Carbon Footprint of Europe Soya certified soybean meal and soybean oil at ATK

FiBL Austria

Georg Zamecnik M.Sc.

April 2023

Imprint

Client

Donau Soja Association

Wiesingerstraße 6/14

A-1010 Vienna

Contractor

FiBL Austria

Doblhoffgasse 7/10

A-1010 Vienna

This study was carried out on behalf of the client. The contractors are responsible for the content, which was developed in constant consultation with the client.

Table of Contents

List of Figures

List of Tables

Summary

The aim of the study was to determine the carbon footprint of soybean meal and crude soybean oil produced by the company ATK (exclusively processing Europe Soya soybeans from Ukrainian cultivation).

The CO2 balance was carried out using the life cycle analysis method and closely follows the international life cycle assessment guidelines (ISO 14040 and 14044). The CO2 balance covers soybean cultivation including upstream processes, transport of the beans to the factory, processing into soybean meal or soybean oil. The scope of the study ends at the factory gate.

The key findings are:

- The greenhouse gas emissions of the balanced soybean meal are 0.363 kg CO2-eq / kg soybean meal.
- The Greenhouse gas emissions of the balanced soybean oil is 0.686 kg CO2-eq / kg soybean oil.
- In both cases, 77.7% of greenhouse gas emissions are caused during cultivation (0.28 kg CO2-eq for soybean meal, 0.53 kg CO2-eq for soybean oil). Only 22.3% of greenhouse gas emissions are caused while processing (0.08 kg CO2-eq for soybean meal, 0.15 kg CO2-eq for soybean oil)
- More than 50% of the greenhouse gas emissions generated during processing are energy-related (36% electricity, 19% gas) and 37% are waste-related (19% waste disposal, 18% wastewater treatment). The remaining 8% is due to the transport of the soybeans from the cultivation areas to the factory.

1. Method

1.1 Objective

The aim of this study was to examine the greenhouse gas emissions of soybean meal and soybean oil produced by ATK along the value chain from agriculture, including the upstream chain, to the finished product.

The main raw material, soybean, originates from the Ukraine and is Europe Soya certified.

1.2 Method, system boundaries and functional unit

The carbon footprint is closely aligned with international life cycle assessment guidelines (ISO guidelines 14040 and 14044). Material and energy flows along the entire value chain were accounted for. From the primary production of the basic and concentrated feedstuffs, including upstream processes (fuel, production materials and energy requirements, etc.), through soybean cultivation and transport to the factory site and processing there. Based on the system boundaries considered, the greenhouse gas emissions for the functional unit 1 kilogram soybean meal or 1 kilogram soybean oil were considered. The ReCiPe 2016 Midpoint (H) V1.07 / World (2010) method was used to calculate CO2 eq emissions. For the allocation of environmental impacts to two or more products from one process, the economic allocation, were used. Allocation by mass and by energy were also performed. The results of these two allocation variants can be found in the form of an overview table in the appendix. The same applies to the results of the other impact categories of the calculation method Recipe 2016 Midpoint (H), which are not treated further during this investigation due to the focus of the investigation "climate impact".

1.3 Data collection

For the primary data collection, FiBL provided the ATK company with a questionnaire containing the parameters relevant for the greenhouse gas balance.

The primary data cover the following areas:

- Processing quantities of raw materials, quantity of goods produced and economic key figures.

- By-products produced

- Material input (water, hexane)

- Energy consumption (electricity, gas)

This allowed for an accurate life cycle inventory for soybean meal/soybean oil production. Where primary data were not available, existing peer-reviewed scientific literature, statistical data, and existing LCA datasets from Ecoinvent 3.8 (Wernet et al., 2016), Agribalyse 3.0 (Asselin-Balençon et al., 2020), and Agri-Footprint 5.0 (Van Paassen et al., 2019) were used.

For the cultivation of soybeans, on which the soybean meal production is based, CO2-eq values for soybean cultivation in Ukraine were provided to FiBL by the Donau Soja Association.

The data basis on which the calculation of greenhouse gas emissions is based is described below.

1.3.1 Production data

In 2021, 150,747 tons of soybeans were processed by ATK. From this quantity, 109,069.5 tons of soybean meal and 25,930.6 tons of soybean oil were produced (see Table 1). This results in a proportional mass ratio of 80.8% to 19.2% for soybean meal and soybean oil based on one unit of soybeans. The straw produced is not considered further due to its low monetary importance (< 5%).

Weight of processed soybeans 2021 (t)	150747	-
Weight of produced soybean meal 2021 (t)	109069.5	72.4%
Weight of produced soybean oil 2021 (t)	25930.6	17.2%
Weight of accrued straw 2021 (t)	11978.6	8%

Table 1 – Processing Quantities

1.3.2 Economic Data

The average prices achieved per ton of product, as well as the total for the processed products, are shown in Table 2. Based on the proportional mass ratio (see chapter 1.3.1) and the ratio of the average prices of soybean meal and soybean oil, the overall economic ratio is 69% (soybean meal) to 31% (soybean oil). This ratio was used for the economic allocation of the environmental impact in this study.

Average price per ton of soybean meal sold 2021 (€)	633
Average price per ton of soybean oil sold 2021 (€)	1199
Price of soybean meal sold Total 2021 (€)	69040993.50
Price of soybean oil sold Total 2021 (€)	31090789.4
Monetary share of by-product soybean meal in %.	69%
Monetary share of by-product soybean oil in %.	31%

Table 2 - Economic allocation

1.3.3 Energy

The energy consumption of the production process for the year 2021 is shown in Table 3. The electricity consumption amounts to about 9.5 million kWh. The annual gas consumption was around 26,000 gigajoules.

Annual electricity demand (kWh)	9529546
Annual natural gas demand (GJ)	25957.868

Table 3 – Energy Demand

1.3.4 Other materials

In addition to the main raw material, soybeans, two other components are used while processing - hexane and water. The amount of hexane used in 2021 was 36.5 tons. Water consumption amounted to 79,400 m^3 (see Table 4).

Hexane demand (t)	36.533
Water demand (m^3)	79413

Table 4 – Other Materials

1.3.5 Transport

ATK's factory plant is located in Adampil, Ukraine. Khmelnytsky, Zhytomyr, Vinnitsa and Rivne were indicated as the main soybean growing areas. Distances between cultivation areas and factory sites are shown in Table 5. From these distances, an average value for the transport distance of 122.5 km was calculated. This was used for the greenhouse gas balance of the truck transport.

Chmelnyzkyj to Adampil (km)	80
Zhytomyr to Adampil (km)	120
Vinnitsa to Adampil (km)	100
Rivne to Adampil (km)	190
Average distance from cultivation to factory (km)	**122.5**

Table 5 – Transport Distance

1.3.6 Cultivation of Soybeans

Greenhouse gas emissions from soybean cultivation were not collected as part of this study. The CO2-eq values of soybean cultivation of Europe Soya-certified soybeans grown in Ukraine, based on calculations by Blonk Consultants, were provided by Donau Soja Association. Per kg of soy, greenhouse gas emissions are 0.2968 kg CO2-eq.

2. Results

2.1.1 Overview

Table 6 below provides an overview of the greenhouse gas emissions in kg CO2-eq / kg soybean meal or soybean oil for all processes.

kg CO_2-eq / kg	Soybean meal	Soybean oil	%
Soybean cultivation	0.28	0.53	77.68%
Energy, Electricity	0.03	0.06	8.02%
Energy, natural gas	0.02	0.03	4.15%
Hexane production	0.00	0.00	0.06%
Truck transport from cultivation to factory	0.01	0.01	1.90%
Waste disposal	0.02	0.03	4.21%
Wastewater treatment	0.01	0.03	3.98%
TOTAL	**0.36**	**0.67**	**100%**

Table 6 – Overall Results

The greenhouse gas potential for the production of 1kg soybean meal, using Europe Soya certified soybeans from Ukraine, is 0.36 kg CO2-eq and 0.67 kg CO2-eq for soybean oil. With 77.7%, the cultivation of soybeans has the clearly largest share of the total emissions in each case. Energy-related GHG emissions amount to about 12%, and waste and wastewater treatment account for about 8%. Transportation by truck causes less than 2%, and production of the required hexane less than 1%.

The following Figure 1 shows the greenhouse gas emissions for soybean meal and oil in an overview and aggregated form, and Figure 2 shows the average percentage distribution of the aggregated processes.

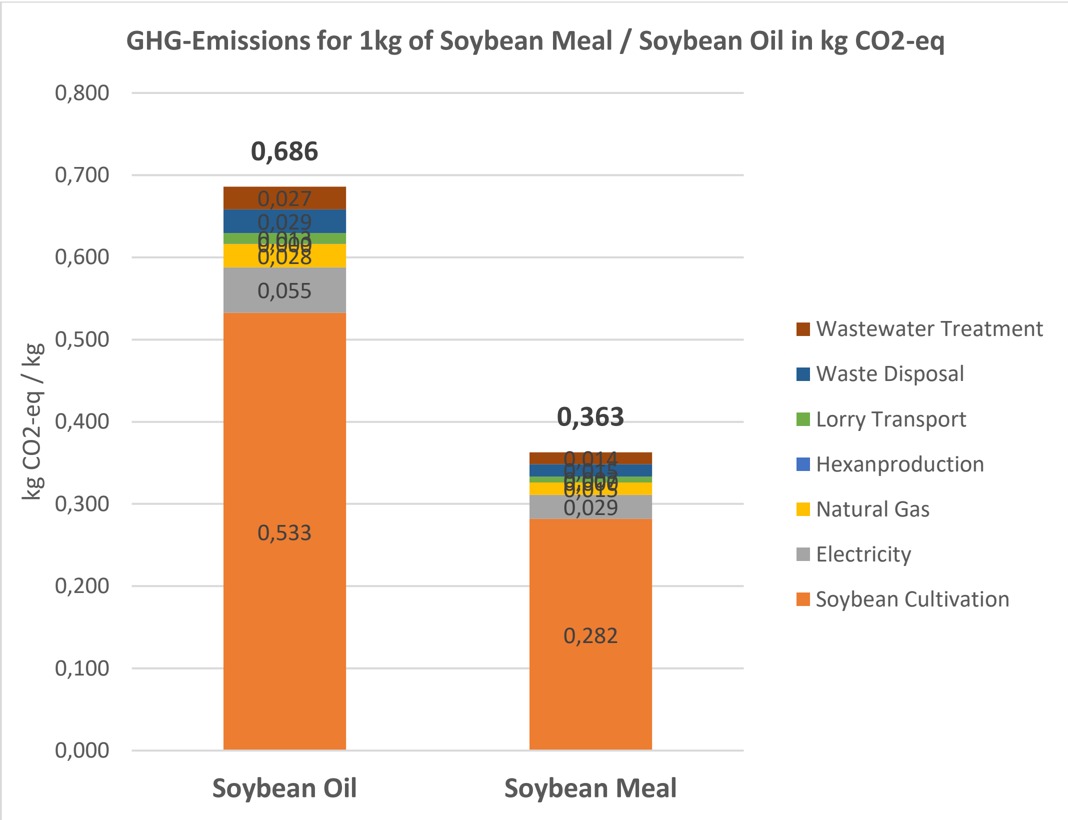

Figure 1 - GHG-Emissions for 1kg of Soybean Meal / Soybean Oil in kg CO2-eq

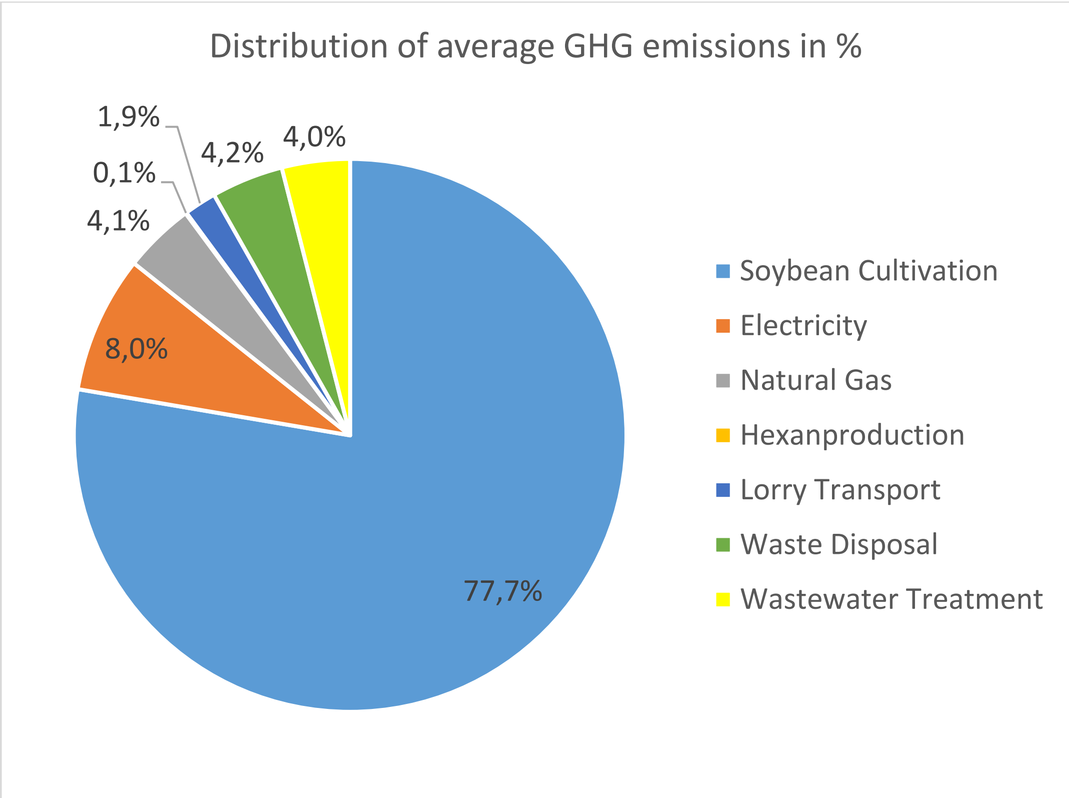

Figure 2 - Distribution of average GHG emissions in %

2.1.2 Results processing

Considering only the results of processing, excluding soybean cultivation, the GHG emissions for one kg of soybean meal are 0.081kg CO2-eq and for one kg of soybean oil 0.153kg CO2-eq (see Figure 3).

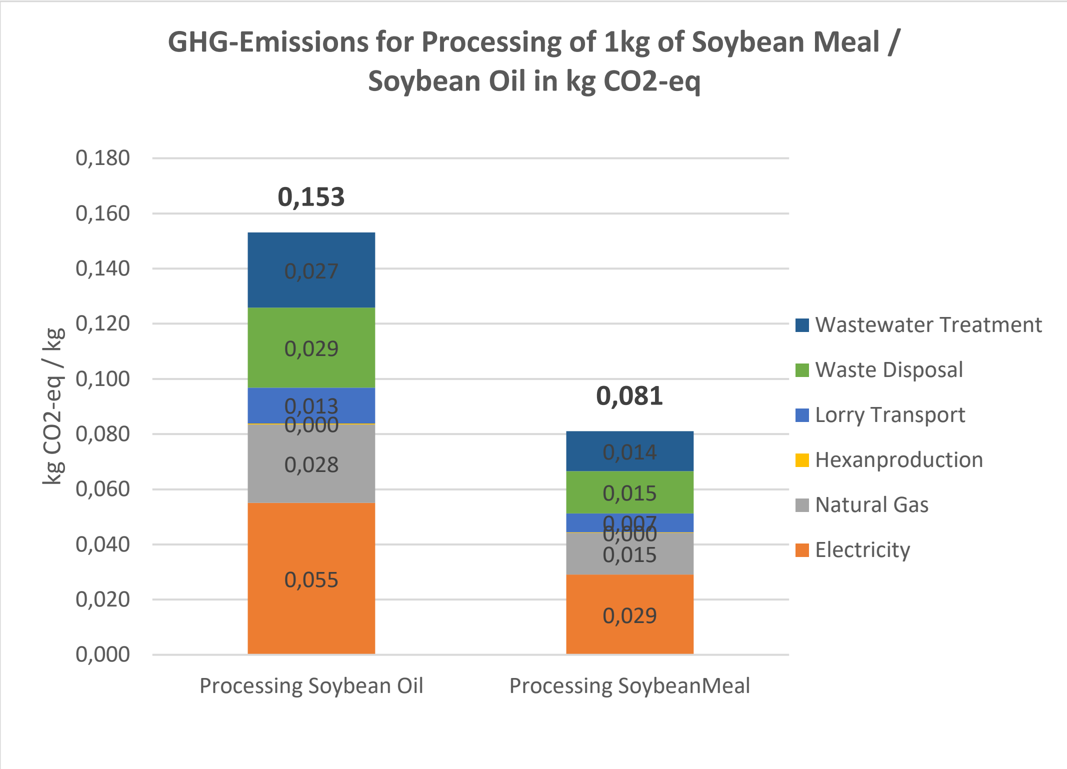

Figure 3 - GHG-Emissions for Processing of 1kg of Soybean Meal / Soybean Oil in kg CO2-eq

In each case, electricity consumption accounts for 36%, natural gas for 19%, truck transport from cultivation to factory for 8%, waste disposal for 19%, and wastewater treatment for 18% (see Figure 4).

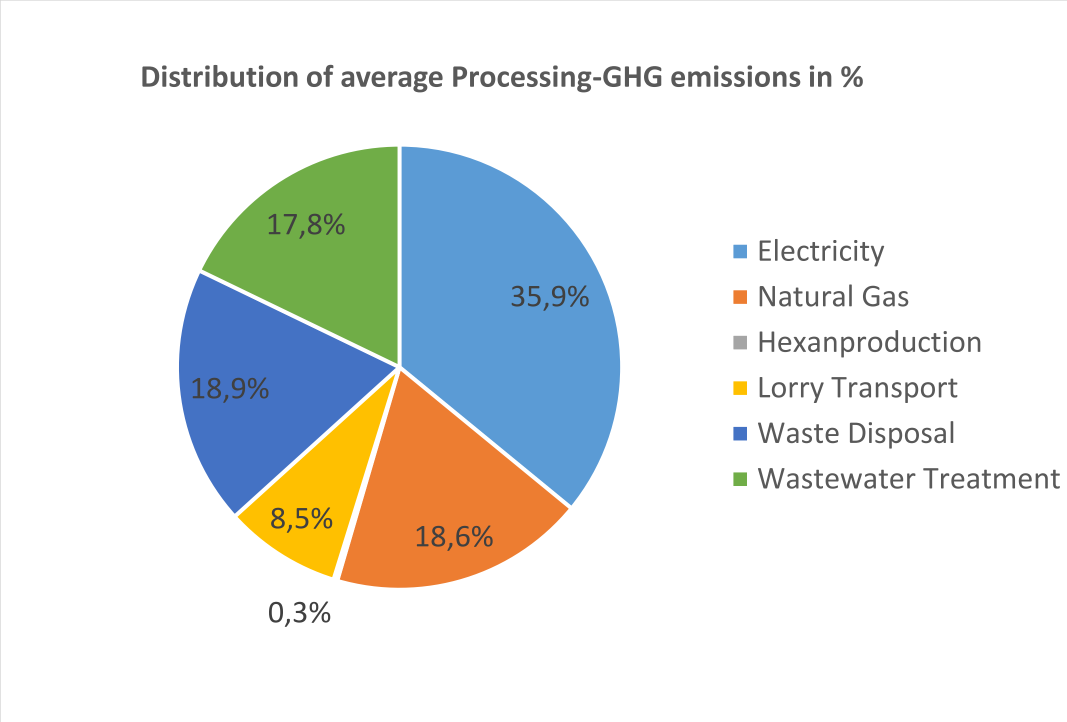

Figure 4 - Distribution of average Processing-GHG emissions in %

3. Discussion

The range of identified data values from Agrifootprint Database for the GHG potential of 1kg of soybean meal or 1kg of soybean oil, with a comparable study framework, ranges from 0.55 kg CO2-eq (meal) or 1.1 kg CO2-eq (oil) for production in the U.S., to 1.92 kg CO2-eq or 3.73 kg CO2-eq in Germany/France, to 4.3 kg CO2-eq or 8.34 kg CO2-eq in Brazil. The total emissions of soybean meal and soybean oil calculated in this study are very low in comparison, averaging 0.363 kg CO2-eq / kg for meal and 0.686 kg CO2-eq / kg for oil, respectively. The decisive process for the respective level of GHG emissions from soybean meal/soybean oil is in any case the cultivation of the soybeans. The average cultivation of 1kg soybean in the EU causes on average 0.78 kg CO2-eq with reference to data sets of the Agrifootprint database (weighted average of the important soybean growing countries within the European Union Italy, France, Romania, Austria, Hungary, Germany, Slovakia). If ATK soybean meal were produced with soybeans from this average EU-mix, the GHG emissions of the soybean meal produced or the soybean oil produced would be more than twice as high (see Figure 5).[1] The reduction potential from processing DS-certified soy from Ukraine is about 56 percent compared to processing Soybeans from the average European-cultivated soybean mix.

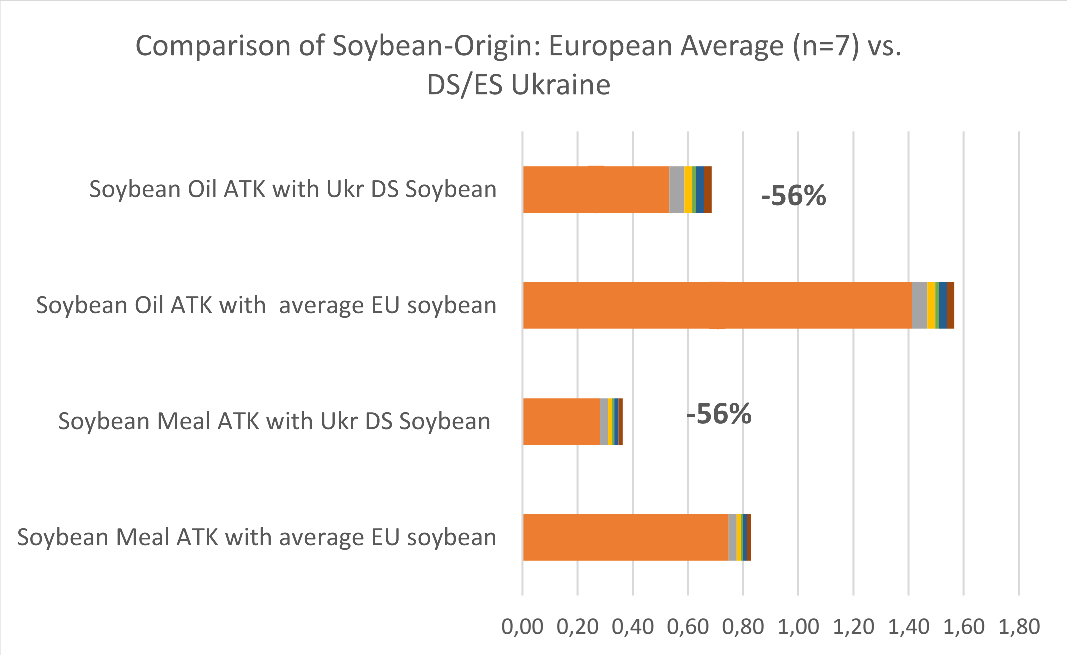

Figure 5- Comparison of GHG-Emissions with soybeans of different origin, intended for internal use only.

Furthermore, it is crucial to which extent the soybeans originate from regions in which deforestation occurs due to soybean cultivation or has occurred in the past 20 years. In particular, the part of soy imports originating from South America is directly or indirectly linked to the destruction of tropical forests and savannas in Brazil and Argentina due to soy cultivation there (Schlatzer and Lindenthal, 2019; Schlatzer et al., 2021). Feeding soybean meal from European cultivation thus holds great reduction potential in terms of CO2 eq emissions. However, LULUC emissions can vary greatly depending on the area/land in which the direct and indirect land use changes take place. In an LCA study of soy production in Brazil and Argentina, Castanheira and Freire (2013) showed that GHG emissions per kg of product can vary from

[1] This comparison is intended for internal purposes. In the event of publication/media exploitation of comparative LCA results, a Critical Review must be carried out in accordance with ISO 14040/44.

0.3 kg to 17.8 kg CO2-eq (including emissions from cultivation, land use change, and transport).

4. Uncertainty analyses

Life cycle assessment data are subject to uncertainties, which were subjected to a separate analysis in order to be able to make statistically reliable statements. For the following uncertainty analyses (Monte Carlo simulation), a confidence interval of 95% applies, i.e. only in 5% of all possible cases does the result lie outside the specified ranges. 1,000 calculation runs per analysis were performed. The following analyses refer to 1kg soybean meal / soybean oil. As can be seen in table 7, the results may show certain ranges, for example due to fluctuating yields.

Impact Category	**Unit**	**5%**	**95%**
Recipe 2016 Midpoint (H)	kg CO_2-eq / kg Product		
1kg Soybean Meal		0.334	0.39
1kg Soybean Oil		0.632	0.742

Table 7 - 95% confidence interval for 1kg soybean meal and 1kg soybean oil

5. Literature

Asselin-Balençon A., Broekema R., Teulon H., Gastaldi G., Houssier J., Moutia A., Rousseau, V., Wermeille A., Colomb V. (2020): AGRIBALYSE v3.0 : the French agricultural and food LCI database. Methodology for the food products. Ed. ADEME 2020.

Castanheira und Freire (2013): Greenhouse gas assessment of soybean production: implications of land use change and different cultivation systems. Journal of Cleaner Production 54 (2013) 49e60. http://dx.doi.org/10.1016/j.jclepro.2013.05.026.

Gavrilova et al., 2019: Emissions from Livestock and Manure Management. Chapter 10. Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. https://www.ipcc-nggip.iges.or.jp/public/2019rf/vol4.html

Guilherme et. al. (2015): Greenhouse gas assessment of Brazilian soybean production: a case study of Mato Grosso State. Journal of Cleaner Production 96 (2015) 418e425. http://dx.doi.org/10.1016/j.jclepro.2014.02.064.

IPCC (2013): Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

IPCC (2019): Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey,

S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)]. In press.

Leclerc, B., P. Georges, B. Cauwel and D. Lairon, (1995): A Five Year Study on Nitrate Leaching under Crops Fertilised with Mineral and Organic Fertilisers in Lysimeters. In Nitrogen Leaching in Ecological Agriculture, Biological Agriculture and Horticulture 11, 301-308.
PRé Sustainability B.V. (2021): SimaPro database manual – Methods Library - Version 4.17.

Schlatzer, M., Lindenthal, T. (2019): Österreichische und europäische Alternativen zu Palmöl und Soja aus Tropenregionen – Möglichkeiten und Auswirkungen; Endbericht an Greenpeace. Forschungsinstitut für biologischen Landbau (FiBL) Österreich und Zentrum für Globalen Wandel und Nachhaltigkeit (gW/N), Universität für Bodenkultur, Wien, 80.

Schlatzer, M., Drapela, T., Lindenthal, T. (2021): Die Auswirkungen des österreichischen Imports ausgewählter Lebensmittel auf Flächenverbrauch, Biodiversität und Treibhausgasemissionen in den Anbauregionen des globalen Südens. Studie im Auftrag von Greenpeace und ORF Mutter Erde. Wien.

Van Paassen, M., Braconi, N., Kuling, L., Durlinger, B., Gual, P. (2019): Agri-footprint 5.0 - Part 1 - Methodology and basic principles. Gouda, the Netherlands.
Van Paassen, M., Braconi, N., Kuling, L., Durlinger, B., Gual, P. (2019): Agri-footprint 5.0 - Part 2 - Description of Data. Gouda, the Netherlands.

Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., and Weidema, B. (2016): The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment, [online] 21(9), pp.1218–1230.

6. Annex

1 kg ATK__Soybean meal, Economic									
ReCiPe 2016 Midpoint (H)	Unit	Sum	Soybean Cultivation	Electricity	Natural Gas	Hexane Production	Transport	Landfill of waste	Waste water treatment
Global warming	kg CO2 eq	0.363	0.282	0.029	0.015	0.000	0.007	0.015	0.014
Stratospheric ozone depletion	kg CFC11 eq	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ionizing radiation	kBq Co-60 eq	0.029	0.002	0.027	0.000	0.000	0.000	0.000	0.000
Ozone formation, Human health	kg NOx eq	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Fine particulate matter formation	kg PM2.5 eq	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ozone formation, Terrestrial ecosystems	kg NOx eq	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Terrestrial acidification	kg SO2 eq	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Freshwater eutrophication	kg P eq	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Marine eutrophication	kg N eq	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000
Terrestrial ecotoxicity	kg 1,4-DCB	0.606	0.540	0.056	0.000	0.000	0.009	0.000	0.001
Freshwater ecotoxicity	kg 1,4-DCB	0.028	0.027	0.001	0.000	0.000	0.000	0.000	0.000
Marine ecotoxicity	kg 1,4-DCB	0.020	0.019	0.001	0.000	0.000	0.000	0.000	0.000
Human carcinogenic toxicity	kg 1,4-DCB	0.002	0.000	0.002	0.000	0.000	0.000	0.000	0.000
Human non-carcinogenic toxicity	kg 1,4-DCB	0.589	0.554	0.034	0.000	0.000	0.000	0.000	0.000
Land use	m2a crop eq	3.150	3.149	0.000	0.000	0.000	0.000	0.000	0.000
Mineral resource scarcity	kg Cu eq	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Fossil resource scarcity	kg oil eq	0.069	0.053	0.007	0.005	0.000	0.002	0.000	0.001
Water consumption	m3	0.466	0.000	0.465	0.000	0.000	0.000	0.000	0.000

1 kg ATK__Soybean oil, Economic									
ReCiPe 2016 Midpoint (H)	Unit	Sum	Soybean Cultivation	Electricity	Natural Gas	Hexane Production	Transport	Landfill of waste	Waste water treatment
Global warming	kg CO2 eq	0.686	0.533	0.055	0.028	0.000	0.013	0.029	0.027
Stratospheric ozone depletion	kg CFC11 eq	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ionizing radiation	kBq Co-60 eq	0.055	0.004	0.051	0.000	0.000	0.000	0.000	0.000
Ozone formation, Human health	kg NOx eq	0.003	0.002	0.000	0.000	0.000	0.000	0.000	0.000
Fine particulate matter formation	kg PM2.5 eq	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Ozone formation, Terrestrial ecosystems	kg NOx eq	0.003	0.002	0.000	0.000	0.000	0.000	0.000	0.000
Terrestrial acidification	kg SO2 eq	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Freshwater eutrophication	kg P eq	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Marine eutrophication	kg N eq	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Terrestrial ecotoxicity	kg 1,4-DCB	1.146	1.021	0.105	0.000	0.000	0.017	0.000	0.001
Freshwater ecotoxicity	kg 1,4-DCB	0.053	0.052	0.001	0.000	0.000	0.000	0.000	0.000
Marine ecotoxicity	kg 1,4-DCB	0.038	0.036	0.002	0.000	0.000	0.000	0.000	0.000
Human carcinogenic toxicity	kg 1,4-DCB	0.004	0.000	0.003	0.000	0.000	0.000	0.000	0.000
Human non-carcinogenic toxicity	kg 1,4-DCB	1.114	1.048	0.064	0.000	0.000	0.001	0.000	0.000
Land use	m2a crop eq	5.952	5.951	0.000	0.000	0.000	0.000	0.000	0.000
Mineral resource scarcity	kg Cu eq	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Fossil resource scarcity	kg oil eq	0.130	0.100	0.013	0.010	0.001	0.004	0.001	0.002
Water consumption	m3	0.880	0.000	0.879	0.000	0.000	0.000	0.000	-0.001

1 kg ATK__Soybean meal, Mass

ReCiPe 2016 Midpoint (H)	Unit	Sum	Soybean Cult	Electricity	Natural Gas	Hexane Prodı	Transport	Landfill of wa	Waste water treatment
Global warming	kg CO2 eq	0.392	0.318	0.033	0.000	0.000	0.008	0.017	0.016
Stratospheric ozone depletion	kg CFC11 eq	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ionizing radiation	kBq Co-60 eq	0.033	0.002	0.030	0.000	0.000	0.000	0.000	0.000
Ozone formation, Human health	kg NOx eq	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Fine particulate matter formation	kg PM2.5 eq	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ozone formation, Terrestrial ecosys	kg NOx eq	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Terrestrial acidification	kg SO2 eq	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000
Freshwater eutrophication	kg P eq	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Marine eutrophication	kg N eq	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000
Terrestrial ecotoxicity	kg 1,4-DCB	0.684	0.609	0.063	0.000	0.000	0.010	0.000	0.001
Freshwater ecotoxicity	kg 1,4-DCB	0.032	0.031	0.001	0.000	0.000	0.000	0.000	0.000
Marine ecotoxicity	kg 1,4-DCB	0.023	0.021	0.001	0.000	0.000	0.000	0.000	0.000
Human carcinogenic toxicity	kg 1,4-DCB	0.002	0.000	0.002	0.000	0.000	0.000	0.000	0.000
Human non-carcinogenic toxicity	kg 1,4-DCB	0.668	0.628	0.039	0.000	0.000	0.000	0.000	0.000
Land use	m2a crop eq	3.570	3.570	0.000	0.000	0.000	0.000	0.000	0.000
Mineral resource scarcity	kg Cu eq	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000
Fossil resource scarcity	kg oil eq	0.069	0.057	0.008	0.000	0.000	0.002	0.001	0.001
Water consumption	m3	0.528	0.000	0.528	0.000	0.000	0.000	0.000	-0.001

1 kg ATK__Soybean oil, Mass

ReCiPe 2016 Midpoint (H)	Unit	Sum	Soybean Cult	Electricity	Natural Gas	Hexane Production	Transport	Landfill of waste	Waste water treatment
Global warming	kg CO2 eq	0.460	0.372	0.039	0.000	0.000	0.009	0.020	0.019
Stratospheric ozone depletion	kg CFC11 eq	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ionizing radiation	kBq Co-60 eq	0.038	0.002	0.036	0.000	0.000	0.000	0.000	0.000
Ozone formation, Human health	kg NOx eq	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000
Fine particulate matter formation	kg PM2.5 eq	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ozone formation, Terrestrial ecosys	kg NOx eq	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000
Terrestrial acidification	kg SO2 eq	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000
Freshwater eutrophication	kg P eq	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Marine eutrophication	kg N eq	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000
Terrestrial ecotoxicity	kg 1,4-DCB	0.801	0.714	0.074	0.000	0.000	0.012	0.000	0.001
Freshwater ecotoxicity	kg 1,4-DCB	0.037	0.036	0.001	0.000	0.000	0.000	0.000	0.000
Marine ecotoxicity	kg 1,4-DCB	0.027	0.025	0.001	0.000	0.000	0.000	0.000	0.000
Human carcinogenic toxicity	kg 1,4-DCB	0.002	0.000	0.002	0.000	0.000	0.000	0.000	0.000
Human non-carcinogenic toxicity	kg 1,4-DCB	0.782	0.736	0.045	0.000	0.000	0.000	0.000	0.000
Land use	m2a crop eq	4.182	4.181	0.000	0.000	0.000	0.000	0.000	0.000
Mineral resource scarcity	kg Cu eq	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000
Fossil resource scarcity	kg oil eq	0.081	0.067	0.009	0.000	0.000	0.003	0.001	0.001
Water consumption	m3	0.618	0.000	0.618	0.000	0.000	0.000	0.000	-0.001

1 kg ATK__Soybean meal, Energy									
ReCiPe 2016 Midpoint (H)	Unit	Sum	Soybean Cultivation	Electricity	Natural Gas	Hexane Production	Transport	Landfill of waste	Waste water treatment
Global warming	kg CO2 eq	0.319	0.258	0.000	0.027	0.000	0.006	0.013	0.014
Stratospheric ozone depletion	kg CFC11 eq	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ionizing radiation	kBq Co-60 eq	0.027	0.002	0.000	0.025	0.000	0.000	0.000	0.000
Ozone formation, Human health	kg NOx eq	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Fine particulate matter formation	kg PM2.5 eq	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ozone formation, Terrestrial ecos	kg NOx eq	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Terrestrial acidification	kg SO2 eq	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Freshwater eutrophication	kg P eq	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Marine eutrophication	kg N eq	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Terrestrial ecotoxicity	kg 1,4-DCB	0.559	0.497	0.000	0.052	0.000	0.008	0.001	0.000
Freshwater ecotoxicity	kg 1,4-DCB	0.026	0.025	0.000	0.001	0.000	0.000	0.000	0.000
Marine ecotoxicity	kg 1,4-DCB	0.019	0.018	0.000	0.001	0.000	0.000	0.000	0.000
Human carcinogenic toxicity	kg 1,4-DCB	0.002	0.000	0.000	0.002	0.000	0.000	0.000	0.000
Human non-carcinogenic toxicity	kg 1,4-DCB	0.550	0.517	0.000	0.032	0.000	0.000	0.000	0.000
Land use	m2a crop eq	2.940	2.940	0.000	0.000	0.000	0.000	0.000	0.000
Mineral resource scarcity	kg Cu eq	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Fossil resource scarcity	kg oil eq	0.053	0.043	0.000	0.006	0.000	0.002	0.001	0.000
Water consumption	m3	0.435	0.000	0.000	0.434	0.000	0.000	0.000	0.000

1 kg ATK__Soybean oil, Energy									
ReCiPe 2016 Midpoint (H)	Unit	Sum	Soybean Cultivation	Electricity	Natural Gas	Hexane Production	Transport	Landfill of waste	Waste water treatment
Global warming	kg CO2 eq	0.742	0.599	0.000	0.063	0.000	0.015	0.031	0.033
Stratospheric ozone depletion	kg CFC11 eq	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ionizing radiation	kBq Co-60 eq	0.062	0.004	0.000	0.058	0.000	0.000	0.000	0.000
Ozone formation, Human health	kg NOx eq	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Fine particulate matter formation	kg PM2.5 eq	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Ozone formation, Terrestrial ecos	kg NOx eq	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Terrestrial acidification	kg SO2 eq	0.004	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Freshwater eutrophication	kg P eq	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Marine eutrophication	kg N eq	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Terrestrial ecotoxicity	kg 1,4-DCB	1.298	1.156	0.000	0.121	0.000	0.020	0.001	0.000
Freshwater ecotoxicity	kg 1,4-DCB	0.061	0.059	0.000	0.002	0.000	0.000	0.000	0.000
Marine ecotoxicity	kg 1,4-DCB	0.043	0.041	0.000	0.002	0.000	0.000	0.000	0.000
Human carcinogenic toxicity	kg 1,4-DCB	0.004	0.000	0.000	0.004	0.000	0.000	0.000	0.000
Human non-carcinogenic toxicity	kg 1,4-DCB	1.278	1.202	0.000	0.074	0.000	0.001	0.000	0.000
Land use	m2a crop eq	6.833	6.833	0.000	0.000	0.000	0.000	0.000	0.000
Mineral resource scarcity	kg Cu eq	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Fossil resource scarcity	kg oil eq	0.123	0.100	0.000	0.015	0.001	0.005	0.002	0.001
Water consumption	m3	1.010	0.000	0.000	1.010	0.000	0.000	-0.001	0.000