Upfield plant-based spreads and margarine vs. dairy butter

Life Cycle Assessment Technical Summary

March 2020
Version 1

In 2018 Quantis conducted a Life Cycle Assessment (LCA) of Upfield's plant-based spreads and margarines in 21 European and North American markets. These products were compared to dairy butter sold in the same markets. This document provides a short summary of the scope of the LCA, the methodology used, what is included in the study and how the calculations were performed to achieve the results, the results for the average Upfield's plant-based spreads and margarines and dairy butter and the methodology and sources used to calculate the equivalences for the comparative claims.

LIFE CYCLE ASSESMENT

LCA is a science based methodology used to assess environmental impacts resulting from for example, greenhouse gas emissions, waste production, water, land and energy use. Environmental impacts are calculated over the life cycle of a product, from extraction of raw materials to the end-of-life.

METHOD

For the study, a framework for conducting a large scale regionalised LCA was developed and applied to compare the environmental impacts of 212 plant-based fat spreads, 16 plant-based creams and 40 dairy alternatives sold in 21 countries, per kg of product. Data was collected with a cradle-to-grave approach for the different product recipes, key ingredients sourcing countries, production factory locations, energy mixes, packaging designs, transportation and end-of-life scenarios. Spatially (archetype) differentiated agricultural life cycle inventory data were generated, as well as land use change (LUC) emissions for agricultural ingredients. A total of 18 environmental indicators were assessed.
The LCA compares environmental impacts of Upfield's plant-based products and dairy butter and creams using an attributional approach as per PAS 2050 (BSI, 2012), aligning with the latest international standards for dairy products, published by the International Dairy Federation (IDF, 2015) and the European Dairy Association (EDA, 2016).

CRITICAL REVIEW

The LCA respects the ISO 14040 and 14044 standards for public disclosure of results. The LCA was peer reviewed by an independent panel of three independent experts on topics such as LCA, agronomy and dairy production, and has been published in the International Journal of Life Cycle Assessment.

FUNCTIONAL UNIT

The functional unit (FU) is a reference unit for which all results are calculated and presented. The functional unit of the study was:

- For the dairy butter vs plant-based fat spreads, the functional unit (FU) was 1 kg of product (fresh matter) for spreading, baking or shallow frying, at consumer's home.
- For the dairy cream vs plant-based cream comparison, the FU was 1 kg product (fresh matter) for whipping or cooking, at consumer level.

ENVIRONMENTAL IMPACT INDICATORS CONSIDERED

The assessment includes 15 environmental impact indicators from the European ILCD 2011 Midpoint+ v1.08 impact assessment method (JRC-IES 2011).
Three additional indicators were included: land occupation (m2.y), which reflects the total area of land used over one year and is a proxy for biodiversity and ecosystem services (Nemecek et al. 2011, Milà i Canals et al. 2012), water consumption (m^3), the total amount of fresh water consumed (ISO 14046), which includes, for example, evapotranspiration from irrigation water, and water scarcity footprint (m^3 water equivalent (eq)) based on the AWARE approach that assesses the water deprivation potential considering spatial water scarcity differences (Boulay et al. 2017).

FROM FARM-TO-PLATE

The LCA considers all identifiable activities across the product life cycle (cradle-to-grave) for all products in the 21 markets where they are sold (see Figure 1).

The study includes the impacts from:

- farming (crop production or milk production)
- production of plant-based spreads and margarine or dairy butter or creams
- packaging
- distribution
- retail
- consumption
- waste management of packaging

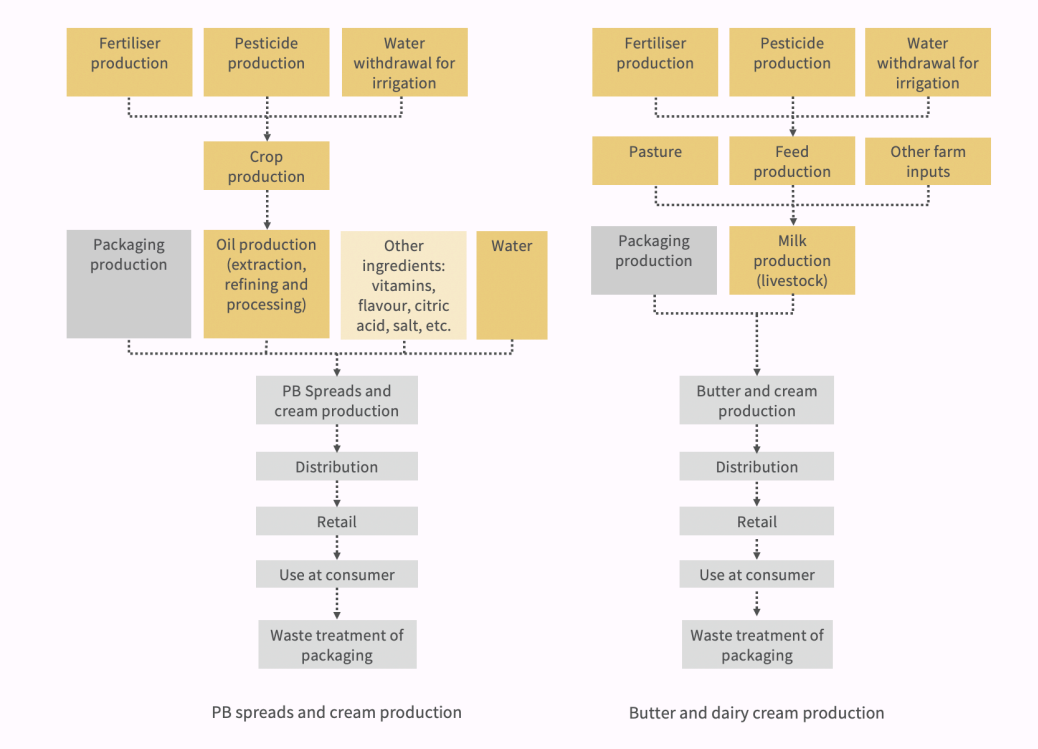

Figure 1. Schematic of the systems evaluated

The study does not include the impacts from:

- Capital goods at the distribution centre and at the point of retail.
- Labour, commuting of workers, administrative work, cattle insemination and disease control processes.
- Food loss and food waste during distribution, at retail point and at the consumer's home.

DATA COLLECTION AND MODELLING

- Plant-based spreads and margarine: Primary data on the recipes and ingredient sources for plant-based spreads and margarine were provided by Upfield. A range of life cycle inventory databases was used to model crop production, oil processing and raw milk production in all markets relevant to each system's supply chain.

  The LCA modelling tool SimaPro version 8.3 was used to model individual datasets (such as oilseeds and packaging) required for plant-based products and for the life cycle of dairy products. Data from all life cycle stages of plant-based spreads and margarine were aggregated and assessed in a customized modular Excel model to enable efficient sensitivity and uncertainty analyses for the large portfolio of product scenarios in this study.

- Dairy butter: Default data representative of North American and European averages and published by the USDA, FIL-IDF Canada, European Dairy Association and the European Commission were used to model dairy processing, packaging and distribution. All data has been assessed to ensure that it meets the quality standards required to make comparative assertions.

RESULTS AND DISCUSSION

All plant-based spreads and margarine had a significantly lower climate impact than dairy butter, with and without land use change (LUC) inclusion. The regionalised analysis highlighted large variabilities across products, ranging from 0.98 to 6.93 (mean 3.3) kg CO_2-eq for 212 plant-based spreads and margarine and 8.08 to 16.93 (mean 12.1) kg CO_2-eq for 21 dairy butter with 95th confidence interval. The main drivers of GHG emissions for plant-based products are oilseed farming and the associated LUC emissions, which can vary significantly depending on the type of oilseed, quantity and sourcing country; in the worst-case scenario, the climate advantage is no longer valid due to LUC. Thus, the inclusion of LUC is essential for a robust assessment and hotspot identification. Overall, the risk of shifting impacts was small, as most of the plant-based spreads and margarine also had lower impacts for the water scarcity footprint and land occupation; 8 of the 212 products were not lower, due to oilseed ingredients with high embodied impacts.

CLIMATE CHANGE IMPACTS

Table 1 shows overall that plant-based spreads and margarine (mean: 3.1 kg CO2-eq) in the 21 markets studied have lower climate change impacts than dairy butter (mean:12.1 kg CO_2-eq), however, Figure 5 shows the regionalized LCA results highlighted large variabilities on the individual product level, driven by difference in product recipe design and spatial variabilities of sourcing ingredients.

	Plant-based spreads and margarine	Dairy butter	GWP difference	
Country	GWP (kg CO_2-eq/kg)	GWP (kg CO_2-eq/kg)	kg CO_2-eq/kg	%
Austria	3.66	13.64	9.98	-73%
Belgium	3.61	12.74	9.13	-72%
Canada	2.23	11.06	8.83	-80%
Switzerland	2.93	12.38	9.45	-76%
Czech Republic	3.23	11.96	8.73	-73%
Germany	2.96	12.68	9.72	-77%
Denmark	3.05	9.87	6.82	-69%
Spain	4.57	14.47	9.90	-68%
Finland	3.2	9.45	6.25	-66%
France	3.71	12.28	8.57	-70%
Greece	3.43	14.20	10.77	-76%
Hungary	2.96	10.43	7.47	-72%
Ireland	3.06	11.77	8.71	-74%
Netherlands	3.24	12.23	8.99	-74%
Poland	2.78	13.12	10.34	-79%
Portugal	4.2	14.47	10.27	-71%
Romania	2.37	10.86	8.49	-78%
Sweden	2.91	10.07	7.16	-71%
Slovakia	3.01	12.06	9.05	-75%
United Kingdom	2.99	12.37	9.38	-76%
United States	3.09	12.05	8.96	-74%
21 Markets	3.14	12.10	8.96	-74%

Table 1. Greenhouse gas emissions (climate footprint) for plant-based spreads and margarine and dairy butter and creams in the 21 markets. Results are expressed in kg CO2eq per kg of product.

FRESHWATER CONSUMPTION

For **freshwater** consumption and water scarcity results, there are high variabilities across product recipes and markets (Table 2). Overall, for plant-based spreads and margarine, differences are driven by yield and irrigation of crops and orchards. Plant-based spreads and margarine generally have a lower water consumption with a few exceptions; dairy butter in Ireland, for example, has a lower water consumption, due to embedded variabilities of dairy farming systems, influenced by different herd structures, feed intake compositions and manure management systems. The dairy farming systems in Ireland have a relatively higher proportion of pasture, hay, silage, haylage and agricultural residues rather than grains and concentrated feed.

	Plant-based spreads and margarine	Dairy butter and creams	WC difference	
Country	WC (m3 water /kg)	WC (m3 water /kg)	(m3 water /kg)	%
Austria	0.06	0.12	0.06	-51%
Belgium	0.06	0.12	0.06	-47%
Canada	0.17	0.33	0.16	-49%
Switzerland	0.06	0.16	0.10	-64%
Czech Republic	0.03	0.12	0.09	-76%
Germany	0.06	0.13	0.08	-58%
Denmark	0.08	0.16	0.09	-53%
Spain	0.07	0.10	0.03	-33%
Finland	0.06	0.21	0.15	-70%
France	0.07	0.09	0.02	-27%
Greece	0.07	0.15	0.09	-57%
Hungary	0.03	0.10	0.07	-68%
Ireland	0.06	0.05	-0.01	24%
Netherlands	0.06	0.11	0.05	-45%
Poland	0.03	0.09	0.06	-68%
Portugal	0.08	0.11	0.03	-28%
Romania	0.02	0.06	0.04	-65%
Sweden	0.05	0.14	0.10	-69%
Slovakia	0.03	0.12	0.09	-77%
United Kingdom	0.07	0.10	0.04	-35%
United States	0.02	0.24	0.22	-90%
21 Markets	0.05	0.15	0.10	-65%

Table 2. Freshwater consumption for plant-based spreads and margarine and dairy butter and creams in the 21 markets. Results are expressed in m3 of water per kg of product.

LAND OCCUPATION

In terms of land occupation, there are some overlaps between plant-based spreads and margarine and dairy butter if the constraints of consumer countries are ignored. However, in the respective consumer markets, most plant-based spreads and margarine (211 of the 212) have lower impacts compared to dairy butter (Table 3).

Overall, when comparing plant-based spreads and margarine and dairy butter products, there is little risk of shifting climate impacts to water and land related impacts, however, special attention should be paid to agricultural ingredients from regions with high embodied land occupation or water scarcity footprints. There are opportunities for further reducing the environmental impacts of plant-based fat spreads by, for example, adapting product recipes, opting for alternative agricultural oilseeds ingredients and/or adapting sourcing countries to avoid deforestation or other land use change related climate risks. Meanwhile, it is important to consider potential constraints, such as the

choice of oils based on consumer preferences (taste, nutritional benefits and product function, e.g. harder fats are used for products in warmer climates).

	Plant-based spreads and margarine	Dairy butter and creams	LO difference	
Country	LO (m2.y /kg)	LO (m2.y /kg)	(m2.y /kg)	%
Austria	3.59	12.40	8.81	-71%
Belgium	4.72	11.43	6.71	-59%
Canada	7.57	11.14	3.57	-32%
Switzerland	2.98	11.53	8.55	-74%
Czech Republic	3.63	10.44	6.82	-65%
Germany	2.97	10.76	7.78	-72%
Denmark	4.38	8.70	4.32	-50%
Spain	5.40	13.93	8.53	-61%
Finland	4.84	9.14	4.30	-47%
France	3.74	11.17	7.44	-67%
Greece	3.26	12.90	9.64	-75%
Hungary	3.30	9.79	6.49	-66%
Ireland	4.51	13.34	8.82	-66%
Netherlands	4.05	9.87	5.82	-59%
Poland	3.15	20.11	16.97	-84%
Portugal	4.08	15.88	11.79	-74%
Romania	2.62	25.50	22.88	-90%
Sweden	3.84	9.64	5.79	-60%
Slovakia	3.30	15.01	11.71	-78%
United Kingdom	4.48	10.60	6.12	-58%
United States	2.93	11.77	8.85	-75%
21 Markets	3.73	11.89	8.16	-69%

Table 3. Land occupation for plant-based spreads and margarine and dairy butter and creams in the 21 markets. Results are expressed inm2 per year per kg of product.

LCA CONCLUSIONS AND OUTLOOK

The regionalized LCA conducted in this study is the largest scale regionalized agricultural LCA comparing dairy butter and plant-based spreads and margarine published to date. It shows that plant-based spreads and margarine have lower climate, water and land impacts than dairy butter, despite variability in product recipes and geographies and influence of LUC emissions. **For climate change,** the assessment shows all plant-based spreads and margarine perform better than dairy butter regardless of the choice of functional unit (mass-based or fat-based), inclusion of LUC, or allocation approach of oilseeds. It also shows that LUC of oilseed ingredients could dominate climate impacts for plant-based spreads and margarine (Figure 2); further, the hypothetical worst-case sourcing scenario (i.e. with the worst combination of oilseed type and sourcing country) performs worse than dairy butter for climate impact, due to LUC associated with growing oilseed ingredients. Thus, inclusion of spatial LUC emissions is important for robust assessment and hotspot identification when taking steps towards mitigating the climate impacts of food products. **With respect to land occupation and water scarcity**, most plant-based spreads and margarine had lower impacts compared to dairy butter in their respective consumer markets, with only a few exceptions (8 of 212 products) which contained oilseed ingredients with high embodied impacts, caused by either very low yield or very high water demand from growing in high water stressed regions.

When moving towards transparency of sustainable supply chains and developing potential mitigation strategies, producers can only understand the impacts of their products and look for opportunities to reduce these impacts if they

fully and accurately assess their product supply chains. The regionalized LCA highlights significant interindividual variabilities on the product level for plant-based spreads and margarine, driven by differences in product recipe designs and spatial variabilities of sourcing ingredients.

The framework introduced and demonstrated in this study offers opportunities for hotspot identification as well as insights for improving the sustainability of a large portfolio of products. For example, towards more sustainable plant-based spreads and margarine, a key factor would be to reduce embodied environmental impacts from oilseed ingredients through better understanding and improvements in supply chain sourcing, farm level agricultural practice, and product recipe design. **The key challenges of performing large scale regionalized LCA lies in the collection and organization of all relevant data and models, performing gap assessment and prioritization, developing missing data or improving data quality, and linking inventory data with impact assessment, to draw robust conclusions and meet requirements for data quality.**

The application of the methodology framework in this study demonstrated the feasibility of conducting large-scale regionalised LCA for agri-food products. This principle is also relevant for other product type evaluations and this study offers stepwise guidance. We believe it will contribute to the operationalisation of regionalised LCA in practice towards identifying inter-product variabilities as well as highlighting hotspots for improving transparency and sustainability of product supply chains.

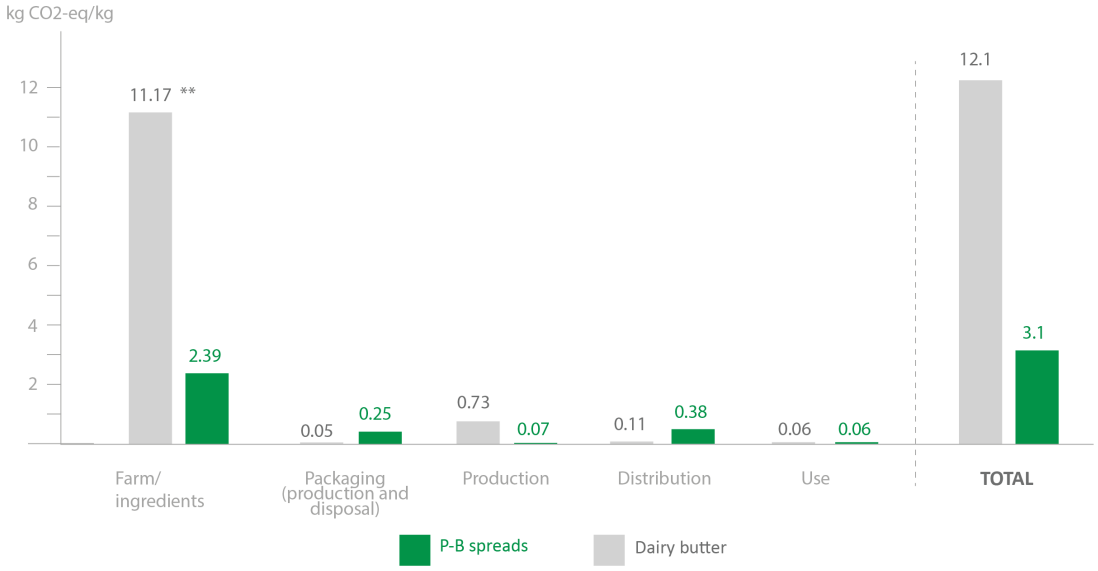

Figure 2. Climate change results per stage of life cycle per 1 kg of product

** CO2-eq emission per kg of dairy butter by farm activity: Enteric emissions: 4.54 kg; Manure management: 1.64 kg; Pasture feed: 0.41 kg2; Pasture peat degradation: 0.32 kg; Feed fodder: 2.23 kg; Fodder land use change: 1.23 kg; other farm activities: 0.81 kg.
The average enteric emissions account for 38% for the dairy butter carbon footprint of the 21 markets, with variabilities ranging from 32-48% for each country market, respectively.

CALCULATION OF EQUIVALENCIES

Using the results of the analysis and other data sources, Quantis made the calculation of equivalencies to put in perspective the results of the greenhouse gas emissions, land occupation and water consumption of plant-based spreads and margarine and dairy butter to make information more meaningful and understandable for a larger audience.

In the equivalencies, the country weighted average results for plant-based spread and margarine are calculated based on the market share of different products, provided by Upfield. The “21 market” weighted for plant-based spreads and margarine and dairy butter are calculated by multiplying the weighted country average carbon footprint, water consumption and land occupation by the market share derived from the 2018 dairy butter production data (Eurostat[1], USDA[2] and Canadian dairy Information Center[3]) for respective countries.

The equivalency calculations are derived using the following data sources:

Equivalency	Equivalency Unit	Explanation	Source
Dairy butter consumption per person	-	Average dairy butter consumption in kg per capita	https://www.statista.com/statistics/415277/butter-consumption-per-capita-by-country-europe/
Smartphone charging	0.008 Kg CO_2-eq	Charging an average smartphone overnight	https://www.zdnet.com/article/heres-how-much-it-costs-to-charge-a-smartphone-for-a-year/ https://slate.com/technology/2012/03/is-charging-your-cell-phone-overnight-a-major-waste-of-energy.html
Plastic bottles saved	0.1 Kg CO_2-eq	500 ml PET bottle (full life cycle, from production to end of life)	ecoinvent v3.4
Km driven in a petrol car	0.25 Kg CO_2-eq	Emissions from driving an average internal combustion engine gas-powered car (tailpipe)	ecoinvent v3.4
Annual Carbon footprint of a person	Kg CO_2 per capital carbon	Average per capita carbon footprint by country. It includes both territorial accounting and consumption-based accounting.	Cite as: Updated from Peters et al. (2012) and Peters et al. (2011) Published by the GCP (global carbon project) team.
Cup of coffee	0.1 Kg CO_2-eq	Full life cycle assessment of 1 Lungo cup of portioned coffee made with a capsule	WFLDB + Ecoinvent
Flight	0.275 Kg CO_2-eq	Air travel, per passenger, life cycle footprint	ecoinvent & IPCC2013
Grilled beef burger patty	2.5 Kg CO_2-eq	Full LCA of a ready-to-eat grilled beef burger patty	RegletteFood_2019-09-19

[1]Eurostat https://ec.europa.eu/eurostat/databrowser/view/tag00038/default/table?lang=en (accessed January 31st, 20202)
[2]USDA https://www.ers.usda.gov/webdocs/DataFiles/48685/Dairyglance.xlsx?v=1337.1 (accessed January 31st, 20202)
[3]Canadian Dairy Information Center https://aimis-simia-cdic-ccil.agr.gc.ca/rp/index-eng.cfm?action=pR&pdctc=&r=261#wb-cont (accessed January 31st, 20202)

DO YOU WANT TO KNOW MORE ABOUT THE STUDY?

Read the complete study published by The International Journal of Life Cycle Assessment and get more detailed information at: https://link.springer.com/article/10.1007/s11367-019-01703-w

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