

*REPORT: THE
CLIMATE
FOOT-PRINT OF
AVERAGE COW
MILK*

COW MILK SWEDEN: 1.5% & 3.0%

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The climate footprint of cow milk

CarbonCloud has assessed the climate footprint of average Swedish milk. This document gives a short summary of how the calculations were performed, what is included and the results for the average Swedish semi-skimmed and whole milk.

Life cycle assessment

Life cycle assessment is used to assess environmental footprints of products. This study is focused specifically on the climate footprint. In a life cycle assessment, all activities – as described in the *goal and scope* – are investigated and their environmental impacts quantified. This means that all greenhouse gas emissions that occur along the production chain of the product are taken into consideration and normalized to the functional unit (the product).

An attributional approach to life cycle accounting

CarbonCloud uses the so-called *attributional* approach to life cycle accounting. This means that all processes in the production are considered, and their combined climate impact is attributed to the product. The attributional approach only accounts for emissions and removals of greenhouse gases generated during a product's life cycle and NOT avoided emissions or actions taken to mitigate released emissions. Carbon offsetting is not taken into account. The attributional approach as described here is in line with major standards for carbon footprinting such as ISO 14067 and GHG Protocol.

This contrasts to the *consequential* approach, which is used to assess the climate impact from changing the level of output of a product. The consequential approach focuses on marginal effects linked to the production of a product.

Functional unit

The functional unit is what is investigated and what all resources and emissions are compared against. This study is based on the following functional unit:

- One kg of packaged food product delivered to the store.

Goal and scope

The goal and scope state the purpose of the study and how the system boundaries are drawn, i.e., what is included and what is excluded.

The goal of this study is to investigate the climate footprint of average Swedish semi-skimmed (1.5% fat) and whole milk (3% fat) in 1L packages delivered to the Swedish market.

Note that the functional unit is for average milk in Sweden. There is variation between farms and dairy plants within Sweden and this study does not cover any specific farm or dairy plant. The study does likewise not claim to say anything about milk produced or delivered to other markets.

From cradle to store

CarbonCloud assesses the climate footprint of the product from *cradle to store*. In this case it means that we consider all major steps of the life cycle from the production of agricultural inputs, through agriculture, transports, refinements and distribution up until the product reaches the gate of the grocery store. Hence, the calculated climate footprint does not consider lighting and refrigeration at the grocery store, transport from grocery store to home, or cooking of product.

What is included?

The climate footprint includes emissions from:

- **Farm:** The agricultural steps in the production of milk.
- **Transport:** Carbon dioxide emissions from transport of inputs to farm, from farm to dairy plant and from dairy plant to market.
- **Factory:** Greenhouse gas emissions from the production of inputs and the electricity consumption at dairy.
- **Packaging:** production and transport of packaging material.

What is not included?

Most importantly the calculations omit

- Capital goods (e.g., manufacture of machinery, trucks, infrastructure)
- Corporate activities and services (e.g., research and development, administrative functions, company sales and marketing)
- Travel of employees to and from work.

Farm

For dairy, the agricultural (farm) step accounts for the largest part of the total emissions, out of the four categories farm, transport, factory and packaging. Emissions from the agricultural step are calculated with an agricultural production system model, that calculates all major greenhouse gas (GHG) emissions related to the production of the functional unit. The agricultural emission calculations are based on the flows of carbon (C) and nitrogen (N) through the crop and livestock systems on a mass and energy balance basis. Further model descriptions can be found in Wirsenius (2000, pp. 13-54), Wirsenius (2003a-b) and Bryngelsson et. al., (2016).

For the farm stage the model calculates:

- Emissions of nitrous oxide (N₂O) from mineral soils used for feed production and grazing
- Nitrous oxide and methane (CH₄) from manure management
- Methane from enteric fermentation
- Indirect emissions of nitrous oxide related to ammonia and nitrate emissions
- Emissions of nitrous oxide and carbon dioxide (CO₂) from organic soils used for feed production and grazing
- Carbon dioxide emissions from production and use of fuels (e.g. for tractors and machinery) and electricity
- Carbon dioxide emissions from transport of inputs to farm, and from farm to dairy

- Emissions of carbon dioxide and nitrous oxide from production of mineral fertilizers and other inputs

Transport

The transport stage includes:

- Transports of milk, from farm to dairy plant (refrigerated)
- Transport from dairy plant to market (refrigerated)

Dairy plant

The raw milk is processed, separated into different fractions, and packaged at the dairy plant.

Electricity use

For electricity we apply an emission intensity factor representing the Nordic power mix that accounts for upstream emissions and power losses.

Time horizon

We use yield data for feed and milk representing the average of the period 2013-2017.

The weighting of greenhouse gases

The total climate impact is given in CO₂ equivalents. All greenhouse gases are weighted with the latest values of GWP₁₀₀ given by IPCC. For methane and nitrous oxide, we use a GWP of 34 and 298, respectively.

Allocation

When a process generates more than one product, the climate impact from the process needs to be allocated between the products. As a general principle economic allocation is used. The allocation between meat and milk of different fat contents has been performed in two ways: (1) according to the principle of economic allocation and (2) according to industry standard (Flysjö et al 2014). The two methods give almost identical results.

Key parameters

Key parameter values for average Swedish milk, are:

- Whole-milk production per cow and year: 9100 kg
- Weight of cow: 650 kg
- Number of calves born per cow and year: 0.91
- Grazing period: 6 months
- Annual yield per hectare of each crop included in feed ration
 - cereals: 5.2 tonne DM/ha/yr
 - grass-legumes leys: 5.6 tonne DM/ha/yr
 - permanent pasture: 1.2 tonne DM/ha/yr (grazed intake)

- Share of cropland and grazing land that is located on organic soil
cereals: 3.8%
- Fat content of consumer milk: 1.5% for semi-skimmed milk, 3% for whole milk

Results

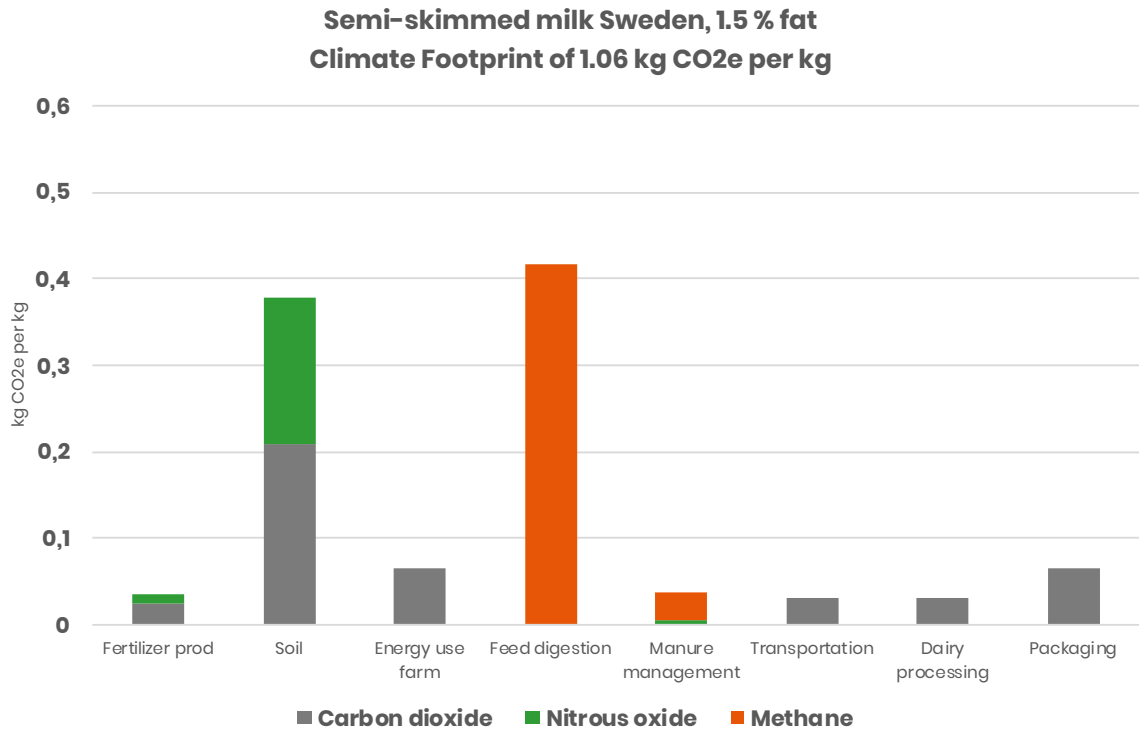
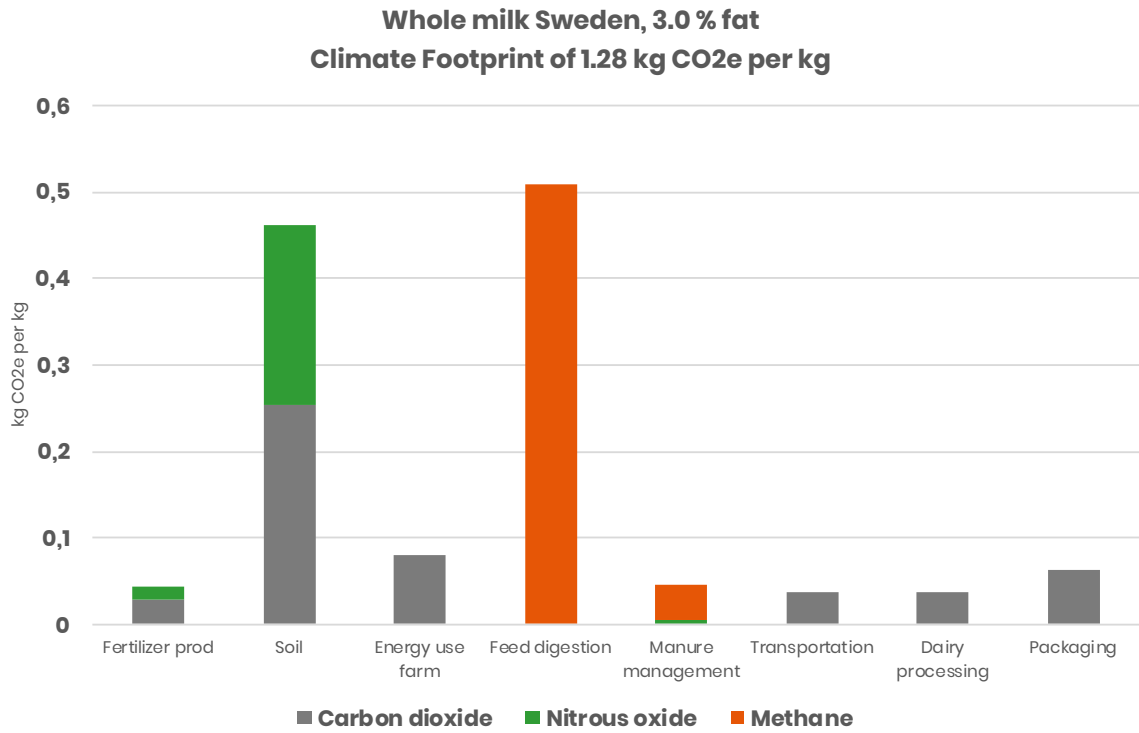


Table 1 Greenhouse gas emissions (climate footprint) per process and gas for whole milk in Sweden, 3.0% fat. All emissions are expressed in the unit kg CO₂e per kg product

	Total	CO ₂	N ₂ O	CH ₄
Fertilizer production	0.044	0.029	0.014	
Soil	0.46	0.25	0.21	
Energy use farm	0.079	0.079		
Feed digestion	0.51			0.51
Manure management	0.046		0.0051	0.041
Transportation	0.037	0.037		
Dairy processing	0.038	0.038		
Packaging	0.064	0.064		
Total CO₂e	1.28			

Table 2 Greenhouse gas emissions (climate footprint) per process and gas for Semi-skimmed milk in Sweden, 1.5% fat. All emissions are expressed in the unit kg CO₂e per kg product

	Total	CO ₂	N ₂ O	CH ₄
Fertilizer production	0.036	0.024	0.012	
Soil	0.38	0.21	0.17	
Energy use farm	0.066	0.066		
Feed digestion	0.42			0.42
Manure management	0.038		0.0042	0.034
Transportation	0.031	0.031		
Dairy processing	0.030	0.030		
Packaging	0.064	0.064		
Total CO₂e	1.06			

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