Environmental footprint of ProTerra certified sugarcane

ProTerra FOUNDATION

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1. Introduction

ProTerra is a multi-crop standard that can also be applied to sugar cane. Central Romana is a sugar mill in the Dominican Republic that has achieved ProTerra certification.

Given the increasing demand for sustainable sugar cane in terms of responsibly produced and processed sugar cane as well as environmental performance, ProTerra asked Mérieux NutriSciences | Blonk to analyse the environmental footprint of sugar from sugar cane certified to the ProTerra Standard. A Life Cycle Assessment (LCA) was conducted including the following environmental impact categories: carbon footprint, water consumption and land use. ProTerra-certified sugar from Central Romana is also compared with default sugar datasets from the Agri-footprint database (Blonk et al., 2022).

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:

- **Sugar cane cultivation**
- **Sugar production**

The environmental impact category in scope is: **Carbon footprint** (tonne CO_2eq/tonne reference product).

The system boundaries are set from **cradle to gate, including all processes from cultivation to factory-gate.**

The life cycle stages included **sugar cane cultivation, oxen labour at the farm, transport and sugar production** in the Dominican Republic.

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

- **1 tonne of sugar cane at the farm (ProTerra-certified/ non-GMO)**
- **1 tonne of sugar at the production plant (ProTerra-certified/ non-GMO)**

2.2 Compliance

The calculations in this study follow the Product Environmental Footprint (PEF) guidance (European Commission, 2021), e.g. in terms of the allocation method used and the land use change accounting approach (see also section 2.3.1).

2.3 Data use

Most of the data for the agricultural and processing stages come from primary sources, collected through questionnaires and direct meetings with Central Romana. The agricultural data focus primarily on the yield, the inputs used in the field, such as energy consumption during field operations, and the quantities of fertilisers and pesticides applied. The Blonk crop model tool was used to estimate on-field emissions,, which calculates emissions based on the inputs provided, such as nitrous oxide (N2O) emissions from fertiliser application. The tool follows state-of-the-art methodologies for the calculation of on-field emissions, such as IPCC.

For the livestock system (the oxen used in the field), data was collected on the type of animals used, their weight and the number of animals. Emissions from the livestock system were calculated based on the IPCC (2019) guidelines (IPCC, 2019), which provide methodologies for calculating methane (CH4) emissions from enteric fermentation and manure management, as well as nitrous oxide (N2O) emissions from manure management. As the oxen only eat pasture and no fertilisation is applied to the pasture, pasture cultivation was not accounted for.

Transport of sugar cane from the farm to the processing facility by train is also included in this study. In the processing phase, most of the data was collected as primary data, including, for instance, energy, water, and chemicals used. However, direct emissions from biomass burning were estimated using Agri-footprint 6.3, as this information was not available. Economic allocation was applied to distribute the environmental impact across the different products produced: sugar, molasses, and electricity generated from bagasse.

2.4 Land use change

In environmental assessments, such as LCA, emissions from land use change (LUC) must be accounted for. According to several LCA guidelines and standards, such as the PEF Guidance, the contribution of LUC should be monitored for a period of 20 years retroactive to the current year.

Due to the lack of primary data on land use change (LUC), the LUC impact tool (Mérieux NutriSciences | Blonk, 2018) was used to model the LUC results for sugar cane in the Dominican Republic. This approach is based on PAS 2050-1 (BSI, 2011) and is implemented in the tool using various data sources from the Food and Agriculture Organization (FAO) and the Intergovernmental Panel on Climate Change (IPCC). The calculation is based on country-level statistics for the expansion and contraction of forestland, grassland, annual cropland, and perennial cropland. The land use change for a specific crop is determined by country-level statistics on the relative expansion of that crop. Since there has been no expansion of sugar cane in the last 20 years, the land use change (LUC) emissions for sugar cane in the Dominican Republic are considered to be zero.

3. Results

3.1 Sugar cane cultivation

One tonne of ProTerra-certified, non-GMO sugar cane, at farm in the Dominican Republic has a carbon footprint of 56.44 kg CO2-eq.

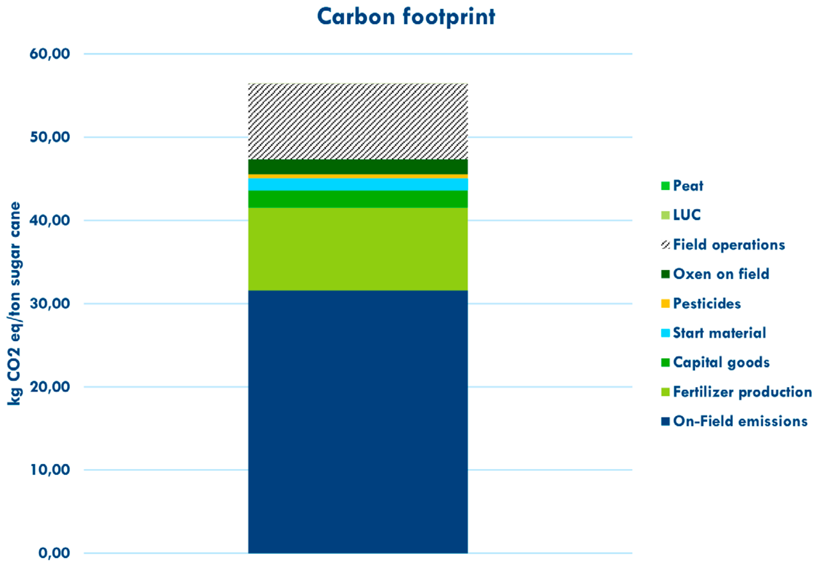

Figure 1. Results for sugar cane at farm.

The contributors are explained below:

- **Peat and land use change (LUC):** Default data using the Blonk peat and LUC model. Peat does not play a significant role in the Dominican Republic and is assumed to be zero. The same assumption is made for LUC, as there has been no expansion of sugar cane crops in this country (see 2.4). A small amount of LUC is observed due to background processes, yet it is insignificant.

- **Field operations:** Emissions from energy use in machinery (e.g. diesel use in tractors) for field operations. These emissions contribute 16% of the total carbon footprint.

- **Oxen on field:** Emissions from the oxen labour at farm. Most of the carbon footprint comes from methane emissions due to enteric fermentation (see Figure 2).

- **Pesticides:** Emissions from pesticide production These emissions are insignificant to the total carbon footprint.

- **Start material:** The same cultivation system from Central Romana is assumed to be applied to the start material cultivation.

- **Capital goods:** Default data is assumed for basic infrastructure.

- **Fertiliser production:** Emissions associated with the production and transport of fertilisers. For example, electricity and heat used in the production of ammonium nitrate. Chemicals used, such as nitric acid, ammonia, phosphoric acid, are generally known to be involved in the production of fertilisers . For this, we used secondary databases to access background processes.

- **On-field emissions:** Field emissions are associated with the application of both fertiliser and crop residues left on the field. For example, when nitrogen fertiliser is applied and when crop residues are left on the field, direct and indirect N2O emissions occur due to the nitrogen content of either fertilisers or the residues. On-field emissions are the primary contributor to the carbon footprint, accounting for approximately 56% of the total impact.

3.2 Sugar production

One tonne of ProTerra-certified, non-GMO sugar, produced from sugar cane, in the Dominican Republic is 685 kg CO2-eq.

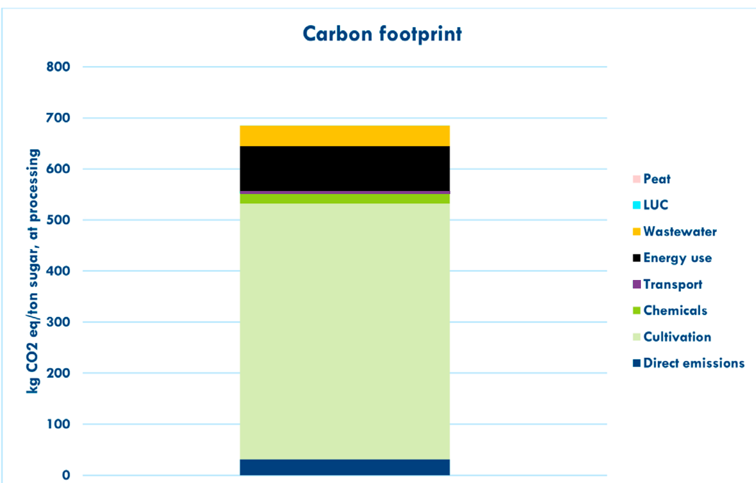

Figure 2. Results for sugar, produced from sugar cane.

- **Peat and land use change (LUC):** Default data using the Blonk peat and LUC model. Peat does not play a significant role in the Dominican Republic and is assumed to be 0. The same assumption applies to LUC, as there has been no expansion of sugar cane crops in this country (see 2.4). A small amount of LUC is observed due to background processes, yet it is insignificant.

- **Wastewater:** Emissions from wastewater treatment: It is assumed that the same amount of water input goes into external wastewater treatment.

- **Energy used:** Energy consumption during the processing phase, in particular diesel used to operate the boiler. These emissions account for 13% of the total carbon footprint.

- **Transport:** Sugar cane is transported to the processing facility by train, which operates on diesel fuel. The contribution of transport is rather low.

- **Chemicals:** Emissions from chemicals used during the processing phase, such as lime and phosphoric acid.

- **Cultivation:** In sugar production, the cultivation stage is the major contributor (about 73%) to climate change (see section 3.1).

- **Direct emissions:** Default data based on Agri-footprint 6.3 – emissions from bagasse burning. These emissions contribute 4.6% to the total carbon footprint.

3.3 Comparison with other countries of origin

3.3.1 Sugar cane cultivation

One tonne of ProTerra-certified, non-GMO sugar cane, at farm in the Dominican Republic is 56.44 kg CO2-eq.

One tonne of sugar cane, at farm, in Mexico is 62.4 kg CO2-eq (Agri-footprint 6.3 database).

One tonne of sugar cane, at farm, in Brazil is 159 kg CO2-eq (Agri-footprint 6.3 database).

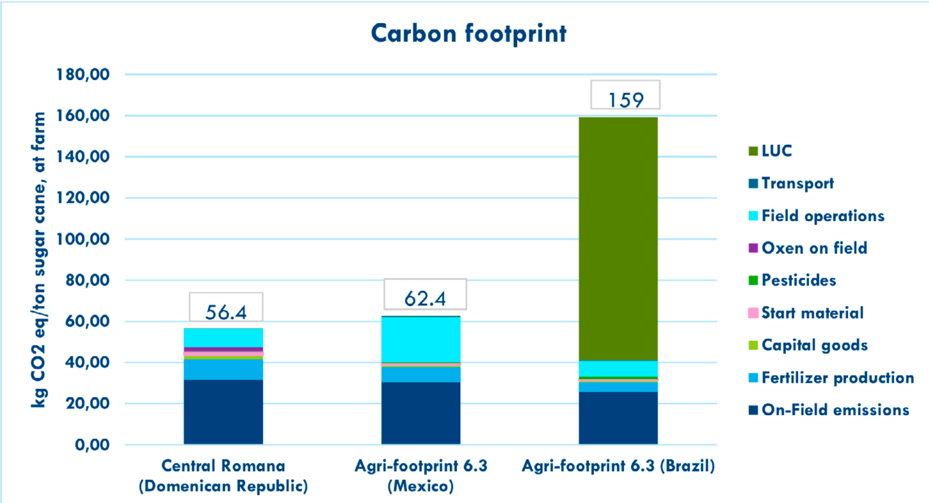

Figure 3. Results for sugar cane at farm.

- It is important to note that the results for the Dominican Republic are widely based on primary data, whereas the results for Mexico and Brazil are based on secondary data from the Agri-footprint 6.3 database.

- Although the yield in the Dominican Republic is significantly lower than in Brazil and Mexico, the carbon footprint per tonne of sugar cane produced for Central Romana is lower. This is mainly due to reduced fertiliser inputs use and energy consumption compared to the other countries. Furthermore, the zero land use change (LUC) in the Dominican Republic contrasts with Brazil, where LUC is a major contributor to climate change.

3.3.2 Sugar production

One tonne of ProTerra-certified, non-GMO sugar, produced from sugar cane, in the Dominican Republic is 685 kg CO2-eq.

One tonne of sugar, produced from sugar cane, in Mexico is 922 kg CO2-eq (Agri-footprint 6.3 database).

One tonne of sugar, produced from sugar cane, in Brazil is 1974 kg CO2-eq (Agri-footprint 6.3 database).

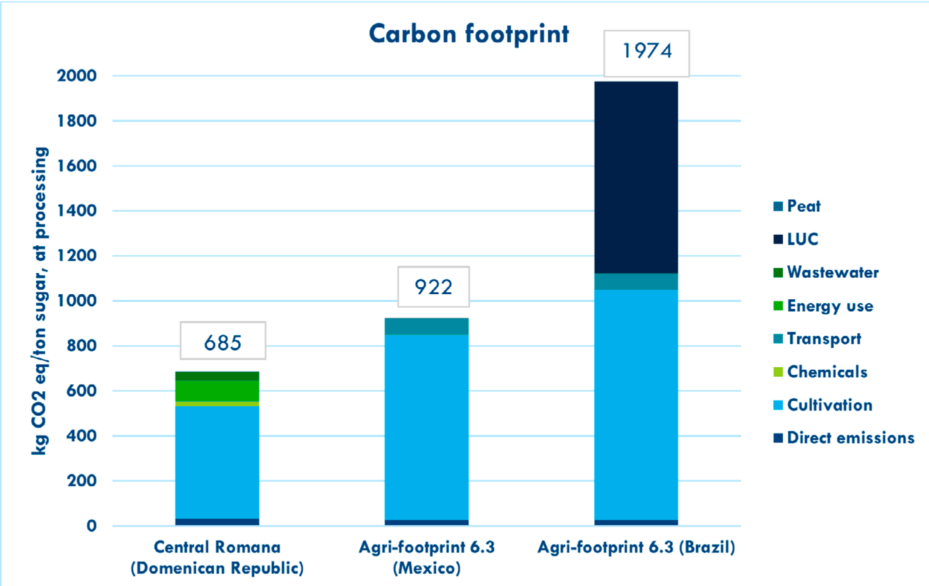

Figure 4. Results for sugar, produced from sugar cane.

* It is important to note that the results for the Dominican Republic are widely based on primary data, whereas the results for Mexico and Brazil are based on secondary data from the Agri-footprint 6.3 database.

* Results from land use change (LUC) in Brazil play a significant role in the carbon footprint, primarily due to the conversion of natural land to sugar cane production and the expansion of sugar cane areas in the country.

* For the sugar modeling in Central Romana, economic allocation was used to distribute the environmental impacts among the different co-products: sugar, molasses, and electricity from bagasse. The Agri-footprint models also use economic allocation, but assume that all the bagasse is used to meet internal energy demands, which is why there is no “energy use” contributor for Mexico and Brazil, and that no excess electricity is sold to the grid.

4. Conclusions and limitations of the study

4.1 Conclusions of the study

- On-field emissions are the main hotspot in sugar cane cultivation, primarily due to N2O emissions from fertilisers and crop residue applications, contributing approximately 56% of the total carbon footprint of ProTerra-certified non-GMO sugar cane at the farm level.

- Fertiliser production and on-field operations at sugar cane cultivation are the second largest contributors after on-field emissions.

- Cultivation is also the primary contributor to the carbon footprint of ProTerra-certified non-GMO sugar derived from sugar cane, accounting for approximately 73% of the total impact.

    - If cultivation is excluded, energy use becomes the main hotspot of sugar production during the processing stage (gate-to-gate).

4.2 Limitations of the study

- Cautionary Note on the use for Carbon Reporting: Please be aware that this environmental footprint study is not fully compliant with the ISO 14040/14044 (ISO 14040, 2006; ISO 14044, 2006) or PEF standards (European Commission, 2021).

- The results are intended for internal use to identify environmental impact hotspots, set reduction targets, ensure regulatory compliance, and address legal issues. They may also be shared with suppliers and customers (B2B), in accordance with relevant laws and protocols. However, these results are not intended for comparative statements or external communication unless accompanied by an appropriate disclaimer provided by Blonk.

- The availability of primary data is essential to ensure accurate calculations. It is recognised that more detailed company-specific data should be further analysed to support environmental claims. Therefore, it is strongly recommended to increase the amount of primary data on ProTerra-certified sugar cane products to enhance the quality of the results.

- Agri-footprint results serve as a reference for comparison, but do not allow a 100% “fair” comparison due to differences in the data used and underlying methodologies. In general, the Agri-footprint default results for Brazil and Mexico were shown to be relatively higher than the ProTerra results.

4.3 References

BSI. (2011). *PUBLICLY AVAILABLE SPECIFICATION: PAS 2050:2011. Specification for the assessment of the life cycle greenhouse gas emissions of goods and services.*

European Commission. (2021). Commission Recommendation (EU) 2021/2279 of 15 December 2021 on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organisations. *Official Journal of the European Union.*

IPCC. (2019). *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. IPCC: Switzerland.*

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

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

Mérieux NutriSciences | Blonk. (2018). *LUC Impact Tool.* https://blonksustainability.nl/tools-and-databases/LUC-impact#LUCImpactTool

Appendix I - Carbon footprint contribution of Oxen and on-field emissions

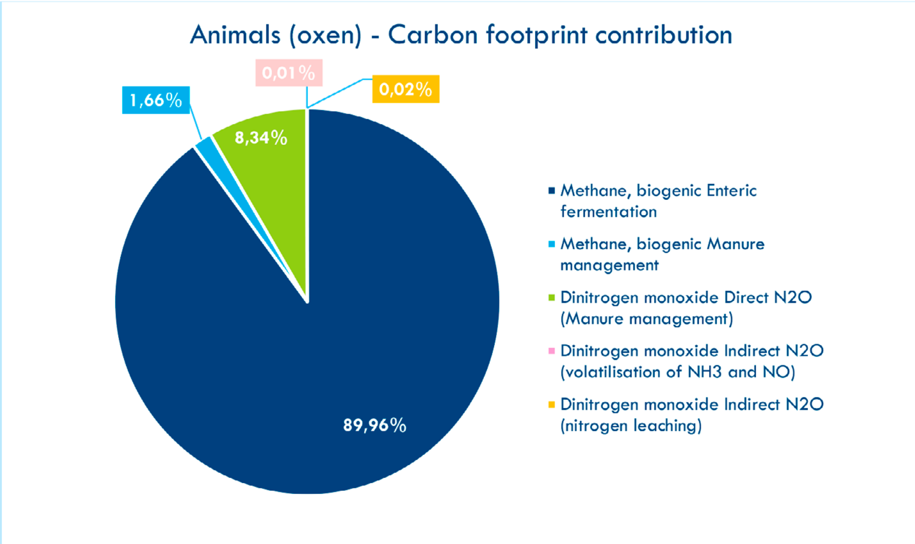

Figure 1. Carbon footprint contribution of oxen labour at farm.

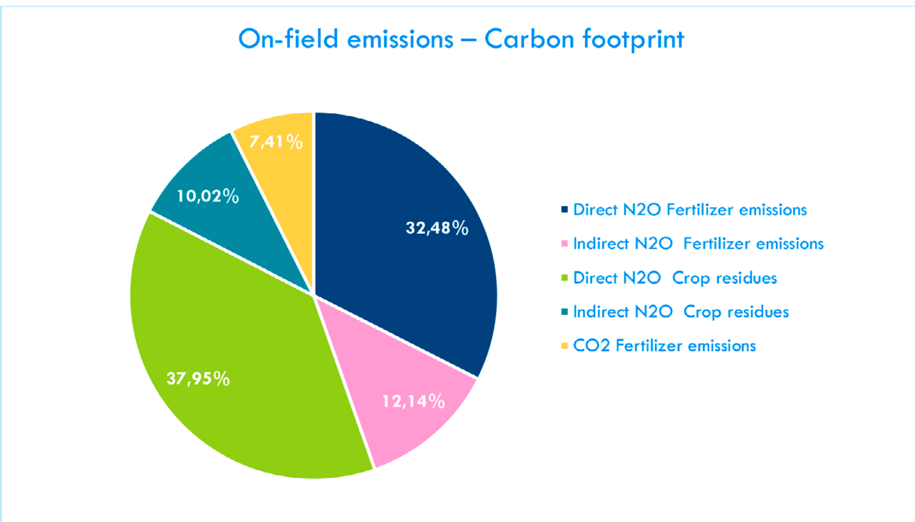

Figure 2. Carbon footprint contribution of on-field emissions at farm.

The calculation of N2O emissions from fertiliser applications and crop residues follows the IPCC (2019) methodology. For crop residues, only nitrogen-related emissions are considered, such as direct N2O and indirect N2O resulting from nitrate leaching or ammonia volatilisation. As N2O has a high global warming potential, it is included in the calculation. However, the carbon stored in the residues left on the field is not taken into account as sugar cane is considered a short-lived crop and the carbon is released in a short carbon cycle. This is in line with the Product Environmental Footprint (PEF) (European Commission, 2021) methodology and other leading guidelines.