Fonterra Carbon Footprint Study: Drivers, Methods, Results and Challenges

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Introduction

Fonterra is a large New Zealand dairy co-operative that collects and processes over 90% of all NZ milk, producing a wide range of dairy products that are marketed throughout the world. They are the largest exporter of dairy products internationally and are a significant contributor to the Gross Domestic Product of New Zealand.

In 2008, Fonterra commissioned a project to determine the greenhouse gas (GHG) footprint (or carbon footprint) of a range of dairy products covering life cycle stages from cradle-to-overseas-port. This research was carried out using Life Cycle Assessment (LCA) methodology relevant to dairying with the aim of meeting the requirements defined in the United Kingdom PAS 2050.

This paper describes the methods, results and learnings from the research and how this is being progressed.

Methods

An LCA methodology was used for estimating the carbon footprint covering NZ average milk production and 5 different dairy products shipped to a range of overseas ports. The system boundary covered cradle-to-overseas-port stages but this paper will largely be confined to the cradle-to-farm-gate stage with a functional unit of one litre of fat and protein corrected milk (FPCM). Data for the farm stage was derived from dairy industry statistics [1] and DairyNZ survey data for over 400 farms from 8 regions throughout NZ. A comprehensive NZ GHG Inventory tier-2 methodology was used for estimating methane and nitrous oxide (N_2O) emissions [2]. This was based on an animal feed intake model [3] that accounted for animal productivity and maintenance requirements. The model operates at a monthly time step and utilises data on livestock numbers, livestock performance and diet quality.

The inventory of GHG emissions covering CH_4 from enteric fermentation by dairy cattle, methane (CH_4) and N_2O from excreta deposited on pasture and from farm dairy effluent, N_2O from N fertiliser, and CO_2 emissions from lime and urea application was based on the IPCC methodology [2]. The LCA model Simapro was used and the emission factors for electricity and fuel were based on Nebel [4] to ensure consistency across NZ primary sector projects. The calculated GHG emissions were allocated between the co-products milk and meat based on the physiological feed requirements of the animal to produce milk and meat, with specific inputs and emissions then being calculated for the milk and meat co-products (consistent with the highest priority method in PAS 2050). This resulted in an allocation ratio for milk and meat of 86%:14%. The carbon footprint (equivalent to Global Warming Potential) for a 100 year time horizon (GWP_{100}) was calculated according to the most recent IPCC reference in kg CO_2-equivalent, i.e. with multiplication factors of CO_2 1, N_2O 298, CH_4 25.

Results

On average across all dairy products and markets, GHG emissions from the cradle-to-farm-gate, processing and transportation stages averaged 85, 15 and 5%, respectively. At the cradle-to-farm-gate stage, the total GHG emissions were equivalent to 940 g CO_2-equivalent/litre milk. The breakdown of this between the various gases was 59% CH_4, 24% N_2O and 17% CO_2. Over 95% of CH_4 emissions was from enteric fermentation, while 75% of N_2O was from animal excreta and farm dairy effluent. Nitrogen fertiliser production and use contributed 25% of N_2O emissions and 34% of CO_2 emissions. Fuel use across all farm activities produced 7% of CO_2 emissions or only 1% of the total farm GHG emissions.

In order to align to the PAS2050 (2008) methodology, the carbon footprint calculations included emissions associated with land use change since 1990. Thus, an estimate was made of land converted from plantation forest to dairy land in NZ since 1990 based on satellite data and this was used to calculate GHG emissions associated with a 20 year period in conjunction with NZ GHG Inventory emission factor for land use change. This source of GHGs represented one-third of the total CO_2 emissions.

Learnings, challenges and the way forward

The Fonterra carbon footprint study highlighted the various “hot-spots” for GHG emissions along the dairy supply chain and where effective reduction strategies can be targeted. The farm stage was identified as the dominant contributor, with GHG emissions associated with animal ingestion of feed (enteric methane and excreta N_2O emissions) representing 75% of the total on-farm emissions. This demonstrates the potential of using improvement in animal feed conversion efficiency for reducing the carbon footprint. In practice, there has been a steady improvement by the NZ dairy industry in milk production per kg feed dry matter intake over time, which represents a reduction in the carbon footprint per litre of milk by over 1% per year since 1990 [5]. The study identified other hot-spots with significant reduction potential on-farm including improving nitrogen fertiliser use efficiency, use of nutrient budgeting to avoid over-use of other fertiliser nutrients or lime, and nitrification inhibitors to reduce soil N_2O emissions from excreta and fertiliser-N.

Determination of the GHG emissions for the production and processing of a range of dairy products to various international ports (i.e. a partial carbon footprint for business-to-business stages) has provided Fonterra with data to provide to their international customers for some of the important ingredients in producing final dairy products to supermarkets and householders. This data can also form a benchmark from which they can demonstrate progress over time in reducing their GHG emissions per kg of product.

The carbon footprint value of 940 g CO_2-equivalent/litre milk (FPCM) is lower than most other published estimates using LCA [6]. However, these estimates are not directly comparable because of possible differences in methodology (e.g. allocation methods, system boundary, emission factors). This demonstrates the critical importance of using harmonized methodology in making valid comparisons of carbon footprint values. This has led to Fonterra and AgResearch contributing to an international research study examining the effects of methodology on the carbon footprint for milk produced under contrasting systems in NZ and Scandanavia. In addition, it has led to Fonterra becoming actively involved with a number of other large international dairy companies in developing and agreeing on an acceptable LCA-based methodology. Potentially, this could be developed into a Product Category Rule aligned to ISO methodology. Harmonisation of methodology is important if product labeling is to be applied in a consistent manner.

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