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LCA of chilled Oatly Oat Drink Semi for Sweden and Finland, and comparison with cow's milk

Addendum to the report "LCA of Oatly Barista and comparison with cow's milk", published on 7 December 2022

Blonk CONSULTANTS

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Date	29-4-2024	
Place	Gouda, NL	
Authors	Caroline te Pas	Blonk Consultants
	Alexander Vanier	Blonk Consultants
	Vasiliki Takou	Oatly
	Estefania Herrera	Oatly

Groen van Prinsterersingel 45
2805 TD Gouda, The Netherlands
www.blonksustainability.nl

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Executive summary

Introduction

A Life Cycle Assessment (LCA) has been performed to compare the environmental performance of chilled Oatly Oat Drink Semi (an oat drink with a fat content of 1.5%) to cow's milk in two sales markets in Europe: Sweden and Finland. Considering the similarity of Oatly Oat Drink Semi to Oatly Barista (same ingredients, yet in slightly different proportions), this study is an addendum to the report "LCA of Oatly Barista and comparison with cow's milk", which was published by Blonk Consultants on December 7th 2022 (Blonk Consultants, 2022)[1], and will from now on be referred to as "the main report". This addendum should be read in conjunction with the main report. The methodology, data choices, and assumptions made, are described in detail in the main report, and have remained unchanged for this report, except for an update of energy and water use in the Oatly factories.

The functional unit considered for this study is 1 liter of chilled Oatly Oat Drink Semi/cow's milk at retail, including packaging manufacturing and packaging end of life. The chilled Oatly Oat Drink Semi is produced at Oatly's End-to-End (E2E) factory in Landskrona, Sweden[2], and then distributed to retail in Sweden and Finland. The foreground data for Oatly Oat Drink Semi is based on company-specific data from the Landskrona factory. In this addendum, updated data (from 2022) has been used for the factory. For cow's milk, a country-specific average market mix of skimmed, semi-skimmed and whole milk was considered, as well as the most common heat treatment type (HTST or UHT) and packaging format (plastic, beverage carton, aseptic/chilled) in Sweden and Finland. Cow's milk from Sweden and Finland has been modelled using data and statistics at national level and has been derived from the main report.

Like the main report, this study has been performed and critically reviewed according to ISO 14040/14044/14071 standards for comparative assertions to be disclosed to the public and is in line with LCA guidelines including the European Product Environmental Footprint Category Rules (PEFCR). The analysis was done for key impact categories from the ReCiPe 2016 impact assessment method (including an uncharacterised land occupation indicator). The study was conducted in March and April 2024.

Results

As can be seen in **Table 1** below, the chilled Oatly Oat Drink Semi for the two markets in scope has a lower impact than cow's milk for all impact categories: for climate change (66% to 76% lower), fine particulate matter formation (67% to 70% lower), terrestrial acidification (79% to 80% lower), freshwater eutrophication (50% to 56% lower), marine eutrophication (69% to 74% lower), land use (49% to 55% lower), land occupation (50% to 57% lower), mineral resource scarcity (18% to 30%), fossil resource scarcity (46% to 47%) and water consumption (60% to 63% lower).

[1] Main report: https://website-production-s3bucket-1nevfd7531z8u.s3.eu-west-1.amazonaws.com/public/website/download/fabc1628-d8e1-4cf8-aacc-1a9694908a42/LCA%20Oatly%20and%20comparison%20to%20cow's%20milk%20(07-12-2022)%20-%20final.pdf

[2] End-to-End (E2E) Factory: The entire production chain happens within Oatly's own factory; from grains to the finished product.

TABLE 1 RELATIVE DIFFERENCES OF CHILLED OATLY OAT DRINK SEMI COMPARED TO COW'S MILK AT RETAIL INCLUDING END-OF-LIFE (EOL) OF PACKAGING. FOR EXAMPLE, -76% INDICATES THAT OATLY OAT DRINK SEMI HAS A 76% LOWER IMPACT COMPARED TO COW'S MILK. THE DIFFERENCES HAVE BEEN COLOR-CODED AS FOLLOWS: GREEN – MORE THAN 10% DIFFERENCE FAVORING OATLY OAT DRINK SEMI, YELLOW – THE DIFFERENCE IS 10% OR LOWER INDICATING SIMILAR PERFORMANCE FOR THE COMPARED PRODUCTS, RED – MORE THAN 10% DIFFERENCE FAVORING COW'S MILK. COW'S MILK REPRESENTS AN AVERAGE MILK PRODUCT AT RETAIL FOR EACH COUNTRY. ABBREVIATIONS USED: FI = FINLAND AND SE = SWEDEN. FURTHER INFORMATION ON THE INDICATORS USED FOR THE IMPACT CATEGORIES CAN BE FOUND IN TABLE 3.

Country of sale	Impact category / Product	Climate change	Fine particulate matter	Terrestrial acidifi-cation	Freshwater eutrophi-cation	Marine eutrophi-cation	Land use	Land occupation	Mineral resource scarcity	Fossil resource scarcity	Water consum-ption
		kg CO_2 eq	*kg PM2.5 eq*	*kg SO_2 eq*	*kg P eq*	*kg N eq*	*m^2a crop eq*	*m^2a*	*kg Cu eq*	*kg oil eq*	*m^3*
Finland	Oatly Oat Drink Semi Retail FI	-76%	-70%	-80%	-56%	-74%	-55%	-57%	-30%	-46%	-63%
Sweden	Oatly Oat Drink Semi Retail SE	-66%	-67%	-79%	-50%	-69%	-49%	-50%	-18%	-47%	-60%

Figure 1 shows the contribution of all life cycle stages to the climate change impact of chilled Oatly Oat Drink Semi and cow's milk, showing that raw materials are the main contributor to the climate change impact of all products in scope. For Oatly Oat Drink Semi, the impact of the raw materials is mainly determined by oats and rapeseed oil, whereas for cow's milk, feed and cow's emissions (linked to enteric fermentation and manure management) are the main contributors.

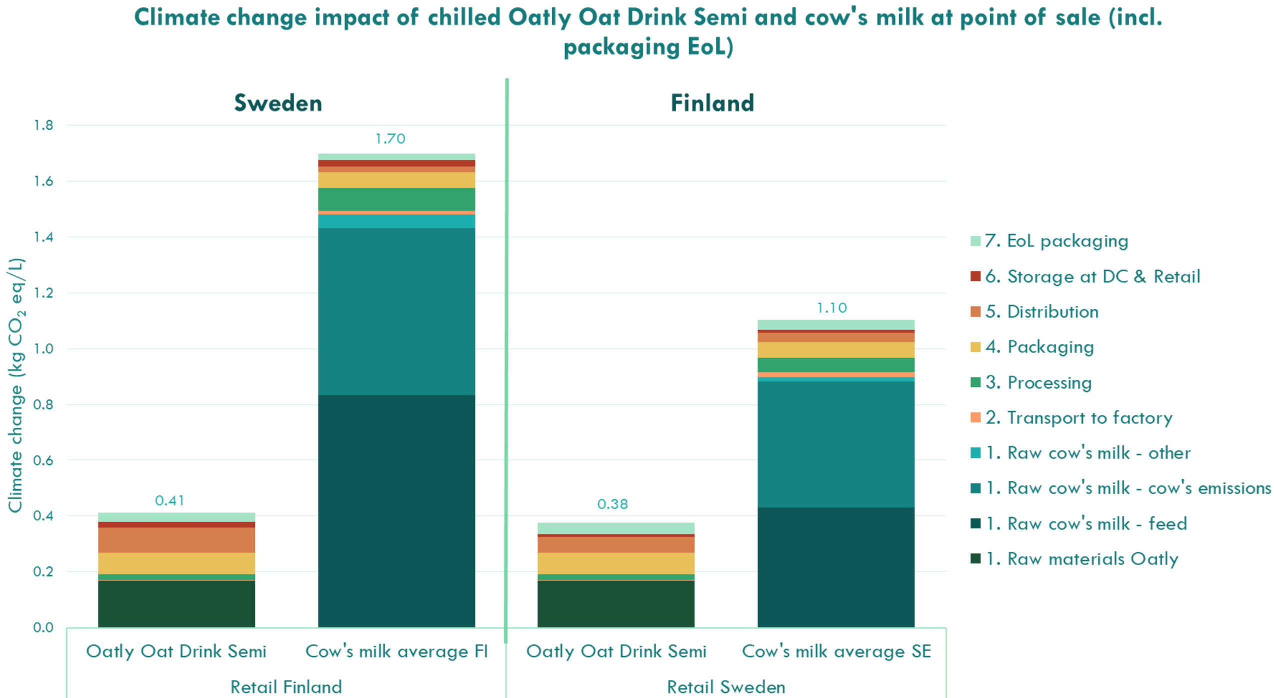

FIGURE 1 CLIMATE CHANGE IMPACT OF CHILLED OATLY OAT DRINK SEMI AND COW'S MILK AT RETAIL INCLUDING END-OF-LIFE (EOL) OF PACKAGING. OATLY OAT DRINK SEMI IS PRODUCED AT OATLY'S END-TO-END FACTORY IN LANDSKRONA, SWEDEN. COW'S MILK REPRESENTS AN AVERAGE COW'S MILK PRODUCT AT RETAIL FOR EACH COUNTRY. ABBREVIATIONS USED: FI = FINLAND AND SE = SWEDEN.

The significance of the differences between Oatly Oat Drink Semi and cow's milk has been determined by an uncertainty analysis.

The main report included further sensitivity analyses, which also apply to the products evaluated in this addendum, as the products in this addendum are very similar and show a comparable impact to the Oatly products in the main report. These sensitivity analyses pointed out that using a different impact assessment method (ReCiPe endpoint, EF3.0 single score) confirmed the overall higher environmental footprint of cow's milk compared to Oatly Barista for all countries in scope. It also showed that results in the impact categories land use, mineral resource scarcity and water impact categories are less robust, as they result in different trends when using a different impact assessment method (EF 3.0). Furthermore, the sensitivity analyses concluded that using different product characteristics (inclusion of use stage, using economic allocation for cow's milk, applying a functional unit based on nutritional characteristics, or making a comparison to semi-skimmed milk (instead of an average of skimmed, semi-skimmed and whole milk)), did not lead to different conclusions on the environmental footprint of Oatly Barista compared to cow's milk.

Conclusions

Based on the results, it can be concluded that chilled Oatly Oat Drink Semi retailed in Sweden and Finland has a lower impact than cow's milk for all impact categories in scope: climate change, fine particulate matter formation, terrestrial acidification, freshwater eutrophication, marine eutrophication, land occupation, land use, mineral resource scarcity, fossil resource scarcity and water consumption.

A detailed analysis of the main drivers and opportunities linked to the environmental impact of Oatly products can be found in the main report.

1. Goal & Scope

1.1 Introduction

This study is an addendum to the report "LCA of Oatly Barista and comparison with cow's milk", which was published by Blonk Consultants on December 7th 2022 (Blonk Consultants, 2022)[3], and will from now on be referred to as "the main report". The current addendum covers the following product: chilled Oatly Oat Drink Semi, produced at the Landskrona factory in Sweden, and retailed in Sweden and Finland. Where the ambient version of Oatly Oat Drink Semi was already modelled in a previous addendum[4], this report considers the chilled version as well as updated factory data. The exact products and markets in scope are listed in Table 2 below. In line with the main report, these Oatly products are compared to cow's milk produced in the country of sale.

The methodology, data choices, and assumptions made, are described in detail in the main report, and have remained unchanged for this report. The following has been updated in this report:

- The energy and water use at the Landskrona factories has been updated to 2022 data.
- Chilled distribution and packaging are considered, using the same data for chilled distribution and packaging as in the main report.
- Background data have been updated to the following database versions: Agri-footprint 3.6 and Ecoinvent 3.9.

Like the main report, this addendum has been subject to a critical review according to ISO 14040/14044 and ISO/TS 14071:2014 standards (ISO, 2006b, 2006a, 2014), carried out by a review panel consisting of four LCA experts (three of which had already reviewed the main report). The review of the addendum focused particularly on elements that were added or changed compared to the main report and assessed the overall conformance with ISO 14040/14044 standards.

This addendum is not a stand-alone report and should be read in conjunction with the main report. It should be noted that, even though they are very similar, the climate change results from this study do not always exactly correspond with those mentioned on the packaging/web page as the latter are calculated by a different LCA provider that uses different background data and different system boundaries.

1.2 Goal and scope

1.2.1 Goal

The goal of this study is in line with the goal mentioned in section 1.2 of the main report: to assess the environmental impact of the chilled Oatly Oat Drink Semi product for the Swedish and Finnish market, and in addition compare them to cow's milk in their respective markets. Further details on the intended use of this study can be found in section 1.2 of the main report.

1.2.2 Scope

The function which the two systems are compared to is defined as follows: the provision of cow's milk or oat-based drinks, to be added to food and beverage items for taste and texture, provided in 1 liter packaging at point of sale.

3 Main report: https://website-production-s3bucket-1nevfd7531z8u.s3.eu-west-1.amazonaws.com/public/website/download/fabc1628-d8e1-4cf8-aacc-1a9694908a42/LCA%20Oatly%20and%20comparison%20to%20cow's%20milk%20(07-12-2022)%20-%20final.pdf

4 "LCA of Oatly "No" Sugars and Oatly Oat Drink (Whole/Semi/Light), and comparison with cow's milk", which was published by Blonk Consultants on April 11th 2023 and can be found here: https://website-production-s3bucket-1nevfd7531z8u.s3.eu-west-1.amazonaws.com/public/website/download/4e1d9280-87ed-41b0-bb7f-82c85977a5a3/Addendum_LCA%20Oatly%20No%20Sugars%20and%20Oat%20Drink%20(11-04-2023)%20-%20final.pdf

The functional units associated with both systems are:

- Oat drink: 1 liter of chilled Oatly Oat Drink Semi, including packaging, at retail.
- Cow's milk: 1 liter of whole, semi-skimmed and skimmed cow's milk (using a country-average mix), including packaging, at retail (chilled storage)

Since Oatly Oat Drink Semi can replace any type of cow's milk, the average cow's milk (whole, semi-skimmed and skimmed) is considered for the comparison[5], consistent to the approach of the main report. The difference in impact between the three cow's milk types has been considered in a sensitivity analysis, as mentioned in section 5.2.

Table 2 lists the reference flows related to the Oatly product in scope, as well as for their cow's milk equivalents. The Oatly Oat Drink Semi products available in Sweden and Finland are both sourced from Oatly's End-to-End factory located in Landskrona, Sweden.

The system boundaries considered for this addendum are from cradle-to-point of sale (including packaging end-of-life), in line with the main report. More details on the system boundaries can be found in section 1.3.2 from the main report.

Nutritional properties of Oatly Oat Drink Semi and cow's milk can be found in Appendix V.

TABLE 2: REFERENCE FLOWS OF THE CHILLED OATLY OAT DRINK SEMI PRODUCTS AND COW'S MILK

Oatly Oat Drink Semi				…Compared with cow's milk				Sold in
Reference flow	Local name	Storage condition	Produced in	Reference flow	Storage condition	Cow's milk type	Produced in	Country
1 liter	Oatly Havredryck 1,5%	Chilled	Landskrona, Sweden	1 liter	Chilled	Mix of HTST-treated whole, semi-skimmed and skimmed milk (beverage carton)	Sweden	Sweden
1 liter	Oatly Kaurajuoma Kevyt	Chilled	Landskrona, Sweden	1 liter	Chilled	Mix of HTST-treated whole, semi-skimmed and skimmed milk (beverage carton)	Finland	Finland

Chilled Oatly Oat Drink Semi

Oatly Oat Drink Semi is an oat-based drink, that is fortified with calcium, other minerals, and vitamins. Rapeseed oil is added to reach a fat content of 1.5%. For this report, the chilled version is considered, which entails different production and storage requirements than Oatly's ambient oat drinks. More specifically, it uses a different packaging concept which does not contain aluminium, and it is transported and stored chilled. The factory process is identical for chilled and ambient products, yet the ambient version is cooled down to 25 degrees Celsius whilst the chilled product requires cooling to about 5 degrees Celsius. The energy demand for this additional step is estimated to be very small compared to the overall process, so the average energy consumption was used for both versions. Chilled packaging and storage have already been modelled for the main report (as a sensitivity analysis), and the same data was used for this addendum.

Cow's milk

Since the Oatly products in this study can replace skimmed, semi-skimmed and whole cow's milk, the country-average mix of whole, semi-skimmed and skimmed cow's milk has been selected for the comparison. Section 1.3 of the main report describes which data have been used to define this country-average mix of cow's milk.

[5] Note that this is also a conservative approach since the average Swedish and Finnish cow's milk have a lower climate change impact than the semi-skimmed cow's milk as can be seen in section 5.2.5 in the main report.

1.2.3 Critical review

A critical review is carried out according to ISO 14040/14044 and ISO/TS 14071:2014 standards (ISO, 2014), in order to assess whether this study is consistent with LCA principles and meets all criteria related to methodology, data, interpretation and reporting. Because of the comparative nature of this LCA, the review is conducted by a panel.

A review panel of four independent and qualified external experts has been compiled, reflecting a balanced combination of qualifications (LCA, dairy, sustainable food systems) and backgrounds.

- Jasmina Burek (chair): Assistant Professor at University of Massachusetts Lowell (based in the US)
- Joseph Poore: Food Sustainability expert at the University of Oxford (based in the UK)
- Jens Lansche: LCA expert (based in Switzerland)
- Hayo van der Werf: LCA expert (based in France)

Since a review panel (with 3 out of 4 of the above reviewers) had already reviewed the main report, and had verified the methodology, data and assumptions made there, for this addendum only one review round was needed. The full review statement and report can be found in Appendix VI of the main report. This addendum includes a shortened review statement applying specifically to this addendum.

The critical review statement and report can be found in Appendix VI.

2. Calculation method

This addendum follows the exact same methodological standards and approaches as listed in chapter 2 of the main report. One small change is that the land occupation indicator is now included as additional impact category (instead of only in the appendix). In the ReCiPe impact assessment method, land use is expressed as intensity of the land use relative to annual crops (see M. A. J. Huijbregts, Steinmann, Elshout, & Stam, 2016 for more information), and hence the unit used is m^2a crop-eq. Due to several shortcomings related to this methodology[6], the land occupation indicator was added, which shows land occupation results without characterization, with the unit m^2a, and thus reflects the surface area needed to produce the products in scope.

Table 3 provides an overview of the impact categories used in this study, including a description of the indicators and characterisation factors belonging to these categories.

Since the products in scope of this addendum are very similar to the products investigated in the main report, this report contains no sensitivity analyses. The main report can be consulted to obtain more insight into results of the sensitivity analyses with regard to applying different impact assessment methods (EF 3.0, 20-year timeframe for global warming), applying a different scope (cradle-to-grave), applying different allocation methods (economic allocation for cow's milk) and applying a different functional unit (including nutritional characteristics). Furthermore, a previous addendum, that investigated the ambient Oatly Oat Drink (Whole, Semi and Light)[7] included a sensitivity analysis that considers different fat contents of cow's milk.

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[6] The ReCiPe 2016 method for land use considers species richness in different land uses by applying a characterization factor (CF) by land type. Certain land types like forests, grassland and permanent crops get a lower characterisation factor (CF < 1) than annual crops (CF = 1). However, this method is somewhat outdated and only provides one global CF per land use type, without differentiating by location/geography, whereas biodiversity varies substantially by geography. Furthermore, the unit m2a crop-eq can be difficult to interpret. To also provide an indication of the actual land surface used for each of the products, this addendum adds a land occupation indicator (m^2 of total land occupied per year), which does not characterise land use (CF = 1 for all land use types). Additional land impact assessment methods were evaluated in the sensitivity analysis in the main report, including the EF 3.0 method which uses the LANCA model to quantify land use.

[7] "LCA of Oatly "No" Sugars and Oatly Oat Drink (Whole/Semi/Light), and comparison with cow's milk", which was published by Blonk Consultants on April 11th 2023 and can be found here: https://website-production-s3bucket-1nevfd7531z8u.s3.eu-west-1.amazonaws.com/public/website/download/4e1d9280-87ed-41b0-bb7f-82c85977a5a3/Addendum_LCA%20Oatly%20No%20Sugars%20and%20Oat%20Drink%20(11-04-2023)%20-%20final.pdf

TABLE 3 OVERVIEW OF KEY IMPACT CATEGORIES (CLASSES OF ENVIRONMENTAL IMPACT TO WHICH LIFE CYCLE INVENTORY DATA ARE RELATED) USED FOR THIS STUDY. IT ALSO INCLUDES RESPECTIVE INDICATORS (QUANTIFIABLE REPRESENTATION OF AN IMPACT CATEGORY) AND CHARACTERISATION FACTORS (FACTORS THAT REPRESENT THE IMPACT INTENSITY OF A SUBSTANCE RELATIVE TO THE COMMON UNIT OF THE IMPACT CATEGORY'S INDICATOR)

Impact category	Indicator	Characterisation Factor	Unit	Description
Impact categories belonging to the ReCiPe impact assessment method				
Climate change	Infrared radiative forcing increase	Global warming potential (GWP)	kg CO_2-eq to air	Increase in global average temperature by the emission of greenhouse gases. the widely used global warming potential (GWP) quantifies the integrated infrared radiative forcing increase of a greenhouse gas (GHG), expressed in kg CO_2-eq. Emissions related to peat oxidation (abbreviated as peat ox in tables and figures) as well as land use change (abbreviated as LUC in tables and figures) are included, but reported separately as required by LCA guidelines such as the PEFCR.
Fine particulate matter formation	PM2.5 population intake increase	Particulate matter formation potential (PMFP)	kg PM2.5-eq to air	Fine Particulate Matter with a diameter of less than 2.5 µm (consisting of organic and inorganic substances) affects the respiratory tract and lungs when inhaled. Particulate matter formation potentials (PMFP) are expressed in kg primary PM2.5-equivalents.
Terrestrial acidification	Proton increase in natural soils	Terrestrial acidification potential (TAP)	kg SO_2-eq to air	Inorganic acids released into the atmosphere—such as sulphates, nitrates, and phosphates—which cause changes in the acidity of the soil. Acidification potentials considers the fate of a pollutant in the atmosphere and the soil.
Freshwater eutrophication	Phosphorus increase in freshwater	Freshwater eutrophication potential (FEP)	kg P-eq to freshwater	Accumulation of nutrients in water overstimulate plant growth, which reduces the level of oxygen. FEP is based on the fate of phosphorus, which is the limiting nutrient in freshwater.
Marine eutrophication	Dissolved inorganic nitrogen increase in marine water	Marine eutrophication potential (MEP)	Kg N-eq to marine water	Accumulation of nutrients in water overstimulate plant growth, which reduces the level of oxygen. MEP is based on the fate of and exposure to nitrogen, which is the limiting nutrient in marine waters.
Land use	Occupation and time-integrated land transformation	Agricultural land occupation potential (LOP)	$m^2 \times yr$ annual cropland-eq	The characterisation factor refers to the relative species loss caused by a specific land use type (e.g. annual crops, permanent crops, forestry, urban land, pasture) proportionate to the relative species loss resulting from annual crop production.
Water use	Increase of water consumed	Water consumption potential (WCP)	m^3 water-eq consumed	Quantity of water used, expressed as m3 of water consumed per m^3 of water extracted
Mineral resource scarcity	Increase of ore extracted	Surplus ore potential (SOP)	kg Cu-eq	The primary extraction of a mineral resource will lead to an overall decrease the concentration of that resource in ores worldwide. The SOP expresses the average extra amount of ore produced in the future caused by the extraction of a mineral resource considering all future production of that mineral resource.
Fossil resource scarcity	Upper heating value	Fossil fuel potential (FFP)	kg oil-eq	Depletion of resources that contain hydrocarbons, such as coal, oil or natural gas. FFP is defined as the ratio between the higher heating value of a fossil resource and the energy content of crude oil.
Additional impact category				
Land occupation	Land area	N/A	$m^2 \times yr$	Occupation or use of a certain area of land for a certain period of time. The inventory data is not characterised.

3. Life Cycle Inventory

This addendum covers chilled Oatly Oat Drink Semi produced at Oatly's end-to-end factory located in Landskrona, Sweden. More details on these factories and the production process can be found in section 3.1.1 of the main report.

The data used for the manufacturing of Oatly Oat Drink Semi of this addendum is identical to Oatly Barista as described in section 3.1.2 of the main report, except for the following:

- The resource use at the factories (energy and water use) has been updated with 2022 data.
- The recipe of Oatly Oat Drink Semi is slightly different than Oatly Barista, with small differences in the proportion of oatbase and rapeseed oil.
- Chilled packaging and distribution are considered. This report uses the same data for chilled distribution and packaging for Sweden and Finland as was used in the main report (found in the sensitivity analysis).

An overview of the data used to model the Oatly products can be found in Appendix II.

For the cow's milk from Sweden and Finland, the same data has been used as in the main report. More detail on how the cow's milk has been modelled can be found in Appendix III, or in section 3.2 of the main report.

4. Life Cycle Impact Assessment (LCIA)

This chapter provides an overview of the key results for all products in scope, whereas the next chapter (Life Cycle Interpretation) provides a more detailed account of the stages and processes contributing most to the impact.

The results for the key impact categories are listed in Table 4 for the Chilled Oatly Oat Drink Semi. The results for all impact categories are included in Appendix IV. Table 5 provides an overview of the relative differences of the Oatly Semi products and cow's milk.

These tables indicate that for both countries, the chilled Oatly Oat Drink Semi has a lower impact than cow's milk when it comes to all of the environmental impact categories.

A further explanation of what causes the differences that can be observed between products can be found in the next chapter (Life Cycle Interpretation). These results are in line with the results from the main report, where relative differences between the Oatly products and cow's milk are of the same order of magnitude for the same categories.

TABLE 4: RESULTS FOR KEY IMPACT CATEGORIES FOR THE CHILLED OATLY SEMI AND COW'S MILK AT RETAIL INCLUDING END-OF-LIFE (EOL) PACKAGING. OATLY OAT DRINK SEMI IS PRODUCED AT OATLY'S END-TO-END FACTORY IN LANDSKRONA, SWEDEN. COW'S MILK REPRESENTS AN AVERAGE COW'S MILK PRODUCT AT RETAIL FOR EACH COUNTRY. ABBREVIATIONS USED: FI = FINLAND AND SE = SWEDEN. FURTHER INFORMATION ON THE INDICATORS USED FOR THE IMPACT CATEGORIES CAN BE FOUND IN TABLE 3.

Sweden retail				
Impact category	**Unit**	**Cow's milk average SE**	**Oatly Oat Drink Semi**	***Difference compared to cow's milk***
Climate change - incl LUC and peat ox	kg CO_2 eq	1.102	0.377	-66%
Climate change - excl LUC and peat ox	kg CO_2 eq	0.923	0.286	-69%
Climate change - only LUC	kg CO_2 eq	0.055	0.024	-57%
Climate change - only peat ox	kg CO_2 eq	0.125	0.068	-46%
Fine particulate matter formation	kg PM2.5 eq	0.00108	0.000356	-67%
Terrestrial acidification	kg SO_2 eq	0.00619	0.00127	-79%
Freshwater eutrophication	kg P eq	0.000206	0.000102	-50%
Marine eutrophication	kg N eq	0.00147	0.000453	-69%
Land use	m^2a crop eq	1.078	0.553	-49%
Land occupation	m^2a	1.282	0.644	-50%
Mineral resource scarcity	kg Cu eq	0.000987	0.000807	-18%
Fossil resource scarcity	kg oil eq	0.0962	0.0512	-47%
Water consumption	m^3	0.00826	0.00327	-60%
Finland retail				
Impact category	**Unit**	**Cow's milk average FI**	**Oatly Oat Drink Semi**	***Difference compared to cow's milk***
Climate change - incl LUC and peat ox	kg CO_2 eq	1.700	0.411	-76%
Climate change - excl LUC and peat ox	kg CO_2 eq	1.151	0.320	-72%
Climate change - only LUC	kg CO_2 eq	0.036	0.024	-33%
Climate change - only peat ox	kg CO_2 eq	0.513	0.068	-87%
Fine particulate matter formation	kg PM2.5 eq	0.00142	0.000425	-70%
Terrestrial acidification	kg SO_2 eq	0.00733	0.00145	-80%
Freshwater eutrophication	kg P eq	0.000266	0.000117	-56%
Marine eutrophication	kg N eq	0.00177	0.000464	-74%
Land use	m^2a crop eq	1.232	0.554	-55%
Land occupation	m^2a	1.517	0.648	-57%
Mineral resource scarcity	kg Cu eq	0.001201	0.000835	-30%
Fossil resource scarcity	kg oil eq	0.1172	0.0637	-46%
Water consumption	m^3	0.00888	0.00331	-63%

TABLE 5 RELATIVE DIFFERENCES OF CHILLED OATLY OAT DRINK SEMI COMPARED TO COW'S MILK AT RETAIL INCLUDING END-OF-LIFE (EOL) OF PACKAGING. FOR EXAMPLE, -76% INDICATES THAT OATLY OAT DRINK SEMI HAS A 76% LOWER IMPACT COMPARED TO COW'S MILK. THE DIFFERENCES HAVE BEEN COLOR-CODED AS FOLLOWS: GREEN – MORE THAN 10% DIFFERENCE FAVORING OATLY OAT DRINK SEMI, YELLOW – THE DIFFERENCE IS 10% OR LOWER INDICATING SIMILAR PERFORMANCE FOR THE COMPARED PRODUCTS, RED – MORE THAN 10% DIFFERENCE FAVORING COW'S MILK. COW'S MILK REPRESENTS AN AVERAGE MILK PRODUCT AT RETAIL FOR EACH COUNTRY. ABBREVIATIONS USED: FI = FINLAND AND SE = SWEDEN. FURTHER INFORMATION ON THE INDICATORS USED FOR THE IMPACT CATEGORIES CAN BE FOUND IN TABLE 3.

Country of sale	Impact category / Product	Climate change	Fine particulate matter	Terrestrial acidifi-cation	Freshwater eutrophi-cation	Marine eutrophi-cation	Land use	Land occupation	Mineral resource scarcity	Fossil resource scarcity	Water consum-ption
		kg CO_2 eq	*kg PM2.5 eq*	*kg SO_2 eq*	*kg P eq*	*kg N eq*	*m^2a crop eq*	*m^2a*	*kg Cu eq*	*kg oil eq*	*m^3*
Finland	Oatly Oat Drink Semi Retail FI	-76%	-70%	-80%	-56%	-74%	-55%	-57%	-30%	-46%	-63%
Sweden	Oatly Oat Drink Semi Retail SE	-66%	-67%	-79%	-50%	-69%	-49%	-50%	-18%	-47%	-60%

5. Life Cycle Interpretation

5.1 Contribution analysis

A contribution analysis shows the contribution of individual life cycle stages to the overall impact results. Contribution analyses are provided for all products in scope and for all key impact categories. Section 5.1.1 of the main report explains in detail which processes contribute to the different impact categories and can be consulted to better understand what is behind the results and the differences that can be observed between the Oatly products and cow's milk. The main report also includes a contribution analysis for cow's milk (section 5.1.3). Notable differences from the main report are included below.

5.1.1 Comparison of chilled Oatly Oat Drink Semi and cow's milk

The contribution analysis for the climate change impact category is shown for the chilled Oatly Oat Drink Semi in Figure 2. Figure 3 shows the contribution analysis for the other impact categories.

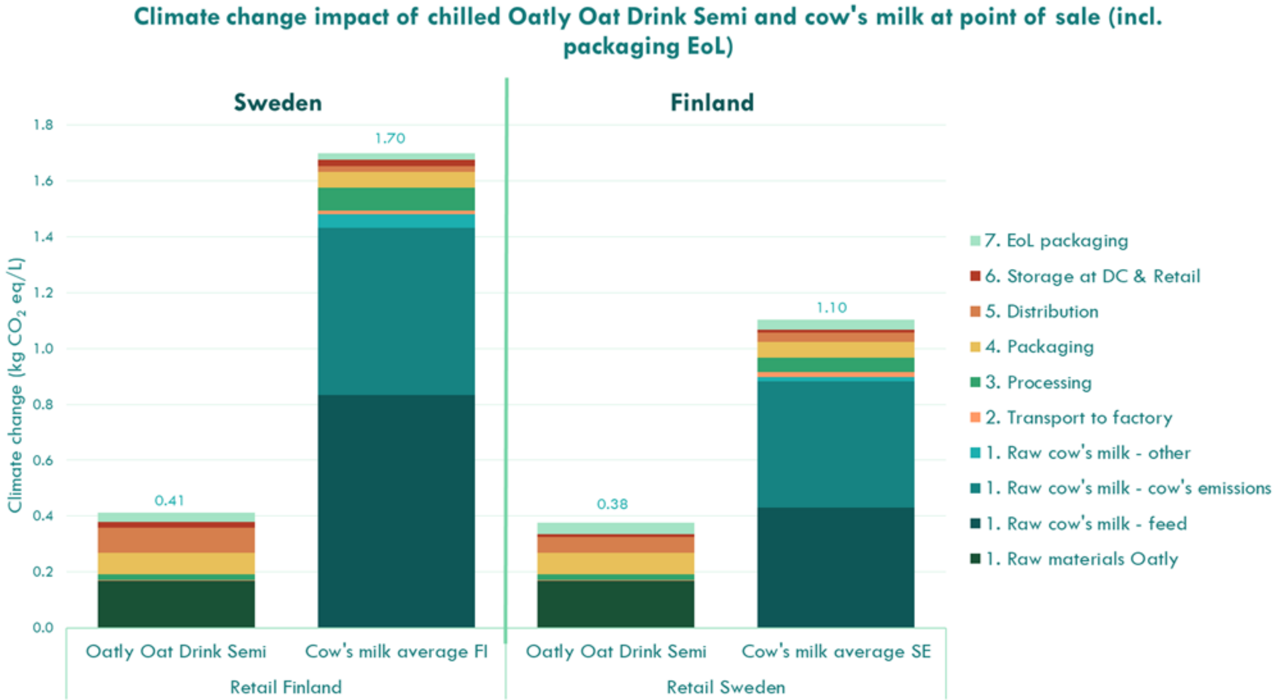

FIGURE 2 CLIMATE CHANGE IMPACT OF CHILLED OATLY OAT DRINK SEMI AND COW'S MILK AT RETAIL INCLUDING END-OF-LIFE (EOL) OF PACKAGING. OATLY OAT DRINK SEMI IS PRODUCED AT OATLY'S END-TO-END FACTORY IN LANDSKRONA, SWEDEN. COW'S MILK REPRESENTS AN AVERAGE COW'S MILK PRODUCT AT RETAIL FOR EACH COUNTRY. ABBREVIATIONS USED: FI = FINLAND AND SE = SWEDEN.

The results from Figure 2 and Figure 3 show that, similar to the results in the main report, the raw material stage is for both Oatly Oat Drink Semi and cow's milk the **largest contributor** to the climate change impact category, as well as to many of the other impact categories. Notable exceptions are the fossil resource scarcity and water consumption categories.

For **fossil resource scarcity**, distribution is the most contributing life cycle stage for Oatly Oat Drink Semi sourced to Finland, due to the long transport distance from the factory in Sweden. Transport distances for cow's milk are lower as it is produced locally. The fossil resource scarcity impact of processing on the other hand, is lower for the Oatly products as the Landskrona factory uses biogas to generate heat, as alternative to the commonly used natural gas.

For the Oatly products, the impact of **water consumption** is mainly determined by the water consumption at the factory (which includes both water for the formulation of the product and process water). Also packaging contributes to the water consumption impact category (mainly related to process water for packaging manufacturing).

The differences between Oatly Oat Drink Semi sourced to Sweden vs to Finland is caused by the different distribution routes: the longer transport distance from the Landskrona factory to retail in Finland results in a higher impact of the distribution stage for most impact categories. Another notable difference between the two products is the higher fossil resource scarcity impact of storage at distribution centre (DC) and retail in Finland due to a higher share of fossil-based electricity in the Finnish electricity mix.


e. Land use
Land use (m2a crop eq/L)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.55
1.23
0.55
1.08
Oatly Oat Drink Semi
Cow's milk average FI
Oatly Oat Drink Semi
Cow's milk average SE
Finland
Sweden
e*. Land occupation
Land occupation (m2a/L)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.65
1.52
0.64
1.28
Oatly Oat Drink Semi
Cow's milk average FI
Oatly Oat Drink Semi
Cow's milk average SE
Finland
Sweden
1. Raw materials
2. Transport to factory
3. Processing
4. Packaging
5. Distribution
6. Storage at DC & Retail
7. EoL packaging
f. Mineral resource scarcity
Mineral resource scarcity (kg Cu eq/L)
0.0020
0.0015
0.0010
0.0005
0.0000
0.00084
0.00120
0.00081
0.00099
Oatly Oat Drink Semi
Cow's milk average FI
Oatly Oat Drink Semi
Cow's milk average SE
Finland
Sweden
g. Fossil resource scarcity
Fossil resource scarcity (kg oil-eq/L)
0.20
0.15
0.10
0.05
0.00
-0.05
0.06
0.12
0.05
0.10
Oatly Oat Drink Semi
Cow's milk average FI
Oatly Oat Drink Semi
Cow's milk average SE
Finland
Sweden
1. Raw materials
2. Transport to factory
3. Processing
4. Packaging
5. Distribution
6. Storage at DC & Retail
7. EoL packaging

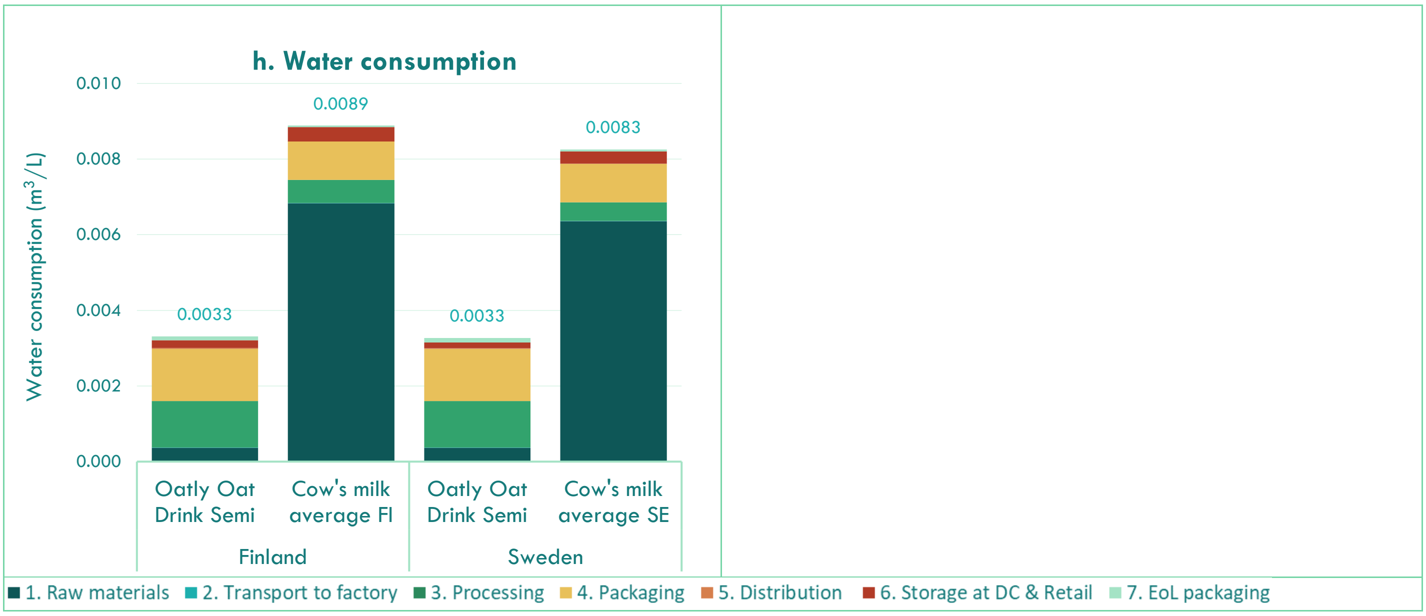

FIGURE 3: KEY IMPACT CATEGORIES OF CHILLED OATLY OAT DRINK SEMI CHILLED AND COW'S MILK AT RETAIL INCLUDING END-OF-LIFE (EOL) OF PACKAGING. OATLY OAT DRINK SEMI IS PRODUCED AT OATLY'S END-TO-END FACTORY IN LANDSKRONA, SWEDEN. COW'S MILK REPRESENTS AN AVERAGE COW'S MILK PRODUCT AT RETAIL FOR EACH COUNTRY. IMPACT CATEGORY E* (LAND OCCUPATION) CONCERNS AN ADDITIONAL IMPACT CATEGORY AS EXPLAINED IN CHAPTER 2. ABBREVIATIONS USED: FI = FINLAND AND SE = SWEDEN. FURTHER INFORMATION ON THE INDICATORS USED FOR THE IMPACT CATEGORIES CAN BE FOUND IN TABLE 3.

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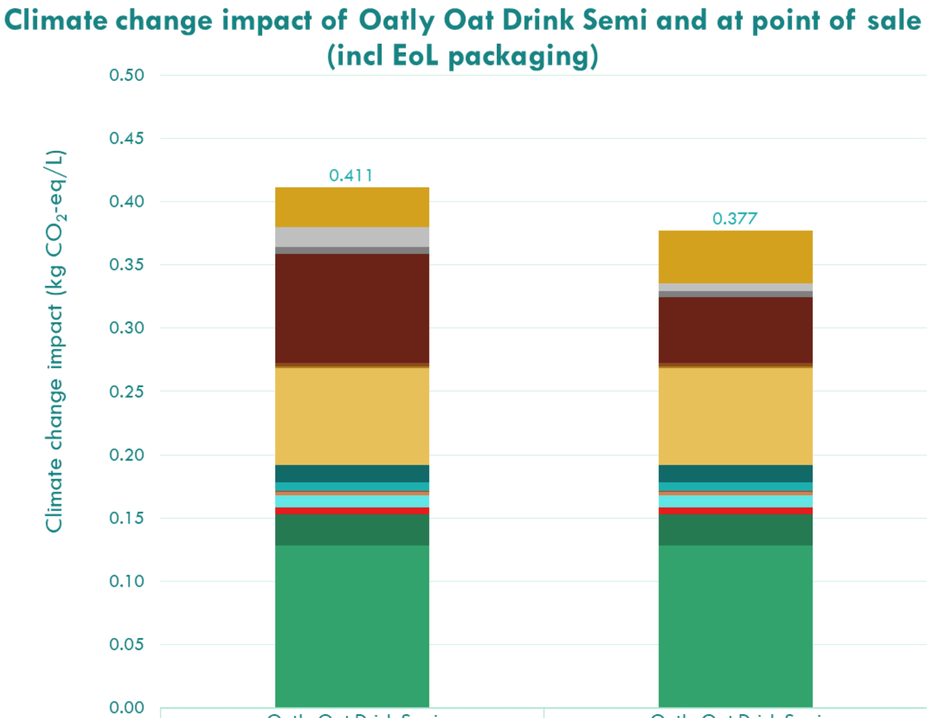
5.1.2 Oatly Semi

Figure 4 shows a detailed contribution analysis for the climate change impact category for the chilled Oatly Oat Drink Semi. As explained in the previous section, the main differences between the two products are caused by the different distribution routes. Furthermore, a difference in the EoL impact can be observed, which is caused by a higher share of the liquid beverage carton going to incineration in Sweden compared to Finland.



	Oatly Oat Drink Semi Finland Retail	Oatly Oat Drink Semi Sweden Retail
10. End of Life of Packaging	0.032	0.042
9b. Storage at Retail	0.016	0.006
9a. Storage at DC	0.005	0.005
8b. Distribution to Retail	0.086	0.052
8a. Distribution to DC	0.003	0.003
7b. Transport of packaging material	0.001	0.001
7a. Packaging	0.077	0.077
6. Processing - Oatly Oat Drink Semi	0.014	0.014
5. Processing - Oat base	0.007	0.007
4b. Transport of other ingredients to factory	0.000	0.000
4a. Transport of oats to factory	0.003	0.003
3. Oats milling	0.009	0.009
2. Oats transport to mill	0.006	0.006
1b. Other ingredient production	0.024	0.024
1a. Oat cultivation	0.128	0.128

FIGURE 4: CLIMATE CHANGE IMPACT OF CHILLED OATLY OAT DRINK SEMI CHILLED AT RETAIL INCLUDING END-OF-LIFE (EOL) OF PACKAGING. OATLY OAT DRINK SEMI IS PRODUCED AT OATLY'S END-TO-END FACTORY IN LANDSKRONA, SWEDEN. ABBREVIATIONS USED: FI = FINLAND AND SE = SWEDEN.

5.2 Sensitivity and uncertainty analyses

Sensitivity analyses serve to evaluate the robustness of the results by assessing the influence of several assumptions and modelling choices that have been made. In the main report, sensitivity analyses were performed to evaluate the choice of impact assessment methods, the choice of functional unit, the choice of allocation method, as well as several choices with regard to characteristics of the systems under study (e.g. inclusion of use stage, comparison to the ambient version of cow's milk). Furthermore, in a previous addendum[8] a sensitivity analysis was performed which compares the Whole, Semi and Light Oat Drink products to cow's milk with corresponding fat content.

These sensitivity analyses in the main report demonstrated that using a different impact assessment method (ReCiPe endpoint, EF3.0 single score) confirm that Oatly Barista has a lower impact than cow's milk for the majority of the impact categories in scope for all countries. It also demonstrated that the results in the impact categories land use, mineral resource scarcity and water impact categories are less robust, as they result in different trends when using a different impact assessment method (EF 3.0), this is due to the disparity in their underlying metrics. Furthermore, the sensitivity analyses in the main report concluded that using different product characteristics (inclusion of use stage, using economic allocation for cow's milk), did not lead to different conclusions on the environmental footprint of Oatly Barista compared to cow's milk. The sensitivity analysis in the previous addendum demonstrated a similar range of differences between cow's milk and Oatly Oat Drink Semi when comparing it to semi-skimmed cow's milk instead of the average mix of skimmed, semi-skimmed and whole cow's milk[9].

Considering how similar the Oatly products in this study are to those investigated in the main report, it was deemed unnecessary to repeat all sensitivity analyses. The conclusions that were drawn based on the sensitivity analyses in the main report also apply to the products in this addendum. This chapter therefore just includes an uncertainty analysis.

Uncertainty in inventory data has been determined using the pedigree matrix, as described in section 2.4.1 of the main report. With this data, a Monte Carlo analysis was run in SimaPro to assess the uncertainty range for each product.

Figure 5 shows the climate change impact results including uncertainty ranges for the 95% confidence interval; meaning that of the 1000 times that the analysis has been repeated, 95% of the intervals that were generated include the true mean value. The graph shows a higher uncertainty range for cow's milk, which is caused by the higher uncertainty factors attributed to emissions from manure management and enteric fermentation and to feed intake (see section 2.7.1 of the main report). Oatly Oat Drink Semi has lower uncertainty ranges due to the use of primary (foreground) data.

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[8] "LCA of Oatly "No" Sugars and Oatly Oat Drink (Whole/Semi/Light), and comparison with cow's milk", which was published by Blonk Consultants on April 11th 2023 and can be found here: https://website-production-s3bucket-1nevfd7531z8u.s3.eu-west-1.amazonaws.com/public/website/download/4e1d9280-87ed-41b0-bb7f-82c85977a5a3/Addendum_LCA%20Oatly%20No%20Sugars%20and%20Oat%20Drink%20(11-04-2023)%20-%20final.pdf

[9] As can be found in the previous addendum, ambient Oatly Oat Drink Semi at retail in Sweden has a 67% lower climate change impact than the average Swedish cow's milk and a 68% lower impact than semi-skimmed Swedish cow's milk. Ambient Oatly Oat Drink Semi at retail in Finland has a 78% lower climate change impact than the average Finnish cow's milk and a 79% lower impact than semi-skimmed Finnish cow's milk. The climate change impact of all cow's milk types (whole, semi-skimmed and skimmed) can be found in section 5.2.5 of the main report.

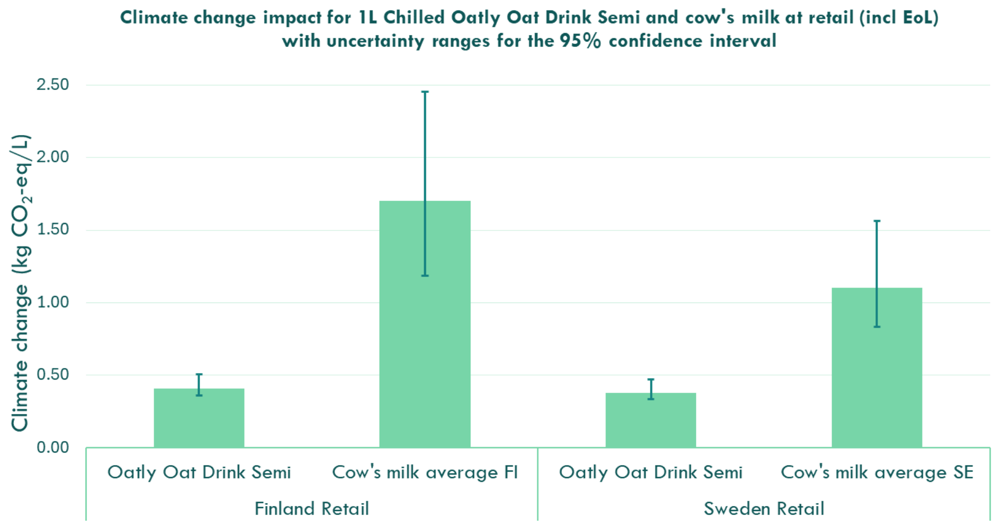

FIGURE 5 CLIMATE CHANGE IMPACT FOR 1L CHILLED OATLY OAT DRINK SEMI AND COW'S MILK AT RETAIL INCLUDING END-OF-LIFE (EOL) PACKAGING, WITH UNCERTAINTY RANGES FOR THE 95% CONFIDENCE INTERVAL

The graph gives an impression of how the chilled Oatly Oat Drink Semi compares to cow's milk when taking these uncertainties into consideration. Generally speaking, if the error bars of the 95% uncertainty interval do not overlap, one can assume differences between products are statistically significant (Payton et al., 2003).

A more accurate way to compare two products is a paired Monte Carlo analysis, which considers the uncertainty of the difference between two products (thus accounting for correlation in data). The number of runs (from the total of 1000 runs) is counted in which product A has a higher impact than product B. In general, it can be assumed that if >90% of the Monte Carlo runs are favourable for one product, the difference can be considered significant (Goedkoop et al., 2013).

Figure 6 below shows the outcome of this paired Monte Carlo analysis for the two products in scope, and for all impact categories. It shows that for all impact categories, the impact of chilled Oatly Oat Drink Semi is consistently and significantly lower than the impact of cow's milk.

It should be noted that the results shown here concern just an approximation rather than an accurate reflection of uncertainty ranges, as uncertainty was estimated for the data in absence of information on variability of the data.

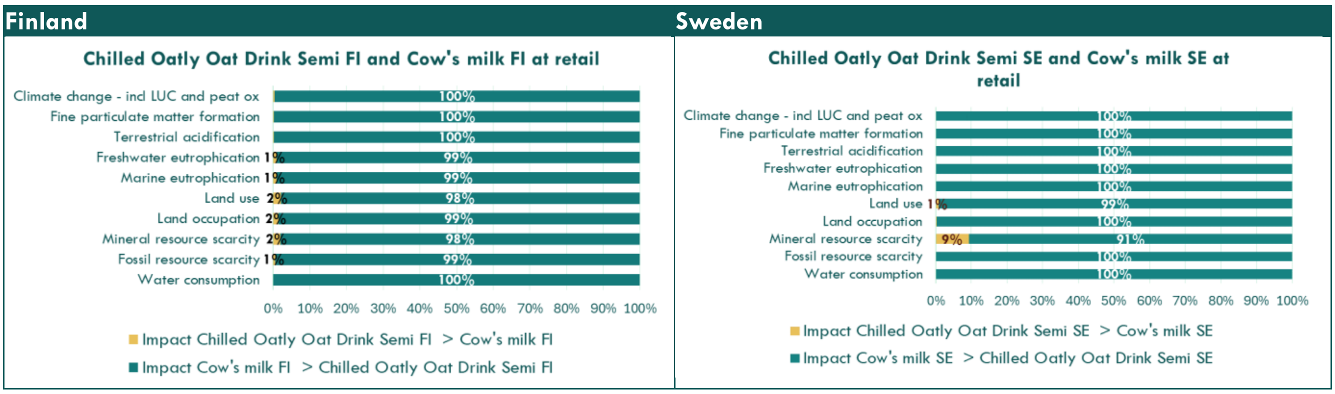

FIGURE 6 PAIRED MONTE CARLO ANALYSIS OF 1L OATLY OAT DRINK SEMI AND COW'S MILK AT RETAIL INCLUDING END-OF-LIFE (EOL) PACKAGING, SHOWING THE PERCENTAGE OF MONTE CARLO RUNS IN WHICH ONE PRODUCT HAS A HIGHER IMPACT THAN THE OTHER. FOR EXAMPLE, FOR CLIMATE CHANGE, OATLY OAT DRINK SEMI AT RETAIL IN FINLAND HAS A LOWER IMPACT THAN COW'S MILK FOR 100% OF THE 1000 MONTE CARLO SIMULATIONS PERFORMED. ABBREVIATIONS USED: FI = FINLAND, SE = SWEDEN.

6. Conclusion

A Life Cycle Assessment (LCA) has been performed to compare the environmental performance of chilled Oatly Oat Drink Semi to cow's milk in two sales markets in Europe: Sweden and Finland. The functional unit considered for this study is 1 liter of chilled Oatly Oat Drink Semi and cow's milk at retail, including packaging manufacturing and packaging end of life.

The results indicate that the chilled Oatly Oat Drink Semi product in both markets has a lower impact than cow's milk for all impact categories in scope, these being: climate change, fine particulate matter formation, terrestrial acidification, freshwater eutrophication, marine eutrophication, land use, land occupation, mineral resource scarcity, fossil resource scarcity and water consumption.

The significance of the abovementioned differences has been determined by an uncertainty analysis. In the main report additional sensitivity analyses were carried out (see section 5.2 of the main report), of which the conclusions also apply to the current products, as they are of similar or relatively lower impact than the Oatly Barista in the main report. The main report concluded that using a different impact assessment method (ReCiPe endpoint, EF3.0 single score[10]) confirmed the overall higher environmental footprint of cow's milk compared to Oatly products for all countries in scope. It also showed that results in the impact categories land use, mineral resource scarcity and water impact categories are less robust, as they result in different trends when using a different impact assessment method (EF 3.0). Furthermore, the sensitivity analyses in the main report concluded that using different product characteristics (inclusion of use stage, using economic allocation for cow's milk, functional unit based on nutritional characteristics), did not lead to different conclusions on the environmental footprint of Oatly products compared to cow's milk. An additional sensitivity analysis in a previous addendum[11], which compared Oatly Oat Drink Semi to semi-skimmed milk (instead of an average mix of skimmed, semi-skimmed and whole cow's milk), also demonstrated a similar range of differences between cow's milk and Oatly Oat Drink Semi.

A detailed analysis of the main drivers and opportunities linked to the environmental impact of Oatly products can be found in the main report.

Conclusions and recommendations presented here are subject to the assumptions and limitations addressed in this report and the main report. Any comparative assessment intended to be disclosed to the public, should transparently refer to the conclusions of these studies, and be accompanied by the critical review statement.

[10] EF 3.0 is the environmental impact assessment method from the European Commission's Product Environmental Footprint (PEF) method

[11] "LCA of Oatly "No" Sugars and Oatly Oat Drink (Whole/Semi/Light), and comparison with cow's milk", which was published by Blonk Consultants on April 11th 2023 and can be found here: https://website-production-s3bucket-1nevfd7531z8u.s3.eu-west-1.amazonaws.com/public/website/download/4e1d9280-87ed-41b0-bb7f-82c85977a5a3/Addendum_LCA%20Oatly%20No%20Sugars%20and%20Oat%20Drink%20(11-04-2023)%20-%20final.pdf

7. References

Blonk Consultants. (2022). *LCA of Oatly Barista and comparison with cow's milk*. Blonk Sustainability, Gouda, the Netherlands. https://blonksustainability.nl/news-and-publications/publications

Goedkoop, M., Oele, M., Leijting, J., Ponsioen, T., & Meijer, E. (2013). *Introduction to LCA with SimaPro 8* (Issue November).

Huijbregts, M. A. J., Steinmann, Z. J. N., Elshout, P. M. F., & Stam, G. (2016). ReCiPe2016 : a harmonized life cycle impact assessment method at midpoint and endpoint level. *The International Journal of Life Cycle Assessment*, 1–16. https://doi.org/10.1007/s11367-016-1246-y

ISO. (2006a). *ISO 14040 Environmental management — Life cycle assessment — Principles and framework*.

ISO. (2006b). *ISO 14044 - Environmental management — Life cycle assessment — Requirements and guidelines*.

ISO. (2014). *ISO 14071 - Environmental management — Life cycle assessment — Critical review processes and reviewer competencies* (Vol. 2014).

Payton, M. E., Greenstone, M. H., & Schenker, N. (2003). Overlapping confidence intervals or standard error intervals: What do they mean in terms of statistical significance? *Journal of Insect Science*, *3*(1996). https://doi.org/10.1093/jis/3.1.34

Appendix I Oatly production modelling (Confidential)

This appendix is not available in this version of the report due to confidential data.

Appendix II Oatly production modelling (Non-confidential)

Life cycle stage	*Description of data*	*Data quality*
1a. Oat cultivation	Modelled using Swedish oat cultivation dataset from Agri-Footprint 6. Agri-footprint datasets consider cultivation-related inputs and resources (yield, water consumption, land occupation/ transformation, input of manure, fertilizers, lime, pesticides, start material, energy and transport of inputs), as well as emissions related to the use of these inputs and resources (nitrous oxide, ammonia, nitrate, nitric oxide, carbon dioxide, phosphorus, pesticide, heavy metals). Emissions from land use change and peat oxidation are included as well. The sourcing countries for the factories are listed below, including the yields for oat cultivation as used in Agri-footprint (these are based on FAO statistics; more information on data used can be found in the publicly available Agri-footprint 6 Methodology Report, Part 2 – Data).	*Good*
1b. Other ingredient production	The quantity of other ingredients used during processing or added to the final product are provided by Oatly. These include enzymes, calcium carbonate, vitamins, salt, and rapeseed oil. Rapeseed oil and a proxy for vitamins was derived from the Agri-footprint database, whereas the other ingredients were modelled using datasets from ecoinvent 3.9.	*Good*
2. Oats transport to mill	To account for transport from oat cultivation to mills, estimates are provided by Oatly (as location of farmers is not available). An estimate of 300km is assumed for the transportation between the Swedish oat fields to the mills in Sweden using diesel trucks. All trucks are modelled with a capacity >20t, a load factor of 80% and an empty return.	*Fair*
3. Oats milling	Primary data was provided by Oatly on energy use (electricity and heat), and water consumption for the 2 mills in Sweden, and 1 mill in Denmark. The oat hulls are going to either animal feed or biogas production. In two Swedish mills, they are used to generate heat for the milling process. For one of the Swedish mills, no information on energy use was available. An estimate was made by assuming the same energy requirements as for the other Swedish mill, but assuming fossil-based energy sources as a conservative assumption for heat. Public information was available for the electricity source in their sustainability report.	*Good*
4a. Transport of oats to factory	Distance based on locations of the mills and the Oatly factory. Transport was modelled using diesel trucks.	*Very good*
5. Processing – oat base	The input use (energy, heat, water) to generate oat base and finished product was provided by Oatly based on data from the production facility in scope. Water use includes both water in the recipe (final product), and water used for processing (mainly cleaning). The quantity of water going to wastewater treatment is also recorded.	*Very good*
6. processing – Oatly final product	The input use (energy, heat, water) to generate oat base and finished product was provided by Oatly based on data from the production facility in scope. Water use includes both water in the recipe (final product), and water used for processing (mainly cleaning). The quantity of water going to wastewater treatment is also recorded. To account for losses during processing, an estimation was provided by Oatly of 5% losses during the production. This concerns a maximum and is based on an interview with Oatly's factory controller (Veljanovski, 2022).	*Very good*

7a. packaging	Primary data on packaging composition is supplied by the packaging manufacturer. Next to the materials used, energy was accounted for processing these materials based on ecoinvent datasets (e.g. injection moulding for the HDPE cap etc). BioPE is used in all beverage cartons used by Oatly. It is generated with sugarcane cultivated in Brazil. A BioPE dataset has been calculated by Quantis (Quantis, 2022) and its climate change impact is slightly higher than regular PE (excl LUC). Land use change was added from Blonk's LUC database to account for the risk of deforestation attributed to sugar cane cultivation in Brazil. Secondary packaging (corrugated board) is also included.	*Very good*
7b. Transport of packaging material	Upstream data for packaging (e.g. of raw materials) is already included in the ecoinvent datasets used. Transport (assuming diesel trucks) was added from the packaging manufacturing facilities to Oatly's corresponding factories based on their locations.	*Very good*
8a. Distribution to DC	The transport from the factory to the distribution center is provided by Oatly. Oatly uses trucks with a capacity of 21.5-36 tons (Månsson, 2022) (modelled as >20ton trucks with a load factor of 80%). For chilled distribution, refrigerated truck transport was modelled based on ecoinvent datasets for refrigerated transport. Since ecoinvent only included a small refrigerated transport option (truck < 16 ton), transport for a >20 ton truck was modelled using the same assumptions as for the smaller trucks: 20% higher fuel use for the refrigeration machine, and the use and emission of 1.71E-5 kg R134/tkm.	*Good*
8b. Distribution to Retail	Transport data is provided by Oatly. An additional 50 km of last mile distribution was added.	*Fair*
9. Storage at DC and retail	This is based on defaults for ambient storage provided by the PEFCR, with storage duration provided by the Dairy PEFCR (section 6.4): • 1 week of storage at DC (assuming 3x storage volume) • 3 days chilled storage at retail (HTST) • 14 days ambient storage at retail (UHT) Loss rates at retail were provided by Oatly.	*Fair-Poor*
10. End of Life of Packaging	The EoL of the packaging material is calculated using the Circular Footprint Formula (CFF) from the PEFCR. The CFF is only applied for primary packaging materials, using country-specific parameters as provided in Annex C of the PEFCR. The CFF annex provides recycling rates for liquid packaging board as a whole. It is assumed that only the paper part of the beverage carton can be recycled (into pulp). All of the plastic and aluminum is assumed to be incinerated and/or landfilled (Kremser et al., 2022; Thoden van Velzen & Smeding, 2022), using country-specific incineration/landfill rates. For secondary packaging material (corrugated board) no CFF was applied, and dataset was selected that already includes recycled material.	*Fair*

Appendix III Dairy production modelling

The section below highlights the data used as well as calculations and assumptions made to model dairy systems in Sweden and Finland. The table below provides an inventory of data used to model the cow's milk datasets. Thereafter, the dairy production system modelling is explained in more detail.

Life cycle stage	Description of data	Data quality

1. Raw milk	A brief overview of the data used to model raw milk is provided below. A detailed overview of all datapoints used, as well as the APS methodology, is provided in the section below.
	
	The following data were collected to calculate the environmental footprint of cow's milk using the APS Footprint tool:
	• Milk output per cow and fat and protein content
	• Herd characteristics
	• Feed ration and characteristics
	• Energy input
	• Water input
	• Bedding material
	
	Based on these parameters, the footprint is calculated per kg of milk output. The footprint consists of:
	• Emissions from manure management and enteric fermentation:
	  ○ Methane (CH_4) from enteric fermentation (calculated with IPCC Tier 2)
	  ○ CH_4 from manure (calculated with IPCC Tier 2)
	  ○ Direct dinitrogen monoxide (also called nitrous oxide) (N_2O) from manure (calculated with IPCC Tier 2)
	  ○ Indirect N_2O from leaching of manure (calculated with IPCC Tier 2)
	  ○ Indirect N_2O from volatilization of ammonia (NH_3) and nitrogen oxides (NOx); (calculated with IPCC Tier 2)
	  ○ Non-methane volatile organic compounds (NMVOC) from manure (calculated with EMEP/EEA Tier 2)
	  ○ Particulate matter (PM2.5 and PM10) from manure (calculated with EMEP/EEA Tier 1)
	• Emissions from the cultivation and processing of feed crops (modelled with Agri-footprint 6.0 data). Agri-footprint datasets consider cultivation-related inputs and resources (yield, water consumption, land occupation/ transformation, input of manure, fertilizers, lime, pesticides, start material, energy and transport of inputs), as well as emissions related to the use of these inputs and resources (nitrous oxide, ammonia, nitrate, nitric oxide, carbon dioxide, phosphorus, pesticide, heavy metals). Emissions from land use change and peat oxidation are covered as well. Further processing of the crops into feed ingredients, as well as country-specific market mixes, are also included.
	• Emissions related to energy use and bedding material (modelled with ecoinvent energy data and Agri-footprint for bedding material).
		Good

2. Transport of milk to factory	Distances have been derived from Blonk's transport dataset, based on national distances (assumed all truck transport): • Finland: 81km • Sweden: 131 km Transport in a refrigerated truck of >20 tons with empty return.	*Fair-Poor*
3. Milk processing	For European countries, the energy, water, and refrigerant use for milk processing has been derived from the Dairy PEFCR (section 6.2.6). Mass allocation was applied based on dry matter values provided in the dairy PEFCR. This resulted in the following mass allocation of milk and cream: • Whole milk: 97.7% milk, 2.3% cream • Semi-skimmed milk: 80.7% milk, 19.3% cream	*Fair*

	• Skimmed milk: 65.3% milk, 34.7% cream With regard to losses, the PEFCR default is applied encompassing losses from farm to retail (applied at retail level).	
4. Milk packaging	The composition of packaging was based on default data from the Dairy PEFCR (section 6.3) Transport of packaging material was included using default transport distances and modes as mentioned in the Dairy PEFCR (section 6.3). Secondary packaging was modelled using default data from the PEFCR (section 6.3).	*Good-Fair*
5. Distribution to DC and retail	For distribution to DCs and supermarkets, the same national distances have been applied as for the transport of raw milk. Transport in a refrigerated truck >20t is assumed for HTST milk, and non-refrigerated transport for UHT milk.	*Fair-Poor*
6. Storage at DC and supermarkets	This is based on defaults for refrigerated storage provided by the PEFCR, with storage duration provided by the Dairy PEFCR (section 6.4): • 1 week of storage at DC (assuming 3x storage volume) • 3 days chilled storage at retail (HTST) • 14 days ambient storage at retail (UHT) Default loss rate was assumed of 5% from farm to retail (Dairy PEFCR section 6.6).	*Fair-Poor*
7. End of Life of packaging	End of Life of packaging material has been modelled using CFF parameters for the respective countries.	*Fair*

System description and data quality

In this section, a short description of the milk production system is provided. A more detailed description on the modelling of dairy systems can be found in the documentation of APS footprint (Blonk Consultants, 2020a).

The APS-footprint framework enables users to perform environmental footprint calculations based on background datasets, parameters defined by the user and modelling of emissions according to specified standards and guidelines. Dairy systems may vary in design and environmental performance due to differences in herd composition, grazing periods, housing types, feeding regimes and manure management systems. The dairy APS module enables a user to model these different characteristics and investigate how they influence environmental impacts. The methodological framework regarding allocation, functional units, boundary definitions and emission modelling are based on published and recognized international guidelines (European Commission, 2018; European Environment Agency, 2016; IPCC, 2006b).

Below are the main parameters used to model the dairy systems in APS are described.

Herd composition

In the APS dairy module, it is necessary to define the animal population (animal type and number) associated with the production system. With APS-footprint, it is also possible to include data based on statistics. This means that the overall population, within a country might be considered as the total herd. The total herd should be presented in a system equilibrium. All inputs should be scaled towards the total herd.

In the dairy module of the APS-footprint tool, four animal types are defined:

Dairy Cow Dairy cows include the milk-producing cattle. Dairy cows start producing milk after giving birth to their first calf, which is usually during their third year of life. Dairy cows are slaughtered at around 4-5 years of age. This animal category includes both dairy cow in lactation and dairy cow in dry period. The weight of dairy cows can vary. Since APS-footprint assumes a system at equilibrium and an average dairy cow weight, it is assumed that there is no weight accumulation of the herd in this stage.

Calves < 1 year Female calves that are not slaughtered are further raised for future replacement of dairy cows. In their first year of life, the weight grows from circa 50 kg to around 300 kg.

Calves 1-2 years In this stage, female calves are raised from 1 year up to 2 years of age. Animals in this stage grow from approximately 300 kg to 600 kg.

Heifers In this stage, female calves are raised from 2 year of age up to calving age. The latter is the age in which it gives birth to calves for the first time, followed by its first lactation period. Calving age varies from 24 up to 26 months in average. This means that heifers are considered as such for a short period of time (few months).

Bulls Sometimes bulls are present on a farm. The average lifespan of bulls varies between 3 to 5 or more years. They usually weigh more than the dairy cows, and their population is very small since one bull can inseminate many cows. In modern systems, bulls might not present since artificial insemination is a common practice. Artificial insemination is not modelled in the dairy APS module. Because of their negligible contribution to the overall impact of the dairy system, bulls are not taken into account.

The number of animals at farm is based on a production period of one year and the average number of present animals is requested as input for APS-footprint. For each animal type, this is called Annual Average Population (AAP).

Feed

Information on feed amount and nutrient content are required as input for the calculations. The feed inputs need to be defined as kg feed (as is) for every AAP for 1 year. Two types of feed are distinguished in the dairy APS module: compound feeds and single ingredients:

- Compound feeds are defined in the compound feed module of the APS-footprint tool. The compound feed formulation can be defined together with inbound (from ingredient production to compounding feed mill) and outbound (from compounding feed mill to farm) transportation and energy use.
- For this project, feed ingredients (crops) are derived from Agri-footprint 6. When a certain region is not covered in APS, the crop (mix) is modelled afterwards in SimaPro.
- The production of single feed ingredients is also based on Agri-footprint 6 (Van Paassen et al., 2019a). This concerns fodder which are directly fed to animals, without the process of including them in a compound feed. This usually happens since they are produced at farm. These include roughages (fresh grass, grass silage, maize silage, straw and hay), wet co-products (spent brewers and distillers' grain) and crops (grains, beets and legumes).

Besides the different types of feed, some feed nutrition related characteristics have to be defined. These characteristics encompass digestibility, overall gross energy (GE) intake, amount of silage and crude protein content in overall diet. Such characteristics should be calculated as a weighted average of the overall diet based on the characteristics at product level. These feed characteristics influence various emissions (such as methane, nitrous oxide, and ammonia) from manure storage and pre-treatment.

Water

There are multiple types of water consumption on the dairy farm. Water is consumed by the animals as drinking water. Water is also used on the farm for management purposes like cleaning the milking area. In practice, water can also be used for irrigation of crops. Irrigation water is already included in the background LCI, such that the total water input on the dairy farm is equal to all water use except the water used for irrigation of crops.

Bedding

Bedding is used in the stable of the dairy cows. Two types of bedding can be selected in APS-footprint: saw dust and straw. These types of bedding are commonly used in typical dairy systems.

Energy

There are several types of energy use on the dairy farm. A main source of energy is electricity (cooling is important), but other fuels, like natural gas and diesel are also used. Electricity use includes all types of farm associated activities. Typical activities are cooling, lighting, ventilation, automated feed and water rationing, automated milking systems, and water recirculation. In APS-footprint, electricity production is based on ecoinvent processes that reflect the national grid. Specific production technologies (e.g. wind or solar electricity) can be altered after exporting the process to SimaPro. Natural gas and diesel are mainly used for the heating system or farm machinery (including the machinery used to store and collect roughage). Diesel used for machines during crop cultivation are not considered here, since this is already included in the cultivation background LCI.

Output

The main output of the dairy APS is raw milk. Required parameters are the yearly farm milk production, the fat content, and the protein content of the milk. Milk losses at farm and milk that is not suitable for consumption (e.g. milk discarded because contaminated by antibiotics or high microbial load) is not accounted in the raw milk output.

The dairy APS module also accounts for live animal leaving the farm. Dairy cows are removed from the herd for various reasons, usually connected to decrease in productivity. These are usually culled. A dairy farm also produces male calves and quite often some surplus female calves which are also co-products of the dairy farm system. These can be slaughtered directly or can be sold for further growth in other production systems. The total amount of liveweight (kg) leaving the dairy APS is required (including both replaced cows and calves).

Mortality output is currently not considered in the dairy APS module, in terms out mortalities (kg) and the fate of mortalities (e.g. rendering, composting, incineration). However, mortality is considered when establishing the steady-state herd size.

Functional unit

The functional unit used in APS is 1 kilogram of Fat-Protein Corrected Milk (FPCM) (corrected to 4% fat and 3.3% protein) as calculated in PEFCR dairy guidelines (European Commission, 2018b):

$$FPCM\ (kg/yr) = Production\ (\ kg/yr)\ x\ (0.1226\ x\ True\ Fat\% + 0.0776\ x\ True\ Protein\% + 0.2534)$$

Where:

- FPCM is the amount of Fat-Protein Corrected Milk (kg/year);
- Production is the amount of milk produced (kg/year);
- True fat is the content of fat present in the produced milk (%);
- True protein in the content if protein in the produced milk (%);

Since this study considers a functional unit of 1 liter of milk “as is” with different fat contents (whole, (semi)skimmed), this FPCM is converted back to milk “as is”.

Allocation at farm

Allocation is used to distribute the overall environmental impacts to the different outputs: milk and animal liveweight (aggregate of replaced dairy cows and sold calves). The dairy module of APS-footprint uses biophysical allocation to calculate the environmental impact of the two co-products. This type of allocation is extensively used in the dairy sector. It was developed by the International Dairy Association (IDF, 2010) and was suggested by the dairy PEFCR (European Commission, 2018):

$$AF = 1 - 6.04\ x\ (Mmeat\ /\ Mmilk)$$

Where AF is the Allocation Factor of milk, $Mmeat$ is the mass of live weight of all animal sold including calves and culled mature animals per year, and $Mmilk$ is the mass if FPCM sold per year.

The allocation for Meat can be calculated as 1 - AF. According to the dairy PEFCR, manure can be considered as a residual product, a co-product or waste. In the APS footprint, manure is treated as a residual product. This means that manure is exported from the farm as product with no economic value. There is no allocation: burden is allocated to other products produced at farm, including pre-treatment of manure.

Sweden

The majority of data on Swedish dairy systems is derived from Cederberg (2009). Since this paper is a bit outdated, the two key parameters influencing efficiency of dairy systems were updated with more recent information: milk output and feed intake. The ratio between the two is called feed efficiency (kg feed per kg milk). The milk output (kg milk/animal) is updated based on the latest NIR, and the feed intake is adjusted based on recent feed efficiency from (Tarekegn et al., 2021). For other data points, it was decided for consistency reasons to base the data on one source as much as possible.

More details on the exact data sources used and assumptions made can be found in the table below (references can be found in the main report).

Data point	Value (per year)	Explanation/source
General details		
Farming method	Conventional	
Year	2009	
Geography	Sweden	
Average annual temperature	2.1	
Total herd size	563268	Cederberg, 2009
OUTPUTS		
Milk (total weight) (kg)	3690820180	Milk yield (9385, from NIR) multiplied by number of dairy cows (see below)
Protein content (%)	3.38	Cederberg, 2009
Fat content (%)	4.25	Cederberg, 2009
Total livestock to slaughter (liveweight) (kg)	91725000	NIR2017/2020 Dairy cows/calves/heifers sent to slaughter multiplied by weight of those animals from NIR 2017
RESOURCE USE		
Electricity use (MJ)	1840494240	Cederberg, 2009 (1300 kWh per dairy cow /year), modelled using Swedish electricity mix
Gas use (MJ)	0	Cederberg, 2009
Diesel use (MJ)	390480000	Cederberg, 2009
Water consumption (kg)	18081075080	From SIK, 2013
HOUSING SYSTEMS		
Housing - Heifers	149000	Dalgaard, 2012 / Cederberg, 2009
Housing - Calves 1-2 year	87000	Dalgaard, 2012 / Cederberg, 2009
Housing - Calves <1 year	194000	Dalgaard, 2012 / Cederberg, 2009
Housing - Dairy cows	393268	Dalgaard, 2012 / Cederberg, 2009
Housing system dairy cows		
RATION		Feed rations are based on a combination of data from Cederberg (2009) and Hendriksson (2013). Ingredients are modelled to represent Swedish conditions, thus using Swedish cultivation data from AFP as well as Swedish market mixes in case of feed from outside the farm. Transport from cultivation country to Sweden, as well as within Sweden, is added.
Concentrate feed	1994	Based on Cederberg. 10 main ingredients were included: rapeseed meal, beet pulp, soymeal, palmkernel exp, grain bran, distiller's dried gr, molasses, fatty acids, grain middlings, peas
Minerals	86	
Grass silage, grown on farm, SE	5350	Adapted N fertilizer input grass based on Cederberg, 2009
Maize silage, grown on farm, SE	294	
Grass for grazing, permanent pasture, SE	1927	Adapted N fertilizer input grass based on Cederberg, 2009
wheat, via feed	133	Swedish market mix
triticale, via feed	114	Swedish market mix
barley, via feed	170	Swedish market mix
oats, via feed	57	Swedish market mix
barley (grain), grown on farm	652	
oats (grain), grown on farm	639	
super pressed pulp	172	sugar beet
straw	66	
Total feed intake (kg/animal)	11654	Total of the above
Gross energy intake (MJ/animal)	112959	Calculated with values from feedipedia
Digestibility (% of GE)	70.2%	Calculated with values from feedipedia
Crude protein in diet (% of DM)	17.9%	Calculated with values from feedipedia
Percentage of silage (% of GE)	41.1%	GE provided by silage/total GE
HOUSING		
Straw for bedding (kg/animal)	44	Based on Danish dairy system, as no Swedish data was available

Saw dust (kg/animal)	6.25	Based on Danish dairy system, as no Swedish data was available
Type (e.g. housed/ free ranging)	housed	
MANURE MANAGEMENT		
Manure management system (select type, e.g. dry lot)	11% solid storage, 79% Liquid/slurry with natural crust cover	From Cederberg (2009) The 2 main manure management systems were modelled, representing 90% of all manure management systems
TIME SPENT DISTRIBUTION		
Time spent grazing (%)	21%	Cederberg, 2009
Time spent in open yard areas (%)	0%	Cederberg, 2009
Time spent in buildings (%)	79%	Cederberg, 2009
Housing system Heifers and Calves 1-2 years		
RATION (in kg as is)		Feed rations are based on a combination of data from Cederberg (2009) and Hendriksson (2013). Ingredients are modelled to represent Swedish conditions, thus using Swedish cultivation data from AFP as well as Swedish market mixes in case of feed from outside the farm. Transport from cultivation country to Sweden, as well as within Sweden, is added.
Concentrate feed	366	
Minerals	16	
Grass silage, grown on farm, SE	2592	
Maize silage, grown on farm, SE	0	
Grass for grazing, permanent pasture, SE	934	
wheat, via feed	27	
triticale, via feed	23	
barley, via feed	34	
oats, via feed	11	
barley (grain), grown on farm	130	
oats (grain), grown on farm	128	
super pressed pulp	0	
straw	57	
Total feed intake (kg/animal)	4317	Total of the above
Gross energy intake (MJ/animal)	36738	Calculated with values from feedipedia
Digestibility (% of GE)	69.4%	Calculated with values from feedipedia
Crude protein in diet (% of DM)	16.2%	Calculated with values from feedipedia
Percentage of silage (% of GE)	59.0%	GE provided by silage/total GE
HOUSING		
Straw for bedding (kg/animal)	44	Based on Danish dairy system, as no Swedish data was available
Saw dust (kg/animal)	6.25	Based on Danish dairy system, as no Swedish data was available
Type (e.g. housed/ free ranging)	housed	
MANURE MANAGEMENT		
Manure management system (select type, e.g. dry lot)	liquid/slurry with natural crust cover	The dominant manure management system was modelled
TIME SPENT DISTRIBUTION		
Time spent grazing (%)	46%	Cederberg, 2009
Time spent in open yard areas (%)	0%	Cederberg, 2009
Time spent in buildings (%)	54%	Cederberg, 2009
Housing system calves <1 year		
RATION (kg as is)		The quantity of feed consumed is based on data from Denmark, as Swedish data was not available. This was deemed appropriate as calves don't have a big contribution compared to dairy cows and heifers. Swedish data was used to model the feed ingredients.
Concentrate feed	78	
Grass silage, grown on farm, SE	4281	
Grass for grazing, permanent pasture, SE	40	Grass dataset modelled based on yield and inputs from (Krizsan, Chagas, Pang, & Cabezas-Garcia, 2021) and Cederberg, 2009
Straw	154	
Total feed intake (kg/animal)	4553	Total of the above

Gross energy intake (MJ/animal)	41348	Calculated with values from feedipedia
Digestibility (% of GE)	80.0%	Calculated with values from feedipedia
Crude protein in diet (% of DM)	18.3%	Calculated with values from feedipedia
Percentage of silage (% of GE)	90.5%	GE provided by silage/total GE
HOUSING		
Straw for bedding (kg/animal)	0	
Saw dust (kg/animal)	0	
Type (e.g. housed/ free ranging)	housed	
MANURE MANAGEMENT		
Manure management system	liquid/slurry with natural crust cover	Based on Denmark
TIME SPENT DISTRIBUTION		
Time spent grazing (%)	33%	Based on Denmark
Time spent in open yard areas (%)	0%	Based on Denmark
Time spent in buildings (%)	68%	Based on Denmark

Finland

The National Inventory Report (NIR) of Finland (Statistics Finland, 2021) is taken as the leading source of the data. The reference year listed in this source is 2019. Important parameters, such as the milk output, the protein and fat content of milk, the average liveweight of animals in different age groups, the share of manure management systems, and the share of grazing and non-grazing periods are retrieved from the NIR.

Various sources are used to complement these data. Data on the herd size- and composition for the year 2019 are retrieved from the Natural Resources Institute Finland database (LUKE, 2019). In addition, LUKE provides data to determine the total amount of livestock (heads) to slaughter (dairy cows and heifers >1 years), which was complemented with data from (Hietala et al., 2021) to determine the share of dairy breed heifers of the total heifers slaughtered (67%).

For the amount and type of bedding material for dairy cows a proxy is retrieved from Hietala et al. (2021), in which the amount and type of bedding material for beef cows is specified. Since this datapoint is expected not to be a key parameter, a proxy is estimated to be appropriate for this purpose.

Moreover, the amount of water consumed (drinking water and cleaning water) is taken from the (confidential) LCA study performed by the Swedish Institute for Food and Biotechnology (SIK) for Oatly. It is assumed that the water used for drinking and cleaning in Sweden is comparable to Finland.

Feed rations for dairy cows and heifers are obtained from ProAgria (ProAgria, 2021). For calves <1 year, no data was available, and hence the feed rations were based on Danish data, which are assumed to be relatively similar to Finland.

Data point	**Value (per year)**	**Explanation / source**
General details		
Year		
Geography	Finland	
Average annual temperature	1.7	Wikipedia (2020)
Total herd size	445,985	
All inputs below need to be defined per year		
Outputs		
Milk (total weight) (kg)	2,349,621,560	NIR (2019)
Protein content (%)	3.5%	NIR (2019)
Fat content (%)	4.4%	NIR (2019)
Total livestock to slaughter (liveweight) (kg)	66,306,215	LUKE (2019) and Hietala (2020)
Resource use		
Electricity use (MJ)	1,271,098,137	Valo (2020)
Gas use (MJ)	32,980,010	Valo (2020)

Diesel use (MJ)		No diesel use for animal farm
Fuel oil use (L)	58,563,834	Valo (2020)
Water consumption (kg)	11,312,547,200	Proxy (SIK, 2013)
Housing systems		
Housing - Heifers	15,001	LUKE (2019)
Housing - Calves 1-2 year	85,086	LUKE (2019)
Housing - Calves <1 year	86,958	LUKE (2019) all heifer calves, corrected with replacement ratio
Housing - Dairy cows	258,940	LUKE (2019)
Housing system dairy cows		
RATION (kg as is)		The quantities of main feed ingredients are based on ProAgria (2021). Quantities were converted to kg as is using dry matter percentages from AFP
Silage	9935	84% grass silage, 16% grain silage (assumed maize silage)
Grazed grass	393	Grass dataset modelled based on yields and inputs from (Smit, Metzger, & Ewert, 2008) and Pallière, C. (2011)
Hay & straw	39	
Cereals	1974	Consists of barley and oats. Modelled using barley and oats market mix
Energy compounds	1143	assuming rapeseed meal and sugar beet pulp (common in Swedish compound feed)
Protein compounds	777	assuming soybean meal (common in Swedish compound feed)
By-products	571	assuming distiller's grain
Minerals and additives	105	
Total feed intake (kg/animal)	14938	Total of the above
Gross energy intake (MJ/animal)	166312	Based on GE data per ingredient from feedipedia
Digestibility (% of GE)	74%	Based on digestibility data per ingredient from feedipedia
Crude protein in diet (% of DM)	20%	Based on crude protein data per ingredient from feedipedia
Percentage of silage (% of GE)	53%	Based on GE data per ingredient from feedipedia
HOUSING		
Straw for bedding (kg/animal)	438	Hietala (2020) based on beef breed
Peat for bedding (kg/animal)	803	Hietala (2020) based on beef breed
Saw dust (kg/animal)	0	
Type (e.g. housed/ free ranging)	housed	
MANURE MANAGEMENT		
Manure management system (select type, e.g. dry lot)		NIR: Dairy cows: 51% slurry with natural cover, 23% solid storage, 14% slurry with no cover, 11% pasture
TIME SPENT DISTRIBUTION		
Time spent grazing (%)	32.5%	NIR: length of the pasture season has been estimated to be 125 to 112 days for dairy cows
Time spent in open yard areas (%)	0.0%	
Time spent in buildings (%)	67.5%	
Housing system Heifers and Calves 1-2 years		
RATION		The quantities of main feed ingredients are based on ProAgria (2021). Quantities were converted to kg as is using dry matter percentages from AFP
Silage	6583	84% grass silage, 16% grain silage (assumed maize)
Grazed grass	819	
Hay & straw	455	
Cereals	110	Consists of barley and oats. Modelled using barley and oats market mix
Energy compounds	15	assuming rapeseed meal and sugar beet pulp (common in Swedish compound feed)
Protein compounds	86	assuming soybean meal (common in Swedish compound feed)
By-products	98	assuming distiller's grain
Minerals and additives	64	
Total feed intake (kg/animal)	8229	Total of the above

Gross energy intake (MJ/animal)	73843	Calculated with values from feedipedia
Digestibility (% of GE)	66%	Calculated with values from feedipedia
Crude protein in diet (% of DM)	15%	Calculated with values from feedipedia
Percentage of silage (% of GE)	80%	GE provided by silage/total GE
HOUSING	**DQR: moderate**	
Straw for bedding (kg/animal)	44	Based on Danish dairy system, as no Finnish data was available
Saw dust (kg/animal)	6.25	Based on Danish dairy system, as no Finnish data was available
Type (e.g. housed/ free ranging)	housed	
MANURE MANAGEMENT	**DQR: moderate**	
Manure management system (select type, e.g. dry lot)		NIR: Heifers: 35% slurry with natural cover, 26% solid storage, 23% pasture, 10% slurry with no cover
TIME SPENT DISTRIBUTION		
Time spent grazing (%)	37.0%	NIR: length pasture season 130 to 140 for heifers
Time spent in open yard areas (%)	0.0%	
Time spent in buildings (%)	63.0%	
Housing system calves < 1 year		
RATION (as is)		The quantity of feed consumed is based on data from Denmark, as Finnish nor Swedish data was not available. This was deemed appropriate as calves don't have a big contribution compared to dairy cows and heifers.
Concentrate feed	78	
Grass silage, grown on farm	4281	
Grass for grazing, permanent pasture	40	
Straw	154	
Total feed intake (kg/animal)	4553	Total of the above
Gross energy intake (MJ/animal)	41348	Calculated with values from feedipedia
Digestibility (% of GE)	80.0%	Calculated with values from feedipedia
Crude protein in diet (% of DM)	18.3%	Calculated with values from feedipedia
Percentage of silage (% of GE)	90.5%	GE provided by silage/total GE
HOUSING		
Straw for bedding (kg/animal)	0	
Saw dust (kg/animal)	0	
Type (e.g. housed/ free ranging)	housed	
MANURE MANAGEMENT		
Manure management system (select type, e.g. dry lot)		NIR: Calves < 1 year: 37% solid storage, 31% slurry with natural cover, 10% pasture, 9% slurry with no cover
TIME SPENT DISTRIBUTION		
Time spent grazing (%)	31.5%	NIR: 100 to 130 for calves
Time spent in open yard areas (%)		
Time spent in buildings (%)	68.5%	

Appendix IV Full LCIA Results

Impact category	Unit	Chilled Oatly Oat Drink Semi – Retail SE	Chilled Oatly Oat Drink Semi – Retail FI
Climate change - incl LUC and peat ox	kg CO2 eq	3.77E-01	4.11E-01
Climate change - excl LUC and peat ox	kg CO2 eq	2.86E-01	3.20E-01
Climate change - only LUC	kg CO2 eq	2.38E-02	2.38E-02
Climate change - only peat ox	kg CO2 eq	6.76E-02	6.76E-02
Stratospheric ozone depletion	kg CFC11 eq	2.24E-06	2.26E-06
Ionizing radiation	kBq Co-60 eq	3.54E-02	3.51E-02
Ozone formation, Human health	kg NOx eq	1.07E-03	1.35E-03
Fine particulate matter formation	kg PM2.5 eq	3.56E-04	4.25E-04
Ozone formation, Terrestrial ecosystems	kg NOx eq	1.32E-03	1.61E-03
Terrestrial acidification	kg SO2 eq	1.27E-03	1.45E-03
Freshwater eutrophication	kg P eq	1.02E-04	1.17E-04
Marine eutrophication	kg N eq	4.53E-04	4.64E-04
Terrestrial ecotoxicity	kg 1,4-DCB	8.29E-01	8.74E-01
Freshwater ecotoxicity	kg 1,4-DCB	2.04E-02	2.13E-02
Marine ecotoxicity	kg 1,4-DCB	1.52E-02	1.64E-02
Human carcinogenic toxicity	kg 1,4-DCB	1.09E-02	1.15E-02
Human non-carcinogenic toxicity	kg 1,4-DCB	3.92E-01	4.18E-01
Land use (Total)	m2a crop eq	5.53E-01	5.54E-01
Land use (Transformation)	m2a crop eq	-1.73E-04	4.60E-05
Mineral resource scarcity	kg Cu eq	8.07E-04	8.35E-04
Fossil resource scarcity	kg oil eq	5.12E-02	6.37E-02
Water consumption	m3	3.27E-03	3.31E-03
Land occupation	m2a	6.44E-01	6.48E-01

Appendix V Nutritional composition of Oatly Oat Drink Semi and cow's milk

Nutritional data is provided for Oatly Oat Drink Semi, as well as semi-skimmed and whole cow's milk (to show possible range for cow's milk) for the countries in scope. All values are provided per 100 ml.

	Unit	Oatly Oat Drink Semi EU	Cow's milk Sweden skimmed	Cow's milk Sweden whole	Cow's milk Finland skimmed	Cow's milk Finland whole
Energy	kJ	200	161	251	142	265
	kcal	48	39	60	34	363
Fat	g	1.5	0.5	3	0.1	3.5
of which saturated	g	0.2	Not reported	Not reported	0	2.2
Carbohydrates	g	7.0	5.2	4.7	4.9	4.8
of which sugars	g	3.4	0	4.8	4.9	4.8
Fiber	g	0.8	0	0	0	0
Protein	g	1.1	3.6	3.5	3.1	3
Salt	g	0.1	0.04	0.04	0.044	0.044
Vitamin D2	µg	1.1	1	1	1	1
Riboflavin	mg	0.21	0.15	0.15	0.19	0.18
Vitamin B12	µg	0.24	0.59	0.58	0.4	0.4
Calcium	mg	120.0	124	120	121	124
Iodine	µg	22.5	12.1	11.8	13.8	13.7
Iron	mg	not reported	0	0	0	0
Potassium	mg	not reported	165	161	160	160
Vitamin A	µg	not reported	8.3	47.888	4.1	28.6
Phosphorus	mg	not reported	105	102	90	90

Source Oatly: https://www.oatly.com/en-gb/products/oat-drink/oat-drink-semi-1-5-1l

Source Finland: https://fineli.fi/fineli/en/index

Source Sweden: https://www7.slv.se/SokNaringsinnehall/

Appendix VI Critical Review Statement and Report

Critical Review Statement

The life cycle assessment (LCA) study *LCA of chilled Oatly Oat Drink Semi for Sweden and Finland, and comparison with cow's milk* addendum to the report *"LCA of Oatly Barista and comparison with cow's milk"* was commissioned by Oatly (commissioner of the study) and carried out by Blonk Consultants (practitioner of the LCA study). Blonk Consultants commissioned a panel of external experts to review the study *LCA of chilled Oatly Oat Drink Semi for Sweden and Finland, and comparison with cow's milk*. The study was critically reviewed by an international panel of experts comprising:

- Jasmina Burek (chair): Assistant Professor, University of Massachusetts Lowell, United States
- Jens Lansche: LCA expert and project manager, Switzerland
- Joseph Poore: Director of the Oxford Martin Programme on Food Sustainability, United Kingdom
- Hayo van der Werf: LCA expert, France

All members of the review panel were independent of any party with a commercial interest in the study. The following is a final statement by the external review panel based on the review of the Draft Report, a version of the document submitted on April 30, 2024.

Critical Review Process

The critical review was performed based on ISO 14044:2006 standard, by a panel of interested parties (ISO 14044, 2006). The critical review panel followed the ISO/TS critical review process guidelines (ISO/TS, 2014). The panel performed the critical review at the end of the LCA study, after LCA practitioners provided the full draft of the LCA report. This is because this study closely follows methods of previously peer reviewed report "LCA of Oatly Barista and comparison with cow's milk", by 3 out of 4 members of the expert panel. One round of review comment was performed after LCA practitioners provided the full draft of the LCA report to the critical review panel. The reviewers took part in communication via email. The critical review report (Appendix VI) includes panel review comments and recommendations and the corresponding responses given by the practitioner of the LCA study.

The critical review panel found the LCA study to be in conformance with ISO 14040 and ISO 14044 standards (ISO 14040, 2006; ISO 14044, 2006) including:

- the methods used to carry out the LCA were consistent with the applicable international standards
- the methods used to carry out the LCA were scientifically and technically valid
- the data used were appropriate and reasonable in relation to the goal of the study
- the interpretations reflected the limitations identified and the goal of the study, and
- the study report was transparent and consistent.

The critical review did not verify nor validate the goals that are chosen for an LCA by the commissioner of the LCA study, nor the ways in which the LCA results are used (ISO/TS, 2014). Finally, following the ISO/TS standard (ISO/TS, 2014) this critical review in no way implies an endorsement of any comparative assertion that is based on an LCA study. The panel asserts conformity with the ISO standards followed (ISO 14040, 2006; ISO 14044, 2006; ISO/TS, 2014) and a scientifically and technically valid methodological approach and results interpretation.

The critical-review process involved the following:

- a review of a draft report according to the above criteria and recommendations for improvements to the study and the report; and
- a review of the final version of the report, in which the authors of the study fully addressed the points as suggested in the draft critical review.

Because the *LCA of chilled Oatly Oat Drink Semi for Sweden and Finland, and comparison with cow's milk* study builds on the foundations of the previous LCA studies study for Oatly, i.e., "*LCA of Oatly Barista and comparison with cow's milk"*, reviewed by 3 out of 4 members of the external review panel, all reviewers' comments were provided via email including:

- April 24, 2024 – reviewers provided comments on the draft of the final LCA report via email.
- April 30, 2024 – reviewers validated changes from the previous review and identified minor editorial changes on the final LCA report via email.

After each review, the LCA practitioner responded and/or and documented the adopted changes and implementation in the next version of the draft report. The Critical Review Report (Appendix VI) includes panel review comments and recommendations and the corresponding responses given by the practitioner of the LCA study.

The review panel concludes based on the goals set forth to review this study, that the study generally conforms to the applicable ISO standards as a comprehensive study that may be disclosed to the public.

The reviewers recognize the tremendous work of the LCA practitioners and stakeholder in completing this study.

May 2, 2024

Dr. Jasmina Burek	Dr. Jens Lansche	Dr. Joseph Poore	Dr. Hayo van der Werf
Panel Chair	Panel Member	Panel Member	Panel Member

LCA of chilled Oatly Oat Drink Semi for Sweden and Finland, and comparison with cow's milk

Addendum to the report "LCA of Oatly Barista and comparison with cow's milk", published on 7 December 2022

Version of the document submitted on April 29, 2024

Critical Review Report

Dr. Jasmina Burek (ISO Review chair)
Assistant Professor
University of Massachusetts Lowell, United States
Tel. 479 422-7146
E-Mail: jasmina_burek@uml.edu

Dr. Jens Lansche (ISO Review panelist)
LCA expert and project manager
Switzerland

Dr. Joseph Poore (ISO Review panelist)
Director of the Oxford Martin Programme on Food Sustainability
United Kingdom

Dr. Hayo van der Werf (ISO Review panelist)
LCA expert
France

1. Introduction

The **Critical Review Report** is the summary report documenting the critical review process according to the ISO/TS 14071:2014 Standard - Environmental management -- Life cycle assessment -- Critical review processes and reviewer competencies: Additional requirements and guidelines to ISO 14044:2006. The **Critical Review Report** provides details of the complete review process (ISO/TS, 2014) and includes review comment iterations of the study "*LCA of chilled Oatly Oat Drink Semi for Sweden and Finland, and comparison with cow's milk*", which is addendum to the report *"LCA of Oatly Barista and comparison with cow's milk"*. The study "*LCA of chilled Oatly Oat Drink Semi for Sweden and Finland, and comparison with cow's milk*" was commissioned by Oatly and life cycle assessment (LCA) was performed by Blonk Consultants. The critical review was commissioned by the practitioners of the LCA study. Critical review was carried out by a panel of reviewers, as defined in ISO 14044:2006 (ISO 14044, 2006). The **Critical Review Report** was prepared by the critical review panel. The **Critical Review Report** applies to the final version *"LCA of chilled Oatly Oat Drink Semi for Sweden and Finland, and comparison with cow's milk"*, published on May 2, 2024.

2. Critical Review Process

The critical review panel followed the ISO/TS critical review process guidelines (ISO/TS, 2014). Because this LCA study includes results which are intended to be used to support a comparative assertion intended to be disclosed to the public, per critical review process guidelines (ISO/TS, 2014), the critical review was conducted by a panel.

Reviewer comments were provided after LCA practitioners provided the full draft of the LCA report to the critical review panel. The critical review report includes panel review comments and recommendations, and the corresponding responses given by the practitioner of the LCA study.

Per critical review process guidelines (ISO/TS, 2014), the goal of this critical review was to verify that:

- the methods used to carry out the LCA study are consistent with the 14040/14044 International Standards (ISO 14040, 2006; ISO 14044, 2006),
- the methods used to carry out the LCA are scientifically and technically valid,
- the data used are appropriate and reasonable in relation to the goal of the study,
- the interpretations reflect the limitations identified and the goal of the study,
- the study report is transparent and consistent.

However, critical review can neither verify nor validate the goals that are chosen for an LCA by the commissioner of the LCA study, nor the ways in which the LCA results are used (ISO/TS, 2014). Finally, following the ISO/TS standard (ISO/TS, 2014) this critical review in no way implies an endorsement of any comparative assertion that is based on an LCA study.

The review was performed by an independent expert panel composed of four members. The critical-review process involved the following:

- a review of a draft report according to the above criteria and recommendations for improvements to the study and the report; and
- a review of the final version of the report, in which the authors of the study fully

addressed the points as suggested in the critical review.

3. Critical Review Results

This section includes a summary of the critical review. A complete list of comments addressing specific statements on the draft LCA report provided by the critical review panelists and subsequent revisions is provided in Appendix VI.

The reviewers recognize the remarkable effort by the LCA practitioners (Blonk Consultants) in conducting the comparative LCA study as well as the stakeholder (Oatly) that provided primary data as well as critical comments. The critical review panel pointed out both the strengths as well as key areas of improvement necessary to conform to the 14040/14044 International Standards (ISO 14040, 2006; ISO 14044, 2006).

3.1. Consistency with 14040/14044 International Standards

The final LCA report is consistent with the 14040 and 14044 International Standards (ISO 14040, 2006; ISO 14044, 2006) and the European Product Environmental Footprint Category Rules (PEFCR) (European Commission, 2017). It was not deemed necessary to repeat all sensitivity analyses, considering that the environmental impacts related to Oatly Barista (main report), are comparable to the results of Oatly Oat Drink Semi at point-of-sale Sweeden and Finland. Thus, the conclusions that were drawn based on the sensitivity analyses in the main report also apply to the products in this addendum.

The study is comprehensive in scope and contains a wealth of information and data related to Oatly Oat Drink Semi product supply chains in their respective sales countries, i.e., Sweeden and Finland. The authors provided information about why the critical review is being undertaken and what data collection covered and to what level of detail and how comparison with the milk was conducted.

3.2. Life Cycle Assessment Approach and Life Cycle Impact Assessment Method

The authors computed results following the attributional LCA approach. In a baseline scenario, Oatly Oat Drink Semi was compared to 1 l of cow milk at the point of sale, i.e., Sweeden and Finland. The life cycle impact assessment was performed using ten key midpoint environmental impact categories from the ReCiPe 2016 impact assessment method (Huijbregts et al., 2016). Overall, the methodology to evaluate the results of the impact assessment and support conclusion are considered appropriate for the goal and scope of the study.

3.3. Data Used for Life Cycle Inventory in Relation to the Goal of the Study

The life cycle inventory (LCI) data necessary to perform LCA of Oatly Oat Drink Semi for Sweeden and Finland markets was taken from the main Oatly Barista report with exception to (1) the energy and water use at the Landskrona factories has been updated to 2022 data, (2) chilled distribution and packaging are considered, using the same data for chilled distribution and packaging as in the main report, (3) background data have been updated to the following database versions: Agri-footprint 3.6 and Ecoinvent 3.9, and (4) nutritional properties of Oatly Oat Drink Semi. The authors of the final report clearly described LCIs and data sources. Also, authors provided information about robustness and limitations of the data used for Oatly Oat Drink Semi and cow's milk LCI and assumptions for sensitivity and uncertainty analyses. Overall, the data used is considered appropriate and reasonable for the goal and scope of the study.

3.4. Interpretation and Limitations within the Goal of the Study

The selected results help to understand the study's conclusions and adequately support derived interpretation. Overall, interpretation of results and limitations of the study discussed in the report are considered appropriate for the goal of the study.

3.5. Transparency and Consistency of the Final Report

The authors provided an addendum report following the 14040/14044 International Standards (ISO 14040, 2006; ISO 14044, 2006) and supplemental information with information concerning the data and methodology used and differences from the main report. The addendum report describes the LCA framework including goal and scope, LCI, LCIA, results and interpretation and conclusion. The key aspects of the data used is described in the LCI section and accompanied with the main Oatly Barista report, which provides more details on the data sources. Overall, the information given in the documentation is considered appropriate for understanding the methodology and data basis for most topics.

Literature

European Commission, 2017. Product Environmental Footprint Category Rules Guidance. PEFCR Guid. Doc. - Guid. Dev. Prod. Environ. Footpr. Categ. Rules (PEFCRs), version 6.3, December 2017. 238.

Huijbregts, M.A.J., Steinmann, Z.J.., Elshout, P.M.F., Stam, G., Verones, F., Vieira, M.D.., Zijp, M., van Zelm, R., 2016. ReCiPe 2016: A harmonized life cycle impact assessment method at midpoint and enpoint level - report 1 : characterization, National Institute for Public Health and the Environment.

ISO/TS, 2014. ISO/TS 14071:2014 - Environmental management -- Life cycle assessment -- Critical review processes and reviewer competencies: Additional requirements and guidelines to ISO 14044:2006 [WWW Document]. URL https://www.iso.org/standard/61103.html (accessed 6.21.19).

ISO 14040, 2006. ISO 14040:2006 - Environmental management - life cycle assessment - principles and framework [WWW Document]. ISO. URL https://www.iso.org/standard/37456.html (accessed 2.22.17).

ISO 14044, 2006. Environmental management - Life cycle assessment — Requirements and guidelines (International Organization for Standardization).

4. List of Specific Reviewer Comments Recommendations and Corresponding Responses

The Critical Review Panel provided comments on the draft report. These comments were addressed and/or incorporated in the final version of the report by the LCA partitioners. The review statement and review panel report including comments of the experts and any responses to recommendations made by the reviewers or by the panel have been included in the final LCA report.

Template for CR comments and commissioner & practitioner responses

Date: 24 April 2024 – 2 May	Document: **LCA of chilled Oatly Oat Drink Semi for Sweden and Finland, and comparison with cow's milk**	Project:

Reviewer[1]	Line number	Clause/ Subclause	Paragraph/ Figure/ Table/	Type of comment[2]	Comments	Proposed change	Response of the commissioner & practitioner
HW	4			ed	It would be good to describe what chilled Oatly Oat Drink Semi is, and how it differs from Oatly Barista.	Add description.	Done
HW	24			ed	Change "between" to "in".	Adjust.	Done
HW	79-80			ed	Mineral resource scarcity is missing in the list of impact categories.	Adjust.	Done
HW			Table 4	ed	In the column "Impact category", to be coherent with Table 3 change "Global warming" to "Climate change".	Adjust.	Done
HW			Table 4	te	Value for "Global warming – incl. LUC and peat ox for cow milk Sweden (1.102)" is not identical to the corresponding value in table 5 of the report LCA of Oatly "No" Sugars and Oatly Oat Drink (Whole/Semi/Light), and comparison with cow's milk (1.124). The difference is small, but still…	Can you check?	This is because an update of the background databases used (Agri-footprint and ecoinvent)
HW			Table 4	te	Value for "Global warming – incl. LUC and peat ox for cow milk Finland" (1.700) is not identical to the corresponding value in table 5 of the report LCA of Oatly "No" Sugars and Oatly Oat Drink (Whole/Semi/Light), and comparison with cow's milk (1.711). The difference is very small, but still…	Can you check?	This is because an update of the background databases used (Agri-footprint and ecoinvent)
HW	261			ed	Delete "in".	Adjust	Done
HW	270			ed	Delete "products".	Adjust	Done
HW	271			ed	Change "as many" to "as to many".	Adjust	Done
HW	285			ed	Change "DC" to "distribution centre (DC)", because this is the first time "DC" is used.	Adjust	Done
HW			Table 6	ed	To be coherent with Table 3 change "Global warming" to "Climate change".	Adjust.	Done
HW	372			ed	Change "all" to "both".	Adjust	Done
HW			Appendix II	ed	To be coherent with Table 3 change "Global warming" to "Climate change".	Adjust	Done
HW				te	I think it would be good to add the equivalents of the appendices II (Oatly production modelling) and III (Dairy datasets) of the report "LCA of Oatly Barista for Poland, Ireland	Adjust	Done

1 Initials of the **Reviewer**
2 **Type of comment: ge** = general **te** = technical **ed** = editorial

Template for CR comments and commissioner & practitioner responses

Date: 24 April 2024 – 2 May	Document: **LCA of chilled Oatly Oat Drink Semi for Sweden and Finland, and comparison with cow's milk**	Project:

Reviewer[1]	Line number	Clause/ Subclause	Paragraph / Figure/ Table/	Type of comment[2]	Comments	Proposed change	Response of the commissioner & practitioner
					and France, and comparison with cow's milk" to this report, to make it more complete. This would supply the reader with relevant information that otherwise can only be found in other Oatly LCA reports.		
JL	42			ed	Typo: "FINALND" should be corrected to "FINLAND"	Adjust	Done
JL	59			ed	"ABBREVIATIONS USED: FI = Finland and SE = SWEDEN." Is repeated. Remove repetition	Adjust	Done
JL	97			ed	"is considered" should read as "are considered"	Adjust	Done
JL	166			ed	"have" should read as *had"	Adjust	Done
JL	211			ed	"is considered" should read as "are considered"	Adjust	Done
JL	307			ed	"ABBREVIATIONS USED: FI = Finland and SE = SWEDEN." Is repeated. Remove repetition	Adjust	Done
JP	59		Figure 1	ed	In the caption, "abbreviation used" is repeated twice	Remove one of the "abbreviation used" sentences	Done
JP	80			ed	Mineral resource scarcity is missing from the impact category list	Add mineral resource scarcity	Done
JP	126			ed	Not clear what (semi-)skimmed means	Replace with semi-skimmed, and skimmed throughout the text	Done
JP	140			ed	"Fortified with calcium, minerals, and vitamins" – gives the idea that calcium is not a mineral	Replace with "fortified with calcium, other minerals, and vitamins"	Done
JP	140			ed	"In line with its fat content (1.5%), rapeseed oil is added." – I find this sentence a bit confusing	Rephrase to something like "Rapeseed oil is added to reach a fat content of 1.5%"	Done
JP	150			ge	Isnt' the Oatly Oat Drink Semi mostly meant to replace semi-skimmed cow's milk? I saw you mention that a "similar range of differences between cow's milk and Oatly Oat Drink Semi when comparing it to semi-skimmed cow's milk instead of the average mix of skimmed, semi-skimmed and whole cow's milk" was found in a previous sensitivity analysis. Is that the reason? If so, I think it's still worth mentioning it earlier in the text and not just in the sensitivity.	Add a paragraph (in the Goal and Scope section?) to explain why the Oatly Semi has been compared to the country average mix of whole, semi-skimmed and skimmed cow's milk rather than with the semi skimmed only.	Done
JP	166			ed	"Since a review panel… had already reviewed the main report, and ~~have~~ verified"	Remove "have" or adjust the verb (has verified/had verified)	Done

1 Initials of the **Reviewer**
2 **Type of comment: ge** = general **te** = technical **ed** = editorial

Template for CR comments and commissioner & practitioner responses

Date: 24 April 2024 – 2 May	Document: **LCA of chilled Oatly Oat Drink Semi for Sweden and Finland, and comparison with cow's milk**	Project:

Reviewer[1]	Line number	Clause/ Subclause	Paragraph / Figure/ Table/	Type of comment[2]	Comments	Proposed change	Response of the commissioner & practitioner
JP			Table 4	ed	Might be useful to clarify the meaning of "LUC" and "peat ox", and why they are reported separately	Add a note to explain what these abbreviations mean (and why associated GHG emissions are also reported separately)	Done, added to Table 3.
JP	251			ge	It would be good to briefly discuss why the impacts of FI cow's milk are higher than the impact of SE cow's milk (what's the main difference between the two systems? Looks like it's related to diet composition). This would be consistent with what discussed in the other report on PL, FR, IE Oatly Barista.	In the Life Cycle Interpretation section, briefly discuss differences in FI and SE dairy production systems.	For FI and SE cow's milk this analysis was already done in the main report (unlike for cow's milk from PL, FR, IE). Reference to relevant section in the main report was added.
JP			Figure 3	ed	The colour that was associated with "Raw cow's milk - feed" in Figure 2 is now used for the raw materials of both cow's milk and oat drink. This is not immediately clear as the new key is shown after the first graphs and there is no mention of it changing in the text.	Explain in the text (e.g., row 262) that in Figure 3 the categories "raw cow's milk – feed", "- other", and "- cow's emissions" are considered as a whole (potentially explain this choice as well).	It's a different colour (dark green for raw materials Oatly vs dark blue for raw materials cow's milk).
JP	285			ed	What does DC mean?	Explain the abbreviation	Done
JP			Figure 4	ed	Change the colour associated to 4b (transport of other ingredients to factory) to avoid confusion with point 2 (Oat transport to mill)		Done
JP	307			ed	Repetition in "abbreviations used"	Remove one of the two sentences	Done
JP			Figure 6	ed	Why a 0% is shown only for some indicators and not for all of them. Is it because it's rounded and not and actual 0?	Either remove the 0s for simplicity or explain what they mean	Done, 0s removed
JP			Appendix 3	ed	The caption of the table says, "Nutritional data is provided for whole cow's milk for the countries in scope." But the table has nutritional data for both skimmed and whole milk. Also, it looks like the Semi (first column) is referring to the oat drink not to cow milk. This should be reflected in the caption. Is the nutritional composition of semi-skimmed cow milk available? It would make more sense to compare Oatly Semi to semi-skilled cow milk.	Adjust the caption. Potentially add semi-skimmed cow milk column.	Done

1 Initials of the **Reviewer**

2 **Type of comment: ge** = general **te** = technical **ed** = editorial

5. Self-declaration of independence

I, the signatory, hereby declare that:

- I am not a full-time or part-time employee of the commissioner or practitioner of the LCA study
- I have not been involved in defining the scope or carrying out any of the work to conduct the LCA study at hand, i.e. I have not been part of the commissioner's or practitioner's project team(s)
- I do not have vested financial, political, or other interests in the outcome of the study

I declare that the above statements are truthful and complete.

Date: May 2, 2024

Name: Dr. Jasmina Burek

Signature:

Name: Dr. Jens Lansche

Signature:

Name: Dr. Joseph Poore

Signature:

Name: Dr. Hayo van der Werf

Signature:

Groen van Prinsterersingel 45

2805 TD Gouda, The Netherlands

www.blonksustainability.nl