INNOVATION CENTER FOR U.S. DAIRY
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The Comprehensive Life Cycle Assessment for Greenhouse Gas and Energy Use for Cheese and Whey Products Summary

The Comprehensive Life Cycle Assessment for Cheese and Whey Products was completed in early 2012 and is intended to provide those in the cheese industry with timely, science-based information to help them innovate to reduce greenhouse gas (GHG) emissions and energy demand from farm gate to consumer table. This report summarizes the GHG and energy results. The additional study components of water use and other impacts are now under review and will be released later in 2012.

Introduction

Over the past few years, consumers have become increasingly aware of the environment, from their own impact to that of manufacturers who provide them with the products they want and use. This awareness and interest further extends to the foods they eat.

Many of today's consumers are asking questions about — and expanding their knowledge of — how particular foods got on their plate or in their glass. At the same time, activist organizations are trying to reach consumers with their own messages, such as the statement by the *Environmental Working Group* that if Americans stopped eating meat and cheese for a week, it would have the same result as people driving 91 billion fewer miles a year.

Given such statements, and with growing consumer interest in natural foods and foods produced in a sustainable way, those associated with the food value chain — from farmers to processors to retailers — are looking to assess the environmental impact of their products. Ultimately, the goal is to identify and improve the product's respective carbon footprint and communicate that back to consumers.

All members in the supply chain increasingly are adding environmental reporting requirements for their raw material and ingredients suppliers as they meet the information demands of their consumers. For commodities such as meat and dairy, the industry has taken the lead in researching the true environmental impact of finished products to provide that information throughout the farm-to-table value chain.

The U.S. dairy industry, for its part, has worked to proactively anticipate and meet the needs of consumers with a commitment to improving its environmental performance. In 2009, the Innovation Center for U.S. Dairy endorsed a voluntary goal to reduce GHG emissions for fluid milk 25 percent by 2020 and subsequently launched a GHG life cycle assessment (LCA) for fluid milk to determine points in the farm-to-table value chain at which the dairy industry can

help reduce GHG emissions. Results of that LCA identified manure management, feed production and enteric methane as key areas for improvement and innovation research.

Following the fluid milk LCA, the Innovation Center for U.S. Dairy focused on cheese and whey, which comprise a significant portion of the dairy products purchased and consumed in the U.S. Per Figure 1, of the approximately 190 billion pounds of milk produced each year, 33 percent is used for cheese, while 24 percent is used for fluid milk. Average per capita consumption of cheese in the U.S. is 24.5 pounds.

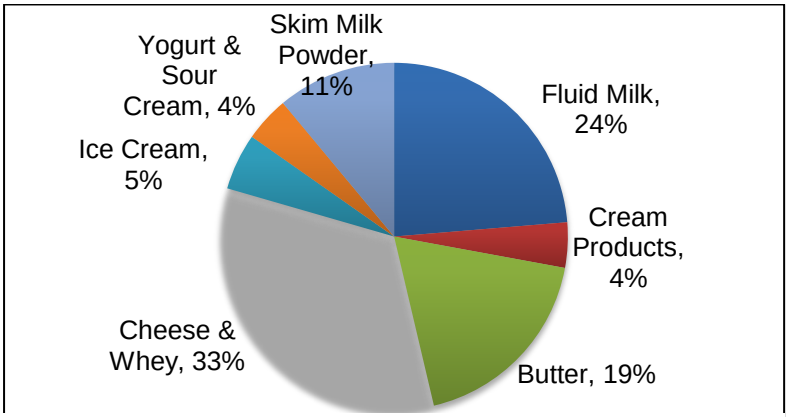

Figure 1. Estimated utilization by various dairy products of milk produced in the U.S. Source: Franco Milani, UW-Madison, based on data from IDFA "Dairy Facts 2009".

Completed in early 2012, the *Comprehensive Life Cycle Assessment for Cheese and Whey Products* was intended to provide those in the cheese industry with timely, science-based information to help them innovate to reduce GHG emissions and energy demand from gate to plate. The study provided a benchmark for cheese manufacturers to measure the industry's progress toward achieving its voluntary reduction goal and compare it to a 2009 average.

The Innovation Center for U.S. Dairy chose the Applied Sustainability Center at the University of Arkansas to conduct the LCA for cheese and whey. The study was led by principal investigator Greg Thoma, Ph.D.

This summary focuses on GHG emissions and energy use. The additional study components of water use and other impacts use are now under review and will be released later in 2012.

LCA Methods

The *Comprehensive Life Cycle Assessment for Cheese and Whey Products* study followed the International Organization for Standardization (ISO) protocols for credibility, transparency and objectivity of methods, data and results.

A third-party review is required by ISO standards. The ISO review process parallels the LCA study and includes three steps: 1. Goal and scope definition; 2. Data collection; and 3. Calculation and interpretation. The ISO review panel included: Manuele Margni, Ph.D.,

Interuniversity Research Centre for the Life Cycle of Products, Processes and Services, Ecole Polytechnique de Montréal; Moshe Rosenberg, D.Sc., Professor and Specialist, Dairy Technology and Engineering Department of Food Science and Technology, University of California, Davis; and Ulf Sonesson, Ph.D., Vice Director, Sustainable Food Production SIK - The Swedish Institute for Food and Biotechnology.

An industry review consisted of a presentation of the LCA results to the Sustainability Council and a one-on-one examination of data with the researchers. An academic review and an NGO review of the findings also were part of the study process.

Researchers chose to study the carbon footprint of two varieties of natural cheese: mozzarella and Cheddar. Cheddar and mozzarella cheese are the most frequently enjoyed cheeses in the U.S., together accounting for two-thirds of per capita consumption.

Researchers followed the entire journey of each natural mozzarella and Cheddar cheese and whey (on a dry weight basis), from the beginning of the life cycle when feed crops are grown to the disposal of the cheese package by the consumer. The farm-to-table chain was divided into nine stages: feed production, milk production, delivery to processor, processing/cheese manufacturing, packaging, distribution, retail, consumption and disposal, as shown in Figure 2. Each of those stages were analyzed separately and later combined to provide a total footprint analysis.

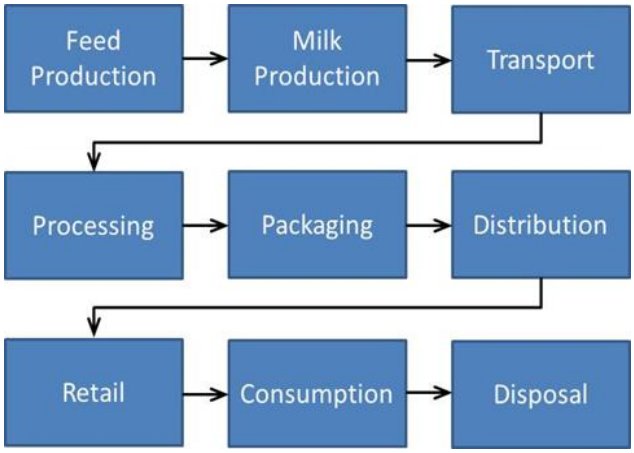

Figure 2. Cheese production and supply system.

Researchers collected data from ten Cheddar manufacturing locations (representing 38 percent of annual U.S. Cheddar production) and six mozzarella production facilities (representing 24 percent of annual U.S. mozzarella production). At each facility, data were collected on the purchase of materials and energy, the production of cheese and other products, and emissions, including solid and liquid waste streams. Results from the 2009 fluid milk LCA were used as background for the milk production step in the manufacture of cheese and whey products.

The study assessed the relative climate change contributions of Cheddar and mozzarella cheese across life cycle stages. Post-farm gate GHG emissions for dry whey production were

also evaluated. A detailed breakdown of the sources of GHG in the Cheddar and mozzarella life cycle *after* the farm gate was also derived.

Researchers used *SimaPro 7.3* as the primary modeling software, along with an *EcoInvent* database that showed "upstream" burdens associated with materials like primary fuels and plant chemicals.

GHG and Energy Use Findings

According to this study, the total carbon footprint from the cheese sector is approximately 54 million metric tons (MMT) of CO_2e, or 0.7 percent of the total GHG emissions in the U.S. The cumulative energy demand from the entire cheese sector is 0.3 percent of total U.S. energy consumption. These are field to customer gate estimates and, therefore, do not include retail or consumption impacts.

As shown in Table 1 the average carbon footprint of cheddar cheese is 8.7 kg of CO_2e per kg of cheese. In comparative context, consuming one kilogram of cheddar cheese contributes GHG emissions equivalent to driving 24 miles in an average fuel-efficient car.

	Carbon Footprint kg CO_2 eq per kg consumed (95% confidence band)	**Cumulative Energy Demand MJ/ kg consumed (95% confidence band)**
Cheddar cheese (dry basis)	13.8 (9.5 – 19.7)	77.7 (46.7 – 166)
Cheddar cheese (36.8% moisture)	8.7 (6.0 – 12.5)	51.1 (30.3 – 111)
Mozzarella cheese (dry basis)	14.6 (10.4 – 20.5)	91.1 (53.6 – 202)
Mozzarella cheese (48.6% moisture)	7.5 (5.3 – 10.7)	46.0 (27.6 – 97.7)
Average natural cheese (dry basis)	14.1	82.5
Average natural cheese (assumed moisture basis)	8.3	49.3
Dry whey (dry basis) [field to customer]	12.4 (9.3 – 16.3)	59.4 (40.6 – 90.4)
Wet whey (dry basis) [field to customer]	10.2	45.3

Table 1. Summary product footprint results for cheese and whey

The average carbon footprint of mozzarella cheese is 7.5 kg of CO_2e per kg of cheese. The carbon footprint of dry whey is 12.4 kg of CO_2e per kg (dry basis), while the impact of wet

whey is 10.2 kg of CO_2e per kg (dry basis). (Note: The whey life cycle does not include impacts from the retail and consumption stages.).

As for the footprint itself, the production of milk used in cheese comprises most of the GHG emissions associated with cheese production.

Hence, evaluating the cheese life cycle *after* the point of milk production is helpful in indentifying ways in which cheesemakers can best innovate to reduce their GHG emissions.

The study suggests that most of the GHG emissions in cheese production (excluding milk production) are energy related, such as CO_2 emissions due to electricity production or the use of fossil fuels in heating or transportation.

Meanwhile, a majority of the energy demand in the production of dry whey stems from electricity and natural gas used for the concentration and drying of whey solids.

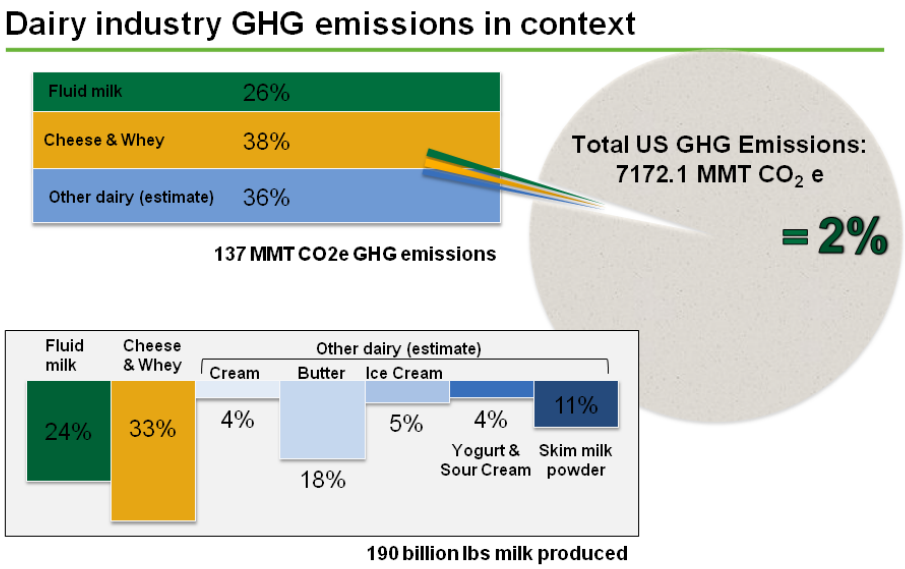

Figure 3. dairy industry GHG emissions in context

From a big picture standpoint, as shown in Figure 3, cheese and whey comprise 38 percent of GHG emissions in the dairy industry, compared with 26 percent for fluid milk and 35 percent for other dairy products combined. Currently, the dairy industry accounts for approximately 2 percent of the total GHG emissions (those from all sources, not just agricultural sources) in the United States.

Energy use and water use findings from the LCA study will be reported later in 2012 and will provide additional insight into the entire impact of cheese and whey production.

Variability

This work is intended to provide a benchmark for the industry to assess future improvements in environmental performance. Public statements by individual brand owners regarding the footprint of cheese or whey alone should be made cautiously, since results are very sensitive to the allocation between cheese and whey processes in a given processing facility.

Conclusions

This GHG and energy demand LCA for cheese and whey was intended to provide a benchmark for the industry to assess future improvement in environmental performance. Based on the results of the study, cheese manufacturers can reduce their respective GHG emissions and increase their energy efficiency by addressing the largest contributors under their direct control.

Cheese manufacturers may also consider a formal energy management program, such as a program supported by the U.S. Environmental Protection Agency's ENERGY STAR program and their ENERGY STAR Focus on Energy Efficiency in Dairy Processing and/or the U.S. Department of Energy's Save Energy Now program.

The Innovation Center for U.S. Dairy has established additional projects, such as Dairy Plant Smart™, to explore options within the cheese and whey sector to identify and develop optimal configurations to improve the sustainability of the category as well as the overall industry. Multiple sustainability projects are under way in areas such as nutrient management practices, feeding rations, manure management, energy efficiency, improved packaging formats, new processing technologies and fuel efficiency.