Measuring dairy supply chain emissions to meet climate goals

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With climate change remaining a global imperative, there will be continued scrutiny of carbon emissions along food and agriculture supply chains. With this in mind, dairy corporations are trying to address the problem of emissions within their own supply chain. An understanding of the dynamics within this unique food chain is a key first step.

A focus on greenhouse gas emissions (GHG) in the dairy supply chain offers a competitive advantage to those who can measure emissions by segment and make investment decisions that follow through on climate pledges, as well as satisfy growing consumer demand for lower carbon intensity (CI) dairy products.

**Executive Summary**

Environmental, Social and Governance (ESG) considerations are rapidly shifting competitive pressures for dairy along with other major production industries. For dairy corporations, GHG emissions have become a critical focus. By understanding the entire dairy supply chain’s role in global carbon emissions, leading firms are beginning to action carbon-focused strategies:

- Reduce total carbon footprint via carbon mitigations
- Achieve lower carbon intensity by building scale to achieve sustainable intensification
“If you can’t measure it, you can’t manage it.” Peter Drucker

There is increasing urgency for leading dairy producers and manufacturers to implement ESG strategies and successfully explain their carbon footprint efficiencies to consumers and financial market stakeholders. This requires a measurement tool (a “dairy carbon calculator”) robust enough to allow retailers and food service providers to measure GHG emissions in their section of the chain and effectively lower the CI of their dairy products. Such analysis must weigh operational, financial, and policy considerations unique to each global operation. IHS Markit provides assessments across the dairy market chain to assist you with CI measurement to select the most effective ways to reduce emissions in your business.

Dairy production is a major part of the problem as well as a critical part of the solution

Dairy’s role in global carbon emissions

Global agriculture is undergoing one of the largest transformations in decades as decarbonization and carbon emission reduction strategies are implemented across the food supply chain. One of the prime upstream commercial agriculture targets is animal agriculture, specifically rumen animals, in which enteric fermentation emissions and emissions from manure have become central to concerns around global GHG emissions. Because of high levels of carbon dioxide (CO2) and methane (CH4) associated with dairy production, this sector is seen as a major part of the problem. However, with effective management of the system, the dairy supply chain becomes a critical part of the solution.
Measuring the footprint of the dairy supply chain

Legendary business analyst and consultant Peter Drucker once said “If you can’t measure it, you can’t manage it.” It’s a well-known concept, but what happens when the factors measured shift and change? Decarbonization and lowering emissions will have a profound impact on the dairy supply chain as retailers and food service providers look to procure dairy products that have a lower CI. Without a method that helps them understand, measure, and track methylene (CH2) and CH4 emissions within the dairy supply chain, this is an impossible task. The corollary to Drucker’s claim, of course is, “If you aren’t measuring it, then you aren’t managing it.”
Drivers of decarbonization in the dairy supply chain

A starting point to understanding the impacts of decarbonization on the dairy supply chain is understanding the forces driving change within the industry. Spurred by an increasingly carbon-aware consumer base, investor pressure on decarbonization has intensified and will continue to grow. Accordingly, most major food and agriculture companies have made carbon emission reduction pledges as a way to get ahead of investor and public demands for low-CI products. The demands arising from these pledges places an indirect pressure on dairy farmers and cooperatives that are, as a result, adopting sustainable practices to fulfill volume commitments (See examples in Box 1). But simply making pledges is not enough and companies are quickly moving to implementation of lower carbon emissions. For food companies, already battered by supply chain issues brought on by the pandemic, these are painful and potentially costly changes. But, as with most challenges there are opportunities. If, for example, it is possible to manage the dairy supply chain such that it can present the consumer with a lower CI dairy product, this represents a serious competitive advantage.

(Box 1) recent dairy carbon pledges:

Dairy Farmers of America (DFA): In 2020, DFA became the first based dairy cooperative to pledge a 30% reduction of absolute Scope 1, 2 and 3 GHG emissions by 2030, where 98% of the emissions are indirect emissions from the DFA supply chain representing 12,500+ family farm-owners. “Cows are the best recyclers,” as quoted by cooperatives sustainability announcements, the pledge will aim to:

- Mitigate methane emissions from cows (enteric fermentation) by supporting advances in feed efficiency, herd nutrition, and feed additives to reduce emissions
- Utilize anaerobic digestors that convert manure and food waste to energy on farms and in plants

Nestlé: As one of the largest global food processors and dairy procurers, Nestlé’s carbon pledge of a 50% cut in Scope 1, 2 and 3 GHG emissions by 2030 creates pressure on dairy farmers to adopt conservation practices on-farm as Nestlé will favor the sourcing of low carbon dairy products. Indirect emissions within Nestlé’s supply chain that account for >90% of total emissions originate from soybean, cocoa, coffee, palm oil, and raw milk products. Nestlé sources these commodities from 29 different countries and GHG emissions associated with raw milk are about 18% of the total Scope 3 emissions.

Land O’Lakes: In partnership with Microsoft, Land O’Lakes announced a lucrative carbon credit program for its dairy farmers aiming to cut 10 million tons of carbon emissions. Dairy farmers serving Land O’Lakes can receive up to $20 per-ton of carbon they sequester through precision nutrient management, cover cropping, and no tillage. In addition to revenue from carbon, the collaboration with Microsoft will particularly help farmers at Land O’Lakes to use the latest technology being offered by Microsoft through artificial intelligence (AI) technologies.

As a direct reflection of these investor and consumer pressures, it is likely there will be policy action that will force decarbonization at the farm and within the food supply chain. Such policies are likely to incentivize farmers to invest in digester technology and other means of reducing emissions. There are many policy levers that can be employed including but not limited to emissions targets, required technologies (e.g., you must have a digester to operate a dairy farm), or linkages of traditional farm supports to regulatory emissions compliance. To the extent that policy actions to reduce emissions are
considered, their potential impacts cannot be assessed unless we understand the entire dairy chain emissions profile. Additionally, companies that can communicate these impacts will have an edge preparing for any policy changes.

**Productivity as an answer to lowering carbon intensity of dairy products**

When we think about decarbonizing the dairy supply chain (or any food supply chain for that matter), most will think of reducing CO2 and CH4 emissions at one or any number of points along the supply chain to produce a product (in this case, a liter1 of milk) that has a CI lower than other products. However, the carbon intensity of a liter of milk is also a function of the efficiency and productivity of the system from which it originates. For example, all other things being equal, if a retail store switches its procurement of milk to a dairy with a herd that is 20% more efficient at producing milk than the current supplier, the CI of the milk it buys will decrease. It might not be a total 20% CI improvement, but higher productivity can lead to a more sustainable supply system.

This concept of “sustainable intensification,” whereby intensifying efficiency gains leads to lower CI of food products, is potentially good news for global agriculture. The industry has a strong history and culture around productivity gains, which can lead to sustainable intensification. And while sustainable intensification of production alone can lower the carbon footprint of food sold to the consumer, at the same time these productivity gains can address food-security issues while increasing profits.

![Farmgate emissions (kgCO2e) per kg raw milk, by intensity of production](image)

At least part of the task of meeting sustainability goals, especially to the consumer, can come from productivity gains. However, the impact on the whole chain needs to be understood in order to describe such impact to the consumer. Productivity gains at the farm and efficiency improvements throughout the dairy supply chain can be individually measured, but quantifying their impact on dairy products delivered to the consumer can be quite complex. To be able to offer consumers a choice in rewarding sustainable dairy products, leading producers and retailers need to measure and quantify the impacts of these productivity and efficiency gains on delivered consumer goods.

1 Milk volumes are expressed in different units in different parts of the world. For simplicity in this document we have chosen to express the units in liters but for reference, one liter of milk equals: 0.26 US gallons, 2.27 pounds, or 1.03 kilograms.
Does rising production always mean rising emissions?

(Box 2) dairy farming intensity:
Over the past 50 years, dairy farming has become more intensive to increase the volume of milk produced by each cow. The Holstein-Friesian, a breed of dairy cow most common in the United States, as well as in the United Kingdom and Europe, has been bred to produce large volumes of milk. Milk production per-cow more than doubled over the past 40 years. In the United States, the average dairy cow produces more than 7.5 gallons of milk per-day. If a dairy cow was producing just enough to feed her calf, she would only produce about one gallon of milk per-day.

The volume of milk per-cow in the United States has increased each year since 1999, from 7,818 liters per-year to around 10,465 liters in 2020 and 7,095 from January through August in 2021. On a global scale, the production of cow milk reached over 500 million metric tons in 2018 and is expected to increase slightly in the following year. There are approximately 250 million cows producing milk around the world, with around 10 million dairy cows in North America, 23 million in Europe, and 6 million in Australia and New Zealand. Milk production is on the rise in Asia, and that includes China, a country not traditionally known for its milk consumption. China currently has more than 12 million milk-producing cows.

In 2018, the 28 member states of the European Union produced the largest volume of in the world, by a large margin. The United States was the second leading producer of milk in that year. While the global production volume of milk, as well as milk production per cow have increased significantly in recent years, per-capita consumption of fluid milk in the United States steadily decreased during the same period. In 2018, the average American consumed around 87 liters of milk per-year, and by 2020, the per-capita consumption of fluid milk had fallen to only 64 liters.
Evaluating costs and benefits of lower carbon intensity in dairy products

There are significant technology investments required to lower the carbon intensity of dairy products delivered to the consumer. As noted above, lower carbon intensity of dairy products can be achieved by directly lowering emissions, increasing productivity and efficiency, or both. In all cases though, investment is likely needed to effect change in the system. If it is productivity, perhaps new breeds or feeding regimes are required. If it is via lower emissions, it might involve feed additives, location changes, or new technologies such as dairy digestors that convert manure into biogas and digestate that can be used, among other things, as fertilizers. And as manure is a major source of greenhouse gas emissions, the use of digestors is an effective path toward reducing dairy emissions. However, at a cost of $500,000 to $5,000,000 there is a significant capital expense involved that must be recouped. How these costs are recouped by the farmer is a major question and only by measuring when and where emissions in the dairy chain occur can the investment in technology and its financial returns be evaluated.

(Box 3) productivity of dairy production and greenhouse (ghg) emissions on a global scale:
The use of a life cycle assessment (LCA) is used to assess GHG emissions from dairy production and processing chains. Milk yield is expressed as kg of fat-protein corrected milk (FPCM) per animal, which is chosen as a proxy for system productivity. On a per cow basis, GHG emissions increase with higher yields. However, GHG emissions per kg of FPCM decline substantially as animal productivity increases. The contribution of different gases to total GHG emissions of dairy production systems vary; CH4 and nitrous oxide (N2O) emissions decrease with increasing productivity, while CO2 emissions increase, but on a lower scale. Productivity increases therefore offer not only a pathway to satisfying increasing demand for milk but also a viable approach to mitigation, especially in regions where milk yields are currently below 2,000 kg/cow a year.
US dairy policy has evolved, but still has components such as federal milk marketing orders (FMMOs) that impact the price of milk. Pricing reforms in the 2018 Farm Bill altered how milk prices are determined and the pandemic has hampered desired results. The Dairy Margin Coverage (DMC) program has been refocused to provide more benefits to small- and medium-sized producers. Larger producers have options linked to the crop insurance program to manage their risk. EU dairy policies removed production quotas in 2015, but still include public intervention and private storage provisions, direct payments, and rural development components. In New Zealand, the 2001 Dairy Industry Restructuring Act reforms created the farmer-owned cooperative Fonterra and removed the single-exporter status of the New Zealand Dairy Board, deregulating exports of dairy products. Fonterra’s share of the domestic market has fallen to 81%, and around 74% of New Zealand farmers have access to more than one processor to take their milk.

The various global dairy policies make the economics of dairy production very local and the drivers of the industry in part reflect local policies. For retailers and food service providers to make good procurement decisions, the conversation must involve CI measures, a way of including policy actions in supply chain dynamics.

**A carbon calculator for dairy ensures good data to make good decisions**

The dairy marketing chain is highly complex. While it is possible to measure a single supply chain from one store to one producer, the permutations of different suppliers, different dairy systems, and multiple locations suggest that good decision-making around carbon reduction requires a reliable calculator that captures all possibilities. And food retailers will need to understand multiple pathways within their dairy supply chains if they are to successfully lower the CI of their dairy products. With a dairy carbon calculator, multiple supply, destination, and technology platforms can be assessed, “what if” scenarios can be evaluated, and effective, sustainable decisions around dairy procurement can be actioned. Talk to your IHS Markit representative to learn more about our analysis of the dairy market chain in your area to guide your decision-making on emissions reduction using CI measurement.
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