stage, emissions are generated, embedded in outputs, and carried forward as products move through production. Only the supplier knows the full set of upstream sourcing emissions, milk utilization for co-products, and the distribution of products to all customers.

This facility-level visibility enables full traceability and product allocation. Once suppliers map emissions to physical outputs, they can distribute emissions across co-products. Physical traceability prevents overlapping claims across buyers, enabling the attribution of emissions to customers based on actual purchasing shares.

PRODUCT-LEVEL ALLOCATION

Within the dairy industry, milk solids allocation methodology enables accurate and credible reporting of product carbon footprints (PCFs). Because many products, co-products and byproducts are derived from the same underlying milk inputs, the dairy industry applies a standard unit of measure for calculating product-level emissions. International Dairy Federation (IDF) established the standard for physical allocation based on milk solids.

Milk solids allocation establishes the principle that all component-derived solids have equal carbon value prior to processing. Physical allocation of solids best represents the causal relationship between milk quality and component-level solids. Together, supplier-led accounting processes follow protein-, butterfat- and lactose-derived product categories as milk solids are allocated to many product specifications.

As milk solids move through a production system, fat, protein, and lactose are balanced, transformed, and recombined into intermediate and finished products. Because these transformations depend on facility-specific processes and product specifications, suppliers know how emissions inputs are distributed to outgoing products.

Product Carbon Footprints (PCFs) are thus standardized, scalable, and repeatable by applying the milk solids allocation factor while maintaining traceability and data integrity from farm to product.

Dairy Components and Milk Solids

Fluid milk is composed of protein (3.3%), butterfat (4%), lactose (4.85%), and minerals (0.8%). IDF methodology defines the equation for calculating the milk solids in a gallon of milk. This standardizes the emissions unit and provides direction for allocating emissions to product categories and products.

Some companies use a dry matter basis, which is also standardized but slightly different than milk solids. These are not interchangeable methodologies or metrics.

PCFs are a powerful tool for carbon accounting as they resolve many of the risks associated with emissions allocation, inventory management, and customer attribution. Even more importantly, PCFs enable project-to-inventory integration, a critical unlock for the market value of data management systems and decarbonization investments. However, just like any emissions intensity based approach, the value of PCF methodology is not due to the ability to generate an estimated, database-generated value that can be put into a report. The value is a result of the supplier's data and product traceability capabilities.

Carbon Intensity versus Product Carbon Footprint

	Carbon Intensity	Product Carbon Footprint (PCF)	Absolute Emissions
Functional Unit	Standardized milk unit (FPCM)	Final Product Unit (cheese, butter, whey, etc.)	Entity level (product, farm, operation total)
Metrics	kg CO23 / kg FPCM	kg CO2e / kg product	tons CO2e / year
Level of Granularity	**Farm level** inputs, herd, manure, energy per one unit of milk	**Product-level** Farm emissions, processing, transport per product	**Entity-level Product,** farm, company, or full supply chain aggregate total
Primary Use Case	**Farm benchmarking** Compare efficiency across herds and regions	**Product-specific emissions** Scope 3 & buyer reqs	**Corporate targets** Net-zero pledges, regulatory, and investor

** Product Carbon Footprint, in this context, references cradle-to-processing gate*

Carbon intensity is well suited for farm-level benchmarking, but it does not show how emissions move through supply chains or how they are distributed across co-products.

Product carbon footprints translate emissions into product-level values, allowing suppliers to allocate emissions across outputs and support product- and customer-level reporting.

Cradle-to-Processing Gate PCFs include Scope 1 and 2 emissions sources providing a comprehensive assessment of suppliers' operations.

SUPPLIER-LED PRODUCT CARBON FOOTPRINTS

Data integrity, product traceability, and milk solids allocation enable differentiated product attributes that are only achieved when suppliers are in the lead. Only supply chain operators have the ability to know precisely how a gallon of farm milk is converted into dozens of product specs. By leveraging their position in the value chain and utilizing leading industry-accepted guidance, suppliers are able to develop low-carbon product markets that signal to farms the value of their data and provide buyers with a scalable commercial opportunity for reducing their carbon footprint.

Supplier-led Product Carbon Footprints provide the greatest market value to farmers and buyers alike. S-PCFs bring the accounting integrity to develop a scalable commercial market for low-carbon products and farm milk while reducing accounting risks for all stakeholders

Dairy suppliers are uniquely positioned to generate accurate product-level inventory calculations for all of their customers. PCF methodology allows for embedding farm, transport, and processing emissions into the products with full traceability to ensure that 100% of the emissions coming into the supplier's economic boundary are fully allocated to the products leaving their operational system. The result is a complete and credible reporting system that ensures no double counting or year-over-year accounting integrity issues.

A direct benefit for buyers is that product-level reporting typically causes a lower carbon footprint than generalized Scope 3 emissions data. PCF standards require allocation of a milk solid-based emission unit only once to the products derived from the solids category (i.e., protein solids applied to whey protein isolate), they eliminate the double counting that is inherent to Scope 3 calculations. As a result, suppliers can report accurate inventory emissions based on the buyers' purchased goods. Because of their traceability capabilities, suppliers can provide reporting for any sourcing agreement (direct ship fluid milk, milk swaps and transfers, component trades, dairy ingredients, and finished goods), and provide data-driven results through a multitude of reporting frameworks. **Critically, PCFs prevent double counting, ensuring confidence and trust in supplier-led reporting.**

In 2025, The Climate Source compared the emissions inventory for a dairy company purchasing condensed skim milk, cream, and powders from a single supplier. Previously, the Scope 3 emissions inventory based on estimated raw milk equivalency volumes and actual farm carbon intensity values was about 240K MT. When PCF methodology was applied and the same data was re-run using actual component percentages and conversion factors, the new inventory was about 109K MT. The total variance resulting from supplier-led, product-level reporting was 131K MT.

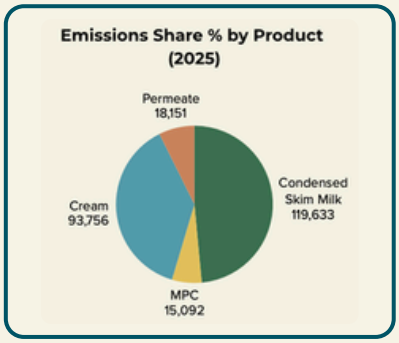
Plant	Raw Milk Volumes kg FPCM	Total Inventory MT CO2e	Farm Carbon Intensity kg CO2e/ kg FPCM	Primary Data Share % of Emissions
West	250M	240,000	0.96	100%
Total	**250M**	**240,000**	**0.96**	**100%**

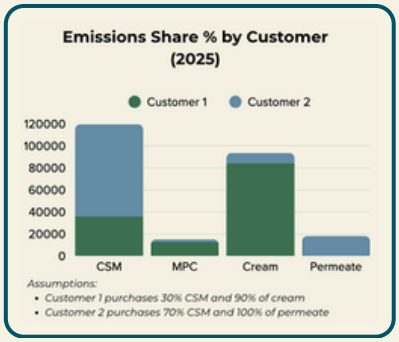
Plant	Product	Raw Milk Equivalency kg Raw Milk	Milk Solids Allocation Factor Product % of Solids	Product Quantity kg Product	Total Inventory MT CO2e	Product Carbon Footprint kg CO2e/ kg Product
West	Cream	10.15	38%	24.31M	93,756	3.86
West	MPC	3.91	6%	12.19M	15,151	1.24
West	Subtotal	**7.03**	**44%**	**36.50M**	108,907	**2.98**
Total				**36.50M**	**108,907**	**2.98**

MARKET OPPORTUNITIES FOR DAIRY SUPPLIERS

In addition to the immediate benefit of reporting an accurate and auditable inventory value, product-level accounting provides clarity to the suppliers for engaging customers in on-farm projects through exclusive and co-investment opportunities.

With insight into how emissions are distributed to each product and the sales volumes of those products, suppliers can develop marketing strategies to optimize their goals. The top right chart shows the percent of emissions distributed to the four products made at the supplier's facility. In the bottom right chart, the supplier can see how those emissions are sold to customers based on their unique product mix. Together, these insights allow for the supplier to determine the best strategy for customer engagement and project development. These insights can be powerful decision criteria for evaluating the marketability of low carbon products.





Market development for low carbon products requires an auditable process for ensuring the product-level claims. Supplier-led PCFs enable low carbon product markets by leveraging global accounting standards for traceability, data quality, methodology, reporting, and verification.

Importantly, supplier-led PCFs activate the procurement team in driving down carbon emissions and investing in corporate decarbonization efforts. Low carbon attributes can be integrated into the product spec, and recognized as premium goods. Low carbon product demand signals can be acted upon by suppliers to develop the supply of low carbon farm milk. A clear demand signal for a premium product spec based on low carbon performance importantly sends the message to farmers that their data has value. As that demand matures and dairy suppliers prove their ability to transfer carbon attributes and assets attached to the milk, suppliers can further leverage traceability and data insights to develop value chain partnerships.

Supplier-led, product-level accounting is the critical unlock for engaging farmers and buyers in decarbonization through low carbon market development.

S-PCFs overcome the key risks for carbon accounting and unlock market opportunities for farmers and processors.

Product Differentiation

Low carbon product attributes based on a credible, auditable standard methodology have the potential of capturing performance-based premiums

Procurement Options

Sourcing decisions can integrate product-level carbon metrics based on primary data and supply traceability

Investment Confidence

On-farm projects are traceable to products and customers, improving the return on investment

CONCLUSION

When a supplier maps emissions by product and then layers in how those emissions distribute across customers based on actual purchasing volumes, a precise picture emerges: each data point represents a quantifiable carbon responsibility tied to a real, active sourcing relationship. That is not a compliance output. That is the architecture of a low-carbon market.

This is where supplier-led PCFs shift from accounting methodology to commercial strategy. With product-level emissions data in hand, a supplier can identify which product specs carry the highest carbon load, which customer relationships represent the strongest co-investment opportunity, and where on-farm project development will generate the greatest return. Rather than approaching farmers with an abstract request to participate in data collection for a reporting requirement, suppliers can provide farmers with a direct value proposition. Reductions you generate are traceable through milk solids to the specific products we make from your milk, and those products command a premium. That is a fundamentally different conversation that gives farmers a clear line of sight between management decisions and market outcomes.

Project development is also transformed by this visibility. On-farm interventions generate reductions that, under conventional Scope 3 frameworks, struggle to find a credible home in a buyer's inventory. With supplier-led PCFs, those reductions are allocated to products, traceable from milk solids to specific product categories, and transferable to the customers who purchased them. Project-to-inventory integration that has long eluded the industry becomes structurally possible when suppliers own the accounting system from farm gate to finished product.

> *"PCFs open up market differentiation. A verified PCF lets a supplier demonstrate year-over-year emissions reductions at the product level."*
>
> *Dairy sustainability professional, Interviewed March 2026*

But the most consequential shift is what supplier-led PCFs do for procurement. Spend-based estimates and farm-level carbon intensity scores do not translate into product attributes that procurement teams can evaluate at the point of purchase. They cannot sit easily alongside product SKUs, volumes, price per unit, and supplier scorecards. However, when a dairy ingredient carries a verified carbon footprint expressed in kg CO_2e per kilogram of product, carbon becomes a product attribute that buyers can evaluate alongside cost, quality, and service. Buyers can write lower-carbon ingredients into sourcing contracts, recognize them as premium inputs, and use them to support programs that reward farm-level reductions. Suppliers can then send a clear market signal to farmers: lower-carbon milk has measurable market value. Farmers engage because the return is tangible, and decarbonization scales through commercial incentives rather than compliance pressure alone.

This is the market that supplier-led, product-level accounting makes possible: one where low-carbon performance is priced, procured, and valued through the same mechanisms that govern every other dimension of product quality and sourcing. The dairy industry already has the traceability infrastructure, product allocation methodology, and supplier relationships needed to build a future-proof accounting system that supports market development. Sustainability, procurement, finance, operations, and sales teams should recognize low-carbon product attributes for what they already are: measurable commercial value. They should engage dairy suppliers as the partners best positioned to deliver that value at scale.

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