Environmental footprint of Guar from India

ProTerra FOUNDATION

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1. Introduction

The ProTerra Foundation is a non-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.

ProTerra asked Mérieux NutriSciences | Blonk to analyse the environmental footprint of guar meal. Chimique India Ltd is India's leading manufacturer and supplier of Guar Gum powder and Guar Meal across the world. For this project, a Life Cycle Assessment (LCA) is performed to assess the environmental impact of Guar Korma (meal) produced by Chimique India Ltd. The following environmental impact categories have been assessed: carbon footprint, water consumption and land use.

2. Methodology and background

2.1 Scope of the study

The goal of the present study is to perform an LCA study of a guar product from Chimique India Ltd. This project is commissioned by ProTerra and performed by Mérieux NutriSciences | Blonk. This work is being carried out within the context of the ProTerra Guar working group.

The study covers the product Guar Korma from Chimique India Ltd., which is a high-protein meal that is sold as animal feed.

The environmental impact categories within the scope are as follows:

1. **Carbon footprint (kg CO2 eq/ton reference product)**
2. **Water consumption (m3 CO2 eq/ton reference product)**
3. **Land use (m2 arable crop eq/ton reference product)**

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

The life cycle stages included are the guar cultivation and processing of guar into guar meal.

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

- **1 ton of guar korma (meal) at the factory gate.**

2.2 Data use

The data for the agricultural and processing stages was primary data provided by Chimique India. The agricultural data primarily focuses on the yield and inputs used in the field, such as energy consumption during field operations. Primary data on cultivation were collected from 15 farms in the Adampur district and 16 farms in the Bhakra district of Haryana. The harvest data was provided for guar beans, excluding the outer pods. The guar bean yields for all the farms had been made uniform to 1606 kg/ha by the data provider; the reason for this was that all the farms are located at very close distances to each other and, thus, receive the same amount of rainfall but also have very similar raw material inputs based on questions asked to Chimique India. Pertaining to this, the cultivation stage was, thus, modeled by averaging all the input data provided for all the farms.

Since guar is a nitrogen-fixing legume crop, no fertilisers are used for cultivation and, hence, zero quantities were reported. Chimique India also reported no use of pesticides, nor any use of irrigation water for guar cultivation. In general, guar is known as a low-input crop, with zero fertilisation, plant protection and irrigation needs, which makes it appropriate for the area grown.

Transport of guar bean from the farm to the processing facility by truck is also included in this study. In the processing phase, most of the data were collected as primary data, for example, energy and water use. Economic allocation was applied to distribute the environmental impact across the different products produced, i.e. guar gum and guar korma.

2.3 Methodology

The applied methodology is an attributional LCA used to assess the environmental impact. The proposed calculation methodology will be to perform an LCA in line with the international standards ISO 14040/14044 (ISO, 2006a, 2006b) and state-of-the-art standards as the guidelines of the Product Environmental Footprint Method (European Commission, 2021).
The inputs and outputs for all life cycle stages were modelled using the LCA software SimaPro (version 10.2.02) (PRé Sustainability, 2023).

The impact calculation was carried out using the ReCiPe impact assessment method (Huijbregts et al., 2016), which was adapted to use the most recent IPCC factors (IPCC, 2019) for assessing environmental impact on climate change.

Climate change, also known as carbon footprint, is expressed in kg CO2 equivalent per unit product output. The carbon footprint was calculated including and excluding the direct land use change (dLuc) following the dLuc methodology (Blonk Consultants, 2021). The impact category land use is represented in terms of m2 of cropland equivalent used annually, while the water consumption is represented in m3 of blue water consumed.

To estimate on-field emissions, from guar cultivation, the Blonk Crop Model tool was used, which calculates emissions based on chemical or organic inputs provided, such as fertilisers and crop protection agents for example nitrous oxide (N2O) emissions from fertilisers or crop residues. In this project, soil emissions are attributed to crop residues, while soil peat oxidation is also accounted for cultivation on peat soils. The Crop Model follows the Agri-footprint 6.3 methodology (Blonk et al., 2022) to calculate such emissions.

3. Results

This section provides the results of the impact assessment for the global warming category (representing climate change potential). Results for water consumption and land use for each of the life cycle stages can be found in .Appendix I and Appendix II.

3.1 Guar cultivation

Figure 1 shows that guar cultivation has a total global warming impact of 218.9 kg CO2 eq./ton guar beans. Of this, 85% of the carbon footprint is due to “cultivation activities”; 12% from the use of fuels, 2% from peat oxidation and 1% from start material production. Emissions from LUC are negligible and only associated with fuel use.

In the case of cultivation activities, these GHG emissions mainly come from the burning of crop residues and residues that are ultimately mixed with the soil. The main emissions generated here are carbon dioxide (CO2) and methane (CH4) from crop burning; in smaller amounts this also leads to nitrous oxide (N2O) and nitrogen oxides (NOx) emissions. When crop residues are simply left behind on the field and eventually mixed with the soil, the emissions profile consists mainly of N2O.

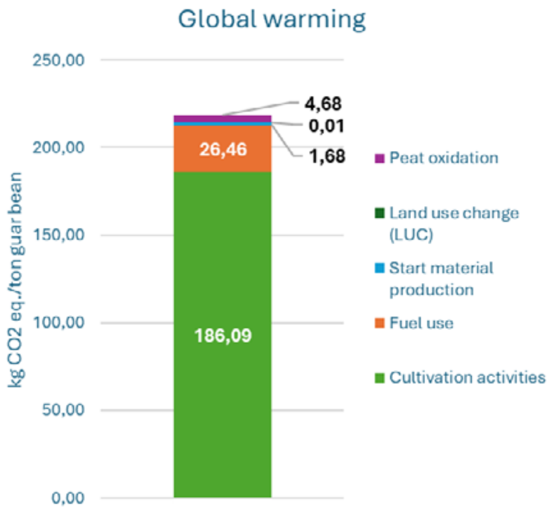

Figure 1: Global warming (total) impact in kg CO2 equivalents per ton of guar beans and respective contributions of processes.

Since, no organic nor synthetic fertiliser application takes place at the guar fields, the carbon footprint of guar beans at cultivation is on the lower side compared to other leguminous annual crops. Additionally, Chimique India reported no land use change (LUC) having taken place in the regions under study in the state of Haryana. The provided information was validated using existing national statistics as well as literature on LUC in Haryana (Kalra, 2001;Gupta et al., 2019;Rani & Singh, 2024).

Peat oxidation impact occurs almost entirely from the use of land for cultivation; a minor part of it originates from start material production. In the current model, peat oxidation emissions are modelled using aggregated geospatial data for cultivated peat soils and crop cultivation, based on the Agri-footprint methodology. These data are country-crop specific and do rely on primary information of the cultivated area in scope.

3.2 Roasted guar korma production

Figure 2 shows that roasted guar korma production has a total global warming impact of 247.8 kg CO2 eq./ton of product.

Of this, 61% originates from the cultivation stage, 18% from fuel use, 12% from electricity use, 6% from transport of guar beans from farm to factory, 2% from packaging production and 2% from peat oxidation.

The emissions profile from fuel, electricity and transport consists of mainly fossil CO2. Emissions from LUC are again negligible at 0.1 kg per ton of roasted guar korma and originate mainly in fuel use. Peat oxidation emissions originate solely from the cultivation stage, as mentioned in paragraph 3.1. Lastly, the emissions associated with packaging come from the production of plastic packaging as well as from that of wooden pallets.

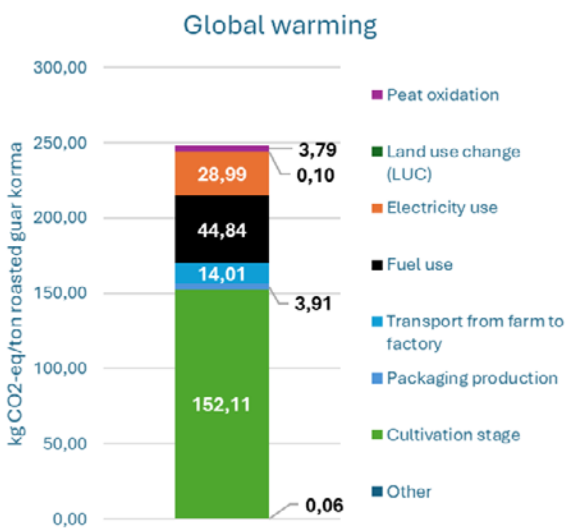

Figure 2: Global warming (total) impact in kg CO2 equivalents per ton of roasted guar korma and respective contributions of processes.

4. Conclusions

- On-field emissions are the main hotspot of guar korma production, primarily due to N2O emissions from burning and application of crop residues, contributing to about 55% of the total carbon footprint.
- The use of diesel fuel at factory operations leads to the second most relevant contribution to the footprint at 18%.
- Lastly, 12% contribution comes from the use of electricity at the factory, which combined with the processes mentioned above forms 85% of the total emissions (most relevant).

5. Project considerations

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

- 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 of this study give a different picture of the environmental impact of roasted guar korma than a previous LCA study (ISO reviewed) conducted at the end of 2024. This study also relied on the same primary data from Chimique India, used in the current study. The misalignment of the impact results could stem from differences in the methodological choices made; however, this is difficult to understand, since the previous LCA model was not available to Blonk at the time of the current project.

Appendix I Land use & water use impacts at cultivation

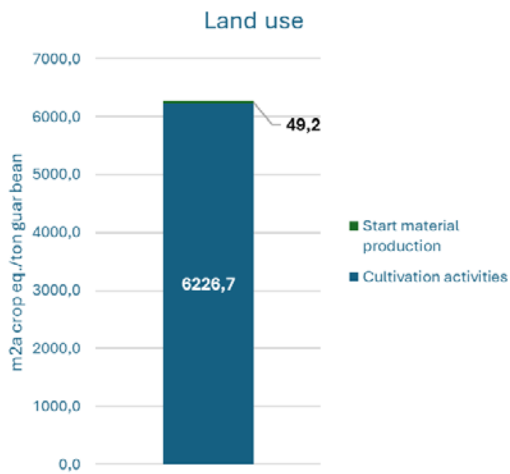

Figure 3: Land use in m2 a crop equivalents per ton of guar beans and respective contributions of processes.

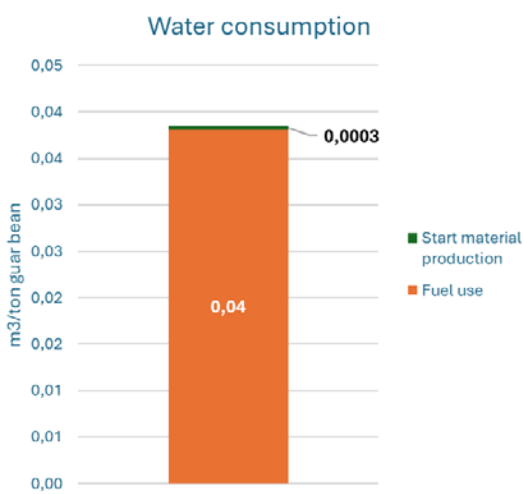

Figure 4: Water consumption impact in m3 per ton of guar beans and respective contributions of processes.

Appendix II Land use & water use impacts at roasted guar korma production

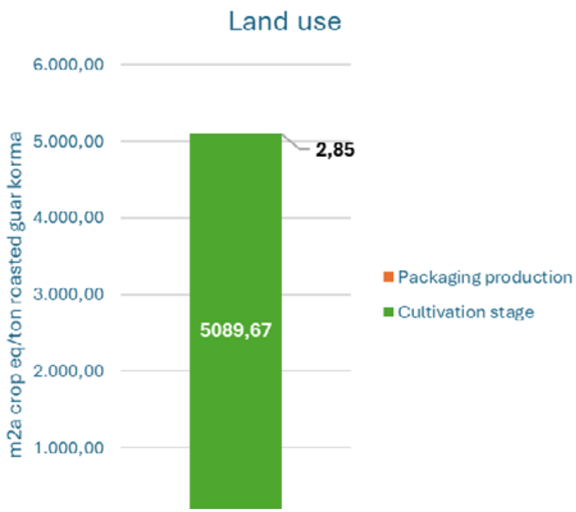

Figure 5: Land use in m2 a crop equivalents per ton of roasted guar korma and respective contributions of processes.

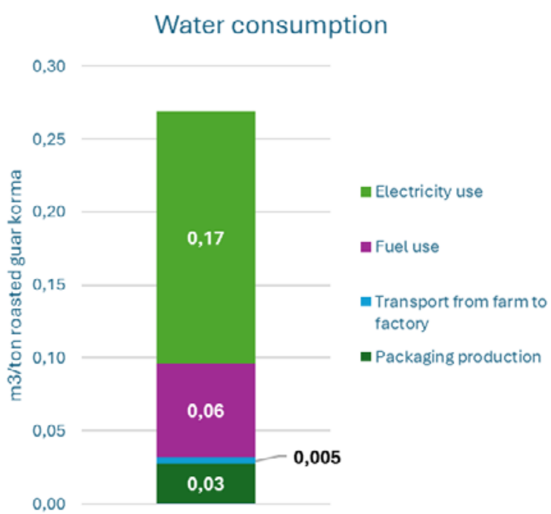

Figure 6: Water consumption impact in m3 per ton of roasted guar korma and respective contributions of processes.