Environmental footprint of ProTerra-certified soybean products

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ProTerra™ FOUNDATION

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1. Introduction

The growing demand for animal feed is driving an expansion in the cultivation of crops such as soybeans, as soybean meal is a relevant protein source in animal diets. Agricultural production involves land use and potential land use change (LUC), including land occupation and conversion. LUC is one of the major environmental issues facing the global agricultural production system. For example, when forests are cleared to make way for agricultural purposes, the carbon stored in the trees and soil is released into the atmosphere in the form of carbon dioxide (CO2) and other emissions. As a result, LUC is a significant driver of global climate change.

In Brazil, one of the world's leading soybean producers, the expansion of soybean cultivation over native vegetation has been a hot topic in discussions regarding the sustainability of Brazilian agricultural production. This expansion can occur by displacing other crops on existing farmland or by displacing other types of land, such as pasture, meadow, or natural vegetation.

The ProTerra Foundation is a not-for-profit organisation that promotes sustainable food and feed supply chains. In 2006 the ProTerra Standard was created to trace and communicate non-GMO crop production and promote sustainable crop production and processing. A key focus area of ProTerra is to supply sustainable Brazilian soy products to the European market. ProTerra-certified material is deforestation-free with a cut-off date of 2008, protects natural habitats and ecosystem services by adopting the concept of High Conservation Values as defined by the HCV Resource Network and promotes environmentally and socially responsible soy production.

ProTerra asked Mérieux NutriSciences | Blonk to analyse the environmental footprint of soy products certified to the ProTerra Standard. A Life Cycle Assessment (LCA) is performed including the following environmental impact categories: carbon footprint, water consumption and land use. ProTerra-certified products are also compared with the respective Agri-footprint database default Agri-footprint (version 6) (Blonk et al., 2022).

This report is an update of previous studies conducted by Blonk. With these updates, ProTerra aims to refine data collection to more accurately reflect the reality of its certified soy products and to evaluate its environmental reduction strategies over time.

2. Methodology and background

2.1 Scope of the study

The goal of the present study is to clearly differentiate between certified and non-certified products and to provide ProTerra customers with improved quality data for their carbon footprint calculations.

The study covers the following products:

- **Soybean production**
- **Soybean meal**
- **Soybean oil**
- **Soy protein concentrate (SPC)**

The following environmental impact categories are in scope:

- **Carbon footprint (tonne CO_2eq/tonne ref. product)**
- **Water consumption (m^3/tonne ref. product)**
- **Land use (occupation)[1] (m2/crop eq/tonne ref. product)**

The system boundaries are set from **cradle-to-European-port.**

The life cycle stages included are **soybean cultivation, transport from farm to crusher, soybean crushing, and transport to the European market.**

The functional units for the different selected products are as follows:

- **1 tonne of Soybean at farm (non-GMO)**
- **1 tonne of Soybean meal**
- **1 tonne of Soybean oil**
- **1 tonne of Soy Protein Concentrate**

[1] The ReciPe midpoint impact category of land use accounts for both the occupation and transformation of land. However, for this study, the transformation of land has not been included in this impact category as the transformation of land is considered from primary data and reported separately for the LUC carbon emissions.

2.2 Compliance

The calculations in this study are aligned as far as possible with the EU PEF guidelines (European Commission Product Environmental Footprint), in terms for example of allocation method use and land use change accounting approach (see also section 2.3.1). Land use change values are based on the BRLUC methodology (Novaes et al., 2017) and state-specific information.

2.3 Data use

The environmental footprint calculations are based on state-specific secondary agricultural data from Embrapa, the Brazilian Agricultural Research Corporation, compiled in the Agribusiness Brazil statistical yearbook. This agricultural data includes, for example, yields, fertilisation information, irrigation data etc. Data from 4 Brazilian states were included: Goiás (GO), Minas Gerais (MG), Mato Grosso (MT) and Paraná (PR). A weighted average was used based on the origin of ProTerra certified soybeans. The data has not been updated in recent years, so for the two states where this agricultural data was not available: Roraima (RR) and Rondônia (RO), an approximation was considered. For the state of RO, the agricultural data from the state of MT were used due to its proximity, and for the state of RR, an average of all four available states was used as none of the available states was particularly close. Due to the small contribution of these two states to the total of the ProTerra-certified soybean (see Table 1), these assumptions have little impact on the results presented.

TABLE 1: Contribution per state ProTerra - certified Brazilian soybeans 2023

State	% Contribution ProTerra soybean
Mato Grosso (MT)	80%
Rondônia (RO)	1%
Goiás (GO)	7%
Paraná (PR)	1%
Minas Gerais (MG)	10%
Roraima (RR)	1%

At the agricultural stage, no impact is allocated to other crops in a crop rotation system, although in some regions of Brazil, it is common practice to grow corn as a second crop in the same soybean cultivation area. This rotation provides benefits for both soybean and corn cultivation, however, the environmental impact of the agrochemical inputs was attributed entirely to the soybeans, and no direct benefits from the previous crop were taken into account. This approach is also applied in Agri-footprint methodology.

In addition, LUC emissions from the production area were fully attributed to soybean production, in line with the guidelines of the BRLUC model. The BRLUC methodology for Land use change emissions calculation is considered to be scientifically sound and we expect it to best reflect the Brazilian reality. As Blonk is not the developer of this tool, the underlying modelling choices and tool updates are subject to Embrapa. The BRLUC tool used in this study is version 2.0, as opposed to version 1.3 used in 2023.

For soybean meal and oil production (soybean crushing), primary data on Brazilian soybean crushers was collected in 2020 and has not been updated since. Although the soy crushing industry is well established and we do not expect significant changes or advances in recent years, the energy mix may have changed. Data from the Agri-footprint 6 database was also used for the transport to Europe.

In the case of the European soybean products analysed, a ProTerra-specific European production mix was used, with the following contribution per country: Ukraine (50,9%), Italy (31,5%), Russia (9,5%), Austria (4,1%), France (2,6%) and Romania (1,4%)[2]. For each of these countries, default processes from Agri-footprint 6 were used to model the cultivation stage.

2.3.1 Direct Land Use Change

In environmental assessments, such as LCA, the LUC emissions must be accounted for. According to several LCA guidelines and standards, such as the EU Product Environmental Footprint (PEF), the contribution of LUC should be monitored for a period of 20 years retrospectively to the current year. In general, land conversion data is collectively available at a country or state level, through international or national statistics and not available at a farm level.

[2] ProTerra soybean origination 2023

In this study, BRLUC model (Novaes et al., 2017) was used to account for direct LUC emissions. The reason for choosing this method is that it brings regionalised data considering the differentiation of land use transition patterns for all Brazilian states and agricultural products, including soybeans. Its temporal coverage ranges from 2000-2019 which is then aligned with IPCC's default 20-year horizon.

Within this study, primary data from satellite imagery was used to assess the land use change that occurred in the last 20 years from the year of the cultivation data analysed, 2023, in the Brazilian ProTerra-certified farms. This satellite imagery can identify changes to the natural vegetation that have occurred on the farms over the last 20 years, this information is used to identify the farms with associated land use change, and consequently to link LUC emissions to the soybeans cultivated in these farms.

Table 2 shows the percentage of ProTerra-certified farm areas per Brazilian state for which the satellite imagery identified changes in the natural vegetation in the past 20 years.

Table 2: Number and area of farms identified as deforested over the past 20 years for Brazil certified ProTerra soybeans 2023

State	Number of farms	Farms deforested past 20 yrs	Total farmed area per sate (ha)	Total deforested area per state (ha)	% Deforested area per total farmed area
Mato Grosso (MT)	145	13	394884	1003	0,25%
Rondônia (RO)	14	0	7011	0	0,00%
Goiás (GO)	89	1	34314	24	0,07%
Paraná (PR)	9	0	5826	0	0,00%
Minas Gerais (MG)	207	0	49995	0	0,00%
Roraima (RR)	2	0	3374	0	0,00%
Total (ProTerra)	466	14	495404	1027	0,21%

The certified ProTerra soybean LUC emissions from cultivation are therefore assigned based on the percentages of deforestation presented in Table 1 and assuming the release of carbon dioxide emissions from the change from natural vegetation to arable land according to the BRLUC methodology.

2.4 Summary updates from the previous year

Compared to the 2023 study, the following updates have been considered:

- Update of the methodology for identifying LUC in certified farms, from questionnaires to satellite imagery.
- Update of certified farmed area per Brazilian state.
- Update of the ProTerra-specific European production mix.

The new method for identifying LUC emissions from soybean cultivation supposes a considerable change from the previous year's exercise. In the previous data collection period, a survey was conducted among ProTerra-certified farmers, aimed at identifying if LUC occurred in their farms through questionnaires. As of last year's exercise, primary data was available for 242 out of 452 farmers and therefore the average LUC emissions of their respective regions were assigned to these farms using a conservative approach. This year's update towards more accurate primary data collection results in a major change from the previous exercise. In last year's report approximately 60% of the ProTerra-certified soybeans were associated with LUC emissions, whereas in this updated study, only 0,2% of the ProTerra-certified soybeans are associated with LUC emissions.

3. Results

3.1 Soybean at farm

A tonne of ProTerra soybean at Brazilian farm:

Carbon footprint	539 kg CO_2-eq/tonne of soybean
Water consumption	0,199 m^3/tonne of soybean
Land use (occupation)	3123 m^2 crop eq./tonne of soybean

A tonne of soybean on a Brazilian farm from Agri-footprint 6 reference:

Carbon footprint	4460 kg CO_2-eq/tonne of soybean
Water consumption	1,47 m^3/tonne of soybean
Land use (occupation)	3338 m^2 crop eq/tonne of soybean

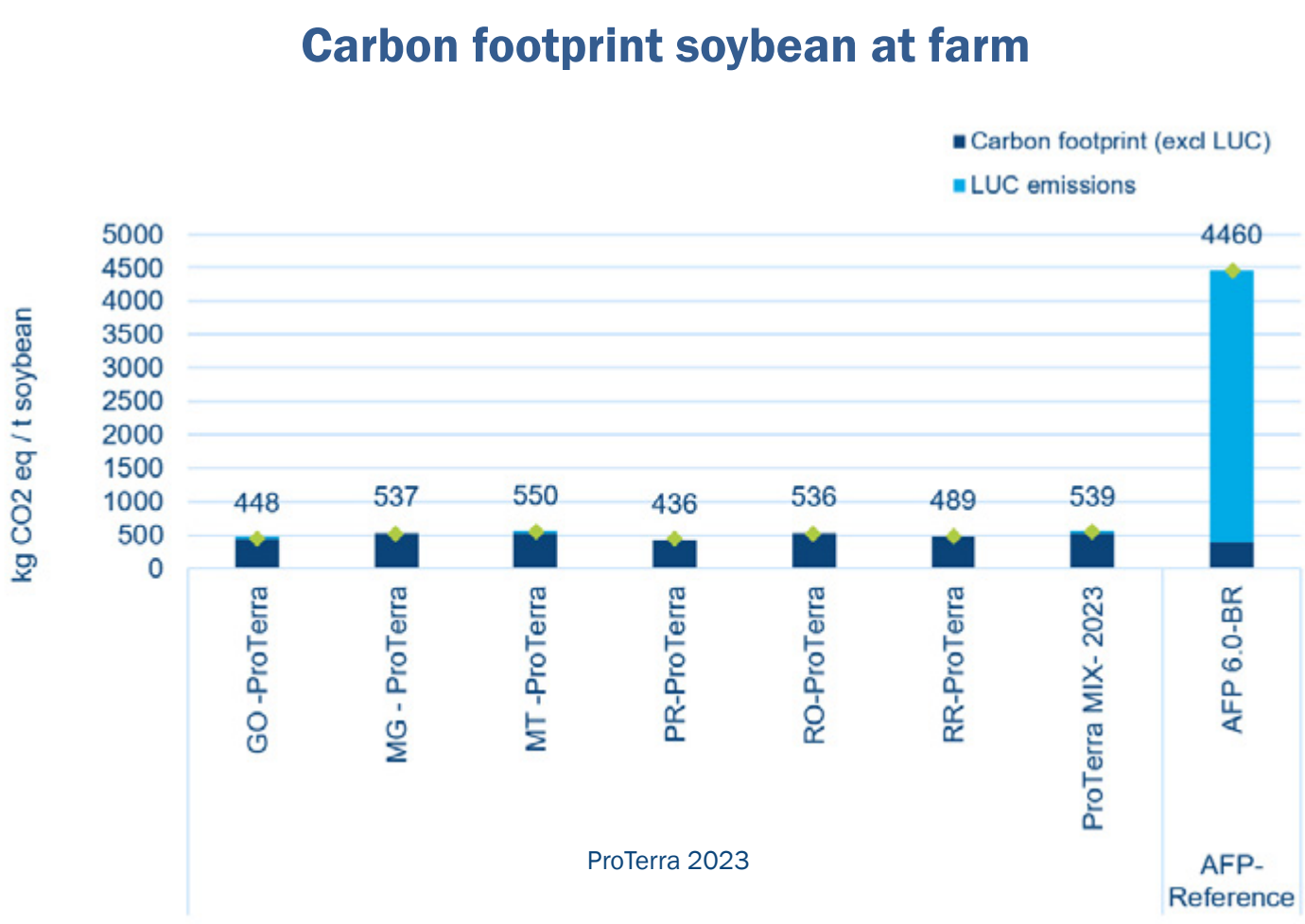


Figure1: Carbon footprint soybean at farm ProTerra-certified Brazil mix and Agri-footprint reference.

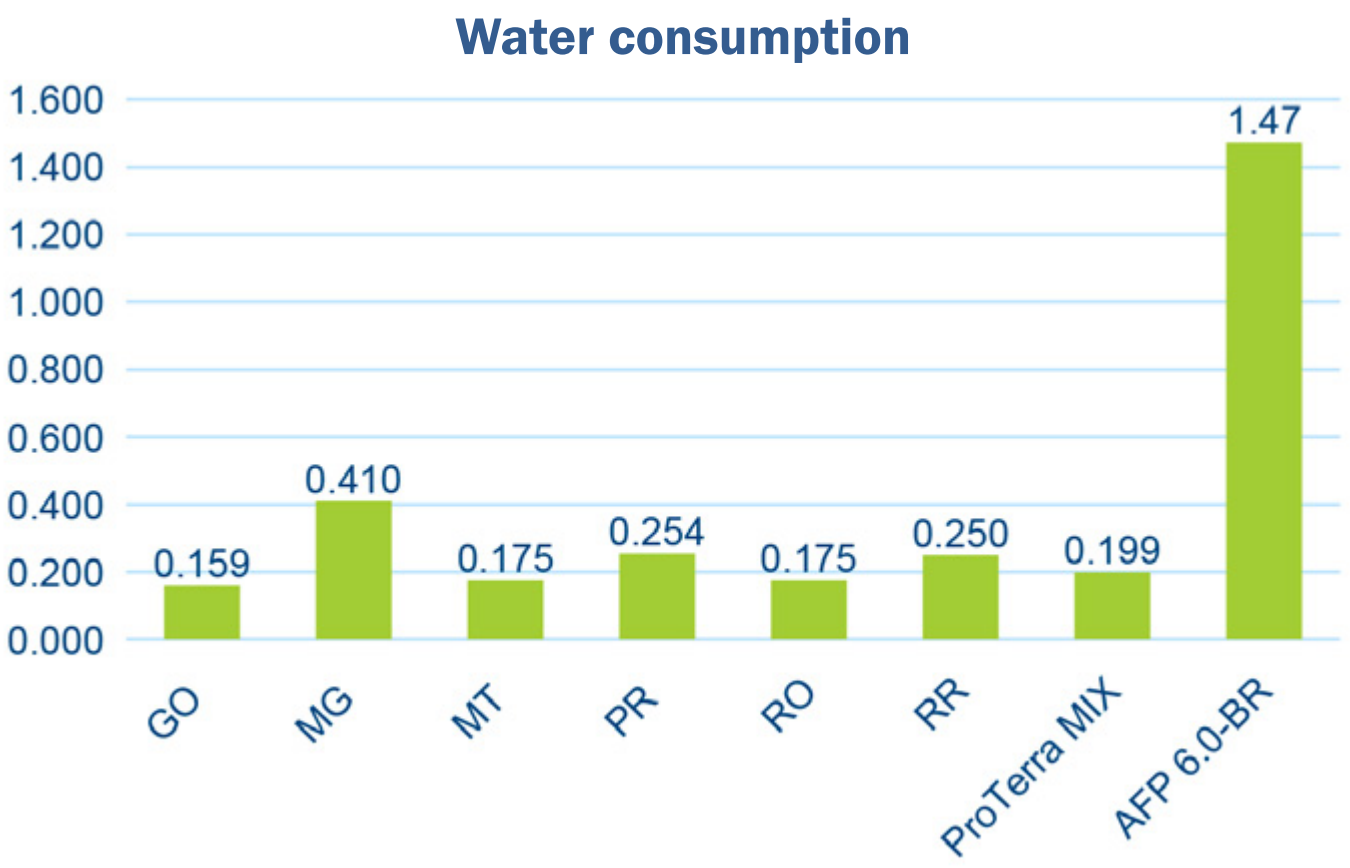


Figure 2: Water consumption soybean at farm ProTerra-certified Brazil mix and Agri-footprint reference.

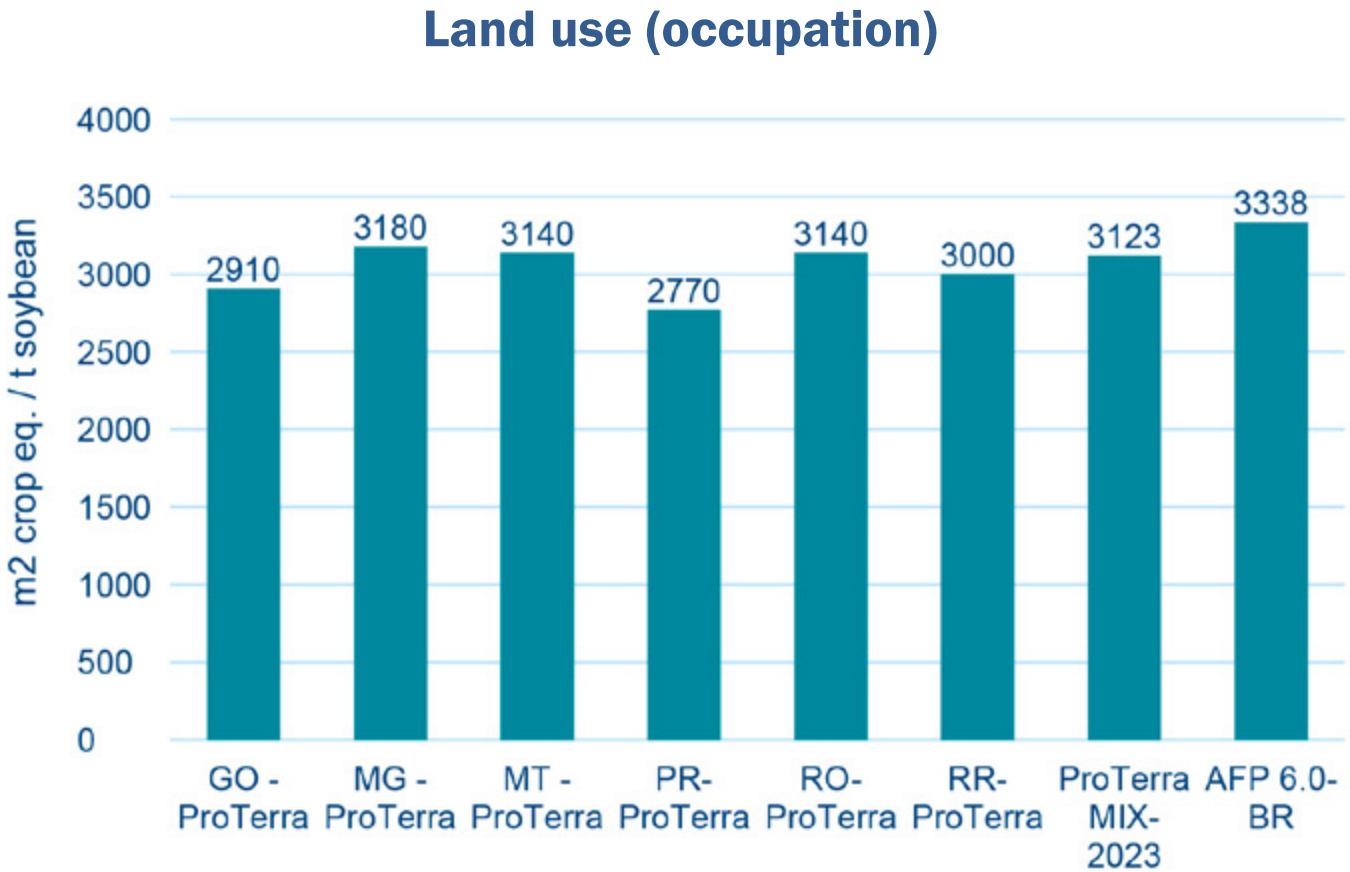


Figure 3: Landuse (occupation) soybean at farm ProTerra-certified Brazil mix and Agri-footprint reference.

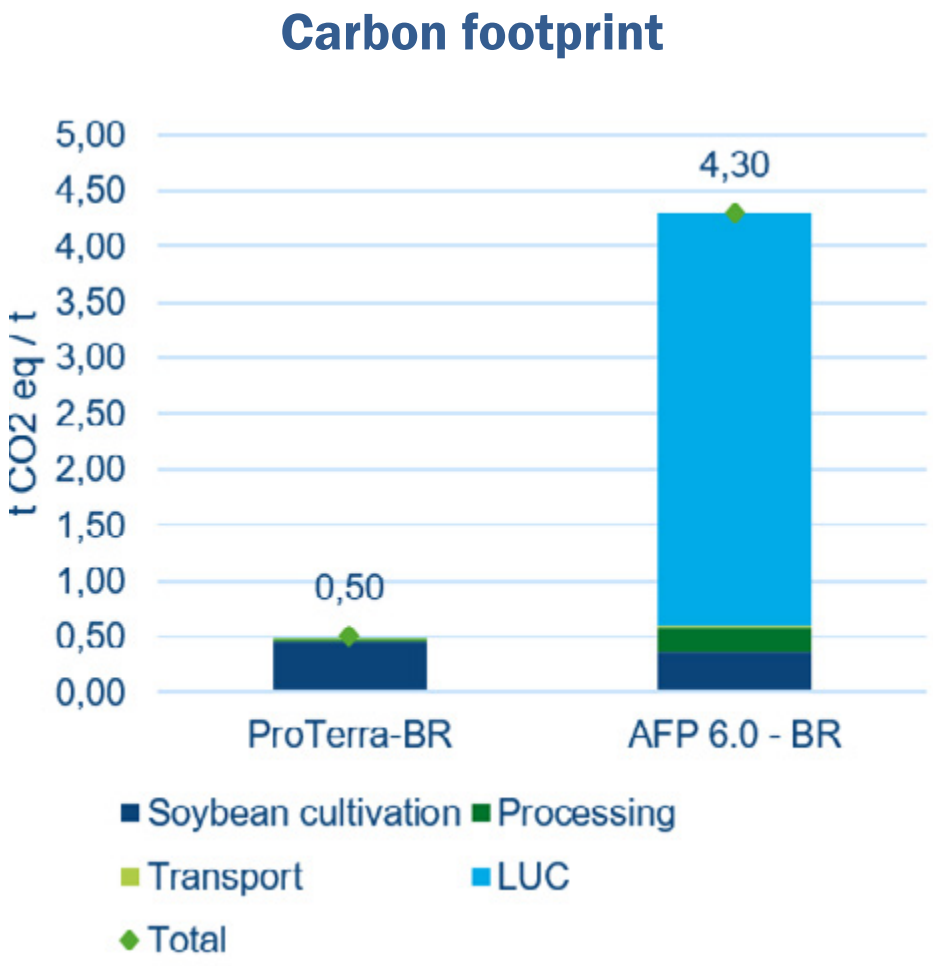
3.2 Soybean meal

A tonne of ProTerra soybean meal shipped from Brazil to Europe:

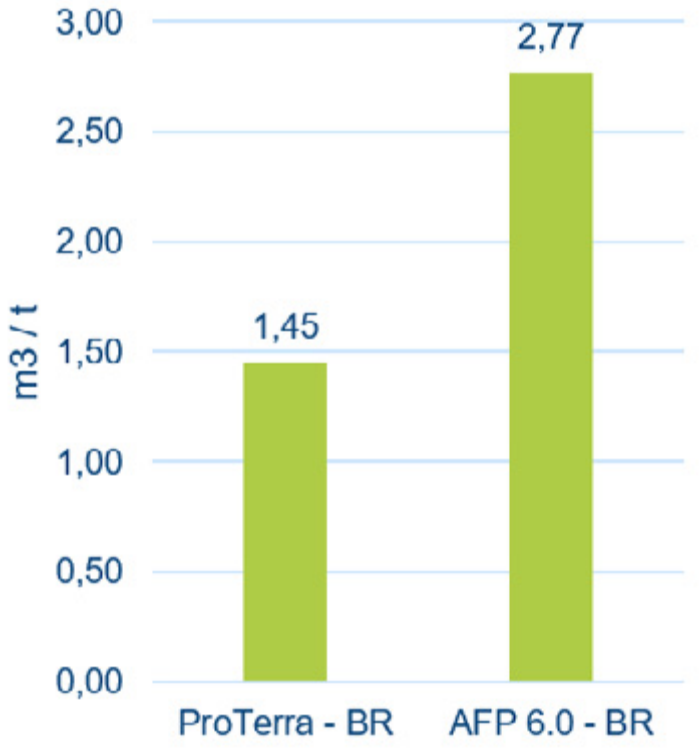
Carbon footprint	0,50 tonne CO_2-eq/tonne of soybean meal
Water consumption	1,45 m^3/tonne of soybean meal
Land use (occupation)	2626 m^2 crop eq./tonne of soybean meal

A tonne of Brazil soybean meal shipped to Europe from Agri-footprint 6 reference:

Carbon footprint	4,30 tonne CO_2-eq/tonne of soybean meal
Water consumption	2,77 m^3/tonne of soybean meal
Land use (occupation)	3043 m^2 crop eq/tonne of soybean meal



Water consumption



Land use (occupation)

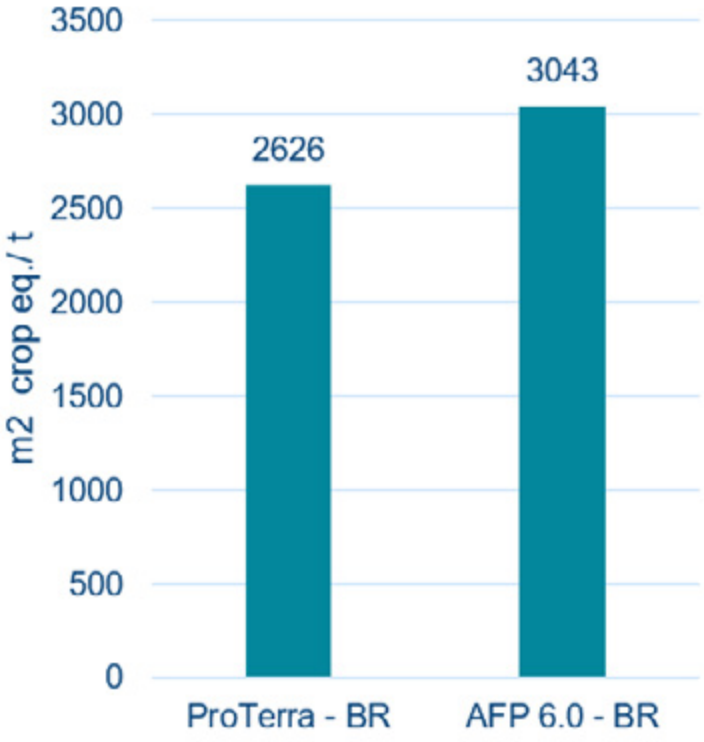


Figure 4: Selected environmental impact results soybean meal ProTerra-certified and Agri-footprint reference

3.3 Soybean oil

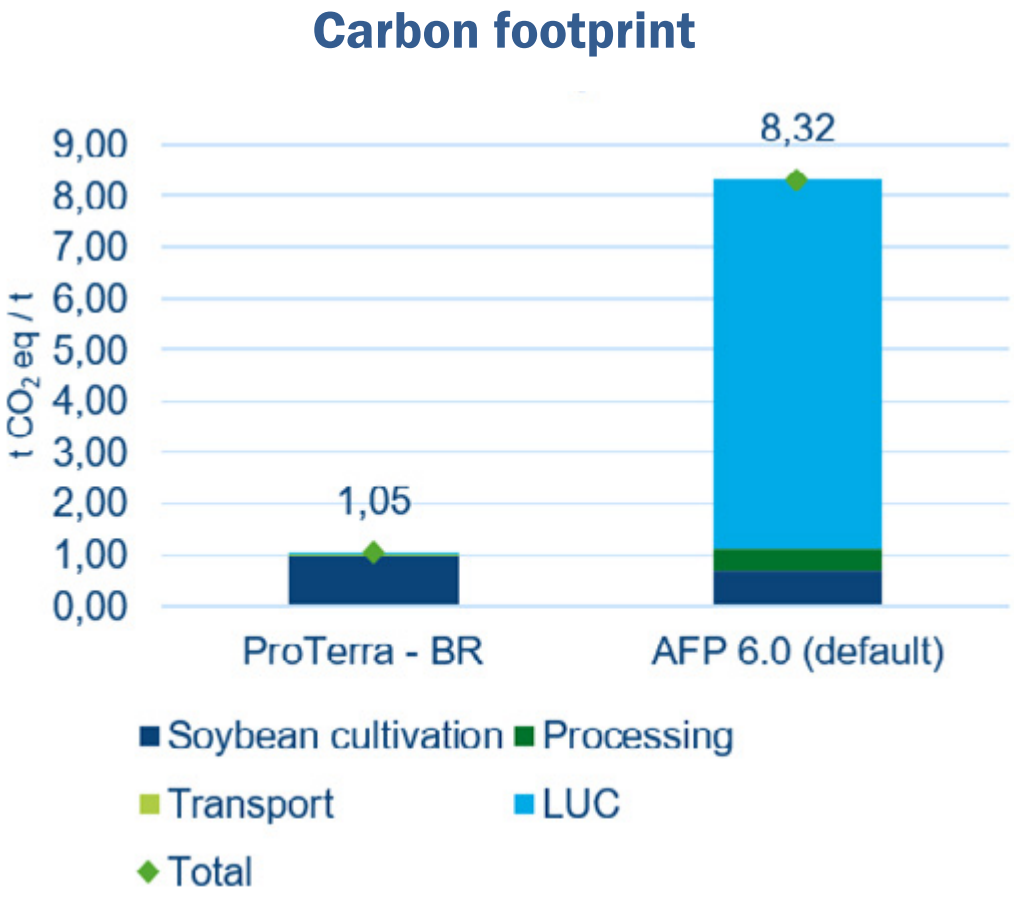
Below are the LCA results for the soybean oil for the ProTerra-certified product and the Agrifootprint reference.

A tonne of ProTerra soybean oil shipped from Brazil to Europe:

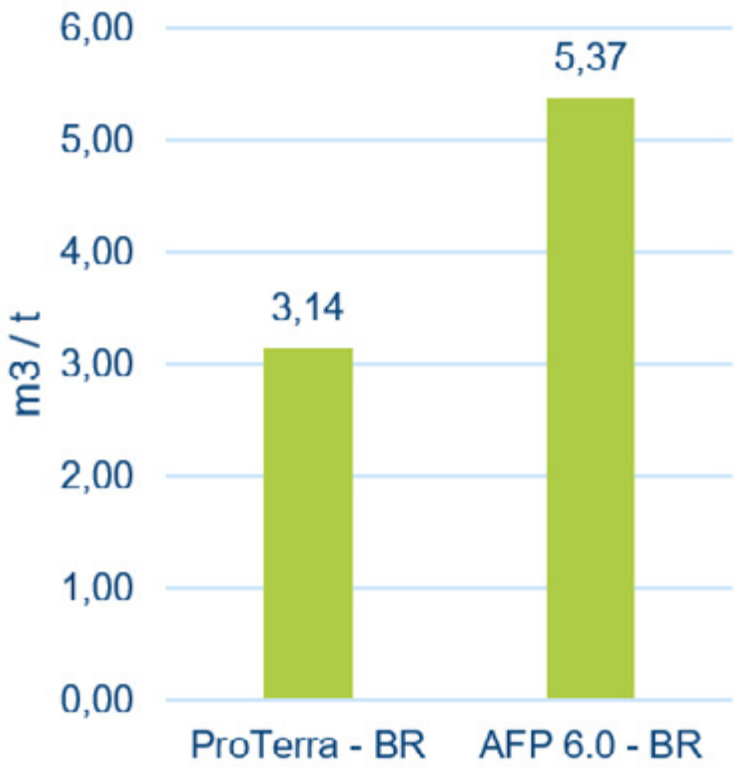
Carbon footprint	1,05 tonne CO_2-eq/tonne of soybean oil
Water consumption	3,14 m^3/tonne of soybean oil
Land use (occupation)	5683 m^2 crop eq./tonne of soybean oil

A tonne of Brazil soybean oil shipped to Europe from Agri-footprint 6 reference:

Carbon footprint	8,32 ton CO_2-eq/ton Soybean oil
Water consumption	5,37 m^3/ton Soybean oil
Land use (occupation)	5907 m^2/ton Soybean oil



Water consumption



Land use (occupation)

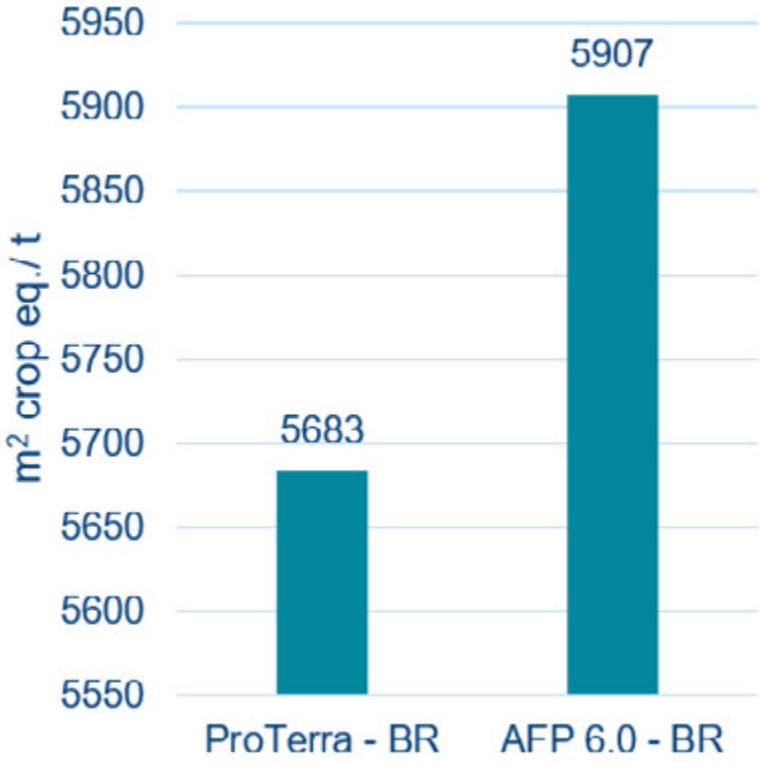


Figure 5: Selected environmental impact results soybean oil ProTerra certified and Agri-footprint reference

3.4 Comparison with European products

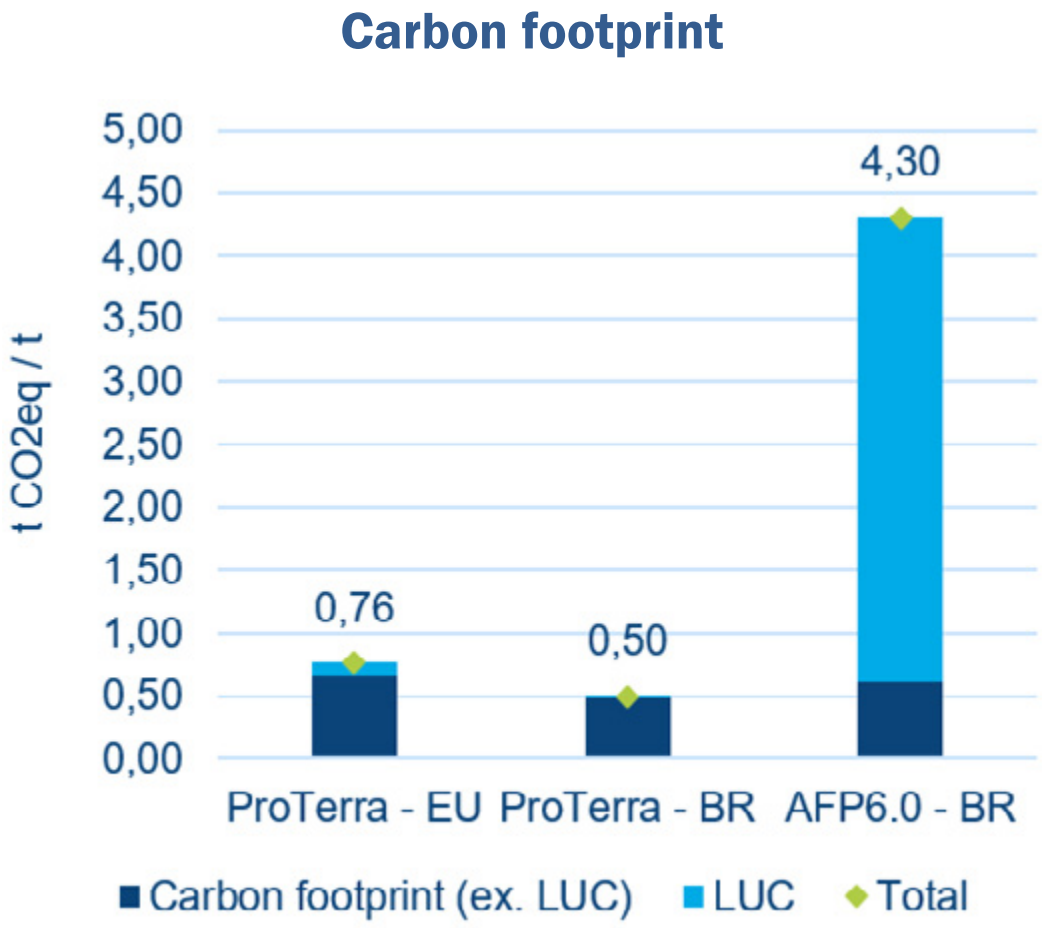
3.4.1 Soybean meal

A tonne of ProTerra soybean meal shipped from Brazil to Europe:

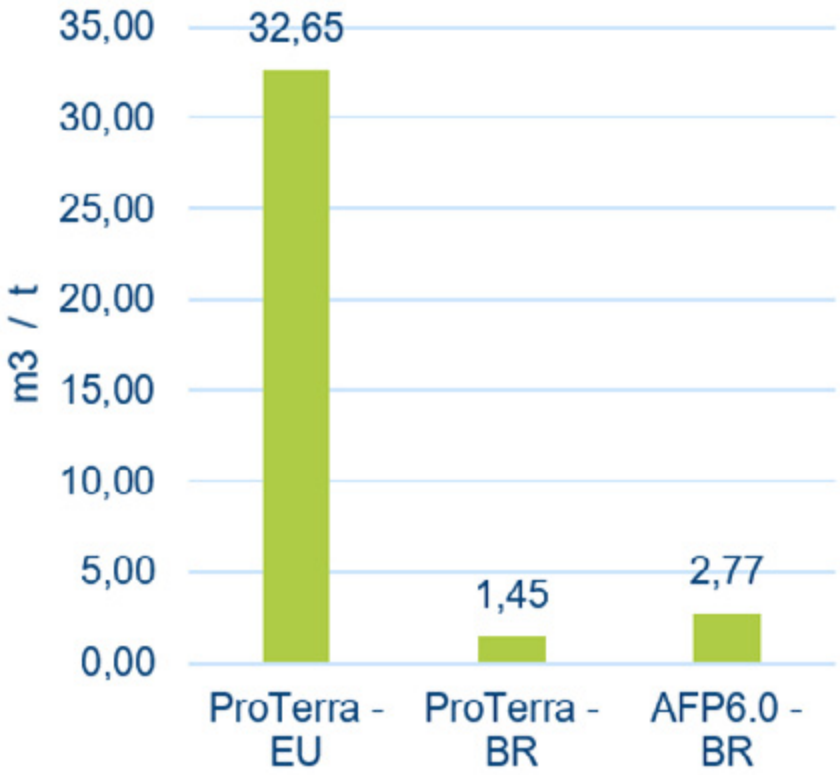
Carbon footprint	0,5 tonne CO_2-eq/tonne of soybean meal
Water consumption	1,45 m^3/tonne of soybean meal
Land use (occupation)	2626 m^2 crop eq./tonne of soybean meal

A tonne of soybean meal from the selected European mix:

Carbon footprint	0,76 tonne CO_2-eq/tonne of soybean meal
Water consumption	32,65 m^3/tonne of soybean meal
Land use (occupation)	3672 m^2 crop eq/tonne of soybean meal



Water consumption



Land use (occupation)

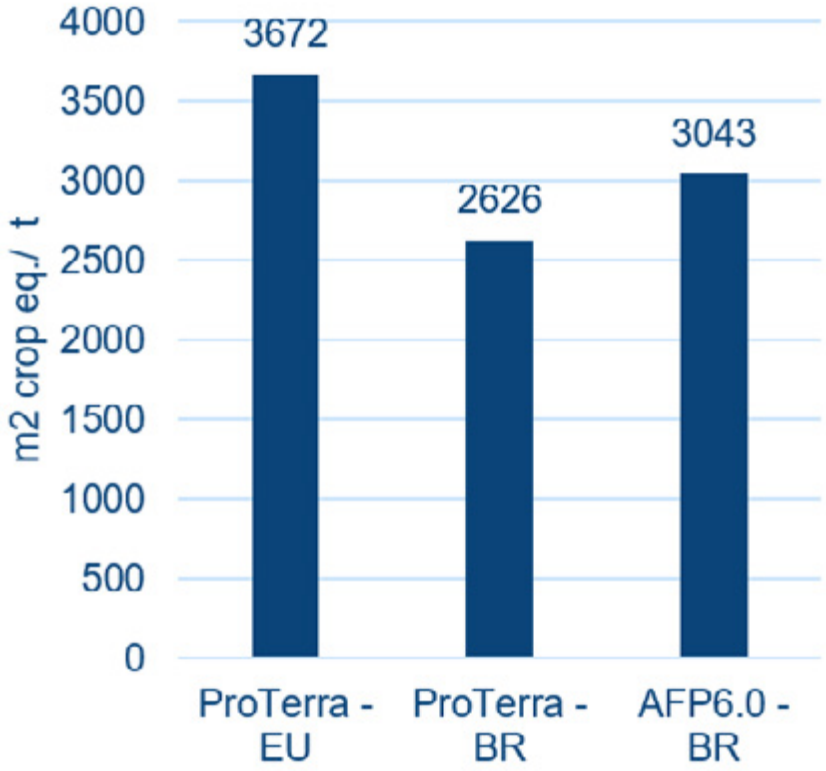


Figure 6: Selected environmental impact results Brazilian soybean meal ProTerra certified, European soybean meal and Agri-footprint reference

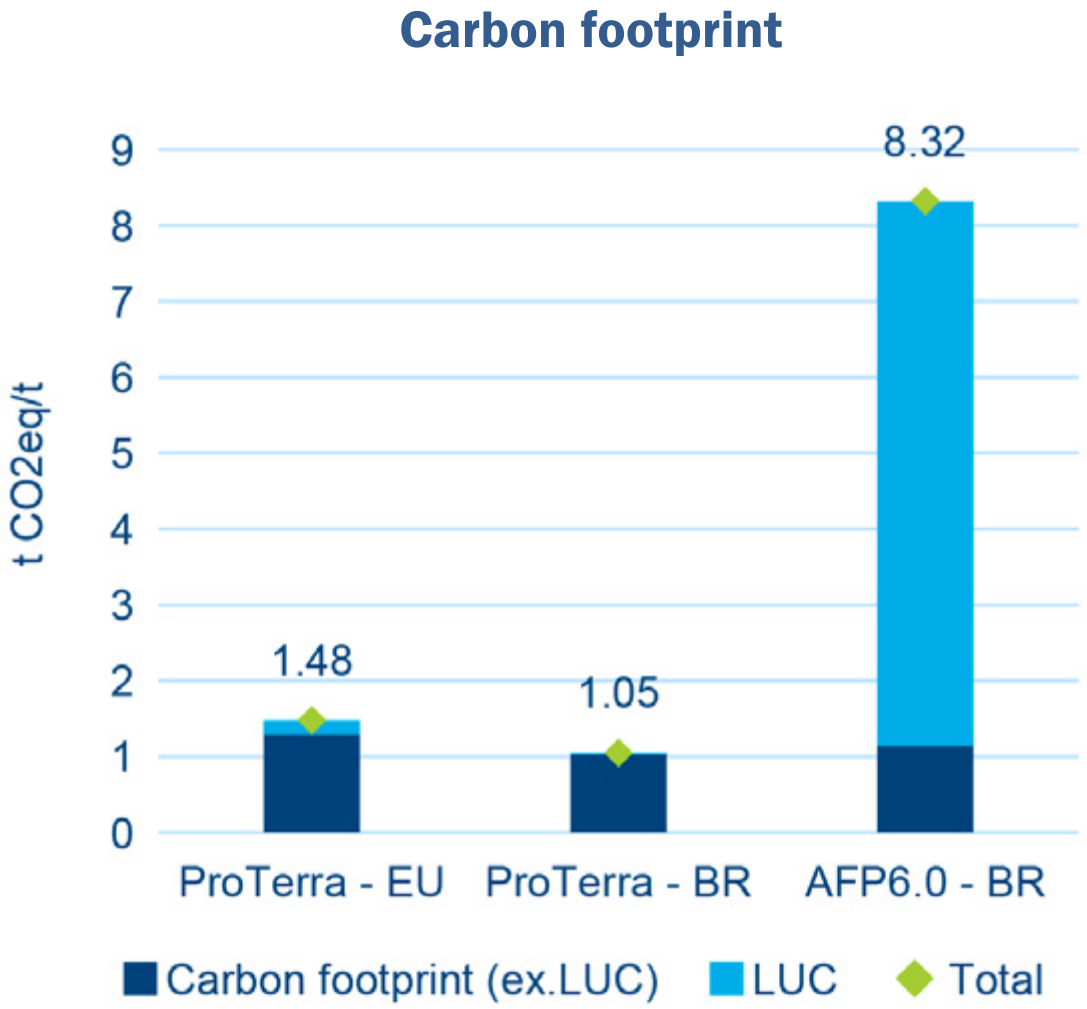
3.4.2 Soybean oil

A tonne of ProTerra soybean oil shipped from Brazil to Europe:

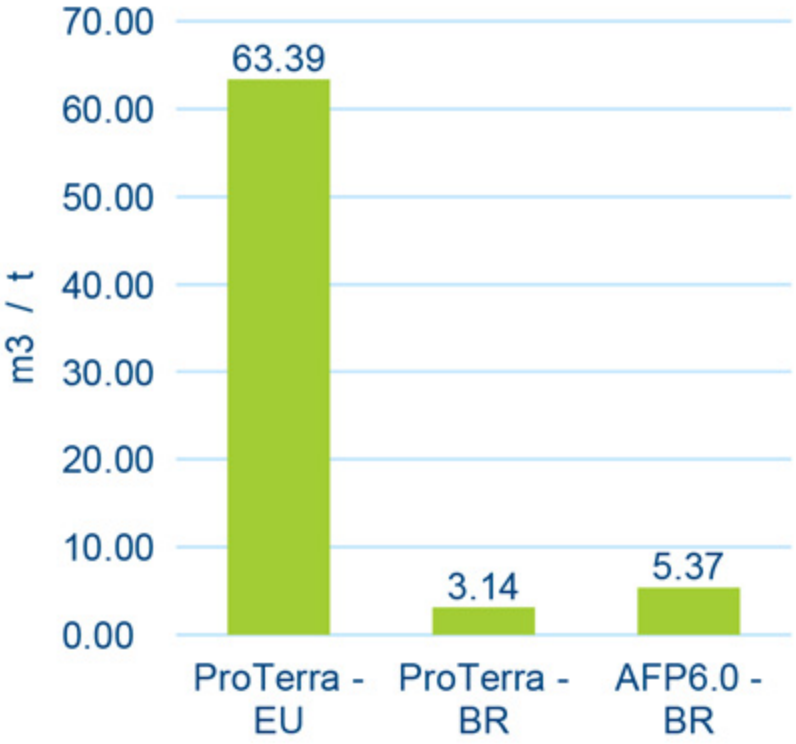
Carbon footprint	1,05 tonne CO_2-eq/tonne of soybean oil
Water consumption	3,14 m^3/tonne of soybean oil
Land use (occupation)	5683 m^2 crop eq./tonne of soybean oil

A tonne of soybean oil from the selected European mix:

Carbon footprint	1,48 tonne CO_2-eq/tonne of soybean oil
Water consumption	63,39 m^3/tonne of soybean oil
Land use (occupation)	7128 m^2 crop eq./tonne of soybean oil



Water consumption



Land use (occupation)

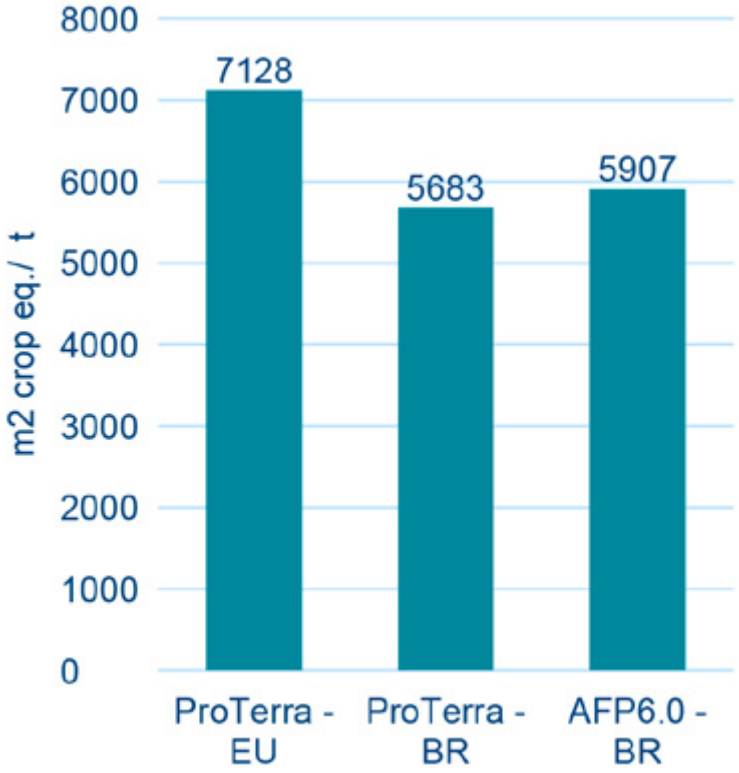


Figure 7: Selected environmental impact results Brazilian soybean oil ProTerra-certified, European soybean oil, and Agri-footprint reference

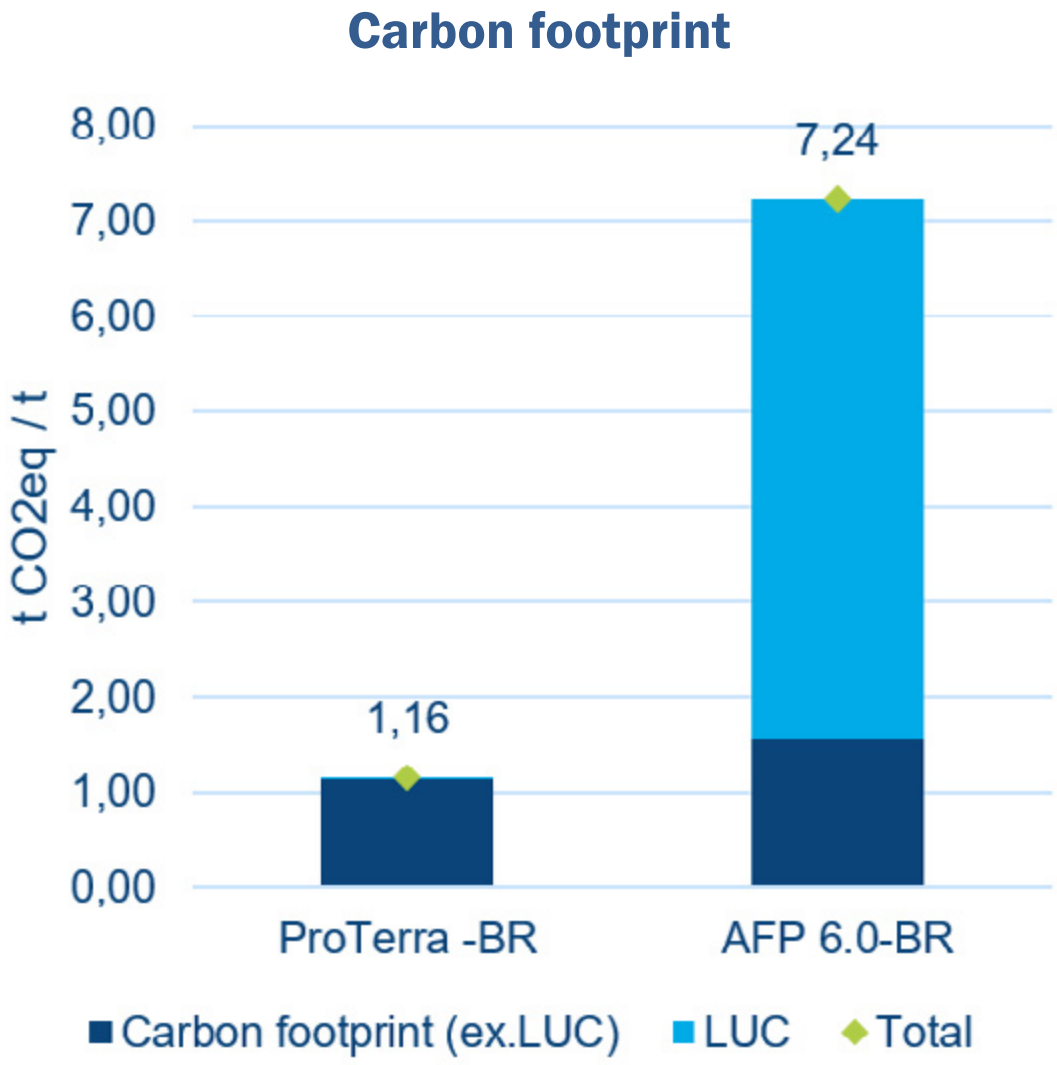
3.5 Soy Protein Concentrate (SPC)

A tonne of ProTerra soybean protein concentrate shipped from Brazil to Europe:

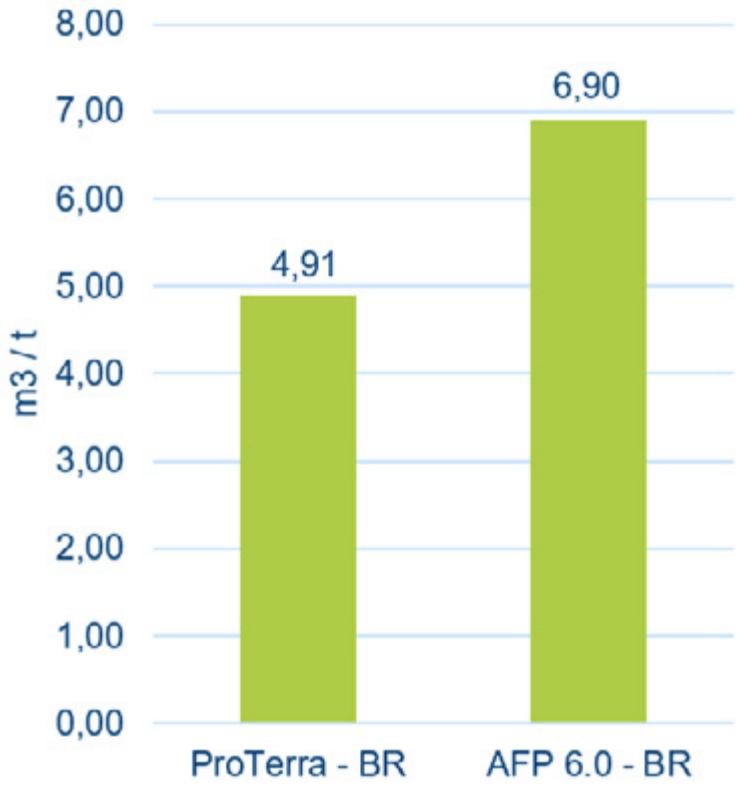
Carbon footprint	1,16 tonne CO_2-eq/tonne of SPC
Water consumption	4,91 m^3/tonne of SPC
Land use (occupation)	4207 m^2 crop eq./tonne of SPC

A tonne of Brazil soybean protein concentrate Agri-footprint 6 reference:

Carbon footprint	7,24 tonne CO_2-eq/tonne of SPC
Water consumption	6,90 m^3/tonne of SPC
Land use (occupation)	4679 m^2 crop eq/tonne of SPC



Water consumption



Land use (occupation)

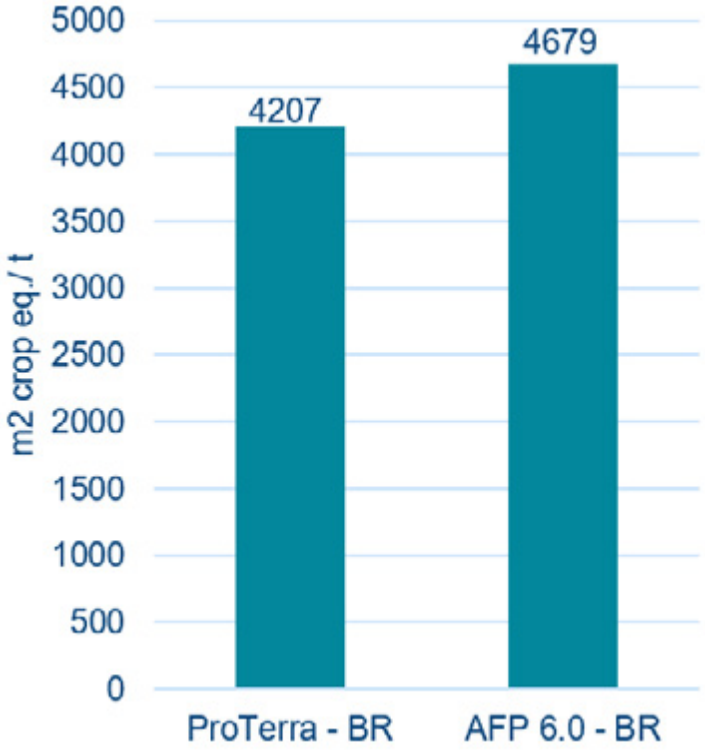


Figure 8: Selected environmental impact results Brazilian soybean protein concentrate ProTerra-certified and Agri-footprint reference

4. Interpretation of results

This section provides an analysis and interpretation of the results presented above, with the following main points:

- The almost negligible LUC emissions associated with the cultivation of the ProTerra-certified soybeans are reflected in a much lower carbon footprint of the soybeans at the farm when compared to the Agri-footprint reference. The impact of cultivation excluding LUC emissions however is comparable.

- The water consumption of the soybean cultivation is also lower for the ProTerra-certified soybean when compared to the Agri-footprint reference, while the land occupation has similar values.

- The lower LUC carbon emissions associated with the ProTerra-certified soybean cultivation result in a lower carbon footprint of the soybean products (soybean meal, soybean oil and soybean protein concentrate) when compared to the Agri-footprint reference. This difference is further amplified as the carbon emissions associated with the soybean processing into soybean products are lower for the certified ProTerra products than for the Agri-footprint reference.

- The Brazilian ProTerra-certified soybean products (soybean meal and soybean oil) have a lower carbon footprint when compared to the European alternatives, this is mainly due to the lower associated emissions from cultivation. These Brazilian ProTerra-certified products also had significantly lower water consumption and land occupation impacts than the European mix.

5. Conclusions and limitations of the study

- It is concluded that the availability of primary data is crucial for accurate calculations. It is acknowledged that in order to make environmental claims, accurate and company-specific data should be used instead of secondary data from LCA databases. It is therefore strongly recommended to increase the amount of primary data for ProTerra soybean products, to improve the quality of the results.

- This environmental footprint study has not been externally verified against ISO 14040/14044.

- ProTerra's ability to certify Brazilian soybean farmers with low or non-conversion of natural vegetation on their farms results in soybeans with lower carbon footprint emissions when compared to average Brazilian soybeans.

- Agri-footprint results serve as a reference for comparison, without however allowing for 100% equal comparison due to divergence in the applied data and underlying methodologies.

6. References

Blonk, H., van Paassen, M., Draijer, N., Tyszler, M., Braconi, N., & Van ri. (2022). Agri-footprint 6 Methodology Report. https://website-production-s3bucket-1nevfd7531z8u.s3.eu-west-1.amazonaws.com/public/website/download/3f96d2ec-b020-43fb-ac4f-8d524697e714/Agri-footprint 6 - Methodology Report - Part 2 - Description of Data.pdf

Novaes, R. M. L., Pazianotto, R. A. A., Brandão, M., Alves, B. J. R., May, A., & Folegatti-Matsuura, M. I. S. (2017). Estimating 20-year land-use change and derived CO2 emissions associated with crops, pasture and forestry in Brazil and each of its 27 states. Global Change Biology, 23(9), 3716–3728. https://doi.org/10.1111/gcb.13708

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