Report June 2024

LCA of Oatly Unsweetened and Super Basic Oatmilks and comparison to cow’s milk in the United States

Addendum to the report “LCA of Oatly Original US and comparison with cow's milk”, published on 7 December 2023

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Title	LCA of Oatly Unsweetened and Super Basic Oatmilks and comparison to cow's milk in the United States	
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Executive summary

Introduction

A Life Cycle Assessment (LCA) has been conducted to compare the environmental performance of Oatly Unsweetened and Super Basic Oatmilks (two chilled oat-based drinks) to cow's milk in the United States (US).

This study is an addendum to the report "LCA of Oatly Original US and comparison with cow's milk", which was published by Blonk Consultants on December 7th, 2023 (Blonk Consultants, 2023) and covered Oatly Original Oatmilk produced and retailed in the United States. 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. This report includes updated data for packaging, energy and water use in factories, as well as new data for the ingredients of both drinks.

The functional unit considered for this study is 1 liter of Oatly Oatmilk (Unsweetened and Super Basic)/cow's milk at point of sale, including packaging manufacturing and packaging end of life. For cow's milk, reduced fat milk (2%) was considered as the main representative product in the US as it has the highest market share (Thoma, Popp, Nutter, et al., 2013a). The foreground data for both Oatmilks is based on company-specific data from Oatly and refers to oatbase production at Oatly's factories in Ogden (Utah) and Millville (New Jersey), as well as processing into the final product at the adjacent co-manufacturers in both locations. For each product, two sourcing scenarios are considered: 1) a single sourcing scenario, where the Oatly product is distributed across the country from one of the factories only (current situation); and 2) a dual sourcing scenario, where an equal share (50/50) of the Oatly products is sourced from both factories (anticipated future situation, see section 1.2 for more information).

Like the main report, this study has been performed and critically reviewed according to ISO 14040/14044/14071 standards (ISO, 2006b, 2006a, 2014), 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) (Zampori, 2019). Even though this is primarily a European standard, the general principles described in these PEFCRs are often valuable input for LCAs in other countries and are therefore applied whenever relevant. 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 seen in Table 1 below, the Oatly Unsweetened and Super Basic Oatmilks in scope have a lower impact than cow's milk for climate change (44% to 61% lower), fine particulate matter formation (64% to 78% lower), terrestrial acidification (78% to 87% lower), freshwater eutrophication (37% to 54% lower), marine eutrophication (60% to 77% lower), land use (32% to 64% lower), land occupation (32% to 58% lower), mineral resource scarcity (32% to 43% lower) and water consumption (81% to 85% lower), depending on the product and scenario.

For fossil resource scarcity, the Oatly Unsweetened and Super Basic Oatmilks have a lower, comparable or higher impact than cow's milk, varying from 11% lower to 37% higher. The relatively high fossil resource scarcity impact for the Oatly products is related to the thermal energy use during processing and the emissions from fossil-based road transportation, with the single sourced products having particularly long distribution distances.

TABLE 1 RELATIVE DIFFERENCES OF OATLY UNSWEETENED AND SUPER BASIC COMPARED TO COW'S MILK AT RETAIL INCLUDING END-OF-LIFE (EOL) OF PACKAGING. FOR EXAMPLE, -39% INDICATES THAT OATLY OATMILK HAS A 39% LOWER IMPACT COMPARED TO COW'S MILK. THE DIFFERENCES HAVE BEEN COLOR-CODED AS FOLLOWS: GREEN – MORE THAN 10% DIFFERENCE FAVORING OATLY OATMILK, YELLOW – THE DIFFERENCE IS 10% OR LOWER INDICATING SIMILAR PERFORMANCE FOR THE COMPARED PRODUCTS, RED – MORE THAN 10% DIFFERENCE FAVORING COW'S MILK. FURTHER INFORMATION ON THE INDICATORS USED FOR THE IMPACT CATEGORIES CAN BE FOUND IN TABLE 3.

Product	Impact category / Sourcing scenario	Climate change	Fine particulate matter	Terrestrial eutroph-cation	Freshwater eutrophic-cation	Marine eutrophic-cation	Land use	Land occupation	Mineral resource scarcity	Fossil resource scarcity	Water consum-ption
		kg CO2 eq	kg PM2.5 eq	kg SO2 eq	kg P eq	kg N eq	m2a crop eq	m2a	kg Cu eq	kg oil eq	m3
Oatly Unsweetened	Single sourcing (Millville)	-52%	-70%	-82%	-52%	-77%	-63%	-57%	-40%	13%	-85%
	Dual sourcing (50% Ogden, 50% Millville)	-61%	-78%	-87%	-54%	-77%	-64%	-58%	-43%	-11%	-85%
Oatly Super Basic	Single sourcing (Ogden)	-44%	-64%	-78%	-37%	-61%	-35%	-34%	-32%	37%	-82%
	Dual sourcing (50% Ogden, 50% Millville)	-56%	-74%	-83%	-39%	-60%	-32%	-32%	-38%	0%	-81%

Figure 1 shows the contribution of all life cycle stages to the climate change impact for Oatly Unsweetened, Oatly Super Basic, and cow's milk. For the Oatly products, the processing and distribution stages are the main contributors to the climate change impact of all products. This impact is linked to thermal energy use during processing and the emissions from (refrigerated) truck transportation. For the cow's milk, raw materials i.e. raw milk production is the main contributor to the climate change impact. The impact of raw milk is mainly attributed to feed and the cow's emissions (linked to enteric fermentation and manure management).

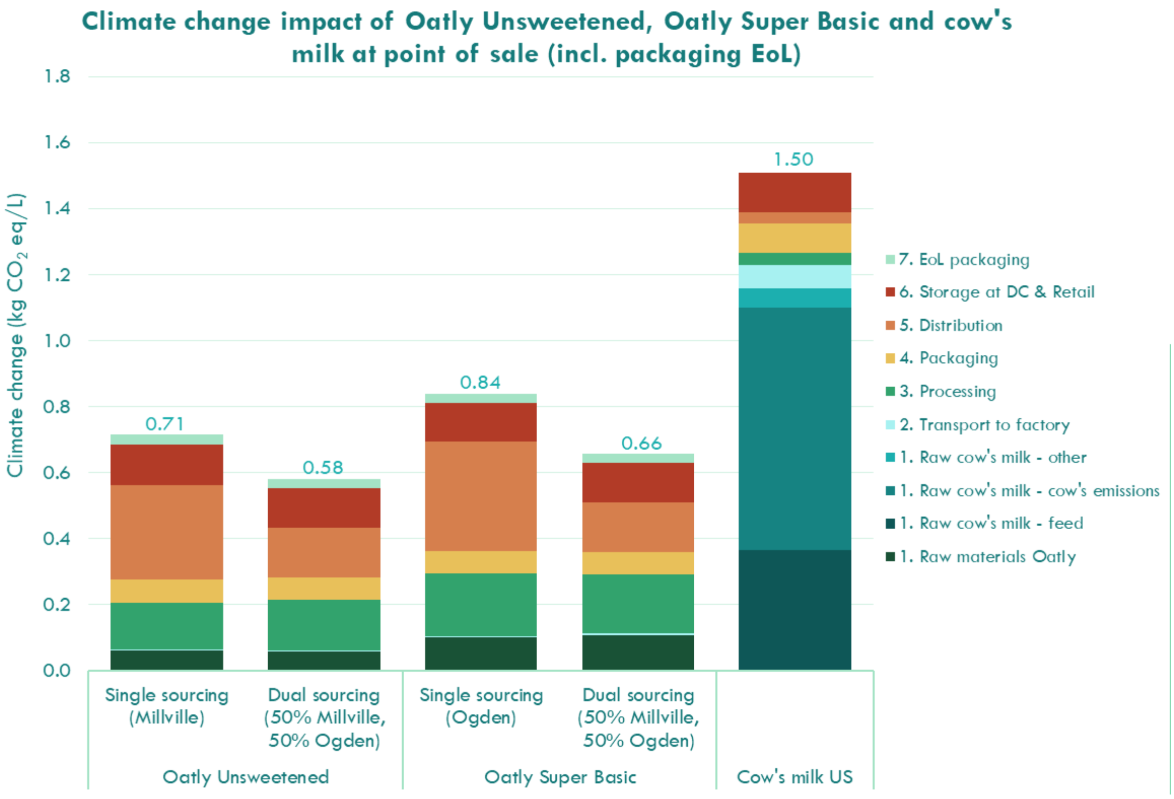

FIGURE 1 CLIMATE CHANGE IMPACT OF THE OATLY PRODUCTS (UNSWEETENED AND SUPER BASIC) AND COW'S MILK AT RETAIL INCLUDING END-OF-LIFE (EOL) OF PACKAGING. THE SOURCING LOCATION IS INDICATED IN BRACKETS: MILLVILLE REFERS TO THE OATLY FACTORY IN MILLVILLE (WHERE OATBASE IS PRODUCED) AND THE ADJACENT PARTNER FACTORY (WHERE THE FINAL PRODUCT IS PRODUCED). OGDEN REFERS TO THE OATLY FACTORY IN OGDEN (WHERE OATBASE IS PRODUCED), AND THE ADJACENT PARTNER FACTORY (WHERE THE FINAL PRODUCT IS PRODUCED). COW'S MILK REPRESENTS US AVERAGE REDUCED FAT (2%) COW'S MILK AT RETAIL. ABBREVIATIONS USED: DC = DISTRIBUTION CENTER

The significance of the differences between the Oatly Oatmilks (Unsweetened and Super Basic Oatmilk) and cow's milk has been determined by an uncertainty analysis. A sensitivity analysis was carried out that considers the NDU (Nutrient Density Unit) as a functional unit based on nutritional properties, showing that the difference in climate change impact between the Oaty Oatmilks and cow's milk is bigger when using the NDU as a functional unit based on nutritional properties compared to a functional unit based on volume. Additionally, the main report included further sensitivity analyses, which also apply to the products evaluated in this addendum, as the products in this addendum show a comparable impact to Oatly Original US/comparison to US cow's milk analysed in the main report[1]. These sensitivity analyses pointed out that using a different impact assessment method (ReCiPe endpoint, TRACI 2.1 impact assessment) confirmed the overall higher environmental footprint of cow's milk compared to the Oatly Original. Furthermore, the sensitivity analyses in the main report concluded that using different product characteristics (inclusion of use stage, different packaging for cow's milk), did not lead to different conclusions on the environmental footprint of Oatly Original compared to cow's milk.

Conclusions

Based on the results, the following conclusions can be drawn for Oatly Unsweetened and Super Basic Oatmilks:

- Oatly Unsweetened and Super Basic Oatmilks (single and dual sourcing scenarios) have a **consistently lower impact** than cow's milk for the impact categories climate change, fine particulate matter formation, terrestrial acidification, freshwater eutrophication, marine eutrophication, land use, land occupation, mineral resource scarcity, and water consumption.
- Oatly Unsweetened and Super Basic Oatmilks (single and dual sourcing scenarios) have a **lower, comparable or higher impact** for fossil resource scarcity compared to cow's milk. For the single-sourcing scenarios, Oatly Super Basic and Oatly Unsweetened Oatmilks have a higher impact for fossil resource scarcity than cow's milk, caused by the relatively long distribution distances from the factories across the whole country. For the dual sourcing scenarios, the distribution distances are shorter, and the fossil resource scarcity impact is lower than (for Oatly Unsweetened Oatmilk) or comparable to (for Oatly Super Basic Oatmilk) cow's milk.
- For Oatly Unsweetened, the dual sourcing scenario has a consistently lower impact than the single sourcing scenario across all impact categories. For Oatly Super Basic Oatmilk, the dual sourcing scenario has a lower impact than the single sourcing scenario for all impact categories except for marine eutrophication, land use, land occupation, and water consumption. This is because the Millville factory requires a slightly higher input of raw oats per kg of oatbase, which results in a slightly higher impact of the raw material stage of the oatmilk sourced from both Millville and Ogden factories compared to the oatmilk sourced solely from the Ogden factory.

Overall, the analysis of Oatly Unsweetened and Oatly Super Basic Oatmilk and its comparison to cow's milk lead to similar conclusions as in the main report.

[1] When comparing the average relative difference between Oatly products and cow's milk for the impact categories in scope, the Oatly products in this report have on average a relatively lower impact than the Oatly products in the main report for all impact categories except for fossil resource scarcity.

1. Goal & Scope

1.1 Introduction

This study is an addendum to the report "LCA of Oatly Original US and comparison with cow's milk", which was published by Blonk Consultants on December 7th, 2023 (Blonk Consultants, 2023) and will from now on be referred to in this addendum as "the main report". The addendum investigates two additional Oatmilks also produced in the US: Oatly Unsweetened and Oatly Super Basic Oatmilk. Like the Oatly Original Oatmilk, they are produced in two production locations: Millville (New Jersey) and Ogden (Utah). Millville refers to the Oatly factory in Millville where oatbase is produced, and the adjacent factory where the final product is produced. Ogden refers to the Oatly factory in Ogden, where oatbase is produced, and the adjacent factory, where the final product is produced. The adjacent factories, where the finished product is produced are co-manufacturers i.e. not operated by Oatly. This report explores two different sourcing scenarios for each of the two drinks: single sourcing and dual sourcing, as further explained in the scope. Dual sourcing presents an anticipated future scenario as the sales of these new products grow (see more details in section 1.2). The exact products and markets in scope are listed in Table 2 below. In line with the main report, these products are compared to average cow's milk (2% fat) produced in the US, considering a functional unit of 1 liter of product.

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 adjusted in this report:

- The ingredients have been adapted to the specific Oatmilk: Oatly Unsweetened and Super Basic.
- The energy and water use at the Ogden and Millville factories have been updated to 2023 data.
- Background data have been updated to the following database versions: Agri-footprint 6.3, and Ecoinvent 3.9.
- The packaging has been updated with 2023 data. It concerns a similar type of (chilled) beverage carton as used for Oatly Original in the main report, however containing fossil LDPE instead of BioPE.
- Distribution data has been updated with distribution distances for single and dual sourcing scenarios, as provided by Oatly.

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 also be noted that the climate change results from this study do not always exactly correspond with those mentioned on the packaging/web page as the latter could be calculated by a different LCA provider that uses different background data and/or system boundaries.

1.2 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 Oatly Unsweetened and Super Basic oat-based drinks, and in addition compare them to cow's milk in the US. Furthermore, the goal is to investigate two production and distribution scenarios: a current scenario (single sourcing), and an anticipated future scenario (dual sourcing). Dual sourcing is modelled because Oatly has already started testing this option. However, the final realization of this scenario is subject to an increase in sales volumes to rationalize the operation of a new factory line and ensure long term viability, therefore not guaranteed. Still, this is a typical pattern that has been observed with other products as sales grow which is comparable to the current context, thus it was considered illustrative of an expected outcome and therefore relevant for inclusion in this study. Distribution data for the dual sourcing is an estimate based on Oatly Original Oatmilk, which is dually sourced from the factories in scope and delivered to similar customer locations.

Further details on the intended use of this study can be found in section 1.2 of the main report.

1.3 Scope

1.3.1 Products in scope and their functional units

The function on which the two systems are compared 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 64 fl oz (1.89 liter) packaging at point of sale.

The functional units and reference flows associated with both systems are:

- Oatmilk: 1 liter of Oatly Unsweetened and Super Basic (oat-based drink), including packaging, at retail.
- Cow's milk: 1 liter of reduced fat (2%) cow's milk as produced and distributed in the US, including packaging, at retail (chilled storage).

For each of the Oatmilks, this report explores two scenarios:

- Single sourcing: the current scenario, in which the Oatmilk is sourced from a single factory (Unsweetened from Millville and Super Basic from Ogden).
- Dual sourcing: an anticipated future scenario (see section 1.2 for more information), in which half of the products are sourced from Millville, and the other half from Ogden. This entails shorter distribution distances from factory to retail.

Table 2 lists the reference flows related to the Oatly products in scope, as well as the cow's milk reference product. 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 Oatmilks and cow's milk can be found in Appendix V.

TABLE 2: REFERENCE FLOWS OF THE OATLY OATMILK PRODUCTS AND COW'S MILK

Product overview		
Reference flow	Sourcing scenario	Produced in
Oatly Unsweetened		
1 Liter	Single sourcing	Oatbase: Oatly factory in Millville, NJ, United States Oatmilk: Adjacent partner factory in Millville, NJ, United States
1 Liter	Dual sourcing	50% from Millville, 50% from Ogden
Oatly Super Basic		
1 Liter	Single sourcing	Oatbase: Oatly factory in Ogden, UT, United States Oatmilk: Adjacent partner factory in Ogden, UT, United States
1 Liter	Dual sourcing	50% from Millville, 50% from Ogden
Cow's milk semi-skimmed		
1 Liter		National average cow's milk produced in the US

Oatly Unsweetened

Oalty Unsweetened is an oat-based drink with 0g sugar, and is fortified with calcium, vitamin D, riboflavin, vitamin B12, iron, potassium, and phosphorus. Next to that, oil is added as a functional ingredient that provides structure and texture to the drink. The 'Unsweetened' Oatmilk means the oats are processed in a way which reduces the amount of maltose that ends up in this product.

In the single sourcing scenario, the Unsweetened Oatmilk is produced only in the factories located in Millville, which is the current situation. In the dual sourcing scenario, the Unsweetened Oatmilk is produced in 2 locations: 50% is sourced from the Millville factories and 50% from the Ogden factories. The packaging for this product is a 64 fl oz (1.89l) beverage carton.

Oatly Super Basic

Oalty Super Basic is an oat-based drink with only four ingredients, namely oat base (water, oats), sea salt and citrus fibre. Next to that, oil is added as a functional ingredient that provides structure and texture to the drink.

In the single sourcing scenario, the Super Basic Oatmilk is produced only in the factories located in Ogden, which is the current situation. In the dual sourcing scenario, the Super Basic Oatmilk is produced 2 locations: 50% is sourced from the Millville factories and 50% from the Ogden factories. The packaging for this product is a 64 fl oz (1.89l) beverage carton.

Cow's milk

Oatly Unsweetened and Super Basic Oatmilk are intended to replace any type of cow's milk, but since reduced fat (2%) milk is the main type of cow's milk sold in the US (Thoma, Popp, Nutter, et al., 2013a), this study focuses on this type. Similar to previous reports, the most common packaging type (HDPE gallon) and pasteurisation type (HTST, high temperature short time) is considered. Section 1.3 of the main report provides further background information. More about the different fat contents in cow's milk can be found in the Barista report (Pas & Westbroek, 2022), where all main fat variations were analysed in the sensitivity analysis.

1.3.2 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.

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 have different nutritional properties than Oatly Original investigated in the main report, this report repeats a sensitivity analysis using a functional unit based on nutritional properties. An uncertainty analysis is also included.

The main report can be consulted to obtain more insight into results of other sensitivity analyses, such as applying different impact assessment methods (TRACI, 20-year timeframe for global warming), applying a different scope (cradle-to-grave), and applying different packaging for cow's milk.

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 Oatly Unsweetened and Oatly Super Basic produced at Oatly's hybrid factories in Ogden (Utah) and Millville (New Jersey). More details on these factories and the production process can be found in section 3.1.1 of the main report[2].

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

- The ingredients have been adapted to the specific Oatmilk products: Oatly Unsweetened and Super Basic Oatmilk.
- The resource use at the factories (energy and water use) has been updated with 2023 data.
- Transport data for the different sourcing scenarios was provided by Oatly.
- The packaging has been updated with 2023 data. It concerns a similar type of beverage carton as used for Oatly Original in the main report, however with fossil LDPE instead of BioPE.

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

For the US cow's milk, the same dataset was used in the main report. More detail on how the cow's milk has been modelled can be found in section 3.2 of the main report, as well as in Appendix III.

[2] Note that the oatbase is no longer transported to the factory on tankers (as described in the main report), but through pipes.

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 Oatly Unsweetened Oatmilk, and in Table 5 for the Oatly Super Basic Oatmilk. The results for all impact categories are included in Appendix IV. Table 6 provides an overview of the relative differences of the Oatly products and cow's milk.

These tables indicate that:

- For both scenarios (single and dual sourcing), the Oatly Unsweetened and Super Basic Oatmilks have a lower impact than cow's milk when it comes to the environmental impact categories climate change, fine particulate matter formation, terrestrial acidification, freshwater eutrophication, marine eutrophication, land use, land occupation, mineral resource scarcity and water consumption.
- For fossil resource scarcity, the Oatly products have a lower, comparable or higher impact than cow's milk. Both single-sourced Oatmilks have a higher fossil resource scarcity impact than cow's milk, whereas the dual-sourced Oatmilks either have a comparable impact (dual-sourced Oatly Super Basic Oatmilk) or lower impact (dual-sourced Oatly Unsweetened Oatmilk).

For Oatly Unsweetened, the dual sourcing scenario has a consistently lower impact than the single sourcing scenario across all impact categories. For Oatly Super Basic Oatmilk, the dual sourcing scenario has a lower impact than the single sourcing scenario for all impact categories except for marine eutrophication, land use, land occupation, and water consumption. This is because the Millville factory requires a slightly higher input of raw oats per kg of oatbase, which results in a slightly higher impact of the raw material stage of the Oatmilk sourced from both Millville and Ogden factories compared to the Oatmilk sourced solely from the Ogden factory. For the climate change impact category, the dual sourcing scenario has a 21% lower impact than the single sourcing scenario for Oatly Super Basic, and a 19% lower impact for Oatly Unsweetened.

Note that the differences observed in the fossil resource scarcity impact between Oatly Oatmilks and cow's milk are in some cases not significant, as is determined by the uncertainty analysis in chapter 5.3. A further explanation of what causes the differences that can be observed between products can be found in the next chapter (Life Cycle Interpretation).

TABLE 4 RESULTS FOR KEY IMPACT CATEGORIES FOR THE OATLY UNSWEETENED OATMILK AND COW'S MILK AT RETAIL INCLUDING END-OF-LIFE (EOL) PACKAGING. IT INCLUDES A SINGLE SOURCING SCENARIO (DISTRIBUTED ACROSS THE COUNTRY FROM ONE PRODUCTION LOCATION) AS WELL AS A DUAL SOURCING SCENARIO (DISTRIBUTED ACROSS THE COUNTRY FROM TWO PRODUCTION LOCATIONS). COW'S MILK REPRESENTS US AVERAGE REDUCED FAT (2%) COW'S MILK AT RETAIL. FURTHER INFORMATION ON THE INDICATORS USED FOR THE IMPACT CATEGORIES CAN BE FOUND IN TABLE 3.

Oatly Unsweetened							
Impact category	**Unit**	**Cow's milk US**	**Oatly Unsweetened**				
			Single sourcing (Millville)	***Difference compared to cow's milk***	**Dual sourcing (Millville & Ogden)**	***Difference compared to cow's milk***
Climate change – incl LUC and peat ox	kg CO_2 eq	1.500	0.715	*-52%*	0.580	*-61%*
Climate change – excl LUC and peat ox	kg CO_2 eq	1.468	0.705	*-52%*	0.570	*-61%*
Climate change – only LUC	kg CO_2 eq	0.018	0.010	*-46%*	0.010	*-46%*
Climate change – only peat ox	kg CO_2 eq	0.015	0.000	*-98%*	0.000	*-98%*
Fine particulate matter formation	kg PM2.5 eq	0.00214	0.000646	*-70%*	0.000477	*-78%*
Terrestrial acidification	kg SO_2 eq	0.0113	0.00200	*-82%*	0.00145	*-87%*
Freshwater eutrophication	kg P eq	0.000342	0.000165	*-52%*	0.000159	*-54%*
Marine eutrophication	kg N eq	0.00105	0.000246	*-77%*	0.000242	*-77%*
Land use (Total)	m^2a crop eq	0.790	0.295	*-63%*	0.285	*-64%*
Land occupation	m^2a	0.990	0.429	*-57%*	0.420	*-58%*
Mineral resource scarcity	kg Cu eq	0.00174	0.00105	*-40%*	0.00099	*-43%*
Fossil resource scarcity	kg oil eq	0.165	0.187	*13%*	0.146	*-11%*
Water consumption	m^3	0.0280	0.00434	*-85%*	0.00409	*-85%*

TABLE 5 RESULTS FOR KEY IMPACT CATEGORIES FOR THE OATLY SUPER BASIC OATMILK AND COW'S MILK AT RETAIL INCLUDING END-OF-LIFE (EOL) PACKAGING. IT INCLUDES A SINGLE SOURCING SCENARIO (DISTRIBUTED ACROSS THE COUNTRY FROM ONE PRODUCTION LOCATION) AS WELL AS A DUAL SOURCING SCENARIO (DISTRIBUTED ACROSS THE COUNTRY FROM TWO PRODUCTION LOCATIONS. COW'S MILK REPRESENTS US AVERAGE REDUCED FAT (2%) COW'S MILK AT RETAIL. FURTHER INFORMATION ON THE INDICATORS USED FOR THE IMPACT CATEGORIES CAN BE FOUND IN TABLE 3.

Oatly Super Basic							
Impact category	**Unit**	**Cow's milk US**	**Oatly Super Basic**				
			Single sourcing (Ogden)	***Difference compared to cow's milk***	**Dual sourcing (Ogden & Millville)**	**Difference compared to cow's milk**
Climate change – incl LUC and peat ox	kg CO_2 eq	1.500	0.837	*-44%*	0.657	*-56%*
Climate change – excl LUC and peat ox	kg CO_2 eq	1.468	0.835	-43%	0.655	-55%
Climate change – only LUC	kg CO_2 eq	0.018	0.001	-92%	0.001	-92%
Climate change – only peat ox	kg CO_2 eq	0.015	0.001	-96%	0.001	-96%
Fine particulate matter formation	kg PM2.5 eq	0.00214	0.000778	*-64%*	0.000563	*-74%*
Terrestrial acidification	kg SO_2 eq	0.0113	0.00248	*-78%*	0.00196	*-83%*
Freshwater eutrophication	kg P eq	0.000342	0.000216	*-37%*	0.000210	*-39%*
Marine eutrophication	kg N eq	0.00105	0.000413	*-61%*	0.000427	*-60%*
Land use (Total)	m^2a crop eq	0.790	0.514	*-35%*	0.537	*-32%*
Land occupation	m^2a	0.990	0.654	*-34%*	0.678	*-32%*
Mineral resource scarcity	kg Cu eq	0.00174	0.00118	*-32%*	0.00109	*-38%*
Fossil resource scarcity	kg oil eq	0.165	0.226	*37%*	0.165	*0%*
Water consumption	m^3	0.0280	0.00497	*-82%*	0.00521	*-81%*

TABLE 6 RELATIVE DIFFERENCES OF OATLY UNSWEETENED AND SUPER BASIC COMPARED TO COW'S MILK AT RETAIL INCLUDING END-OF-LIFE (EOL) OF PACKAGING. FOR EXAMPLE, -39% INDICATES THAT OATLY OATMILK HAS A 39% LOWER IMPACT COMPARED TO COW'S MILK. THE DIFFERENCES HAVE BEEN COLOR-CODED AS FOLLOWS: GREEN – MORE THAN 10% DIFFERENCE FAVORING OATLY OATMILK, YELLOW – THE DIFFERENCE IS 10% OR LOWER INDICATING SIMILAR PERFORMANCE FOR THE COMPARED PRODUCTS, RED – MORE THAN 10% DIFFERENCE FAVORING COW'S MILK.

Product	**Impact category** / **Sourcing scenario**	**Climate change**	**Fine particulate matter**	**Terrestrial eutroph-cation**	**Freshwater eutrophic-cation**	**Marine eutrophic-cation**	**Land use**	**Land occupation**	**Mineral resource scarcity**	**Fossil resource scarcity**	**Water consum-ption**
		kg CO2 eq	*kg PM2.5 eq*	*kg SO2 eq*	*kg P eq*	*kg N eq*	*m2a crop eq*	*m2a*	*kg Cu eq*	*kg oil eq*	*m3*
Oatly Unsweetened	Single sourcing (Millville)	-52%	-70%	-82%	-52%	-77%	-63%	-57%	-40%	13%	-85%
	Dual sourcing (50% Ogden, 50% Millville)	-61%	-78%	-87%	-54%	-77%	-64%	-58%	-43%	-11%	-85%
Oatly Super Basic	Single sourcing (Ogden)	-44%	-64%	-78%	-37%	-61%	-35%	-34%	-32%	37%	-82%
	Dual sourcing (50% Ogden, 50% Millville)	-56%	-74%	-83%	-39%	-60%	-32%	-32%	-38%	0%	-81%

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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 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. Notable differences from the main report are included below.

5.1.1 Comparison of Oatly Oatmilks Unsweetened and Super Basic to cow's milk

The contribution analysis for the climate change impact category is shown in Figure 2 for the different Oatly Oatmilks (Unsweetened and Super Basic with each two sourcing scenarios) and cow's milk. Figure 3 shows the contribution analysis for the other impact categories. In Figure 2 the raw material stage of cow's milk has been split up to show the contribution of feed, cow's emissions and other processes to the raw material stage.

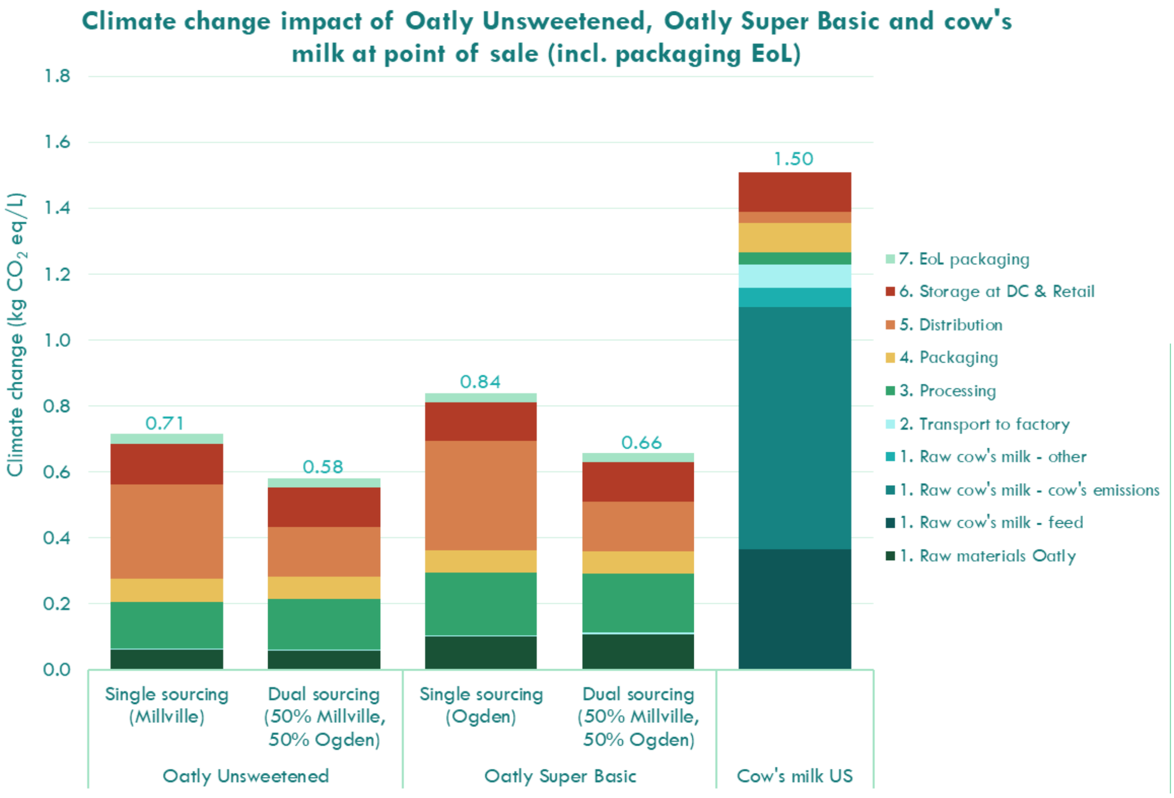


FIGURE 2: CLIMATE CHANGE IMPACT OF THE OATLY PRODUCTS (UNSWEETENED AND SUPER BASIC) AND COW'S MILK AT RETAIL INCLUDING END-OF-LIFE (EOL) OF PACKAGING. THE SOURCING LOCATION IS INDICATED IN BRACKETS: MILLVILLE REFERS TO THE OATLY FACTORY IN MILLVILLE (WHERE OATBASE IS PRODUCED) AND THE ADJACENT PARTNER FACTORY (WHERE THE FINAL PRODUCT IS PRODUCED). OGDEN REFERS TO THE OATLY FACTORY IN OGDEN (WHERE OATBASE IS PRODUCED), AND THE ADJACENT PARTNER FACTORY (WHERE THE FINAL PRODUCT IS PRODUCED). COW'S MILK REPRESENTS US AVERAGE REDUCED FAT (2%) COW'S MILK AT RETAIL.

As can be seen in **Figure 2** and **Figure 3**, for Oatly Unsweetened and Super Basic Oatmilks, the distribution stage is the largest contributor to the impact categories climate change, fine particulate matter formation, terrestrial acidification and fossil resource scarcity. For freshwater eutrophication, marine eutrophication, land use, and land occupation, the raw material stage is the largest contributor. The mineral resource scarcity impact of the Oatly products is mainly determined by the use of renewable electricity (wind and solar) at the Oatly factories, as well as packaging. For the cow's milk, the raw cow's milk contributes most to all impact categories.

The distribution stage of Oatly drinks has a higher impact fossil resource scarcity and climate change impact compared to cow's milk due to the longer distribution distances for Oatly (cow's milk is more locally produced).

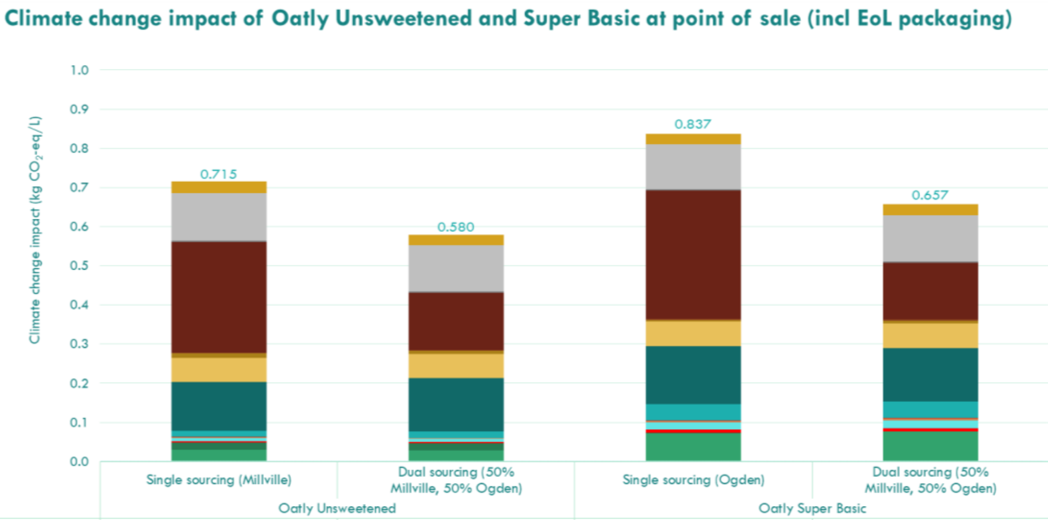
The land use and land occupation impacts are higher for cow's milk than for Oatly products, which is mainly linked to the raw materials as well as the packaging. Furthermore, the Oatly packaging has a higher impact compared to the cow's milk packaging, which is due to the use of paper in the beverage carton as opposed to HDPE in the milk bottle.

FIGURE 3: KEY IMPACT CATEGORIES OF THE OATLY UNSWEETENED, OATLY SUPER BASIC AND COW'S MILK AT RETAIL INCLUDING END-OF-LIFE (EOL) OF PACKAGING. THE SOURCING LOCATION IS INDICATED IN BRACKETS: MILLVILLE REFERS TO THE OATLY FACTORY IN MILLVILLE (WHERE OATBASE IS PRODUCED) AND THE ADJACENT PARTNER FACTORY (WHERE THE FINAL PRODUCT IS PRODUCED). OGDEN REFERS TO THE OATLY FACTORY IN OGDEN

(WHERE OATBASE IS PRODUCED), AND THE ADJACENT PARTNER FACTORY (WHERE THE FINAL PRODUCT IS PRODUCED). COW'S MILK REPRESENTS US AVERAGE REDUCED FAT (2%) COW'S MILK AT RETAIL.

5.1.2 Oatly Unsweetened and Super Basic Oatmilks

Figure 4 shows a detailed contribution analysis for the climate change impact category for Oatly Unsweetened and Super Basic Oatmilks. It shows that distribution is the biggest contributor to the impact for both products, with dual sourcing performing better. The second biggest contributor is processing the finished product and storage at retail. Contribution of the raw material is relatively low, especially for the unsweetened oatmilk.



	Oatly Unsweetened: Single sourcing (Millville)	Oatly Unsweetened: Dual sourcing (50% Millville, 50% Ogden)	Oatly Super Basic: Single sourcing (Ogden)	Oatly Super Basic: Dual sourcing (50% Millville, 50% Ogden)
10. End of Life of Packaging	0.029	0.028	0.027	0.028
9b. Storage at retail	0.121	0.118	0.114	0.118
9a. Storage at DC	0.003	0.003	0.003	0.003
8b. Distribution to Retail	0.282	0.146	0.329	0.146
8a. Distribution to DC	0.002	0.002	0.003	0.002
7b. Transport of packaging material	0.012	0.008	0.003	0.008
7a. Packaging	0.061	0.062	0.063	0.062
6. Processing - Oatly finished product	0.125	0.136	0.148	0.137
5. Processing - oat base	0.016	0.016	0.042	0.042
4b. Transport of other ingredients to factory	0.001	0.001	0.001	0.001
4a. Transport of oats to factory	0.002	0.002	0.004	0.005
3. Oats milling	0.008	0.007	0.019	0.020
2. Oats transport to mill	0.003	0.003	0.008	0.009
1b. Other ingredient production	0.018	0.018	0.000	0.000
1a. Oat cultivation	0.031	0.029	0.073	0.077

FIGURE 4: CLIMATE CHANGE IMPACT OF THE OATLY PRODUCTS (UNWEETENED AND SUPER BASIC) AT RETAIL INCLUDING END-OF-LIFE (EOL) OF PACKAGING. TWO FACTORIES ARE CONSIDERED, THE FIRST LOCATED IN OGDEN AND THE SECOND LOCATED IN MILLVILLE. FOR EACH PRODUCT TWO SCENARIOS ARE CONSIDERED WITH A VARIATION IN THE SOURCE/LOCATION OF PRODUCTION. THE UNSWEETENED DRINKS SINGLE SOURCED SCENARIO IS PRODUCED IN THE MILLVILLE FACTORY, AND THE SUPER BASIC DRINKS SINGLE SOURCED SCENARIO IS PRODUCED IN THE OGDEN FACTORY. THE DUAL SOURCE PRODUCTS ARE 50% SOURCED FROM THE MILLVILLE FACTORY AND 50% FROM THE OGDEN FACTORY.

5.2 Sensitivity analysis

Since Oatly Unsweetened and Oatly Super Basic Oatmilks have different nutritional characteristics than the Oatly Original Oatmilk studied in the main report, the sensitivity analysis considering nutritional properties as functional unit was repeated for this addendum. Further sensitivity analyses (which consider different product characteristics such as inclusion of the use stage, different allocation method or different packaging for cow's milk) were not deemed necessary to repeat, and can be found in section 5.2 of the main report.

This section considers the NDU (Nutrient Density Unit) as functional unit, as explained in section 2.7.2 of the main report. The NDU considers protein, essential fatty acids, dietary fiber, and energy. It is suitable as functional unit in LCA as it leaves out limiting macronutrients (which can lead to negative values). The NDU is based on the nutrient content per 100 g of product and is calculated as follows (Dooren, 2018):

$$Nutrient\ Density\ Unit = \frac{\left(\frac{\text{g essential fatty acids}}{12.4\ g}\right) + \left(\frac{\text{g protein}}{50\ g}\right) + \left(\frac{\text{g fibre}}{25\ g}\right)}{3 \times \left(\frac{\text{kcal energy}}{2000\ kcal}\right)}$$

The data as provided in Table 7 has been used to calculate the NDU. For cow's milk, the data has been derived from Food Data Central[3], which contain national food composition tables. A complete nutritional profile of the Oatly products and cow's milk can be found in Appendix V. The higher the NDU, the higher amount of encouraged macronutrients the food provides.

TABLE 7 MACRONUTRIENT CONTENT PER 100G OF COW'S MILK, OATLY UNSWEETENED AND OATLY SUPER BASIC.

	Cow's milk (2%)	Oatly Unsweetened	Oatly Super Basic
Essential fatty acids (g)	0.052	0.14	0.19
Protein (g)	3.36	0.00	1.29
Fiber (g)	0	0.43	0.86
Energy (kcal)	50	17.22	34.43
NDU	**0.95**	**1.11**	**1.46**

The resulting climate change impact calculated per NDU is shown in **Figure 5**. The differences in climate change impact between the Oatly products and cow's milk are bigger when using a functional unit based on NDU compared to a functional unit based on volume.

As mentioned in section 2.7.2 of the main report, this method was deemed appropriate to evaluate the influence of nutritional properties in this sensitivity analysis. A potential follow-up research could take into consideration more complex nutritional indices. Currently there's no consensus on which nutritional index is best fit for LCA purposes.

[3] https://fdc.nal.usda.gov/index.html

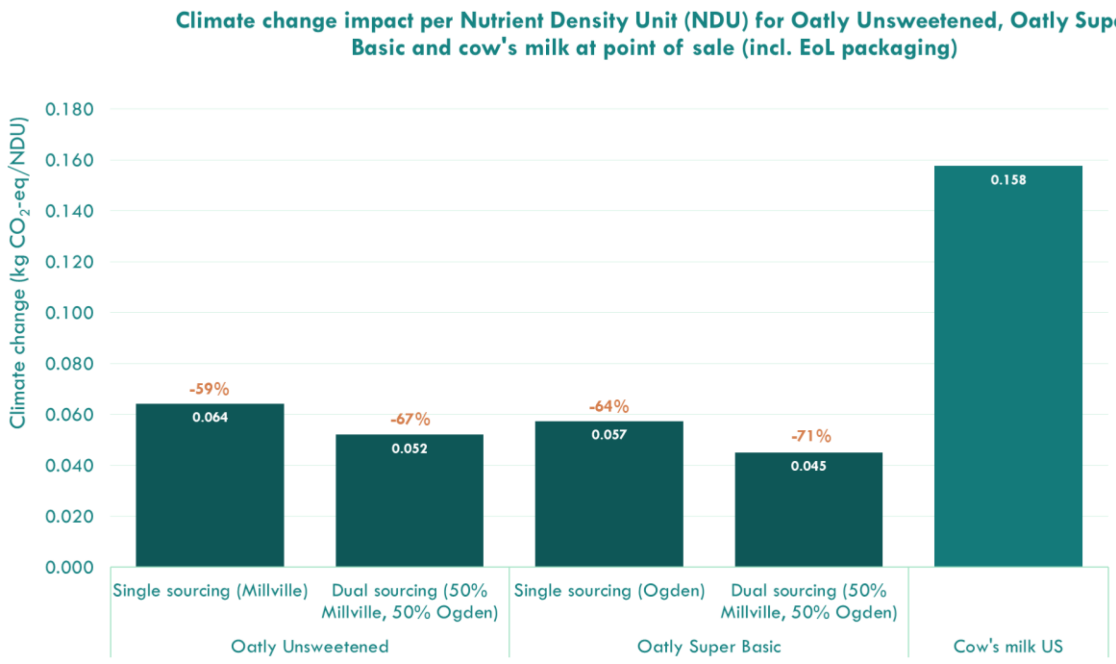


FIGURE 5 : CLIMATE CHANGE IMPACT PER NUTRIENT DENSITY UNIT (NDU) FOR OATLY UNSWEETENED, OATLY SUPER BASIC AND COW'S MILK AT POINT OF SALE INCLUDING END-OF-LIFE (EOL) OF PACKAGING. TWO FACTORIES ARE CONSIDERED, THE FIRST LOCATED IN OGDEN AND THE SECOND LOCATED IN MILLVILLE. FOR EACH PRODUCT TWO SCENARIOS ARE CONSIDERED WITH A VARIATION IN THE SOURCE/LOCATION OF PRODUCTION. THE UNSWEETENED DRINKS SINGLE SOURCED SCENARIO IS PRODUCED IN THE MILLVILLE FACTORY, AND THE SUPER BASIC DRINKS SINGLE SOURCED SCENARIO IS PRODUCED IN THE OGDEN FACTORY. THE DUAL SOURCE PRODUCTS ARE 50% SOURCED FROM THE MILLVILLE FACTORY AND 50% FROM THE OGDEN FACTORY.

5.3 Uncertainty analyses

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 6 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 Unsweetened and Super Basic Oatmilks have lower uncertainty ranges due to the use of primary (foreground) data.

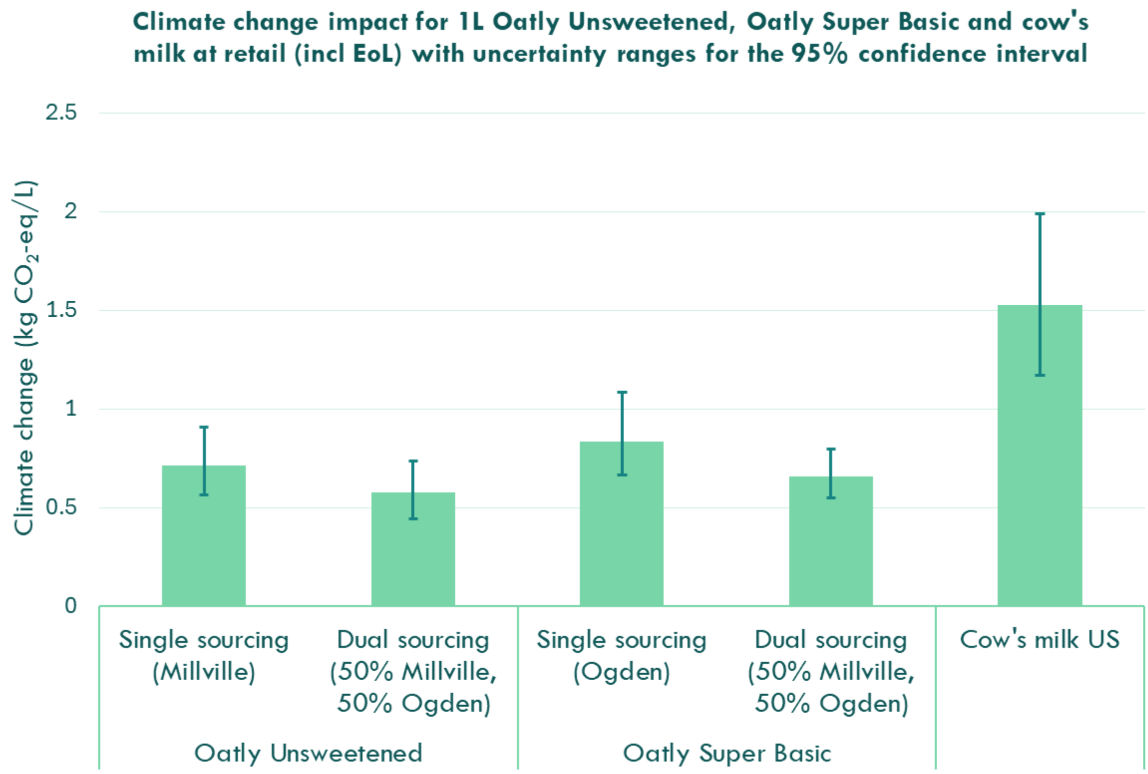


FIGURE 6 CLIMATE CHANGE IMPACT FOR 1L OATLY DRINKS AND COW'S MILK AT RETAIL INCLUDING END-OF-LIFE (EOL) PACKAGING, WITH UNCERTAINTY RANGES FOR THE 95% CONFIDENCE INTERVAL.

The graph gives an impression of how Oatly Unsweetened and Super Basic Oatmilks compare 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 7 below shows the outcome of this paired Monte Carlo analysis for all products in scope, and for all impact categories. It shows that for climate change, fine particulate matter formation, terrestrial acidification, freshwater eutrophication, marine eutrophication, land use, land occupation, mineral resource scarcity and water consumption, the impact of Oatly Unsweetened and Super Basic Oatmilks is consistently and significantly lower than the impact of cow's milk. When it comes to fossil resource scarcity, the impact of the single-sourced Oatly Super Basic Oatmilk is significantly higher than cow's milk, but the difference is not significant for the other sourcing scenarios.

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.

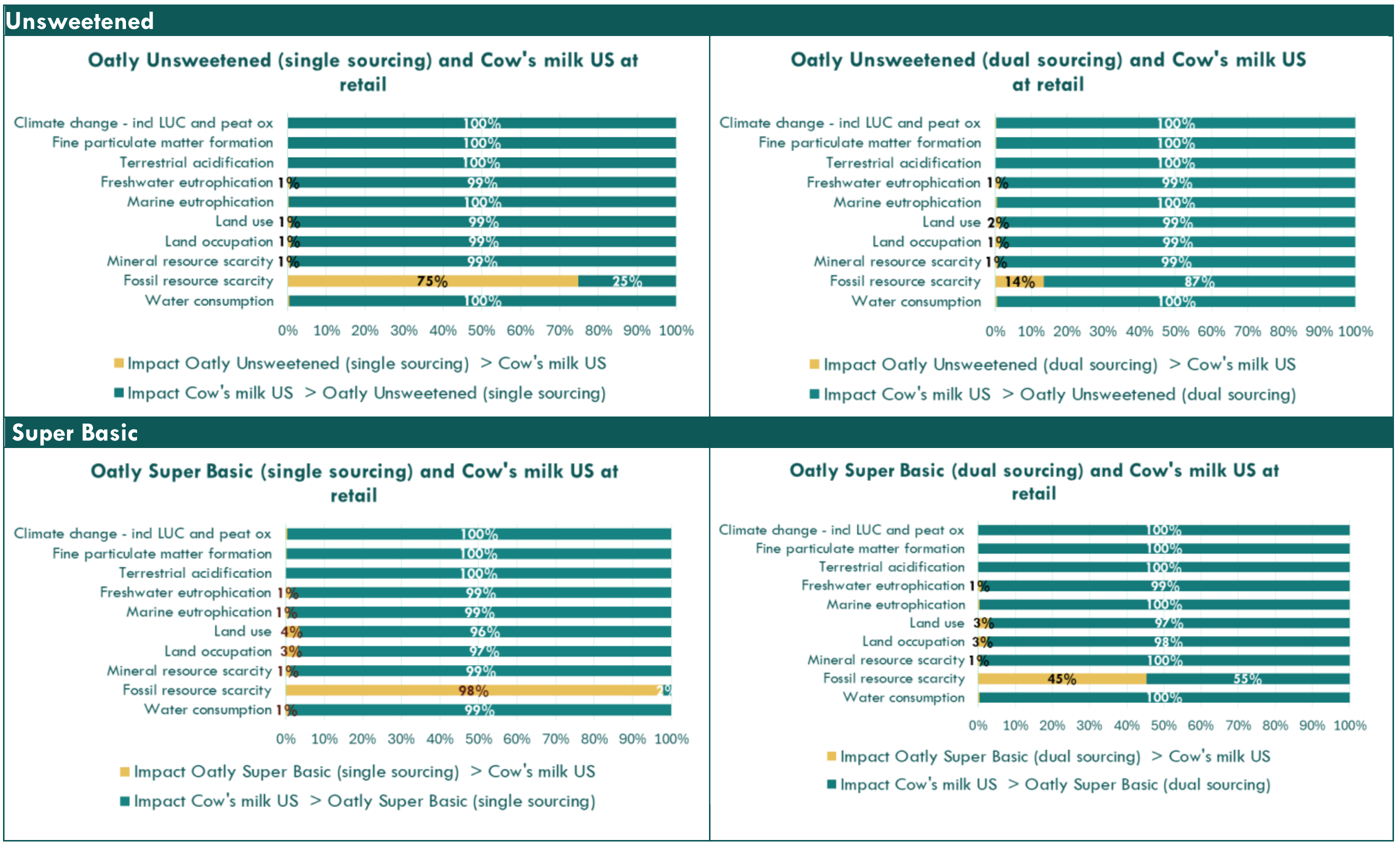


FIGURE 7 PAIRED MONTE CARLO ANALYSIS OF 1L OATLY DRINKS (OATLY UNSWEETNENED AND OATLY SUPER BASIC) AND COW'S MILK AT RETAIL INCLUDING END-OF-LIFE (EOL) PACKAGING, SHOWING THE PERCENTAGE OF MONTE CARLO RUNS IN WHICH ONE PRODUCT HAS A HIGHER IMPACT THAN THE OTHER. FOR EXAMPLE, FOR CLIMATE CHANGE, OATLY UNSWEETENED SINGLE SOURCED HAS A LOWER IMPACT THAN COW'S MILK FOR 100% OF THE 1000 MONTE CARLO SIMULATIONS PERFORMED.

6. Conclusion

A Life Cycle Assessment (LCA) has been performed to compare the environmental performance of Oatly Unsweetened and Super Basic Oatmilk to cow's milk in the United States (US). The functional unit considered for this study is 1 Liter of Oatly Oatmilk (Unsweetened and Super Basic)/cow's milk at point of sale, including packaging manufacturing and packaging end of life. Two sourcing scenarios were considered for each of the Oatmilks: 1) a single sourcing scenario, where the drink is distributed across the country from one of the factories only (current situation); and 2) a dual sourcing scenario, where an equal share (50/50) of the drinks is sourced from both factories (anticipated future situation). This study has been performed and critically reviewed according to ISO 14040/14044/14071 standards for comparative assertions to be disclosed to the public.

The results show that Oatly Unsweetened and Super Basic Oatmilks (single and dual sourcing scenarios) have a lower impact than cow's milk for the impact categories climate change, fine particulate matter formation, terrestrial acidification, freshwater eutrophication, marine eutrophication, land use, land occupation, mineral resource scarcity and water consumption.

For Oatly Unsweetened, the impact of the dual sourcing scenario is consistently lower than that of the corresponding single sourcing scenario. For Oatly Super Basic Oatmilk, the dual sourcing scenario has a lower impact than the single sourcing scenario for all impact categories except for marine eutrophication, land use, land occupation, and water consumption. This is because the Millville factory requires a slightly higher input of raw oats per kg of oatbase, which results in a slightly higher impact of the raw material stage of the Oatmilk sourced from both Millville and Ogden factories compared to the Oatmilk sourced solely from the Ogden factory.

For fossil resource scarcity, the Oatly Unsweetened and the Super Basic Oatmilks have a lower, comparable or higher impact than cow's milk. This is related to the relatively high impact of the processing stage (thermal energy from natural gas) and distribution stage (long transport distances) of the Oatly products. The single-sourced Oatly Super Basic and Oatly Unsweetened Oatmilks have a higher impact for fossil resource scarcity than cow's milk, caused by the relatively longer distribution distances from the individual factories across the whole country. For the dual sourcing scenarios, the distribution distances are shorter and the fossil resource scarcity impact is lower than cow's milk (dual-sourced Oalty Unsweetened Oatmilk) or comparable to cow's milk (dual-sourced Oatly Super Basic Oatmilk).

The significance of the aforementioned differences has been determined by an uncertainty analysis. Furthermore, a sensitivity analysis was carried out that considers the NDU (Nutrient Density Unit) as a functional unit based on nutritional properties. This sensitivity analysis showed that the differences in climate change impact between the Oatly products and cow's milk are bigger when using the NDU as a functional unit based on nutritional properties compared to a functional unit based on volume. In the main report additional sensitivity analyses were carried out, the conclusions of which also apply to the current products, as they are of similar impact than the Oatly Original in the main report[4]. The main report for Oatly Original US concluded that using a different impact assessment method (ReCiPe endpoint, TRACI 2.1 impact assessment) confirmed the overall higher environmental footprint of cow's milk compared to Oatly products for all countries in scope. Furthermore, the sensitivity analyses in the main report concluded that using different product characteristics (inclusion of use stage, different packaging for cow's milk), did not lead to different conclusions on the environmental footprint of Oatly Oatmilks compared to cow's milk.

A detailed analysis of the main drivers and opportunities linked to the environmental impact of Oatly products can be found in the main report. It should be noted that the ingredients of Oatly Unsweetened and Oatly Super Basic Oatmilks differ from Oatly Original Oatmilk, which influences the impact of the raw material stage. Also, data related to distribution distances, packaging, and energy and water use at the factories, have been updated.

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.

[4] When comparing the average relative differences between Oatly products and cow's milk for the impact categories in scope, the Oatly products in this report have on average a relatively lower impact than the Oatly products in the main report for all impact categories except for fossil resource scarcity.

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

Blonk Consultants. (2023). *LCA of Oatly Original US 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

Zampori, L., & Pant, R. (2019). *Suggestions for updating the Product Environmental Footprint (PEF) method*.

Appendix I Oatly production modelling (Confidential data)

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 oat cultivation datasets from Agri-Footprint 6.3. 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. For the US production of Oatly Original, oats originate from Canada.	*Good*
1b. Other ingredient production	The quantity of other ingredients used during processing or added to the final product are provided by Oatly, and described in section 1.3.1. Rapeseed oil (from Canadian origin) and a proxy for vitamins was derived from the Agri-footprint database, whereas the other ingredients were modelled using datasets from ecoinvent 3.9. Citrus fibre was modelled based on citrus peels, a by-product from juice production.	*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 500km is assumed for the transportation between the Canadian oat fields to the mill in Canada diesel trucks, based on the radius of the area that the supplier has indicated to be sourcing their oats from (largest distance). 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 1 mill in Canada. The oat hulls are going to either animal feed or biogas production.	*Good*
4a. Transport of oats to factory	Distance based on locations of the mills and the Oatly factory. Transport was modelled using diesel trains for Canada	*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 facilities 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 Original	The input use (energy, heat, water) to generate oat base and finished product was provided by Oatly based on data from the production facilities 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 (such as LDPE, aluminum, paperboard), energy was accounted for processing these materials based on ecoinvent datasets (sheet rolling for aluminum, injection moulding for the HDPE cap etc). In contrast to the Oatly Original US in the main report, the packaging for Oatly Unsweetenened and Super Basic Oatmilks contains LDPE instead of BioPE. Secondary packaging (corrugated board) is also included.	*Very good*

Life cycle stage	Description of data	Data quality
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%). In the US, the transport of Oatly Original is 100% chilled transportation. Refrigerated transport was modelled based on ecoinvent datasets for refrigerated transport. To align with other transport datasets used in the Oatly models, which were modelled using AFP, a >20 ton truck from AFP was used with 20% extra fuel use plus ecoinvent's reefer operation dataset. Transport to warehouses connected to the Ogden factory concerned electric trucks, while transport from the Cumberland factories concerned diesel trucks.	*Good*
8b. Distribution to Retail	For the US, Oatly has provided data on the transport distance from DC to retail by means of diesel trucks.	*Fair*
9. Storage at DC and retail	For the US, storage at DC and retail was modelled using data from Burek et al. (2017).	*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. For the US, recycling rates are derived from (Thoma, Popp, Nutter, et al., 2013a). For secondary packaging material (corrugated board) no CFF was applied, and dataset was selected that already includes recycled material.	*Fair*

References

Burek, J., Kim, D., Nutter, D., Selke, S., Auras, R., Cashman, S., … Thoma, G. (2017). Environmental Sustainability of Fluid Milk Delivery Systems in the United States. Journal of Industrial Ecology, 00(0). https://doi.org/10.1111/jiec.12531

Månsson, M. (2022). *Interview between Vasiliki Takou, LCA Lead Oatly, and Martin Månsson, Oatly's 3PL Supply Chain Logistics Manager*.

Thoma, G., Popp, J., Nutter, D., Shonnard, D., Ulrich, R., Matlock, M., … Adom, F. (2013). Greenhouse gas emissions from milk production and consumption in the United States: A cradle-to-grave life cycle assessment circa 2008. International Dairy Journal, 31(1), S3–S14. https://doi.org/10.1016/j.idairyj.2012.08.013

Veljanovski, V. (2022). *Interview between Vasiliki Takou, LCA Lead Oatly, and Vlade Veljanovski, factory controller at Oatly*.

Appendix III Dairy production modelling

The tables below highlight the data used as well as calculations and assumptions made to model dairy systems in US. The complete dairy model is identical to the cow's milk modelling in the Oatly Barista study (Blonk Consultants, 2022).

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 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 be 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 a 2% fat content, 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 animals sold including calves and culled mature animals per year, and $Mmilk$ is the mass of 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.

United States

The National Inventory Report (NIR) of the USA (United States Environmental Protection Agency, 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 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.

The total livestock to slaughter weight is based on the USDA Quickstat database (2022). Total livestock amounts (heads) include the total amount and average weight of dairy cows and dairy calves sent to slaughter. The total amount of livestock slaughtered does not include heifers sent to slaughter, because the type of heifers (beef breed or dairy breed) could not be distinguished from the source.

The average on-farm resource use is retrieved from “Greenhouse Gas Emissions from Production of Fluid Milk in the US," an unpublished paper by Thoma et al. (Thoma, 2010). The on-farm resource use is a weighted average, based on three archetypical farms as presented in the paper.

Data on feed rations is based on (Thoma, Popp, Shonnard, et al., 2013a), as more recent data was not available. Thoma et al. provide detailed feed consumption data per state and per animal type, which was converted to a weighted national average.

Data retrieved from Blonk Consultant’s Californian dataset created for APS footprint (Blonk Consultants, 2020a) was used for bedding material, and some components of the feed ration (protein mix and partial mix ration).

More details on the sources used and assumptions made can be found in the table below.

Data point		Value (per year)	Explanation
General details			
Farming method		Conventional	

Year	2019	
Geography	United states	
Average annual temperature	8.55	Wikipedia (2020)
Total herd size	18803000	NIR (2021)
OUTPUTS		
Milk (total weight) (kg)	100726995023.26	total production from NIR (2021)
Protein content (%)	3.42%	based on APS Californian dataset (Blonk Consultants, 2020a)
Fat content (%)	3.92%	based on "Environmental assessment of United States dairy farms" (Rotz et al. 2021) averaged for all regions
Total livestock to slaughter (liveweight) (kg)	2250457129	based on USDA (2022) Quickstat, year 2019
RESOURCE USE		
Electricity use (MJ)	5946555785	from Thoma et al. (Thoma, 2010)
Heat (MJ)	6692629818	from Thoma et al. (Thoma, 2010)
Diesel use (MJ)	20346732702	from Thoma et al. (Thoma, 2010)
Water consumption (kg)	4.03872E+11	Based on APS Californian dataset
HOUSING SYSTEMS		
Housing - Heifers	3270000	Heifers and calves 1-2y
Housing - Calves <1 year	6189000	
Housing - Dairy cows	9344000	
Housing system dairy cows		
RATION (kg as is)		Ration for grazing and non-grazing seasons per region and per animal type obtained from Thoma (2013b), corrected for the length of grazing and non-grazing season, then multiplied by number of animals per region (based on NIR) to obtain weighted average diet per animal type per year. Top 15 feed ingredients are included (extrapolated to match total weight), adjusted for higher milk production in 2020.
Pasture	3089	
Corn Silage	3686	
Corn	1503	
Alfalfa Silage	742	
Alfalfa Hay	678	
Partial Mix Ration	704	modelled based on compound feed from Californian dairy
Corn, HM	658	high moisture corn
Grain Mix	525	
Ddg (Distiller's dried grains), Dry	454	
Protein Mix	341	modelled based on compound feed from Californian dairy
Cottonseed	305	
Soybean Meal	290	
Supplement	245	
Corn Gluten Feed	221	
Canola Meal	154	
Total feed intake (kg/animal)	13596	Based on Thoma (2013b), as is
Gross energy intake (MJ/animal)	153887	NIR
Digestibility (% of GE)	66.70%	NIR
Crude protein in diet (% of DM)	18.65%	Calculated based on ration and feed tables from Thoma (2013)
Percentage of silage (% of GE)	18%	Based on feed from Thoma, on NE instead of GE
HOUSING		
Straw for bedding (kg/animal)	250	Based on APS Californian dataset: 250 kg/dairy cow
Saw dust (kg/animal)	125	Based on APS Californian dataset: 125 kg/dairy cow
Type (e.g. housed/ free ranging)	housed	Based on APS Californian dataset
MANURE MANAGEMENT		
Manure management system (select type, e.g. dry lot)		Three most common types: 38.4% anaerobic lagoon, 24.9% solid storage, 14.6% deep pit (NIR)
TIME SPENT DISTRIBUTION		
Time spent grazing (%)	49.6%	Based on Thoma (2013b)
Time spent in open yard areas (%)	30.4%	Based on (USDA, 2016)
Time spent in buildings (%)	20%	Based on (USDA, 2016)
Housing system heifers and calves 1-2 years		
RATION (kg as is)		Ration for grazing and non-grazing seasons per region and per animal type obtained from Thoma (2013b), corrected for the length of grazing and non-grazing season, then multiplied by number of animals per region (based on NIR)

		to obtain weighted average diet per animal type per year. Top 15 feed ingredients are included (extrapolated to match total weight), adjusted for higher milk production in 2020.
Pasture	2210	Based on grass dataset from Californian dataset
Corn Silage	2454	
Alfalfa Hay	407	
Corn	370	
Wheat Straw	280	
Supplement	263	
Grass Hay	265	
Partial Mix Ration	209	modelled based on compound feed from Californian dairy
Alfalfa Silage	148	
Ddg, Dry	163	Maize distillers grains
Soybean Meal	135	
Grain Mix	120	
Protein Mix	81	modelled based on compound feed from Californian dairy (APS Californian dataset)
Corn Gluten Feed	63	
Oat Hay	47	
Total feed intake (kg/animal)	7215	Based on Thoma (2013b)
Gross energy intake (MJ/animal)	69411	NIR
Digestibility (% of GE)	63.70%	NIR
Crude protein in diet (% of DM)	18.49%	Calculated based on ration and feed tables from Thoma (2013)
Percentage of silage (% of GE)	21%	Based on feed from Thoma, on NE instead of GE
HOUSING		
Straw for bedding (kg/animal)	0	Based on AFP Californian dataset
Saw dust (kg/animal)	0	Based on AFP Californian dataset
Type (e.g. housed/ free ranging)	housed	Based on AFP Californian dataset
MANURE MANAGEMENT		
Manure management system (select type, e.g. dry lot)		Two most common types: 80% dry lot, 14% daily spread (based on NIR)
TIME SPENT DISTRIBUTION		
Time spent grazing (%)	49.6%	Based on Thoma (2013b) (assumed same as dairy cows)
Time spent in open yard areas (%)	30.4%	Based on (USDA, 2016)
Time spent in buildings (%)	20%	Based on (USDA, 2016)
Housing system calves < 1 year		
RATION (kg as is)		Ration for grazing and non-grazing seasons per region and per animal type obtained from Thoma (2013b), corrected for the length of grazing and non-grazing season, then multiplied by number of animals per region (based on NIR) to obtain weighted average diet per animal type per year. Top 15 feed ingredients are included (extrapolated to match total weight), adjusted for higher milk production in 2020.
Pasture	1104	
Corn Silage	843	
Alfalfa Hay	297	
Alfalfa Silage	270	
Barley	217	
Partial Mix Ration	194	modelled based on compound feed from APS Californian dataset
Wheat Straw	123	
Grass Hay	120	
Wheat Silage	113	
Corn	107	
Oat Silage	108	
Ddg, Dry	86	
Cotton Gin Trash	88	
Sorghum Silage	91	
Supplement	76	
Total feed intake (kg/animal)	3835	Based on Thoma (2013b)
Gross energy intake (MJ/animal)	8598	NIR
Digestibility (% of GE)	63.70%	NIR
Crude protein in diet (% of DM)	18.36%	Calculated based on ration and feed tables from Thoma (2013)
Percentage of silage (% of GE)	23%	Based on feed from Thoma, on NE instead of GE

HOUSING		
Straw for bedding (kg/animal)	0	APS Californian dataset - no straw
Saw dust (kg/animal)	0	APS Californian dataset - no saw dust
Type (e.g. housed/ free ranging)	housed	APS Californian dataset
MANURE MANAGEMENT		
Manure management system (select type, e.g. dry lot)		Two most common types: 80% dry lot, 14% daily spread
TIME SPENT DISTRIBUTION		
Time spent grazing (%)	0%	based on APS Californian dataset
Time spent in open yard areas (%)	*100%*	based on APS Californian dataset
Time spent in buildings (%)	0%	based on APS Californian dataset

References

Blonk Consultants. (2020a). APS footprint methodology dairy. Retrieved from https://elasticbeanstalk-eu-west-1-035027530995.s3-eu-west-1.amazonaws.com/public/methodology/APS-footprint+methodology+-+dairy.pdf

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

European Commission. (2018b). Product Environmental Footprint Category Rules for Dairy Products. 168. Retrieved from http://ec.europa.eu/environment/eussd/smgp/pdf/PEFCR-DairyProducts_2018-04-25_V1.pdf

European Environment Agency. (2016). EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 Technical guidance to prepare national emission inventories.

IDF. (2010). The IDF guide to standard LCA methodology for the dairy sector. Bulletin of the International Dairy Federation, 445, 1–40

IPCC. (2006). IPCC Guidelines for National Greenhouse Gas Inventories. Emissions from livestock and manure management. (Vol. 4 chp 10). Geneva, Switzerland.

NIR (2021) United States Environmental Protection Agency. Inventory of U.S. Greenhouse gas emissions and sinks.

Rotz, A., Stout, R., Leytem A., Feyereisen, G., Waldrip H., … Kleinman, P. (2021) Environmental assessment of United States Dairy farms. Journal of Cleaner Production, 315, 128153.

Thoma, G. (2010). Greenhouse Gas Emissions from Production of Fluid Milk in the US.

Thoma, G., Popp, J., Nutter, D., Shonnard, D., Ulrich, R., Matlock, M., … Adom, F. (2013). Greenhouse gas emissions from milk production and consumption in the United States: A cradle-to-grave life cycle assessment circa 2008. International Dairy Journal, 31(1), S3–S14. https://doi.org/10.1016/j.idairyj.2012.08.013

Thoma, G., Popp, J., Shonnard, D., Nutter, D., Matlock, M., Ulrich, R., … East, C. (2013). Regional analysis of greenhouse gas emissions from USA dairy farms: A cradle to farm-gate assessment of the American dairy industry circa 2008. International Dairy Journal, (Lci), 1–11. https://doi.org/10.1016/j.idairyj.2012.08.013

United States Environmental Protection Agency. (2021). Inventory of U.S. Greenhouse gas emissions and sinks.

USDA. (2016). Dairy 2014, Dairy Cattle Management Practices in the United States. Fort Collins, CO.

USDA. (2022). USDA Quick Stats Database. Retrieved from https://quickstats.nass.usda.gov/

Appendix IV Full LCIA Results

Oatly Unsweetened Oatmilk and cow's milk

All impact categories (FU : 1L, at retail)		Oatly Unsweetened		
Impact category	Unit	Single sourcing (Millville)	Dual sourcing (50% Millville, 50% Ogden)	Cow's milk US
Climate change - incl LUC and peat ox	kg CO2 eq	7.15E-01	5.80E-01	1.50E+00
Climate change - excl LUC and peat ox	kg CO2 eq	7.05E-01	5.70E-01	1.47E+00
Climate change - only LUC	kg CO2 eq	9.69E-03	9.68E-03	1.79E-02
Climate change - only peat ox	kg CO2 eq	2.51E-04	2.40E-04	1.47E-02
Stratospheric ozone depletion	kg CFC11 eq	9.26E-07	8.24E-07	6.41E-06
Ionizing radiation	kBq Co-60 eq	3.11E-02	2.57E-02	3.05E-02
Ozone formation, Human health	kg NOx eq	2.72E-03	1.70E-03	2.49E-03
Fine particulate matter formation	kg PM2.5 eq	6.46E-04	4.77E-04	2.14E-03
Ozone formation, Terrestrial ecosystems	kg NOx eq	3.05E-03	2.01E-03	2.69E-03
Terrestrial acidification	kg SO2 eq	2.00E-03	1.45E-03	1.13E-02
Freshwater eutrophication	kg P eq	1.65E-04	1.59E-04	3.42E-04
Marine eutrophication	kg N eq	2.46E-04	2.42E-04	1.05E-03
Terrestrial ecotoxicity	kg 1,4-DCB	1.25E+00	9.84E-01	3.03E+00
Freshwater ecotoxicity	kg 1,4-DCB	2.30E-02	2.15E-02	7.85E-02
Marine ecotoxicity	kg 1,4-DCB	2.16E-02	1.98E-02	4.38E-02
Human carcinogenic toxicity	kg 1,4-DCB	1.57E-02	1.38E-02	1.76E-02
Human non-carcinogenic toxicity	kg 1,4-DCB	3.65E-01	3.46E-01	8.49E-01
Land use (Total)	m2a crop eq	2.95E-01	2.85E-01	7.90E-01
Land use (Transformation)	m2a crop eq	7.62E-03	6.13E-03	1.07E-02
Mineral resource scarcity	kg Cu eq	1.05E-03	9.88E-04	1.74E-03
Fossil resource scarcity	kg oil eq	1.87E-01	1.46E-01	1.65E-01
Water consumption	m3	4.34E-03	4.09E-03	2.80E-02
Land occupation	m2a	4.29E-01	4.20E-01	9.90E-01

Oatly Super Basic Oatmilk

All impact categories (FU : 1 l, at retail)		Oatly Super Basic		
Impact category	**Unit**	Single sourcing (Ogden)	Dual sourcing (50% Millville, 50% Ogden)	Cow's milk US
Climate change - incl LUC and peat ox	kg CO2 eq	8.37E-01	6.57E-01	1.50E+00
Climate change - excl LUC and peat ox	kg CO2 eq	8.35E-01	6.55E-01	1.47E+00
Climate change - only LUC	kg CO2 eq	1.38E-03	1.37E-03	1.79E-02
Climate change - only peat ox	kg CO2 eq	5.17E-04	5.46E-04	1.47E-02
Stratospheric ozone depletion	kg CFC11 eq	1.59E-06	1.61E-06	6.41E-06
Ionizing radiation	kBq Co-60 eq	2.39E-02	2.66E-02	3.05E-02
Ozone formation, Human health	kg NOx eq	3.19E-03	1.97E-03	2.49E-03
Fine particulate matter formation	kg PM2.5 eq	7.78E-04	5.63E-04	2.14E-03
Ozone formation, Terrestrial ecosystems	kg NOx eq	3.79E-03	2.59E-03	2.69E-03
Terrestrial acidification	kg SO2 eq	2.48E-03	1.96E-03	1.13E-02
Freshwater eutrophication	kg P eq	2.16E-04	2.10E-04	3.42E-04
Marine eutrophication	kg N eq	4.13E-04	4.27E-04	1.05E-03
Terrestrial ecotoxicity	kg 1,4-DCB	1.41E+00	1.12E+00	3.03E+00
Freshwater ecotoxicity	kg 1,4-DCB	2.87E-02	2.92E-02	7.85E-02
Marine ecotoxicity	kg 1,4-DCB	2.29E-02	2.25E-02	4.38E-02
Human carcinogenic toxicity	kg 1,4-DCB	1.71E-02	1.60E-02	1.76E-02
Human non-carcinogenic toxicity	kg 1,4-DCB	4.35E-01	4.28E-01	8.49E-01
Land use (Total)	m2a crop eq	5.14E-01	5.37E-01	7.90E-01
Land use (Transformation)	m2a crop eq	3.29E-03	1.19E-03	1.07E-02
Mineral resource scarcity	kg Cu eq	1.18E-03	1.09E-03	1.74E-03
Fossil resource scarcity	kg oil eq	2.26E-01	1.65E-01	1.65E-01
Water consumption	m3	4.97E-03	5.21E-03	2.80E-02
Land occupation	m2a	6.54E-01	6.78E-01	9.90E-01

Appendix V Nutritional composition of Oatly Oatmilks and cow's milk

The table below provides nutritional data for Oatly Unsweetened and the Super Basic Oatmilks, as well as skimmed cow's milk. All values are provided per 100 g. The data was provided by Oatly and is based either on the information printed on pack, on the product's website, or on a recent lab test.

	Unit	Oatly Unsweetened	Oatly Super Basic	Cow's milk (2%)
Energy	kcal	17.2	34.4	50.00
Fat	g	0.65	0.43	1.90
of which saturated	g	-	-	1.11
Essential fatty acids	g	0.143	0.186	0.05
Carbohydrates	g	2.58	6.89	4.90
of which sugars	g	-	3.01	4.89
Dietary Fiber	g	0.43	0.86	-
Protein	g	-	1.29	3.36
Sodium	mg	49.50	47.35	39.00
Vitamin D	µg	1.72	-	1.13
Riboflavin	mg	0.25	-	0.14
Vitamin B12	µg	0.52	-	0.55
Calcium	mg	137.73	-	126.00
Iron	mg	0.13	-	-
Potassium	mg	167.86	30.13	159.00
Vitamin A	µg	73.17	-	83.00
Phosphorus	mg	94.69	-	103.00

Source cow's milk: https://fdc.nal.usda.gov/fdc-app.html#/food-details/746778/nutrients

Appendix VI Critical Review Statement and Report

Critical Review Statement

The life cycle assessment (LCA) study *LCA of Oatly Unsweetened and Super Basic Oatmilks and comparison to cow's milk in the United States* addendum to the report *"LCA of Oatly Original US 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 Oatly Unsweetened and Super Basic Oatmilks and comparison to cow's milk in the United States*. 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, with support from Valentina Caldart, Data Lead, HESTIA
- 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 June 3, 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 "Addendum to the report "LCA of Oatly Original US and comparison with cow's milk", by 3 out of 4 members of the expert panel. One round of review comments 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 Oatly Unsweetened and Super Basic Oatmilks and comparison to cow's milk in the United States* study builds on the foundations of the previous LCA studies study for Oatly, i.e., "*LCA of Oatly Original US 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:

- May 1, 2024 – reviewers provided comments on the draft of the final LCA report via email.
- May 27, 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 a stakeholder in completing this study.

June 4, 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 Oatly Unsweetened and Super Basic Oatmilks and comparison to cow's milk in the United States

Addendum to the report "LCA of Oatly Original US and comparison with cow's milk", published in December 2023

Version of the document submitted on June 3, 2024

Critical Review Report

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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 Oatly Unsweetened and Super Basic Oatmilks and comparison to cow's milk in the United States*", which is addendum to the report *"LCA of Oatly Original US and comparison with cow's milk" published in December 2023.* The study "*LCA of Oatly Unsweetened and Super Basic Oatmilks and comparison to cow's milk in the United States*" 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 Oatly Unsweetened and Super Basic Oatmilks and comparison to cow's milk in the United States"*, published on June 3, 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). Given that the products evaluated in this supplementary document have different nutritional profiles compared to the Oatly original product analyzed in the primary study, a sensitivity analysis was conducted by the researchers utilizing nutrient density as a measure of comparison. Authors conducted a sensitivity analysis considering nutrient density unit (NDU) as a functional unit based on nutritional properties. The results showed that the difference in climate change impact between Oatly Unsweetened and Super Basic Oatmilks and cow's milk is more pronounced when using NDU as the functional unit based on nutritional properties, compared to a functional unit based on volume. It was not deemed necessary to repeat most of the sensitivity analyses, considering that the environmental impacts were comparable to the results of "*LCA of Oatly Original US and comparison with cow's milk*". 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 Unsweetened and Super Basic Oatmilks product supply chains in the United States. 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 Unsweetened and Super Basic Oatmilks were compared to 1 l of cow milk in the United States. 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 Unsweetened and Super Basic Oatmilks for U.S. market was collected from Oatly's hybrid factories in Ogden (Utah) and Millville (New Jersey) as reported in the Oatly Original report with few updates including the ingredients have been adapted to the specific Oatmilk products: (1) Oatly Unsweetened and Super Basic Oatmilk, (2) the resource use at the factories (energy and water use) has been updated with 2023 data, (3) transport data for the different sourcing scenarios was provided by Oatly, and (4) the packaging has been updated with 2023 data, which concerns a similar type of beverage carton as used for Oatly Original in the main report, however with fossil LDPE instead of BioPE.

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 Unsweetened and Super Basic Oatmilks 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, life cycle impact assessment, results and interpretation and conclusion. The key aspects of the data used are described in the LCI section and accompanied with the main Oatly Original 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

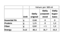
guidelines to ISO 14044:2006 [WWW Document]. URL https://www.iso.org/standard/61103.html (accessed 6.21.19).
ISO 14040, 2006. ISO 14040:2006 - Environmental management - life cycle assessment - principles and framework [WWW Document]. ISO. URL https://www.iso.org/standard/37456.html (accessed 2.22.17).
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: 28 April 2024 – 3 June 2024	Document: **LCA of Oatly Unsweetened and Super Basic Oatmilks and comparison to cow's milk in the United States**	Project:

Reviewer[1]	Line number	Clause/ Subclause	Paragraph/ Figure/ Table/	Type of comment[2]	Comments	Proposed change	Response of the commissioner & practitioner
HW	27			ed	Change "between" to "in".	Adjust.	Done
HW	92-93			te	"For both Oatly Unsweetened and Oatly Super Basic Oatmilk, the dual sourcing scenario has a consistently lower impact than the single sourcing scenario across all impact categories." According to Table 1 this seems not to be the case for Oatly super basic for the marine eutrophication, land use, land occupation and water consumption impacts.	Can you check.	Done, explanation added
HW	146			ed	Delete "based"	Adjust.	Done
HW	201			ed	Change "have" to "had".	Adjust.	Done
HW	213-214			ge	"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. Only an uncertainty analysis is included." From a nutritional point of view the products assessed in this addendum are quite distinct from the Oatly original product investigated in the main report, as can be seen in the table below, which is based on nutritional data from the main report (for Oatly original) and from this report (for Oatly unsweetened and oatly basic).. Consequently I think it would be good to carry out a sensitivity analysis using the nutrient density unit as a functional unit as was done in the main report. 	Can you do the sensitivity analysis.	Done, see new section 5.2.
HW	256			ed	Change "dual-sourced" to "single-sourced"	Adjust.	Done
HW	257-258			ed	Change 3 times "single-sourced" to "dual-sourced"	Adjust	Done
HW	260-261			te	"For both Oatly Unsweetened and Oatly Super Basic Oatmilk, the dual sourcing scenario has a consistently lower impact than the single sourcing scenario across all impact categories." According to Table 5 this is not the case for Oatly super basic for the marine eutrophication, land use, land occupation and water consumption impacts, for which it has a higher impact than the single sourcing scenario. This is surprising, the reason for this needs to identified.	Can you check.	This is because of the slightly lower efficiency of the Millville factory (higher inputs of raw oats needed), explanation added.

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

Template for CR comments and commissioner & practitioner responses	Date: 28 April 2024 – 3 June 2024	Document: **LCA of Oatly Unsweetened and Super Basic Oatmilks and comparison to cow's milk in the United States**	Project:

Reviewer[1]	Line number	Clause/ Subclause	Paragraph/ Figure/ Table/	Type of comment[2]	Comments	Proposed change	Response of the commissioner & practitioner
HW	320			te	Figure 3c suggests that for Freshwater eutrophication EoI packaging rather than raw material is the largest contributor.	Can you check.	In the graphs both seem similar, but the numbers confirm a higher contribution of the raw material stage than packaging.
HW			Figure 3	te	Some discrepancies for values in Tables 4 and 5 versus values in Figure 3: • Oatly unsweetened single sourcing mineral resource scarcity: 0.00105 kg Cu eq in Table 4, 0.00098 in Figure 3 • Oatly super basic single sourcing mineral resource scarcity: 0.00118 kg Cu eq in Table 4, 0.00110 in Figure 3 • Oatly super basic dual sourcing mineral resource scarcity: 0.00109 kg Cu eq in Table 4, 0.00105 in Figure 3	Can you check.	There was still an old version of figure 3f, now it is updated
HW			Figure 6	ed	To be coherent with Table 3 change "Global warming" to "Climate change".	Adjust.	Done
HW	388			ed	Change "insignificant" to "not significant".	Adjust.	Done
HW	404			ed	Change "atpoint" to "at point"	Adjust.	Done
HW	413-414			te	"The impacts of the dual sourcing scenarios are consistently lower than those of the corresponding single sourcing scenarios" According to Table 5 this is not the case for Oatly super basic for the marine eutrophication, land use, land occupation and water consumption impacts, for which it has a higher impact than the single sourcing scenario.	Can you check.	Done, explanation added
HW	424			ed	Change "of which the conclusions" to "the conclusions of which".	Adjust.	Done
HW			Appendix II		References cited in this appendix are not in reference list.	Adjust.	Done (added below table)
HW			Appendix III		References cited in this appendix are not in reference list.	Adjust.	Done (added below table)
HW			Appendix IV		To be coherent with Table 3 change "Global warming" to "Climate change".	Adjust.	Done. Scientific format only kept in appendix, not in main report.

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Template for CR comments and commissioner & practitioner responses

Date: 28 April 2024 – 3 June 2024	Document: **LCA of Oatly Unsweetened and Super Basic Oatmilks and comparison to cow's milk in the United States**	Project:

Reviewer[1]	Line number	Clause/ Subclause	Paragraph/ Figure/ Table/	Type of com-ment[2]	Comments	Proposed change	Response of the commissioner & practitioner
					As suggested in a previous review by Joseph Poore, it would be tter not to use the "scientific' format to facilitate understanding of the numbers.		
HW			Appendix V		According to the Table Oatly unsweetened contains 0% protein, is this correct? Seems strange, since oat is the ingredient that supplies protein.	Can you check.	0% protein is indeed correct.
JP/VC			Table 1	ed	"Milville" should be "Millville" in the Oatly unsweetened – Single sourcing cell	Change Milville to Millville	Done
JP/VC			Figure 1	ed	What does DC mean?	Clarify meaning of DC in the figure	Done
JP/VC	93			te	You write "For both Oatly Unsweetened and Oatly Super Basic Oatmilk, the dual sourcing scenario has a consistently lower impact than the single sourcing scenario across all impact categories", but this is not always true especially for the Super Basic (for marine eutrophication, land use, land occupation, water consumption the single sourcing has a lower/comparable impact)	Specify in which categories the impact is lower, or say "lower or comparable"	Done
JP/VC	147			te	The FU is 1 l, but you define the "function based on which the two systems are compared" as cow's milk or oat drink "provided in 64 fl oz (1.89 liter) packaging at point of sale" – all comparisons are per 1 L		FU is 1L, served from a 1.89 liter packaging. For all Oatly studies an FU of 1 liter has been used.
JP/VC	156			ed	Missing parenthesis at the end		Done
JP/VC	256			ed	Dual-sourced and Single-sourced are inverted (single-sourced oat drink have a higher fossil resource impact than cow milk, not dual-sourced; and dual-sourced have either a comparable or lower impact)	Invert dual and single sourced	Done
JP/VC	260			ed	See comment on line 93	Specify in which categories the impact is lower, or say "lower or comparable"	Done
JP/VC			Table 4 and 5	ed	Even when the impact is higher for the oat drink (e.g., for the fossil resource scarcity indicator), the number representing the difference is in green. I'd keep the colour coding used for e.g., Table 1.	Use red/yellow to make it clear if the difference is in favour of the oat drink or not.	In this table just one colour has been used for the difference, in line with other reports. But changed it to blue to avoid confusion with colour coding used in Table 1.

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Template for CR comments and commissioner & practitioner responses

Date: 28 April 2024 – 3 June 2024	Document: **LCA of Oatly Unsweetened and Super Basic Oatmilks and comparison to cow's milk in the United States**	Project:

Reviewer[1]	Line number	Clause/ Subclause	Paragraph/ Figure/ Table/	Type of comment[2]	Comments	Proposed change	Response of the commissioner & practitioner
JP/VC			Table 4 and 5	ed	It might not be clear to everyone what LUC and peat ox mean, and why their impact is shown separately	Add a note to explain what LUC and peat ox mean and why they are shown separately	Done, added in Table 3.
JP/VC			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 309) that in Figure 3 the categories "raw cow's milk – feed", "- other", and "- cow's emissions" are considered (potentially explain this choice as well).	Done
JP/VC			Figure 4	ed	Colours for 4b and 2 are too similar	Change the color associated to 4b (transport of other ingredients to factory) to avoid confusion with point 2 (Oat transport to mill)	Done
JP/VC			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
JP/VC	404			ed	Typo in atpoint	Replace "atpoint" with "at point"	Done
JP/VC	413			ed	See comment for line 93	Specify in which categories the impact is lower, or say "lower or comparable"	Done
JP/VC	542			ed	Typo "Below are the main parameters used to model the dairy systems in APS are described"	Delete "are described""	Done
JP/VC	564			ed	Typo "In modern systems, bulls might not present since artificial insemination…"	Bulls might not BE present	Done
JP/VC	628			ed	"Since this study considers a functional unit of 1 liter of milk "as is" with different fat contents (whole, (semi)skimmed)" seems to refer to the main report and not this specific addendum in which only semi-skimmed milk is considered	You could say this study considers a function unit of 1 liter of milk with 2% fat content	Done
JP/VC	638			ed	"Mmeat is the mass of liveweight of all animal sold" - typo	Should be all animals sold	Done
JP/VC	639			ed	"$Mmilk$ is the mass if FPCM sold per year", typo	The mass of FPCM sold	Done
JP/VC	662		Table below	ed	No clear what's ddg	Write dry distiller grains instead	Done

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Date: 28 April 2024 – 3 June 2024	Document: **LCA of Oatly Unsweetened and Super Basic Oatmilks and comparison to cow's milk in the United States**	Project:

Reviewer[1]	Line number	Clause/ Subclause	Paragraph/ Figure/ Table/	Type of comment[2]	Comments	Proposed change	Response of the commissioner & practitioner
JL	92-93			te	"For both Oatly Unsweetened and Oatly Super Basic Oatmilk, the dual sourcing scenario has a consistently lower impact than the single sourcing scenario across all impact categories." The statement seems to be oversimplified to me as e.g. for marine eutrophication and water consumption, the impacts are equal for Oatly unsweetened	Adjust.	Done
JL	151/152			ed	"Cow's milk: 1 liter of reduced fat (2%) cow's milk as produced a distributed in the US, including packaging, at retail (chilled storage)." It should read "…and distributed", right?	Adjust	Done
JL	213-214			te	"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. Only an uncertainty analysis is included." In the main report, the nutrient density unit (NDU), which assesses protein, fiber and saturated fatty acids, was used as basis for a nutrient-based FU. In terms of these ingredients, the two products analysed here differ significantly from Oatly original. Therefore, the similarity is not given and the sensitivity analysis should be carried out again.	Include sensitivity analysis with a FU based on NDU.	Done
JL	256-258			ed	Single-sourced and dual-sourced are mixed up	Please check and correct	Done
JL	404			ed	" atpoint" should read "at point"	Adjust	Done
JL	413-414			te	The impacts of the dual sourcing scenarios are consistently lower than those of the corresponding single sourcing scenarios. See comment above: The statement seems to be oversimplified to me as e.g. for marine eutrophication and water consumption, the impacts are equal for Oatly unsweetened	Adjust.	Done
JL	424-425 and 428-430			te	" In the main report additional sensitivity analyses were carried out, of which the conclusions also apply to the current	Adjust after sensitivity analysis was included.	Done

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Reviewer[1]	Line number	Clause/ Subclause	Paragraph/ Figure/ Table/	Type of comment[2]	Comments	Proposed change	Response of the commissioner & practitioner
					products, as they are of similar impact than the Oatly Original in the main report5." " Furthermore, the sensitivity analyses in the main report concluded that using different product characteristics (inclusion of use stage, a functional unit based on nutritional characteristics, different packaging for cow's milk), did not lead to different conclusions on the environmental footprint of Oatly Oatmilks compared to cow's milk." See comment above: In the main report, the nutrient density unit (NDU), which assesses protein, fiber and saturated fatty acids, was used as basis for a nutrient-based FU. In terms of these ingredients, the two products analysed here differ significantly from Oatly original. Therefore, the similarity is not given and the sensitivity analysis should be carried out again.		
JL	564			ed	"bulls might not present" should read as "bulls might not be present"	Adjust	Done
JL	628-629			ed	" 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". The above sentence seems to be in contradiction with the text in e.g. lines 13/14, 66 or 151. There it is stated that "reduced fat milk (2%)" was modelled.	Adjust	Done
JL			Appendix IV	ed	Use the term climate change instead of global warming for consistency reasons	Adjust	Done
JB	9			ed	The methodology, data choices, and assumptions made, No comma is needed after made	Delete comma	Done
JB	18-20			ed	"For each product, two sourcing scenarios are considered: 1) a single sourcing scenario, where the Oatly product is distributed	Provide justification for 2 scenarios?	Done, added in section 1.2.

[5] When comparing the average relative differences between Oatly products and cow's milk for the impact categories in scope, the Oatly products in this report have on average a relatively lower impact than the Oatly products in the main report for all impact categories except for fossil resource scarcity.

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Reviewer[1]	Line number	Clause/ Subclause	Paragraph/ Figure/ Table/	Type of comment[2]	Comments	Proposed change	Response of the commissioner & practitioner
					across the country from one of the factories only (current situation); and 2) a dual sourcing scenario, where an equal share (50/50) of the Oatly products is sourced from both factories (future situation)." Justification for scenarios is missing.		
JB	24			ed	Missing citation for PEFCR	Add citation	Done
JB	36			ed	Oatly Oatmilks – perhaps define above that Oatly Oatmilks includes Unsweetened and Super Basic	Add definition for Oatly Oatmilks when talking about overall trends of impacts	Done
JB	38-39			ed	with the single sourced products having particularly long distribution distances.		
JB	49			ed	Oatly Oatmilk or "Oatly Oatdrink" ?	Consolidate terminology for products	Done
JB	111-112			te	"This report explores two different sourcing scenarios for each of the two drinks: single sourcing and dual sourcing, as further explained in the scope." Rationale is missing. Also is dual sourcing future scenario (the plant is still not operating?	Provide justification	Done
JB	113			ge	"cow's milk produced in the US." If for Oatly is market based than I would add average for cow's milk		Done
JB	116			ed	"The methodology, data choices, and assumptions made,"	Remove comma	Done
JB	140-142			te	"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 Oatly Unsweetened and Super Basic oat-based drinks, and in addition compare them to cow's milk in the US." From the summary statement it appears that the goal is to evaluate future scenario (prospective LCA) in addition to current situation. If it's one of the goals – than rationale should be provided. Or if dual sourcing is scenario analysis, then make it clear in the summary and provide rationale.	Revise based on the comment	Done
JB	146-152			te	2 different functional units were provided. I believe the first is correct and then the second one is how results were presented on per liter?	Please clarify.	First paragraph states function only, second one mentions the functional unit, including reference flow (1 liter)

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Template for CR comments and commissioner & practitioner responses

Date: 28 April 2024 – 3 June 2024	Document: **LCA of Oatly Unsweetened and Super Basic Oatmilks and comparison to cow's milk in the United States**	Project:

Reviewer[1]	Line number	Clause/ Subclause	Paragraph/ Figure/ Table/	Type of com-ment[2]	Comments	Proposed change	Response of the commissioner & practitioner
JB	157-158			te	Dual-sourcing – needs more information why this future scenario is included in the goal. Also, the statement needs clarification if data is from already established facility or how data was obtained for future scenario apart from distances.	Please clarify dual-sourcing and future scenario per comment.	Done.
JB			Table 2	te	"Locally in the US" – not clear what locally means– for example, market specific, regional?	Please clarify what it means locally	Done
JB	185			ed	on this type.Similar . Missing space after dot.	Add space	Done
JB	264			ed	Note that the differences observed between Oatly Oatmilks and cow's milk are in some cases not significant. Mention which impact categories in Table 4	Please include impact categories for which result not significant and point to Table 4	Done
JB	290			Tabl e 6	"Oatly Oatdrink" – keep terminology consistent	Please align terminology.	Done
Comments on the revised version, 27 May 2024							
HW			Appendix II	ed	In the title of the appendix, change Oalty" to "Oatly" In the references, can you change "homa" to "Thoma"?	Adjust.	Done
HW			Appendix III	ed	Several references cited in this appendix are not in reference list, e.g. Pas & Westbroek, 2022, Blonk Consultants, 2020a, IDF 2010, Quickstat database, 2022, NIR, 2021, Rotz et al. 2021,	Adjust.	Done
HW			Appendix V	ed	Heading letters in the table are in white, for better legibility can you change this to black?	Adjust.	Done
			Appendix V	te	According to the table, Oatly Super basic contains 0.22 g of fat per 100 g, all of this is saturated fat and most (0.186 g) are essential fatty acids. However, according to Appendix I, there is no rapeseed oil as an input for the production of Oatly super basic. So I wonder which ingredient supplies the fat? Furthermore, according to the Oatly website (https://us.oatly.com/products/super-basic-oatmilk) Oatly super basic contains no saturated fat. So maybe there is a mistake here. Oatly unsweetened contains 0.65 g of fat per 100 g, no value is given for saturated fat content and essential fatty acid content is lower than for Oatly super basic (0.143. g). Is there an explanation for the fact that the proportion of essential fatty	Can you check?	The value of saturated fat entered was indeed an error, and the website is correct. Oatly Super basic contains 0.43 g of fat per 100g, 0g of saturated fat, and 0.186 g of essential fatty acids (EFA). That is correct, even after fixing the error that continues being the case: Unsweetened has 0.65 g of fat, and 0.143 g of EFA, while Super Basic has 0.43 g of fat, and 0.186 g of EFA. Because Unsweetened and Super Basic are different formulations and the fact that oats

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					acids relative to total fat is lower for Oatly unsweetened that for Oatly Super basic?		can contribute to some fat and EFA content, it is expected that the proportion of EFA relative to total fat differs.
JL			Line 70-73		"A sensitivity analysis was carried out that considers a functional unit based on nutritional properties, showing that the difference in climate change impact between the Oaty Oatmilks and cow's milk is bigger when using a functional unit based on nutritional properties compared to a functional unit based on volume." I would recommend being a little more precise here. In this study, NDU was selected as the functional unit and the sensitivity was calculated on this basis. This means that the results apply to NDU as a functional unit that is based on nutritional properties. However, this is not sufficient to draw a general conclusion about how the results would behave if any other nutritional indicators were used as the functional unit. I therefore suggest the following change: "A sensitivity analysis was carried out that considers NDU as a functional unit based on nutritional properties, showing that the difference in climate change impact between the Oaty Oatmilks and cow's milk is bigger when using NDU as a functional unit based on nutritional properties compared to a functional unit based on volume."	Adjust according to the comment	Done
			489-492		See comment above "Furthermore, a sensitivity analysis was carried out that considers a functional unit based on nutritional properties. This sensitivity analysis showed that the differences in climate change impact between the Oatly products and cow's milk are bigger when using a functional unit based on nutritional properties compared to a functional unit based on volume." I would recommend being a little more precise here. In this study, NDU was selected as the functional unit and the sensitivity was calculated on this basis. This means that the results apply to NDU as a functional unit based on nutritional properties. However, this is not sufficient to draw a general conclusion about how the results would behave if any other	Adjust according to the comment	Done

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Reviewer[1]	Line number	Clause/ Subclause	Paragraph/ Figure/ Table/	Type of comment[2]	Comments	Proposed change	Response of the commissioner & practitioner
					nutritional indicators were used as the functional unit. I therefore suggest the following change: Furthermore, a sensitivity analysis was carried out that considers NDU as a functional unit based on nutritional properties. This sensitivity analysis showed that the differences in climate change impact between the Oatly products and cow's milk are bigger when using NDU as a functional unit based on nutritional properties compared to a functional unit based on volume		

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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: June 4, 2024

Name: Dr. Jasmina Burek

Signature:

Name: Dr. Jens Lansche

Signature:

Name: Dr. Joseph Poore, with support from Valentina Caldart

Signature:

Name: Dr. Hayo van der Werf

Signature

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