Report

Climate footprint for Enriched ambient oat drink, SE

Oatly

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Content

The climate footprint of Oatly Enriched oat drink

The food system directly accounts for a quarter of global anthropogenic greenhouse gas emissions responsible for climate change, through biological soil organic processes, manure management, enteric fermentation, carbon leakage from organic soils, and deforestation.[1] On top of this there are emissions from fossil fuel use in machinery, fertilizer production, transports, heating, refinement, and other gases from leakage from e.g. refrigerants used in the value chain. By far the most important greenhouse gases from food production are nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2).

Climate change is by no means the only negative externality associated with food production. Food production is also the main driver for antibiotic resistance, animal welfare issues, unsustainable water extraction, eutrophication, biodiversity loss from pesticide usage and habitat destruction. There are also important public health and worker-safety issues related to food production. This is not intended as a comprehensive list of food production related externalities. Most of these issues are not causally linked, which means that they to a large degree can be solved one at a time.

Focus in this study is solely on climate change, as it is a climate footprint assessment. This focus is chosen without any ranking of the importance of climate change relative any other of the negative externalities associated with food production.

CarbonCloud has calculated the climate footprint of 1 kg of Oatly Enriched Oat Drink Ambient, to be sold in Sweden with the purpose to communicate the climate footprint and to identify areas for improvement in the life cycle of this product. This document is a summary of the results and how the calculations were done and what is included.

[1] IPCC, 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

Approach

An attributional approach to life cycle accounting

CarbonCloud uses the 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 gasses 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 foot-printing 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.

From cradle to store

CarbonCloud assess the climate footprint of the product from cradle to store. In this case it means that we consider all steps of the life cycle from the farm up until the product reaches the shelf of the grocery store. Hence, the calculated climate footprints do not consider e.g. lighting and refrigeration at the grocery store, transport from grocery store to home, consumption of product or disposal of packaging.

Time horizon

Yield data represent the average of the period 2013-2017. Data from Oatly's production facilities represent year 2017.

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.

Drinks are normally measured in volume (liter), whereas climate footprints are compared to weight (kg) of the product. Most drinks have densities close to one. A 1 L package of drink thus typically weighs close to 1 kg.

The weighting of greenhouse gases

The total climate impact is given in carbon dioxide equivalents (CO_2e). The calculation includes emissions to the atmosphere of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O). Sulfur hexafluoride (SF_6) is indirectly included in the emission factor for the electricity mix. Perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs) emissions are included in the emissions from chilled transport.

All greenhouses gases are weighted with the latest values of GWP_{100} given by the IPCC (Edenhofer et al, 2014). For methane, nitrous oxide and sulphur hexafluoride we use a GWP of 34, 298 and 23 500 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 in this study, economic allocation is applied. This means that the climate impact from a process is allocated between the products in proportion to their economic value.

Material for this calculation is that rapeseed oil and rapeseed cake are produced in the same process, their upstream emissions are allocated according details in Table 1. There are additional by-products from the oat base production. Oatly sends these by-product streams to be used as animal feed and for biogas production. Since Oatly does not receive any financial compensation for this, they have no economic value and no climate footprint is allocated to these by-products. That is, the upstream emissions for oat production are allocated to 100% to Oatly's products and 0% to the biogas and animal feed.

Impact allocated to	Percentage impact (economic allocation)
Rapeseed oil	70%
Rapeseed cake	30%

Table 1. Allocation for rapeseed[2]

Agricultural calculation model

Emissions from agriculture stem from a range of processes, such as energy related activities (like fuels for tractors), soil nitrogen processes, carbon leakage from organic soils, and biological

[2] Flysjö et al 2008

processes from livestock (where applicable). The emissions correlate with yield levels in a non-linear manner.

Emissions from agriculture are calculated with ALBIO (Agricultural Land use and Biomass), a computer model that calculates all greenhouse gas (GHG) emissions related to the production of a specified food product. The model represents all major supply steps related to food production and use, from production of inputs to processing and transportation of end-use-ready food items.

For the production of oats and rapeseed oil, the model accounts for:

- Emissions of nitrous oxide (N_2O) from mineral soils
- *Indirect* emissions of nitrous oxide (N_2O) related to ammonia and nitrate emissions from soils
- Emissions of nitrous oxide (N_2O) and carbon dioxide (CO_2) from organic soils
- Carbon dioxide (CO_2) emissions from production and use of fuels (e.g. for tractors and machinery) and electricity
- Emissions of carbon dioxide (CO_2) and nitrous oxide (N_2O) from production of mineral fertilizers and other inputs

The model represents the flows of nitrogen (N) through the crop and livestock systems (where applicable) on a mass balance basis. Further model descriptions can be found in Wirsenius (2000, pp. 13-54), Wirsenius (2003a-b) and Bryngelsson (2016).

What is included?

The climate footprint includes emissions from:

- **Agriculture**: The agricultural production of oats, rapeseed and other ingredients (fertilizers, pesticides, use of farm equipment)
- **Processing of Ingredients**: Electricity and gas consumption in the mill (dehulling of the oats) and the rapeseed oil production facility.
- **Transport of Ingredients**: The transport of ingredients from field to factory and between factories.
- **Factory Oatly**: Electricity and gas consumption in the oatbase and oat drink production facilities.
- **Packaging:** production and transport of packaging material
- **Distribution**: The distribution of the final product from factory to market.

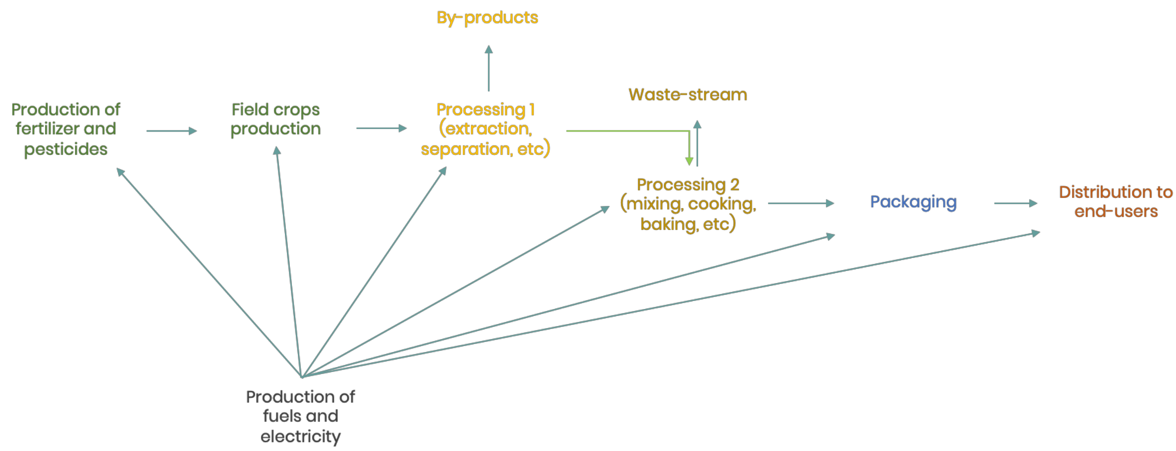

Figure 1. Climate footprint includes emissions from agriculture, processing of ingredients, transport of ingredients, factory Oatly, packaging and distribution

What is not included?

Most importantly the calculations omit

- Product losses after filling
- Manufacture of capital goods (e.g. manufacture of machinery, trucks, infrastructure)
- Corporate activities and services (e.g. research and development, administrative functions, company sales and marketing)
- Transport of employees to and from work

Inventory data

Ingredients in Enriched ambient oat drink are water, oats, rapeseed oil, calcium carbonate, calcium phosphate, iodised salt and vitamins. Oats and rapeseed oil make up more than 95% of the dry mass (DM) in the oat drink. Oats and rapeseed oil are explicitly calculated and for the rest a conservative number (2 kg CO_2e/kg substance) has been used and added to the climate footprint.

Agriculture

For the agricultural ingredients in Enriched ambient oat drink the parameters in Table 2 have been used. Dry mass (DM) is used throughout the calculations.

				% of GHG emissions that stem from[3]			
Ingredient	gram CO2e/kg oat drink	Region	Yield Mg DM/ha/yr	Fertilizers and other inputs	Soil nitrogen process	Organic soil	Energy
Rapeseed oil	18	SE	3.25	22%	32%	26%	20%
Oat	94	SE	3.99	23%	27%	38%	12%

Table 2. Agricultural input data for Enriched ambient oat drink, SE

Processing of Ingredients

Energy consumption is listed in Table 3. For electricity an emission intensity factor representing the Nordic power mix that accounts for upstream emissions and power losses is applied.

Process	Energy use MJ	Reference unit	kg CO_2e/MJ[4]	Total kg CO_2e
Mill	0.86	/kg hulled oats	0.035	0.0301/kg hulled oats
Rapeseed oil	0.1	/kg DM	0.035	0.0035/ kg DM

Table 3. Electricity consumption for Enriched ambient oat drink, SE

[3] Wirsenius, 2019

[4] Energimyndigheten 2018

Fossil fuels and biofuels are used for process heat and as fuel for mechanical energy in farm equipment, transport and factories. The gas demand at the oatbase-production facilities is met with biogas.

Usage levels, emission intensities and emission levels are specified in Table 4 below.

Process	Energy use MJ	Reference unit	kg CO_2e/MJ[5]	Total kg CO_2e/kg product
Rapeseed	1.04	MJ diesel/kg DM harvested	0.089	0.093
Oats	0.7	MJ diesel/kg DM harvested	0.089	0.06
Rapeseed oil	6.2	MJ diesel/kg DM	0.089	0.055

Table 4. Fuel consumption for Enriched ambient oat drink, SE

Transport of Ingredients

Transport occurs between most steps in the production chains of food products. Efficiencies differ between transport modes where some are more efficient than others. Table 6 below specifies transport mode, load factor, fuel type and emission intensity. For transport where no primary data was available, conservative assumptions were made based on transport modes typical for each region.

Transport	Mode	Load factor (weight)	Fuel type	kg CO_2e/MJ [6]	km	Fuel use MJ/ton/km	Total kg CO_2e/kg product
Oat field to mill	Truck	0.5	Diesel	0.089	100	0.8	0.007
Rapeseed field to factory	Truck	0.5	Diesel	0.089	80	0.8	0.006
Rapeseed oil to oat base production	Truck	0.5	Diesel	0.089	153	0.8	0.011
Oat mill to oat base production	Truck	0.9	Diesel	0.089	530	0.4	0.019
Oat base production to oat drink production	Truck	0.9	Diesel	0.089	190	0.4	0.0068

Table 5. Transport of Ingredients for Enriched ambient oat drink, SE

[5] Energimyndigheten 2018
[6] Edwards et al, 2014

Factory Oatly

Energy consumption is listed in Table 3. For electricity an emission intensity factor representing the Nordic power mix that accounts for upstream emissions and power losses is applied.

Process	Energy use MJ	Reference unit	kg CO2e/MJ7	Total kg CO2e
Factory rapeseed oil	0.1	/kg DM	0.035	0.0035/ kg DM
Factory (Landskrona and Trensum)	0.56	/kg product	0.035	0.0196/kg product

Table 6. Electricity consumption for Enriched ambient oat drink, SE

Fossil fuels and biofuels are used for process heat and as fuel for mechanical energy in farm equipment, transport and factories. The gas demand at the oatbase-production facilities is met with biogas.

Usage levels, emission intensities and emission levels are specified in Table 4 below.

Process	Energy use MJ	Reference unit	kg CO_2e/MJ[8]	Total kg CO_2e/kg product
Factory (Landskrona and Trensum)	1.1	MJ biogas /kg product	0.03[9]	0.03

Table 7. Fuel consumption for Enriched ambient oat drink, SE

Packaging

The climate impact for packaging depends on the material used, processes in manufacturing of the material, and its ability to be recycled. This study uses average numbers for the recycling of materials. In Table 5 assumptions for packaging are listed.

[7] Energimyndigheten 2018

[8] Energimyndigheten 2018

9 The gas leakage from production not included

Type	Material / kg product	Emission factor kg CO_2[10]/kg material	Total g CO_2 /kg product
Primary packaging	Cardboard: 22.45 g	1	22.45
	Polyethene: 7.79 g	2.5	19.5
	Aluminium: 0.141 g	10	1.41
Secondary packaging	Cardboard: 17.5 g	1	17.5
Tertiary packaging	Polyethene: 0.54 g	2.5	1.35

Table 8. Packaging for Enriched ambient oat drink, SE

Distribution

Transport occurs between most steps in the production chains of food products. Efficiencies differ between transport modes where some are more efficient than others. Table 6 below specifies transport mode, load factor, fuel type and emission intensity. For transport where no primary data was available, conservative assumptions were made based on transport modes typical for each region.

Transport	Mode	Load factor (weight)	Fuel type	kg CO_2e/MJ [11]	km	Fuel use MJ/ton/km	Total kg CO_2e/kg product
Oat drink production facility to warehouse	Truck	0.9	Diesel	0.089	190	0.4	0.0068
Warehouse to wholesaler	Truck	0.9	Diesel	0.089	450	0.4	0.016
Wholesaler to grocery store	Truck	0.5	Diesel	0.089	50	2.9	0.013

Table 9. Transport of Ingredients for Enriched ambient oat drink, SE

[10] Hilllman et al, 2016
[11] Edwards et al, 2014

Results

The climate footprint for the enriched ambient oat drink is 0.27 kg CO_2e per kg product. The climate footprint separated into main process steps is depicted in Figure 2. The agricultural stage has the largest climate impact followed by packaging, distribution, factory and transport of ingredients.

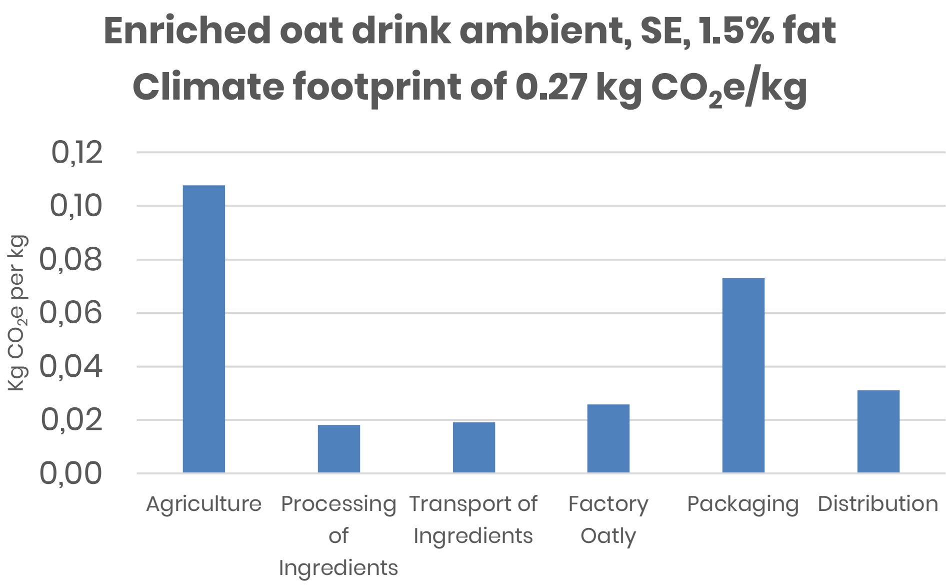

Figure 2. Climate footprint separated into main process steps

	kg CO_2e/kg product
Agriculture	0.11
Processing of Ingredients	0.02
Transport of Ingredients	0.02
Factory Oatly	0.03
Packaging	0.07
Distribution	0.03
Total	**0.27**

Table 10. Greenhouse gas emissions (climate footprint) per major process for Enriched ambient oat drink. All emissions are expressed in the unit kg CO_2e per kg product.

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