Footprint Pro Carbono: a robust tool for carbon accounting of agricultural products

Marília I. S. Folegatti[1], José Paulo P. das Dores Savioli[1], Renata P. Ferreira[2], Thaís E. Hiramoto[2], Anna Leticia M. T. Pighinelli[1], Nilza Patricia Ramos[1], Adriano Anselmi[2]

[1]Embrapa Environment, Rod. SP 340, km 127,5, Jaguariúna/SP, Brazil. Postal code 69, zip code 13918-110. marilia.folegatti@embrapa.br
[3]Bayer S.A. Rua Domingos Jorge, 1100, São Paulo/SP, Brazil

E-mail contact address: marilia.folegatti@embrapa.br

1. INTRODUCTION

The pressing urgency of global climate change demands immediate action. In Brazil, the agricultural sector stands out as a significant contributor to greenhouse gas (GHG) emissions, representing 33.2% of the nation's total emissions (Brazil, 2021). Effective mitigation and management of GHG emissions in agriculture require robust methodologies, tools, and targeted policies. One such essential tool is Footprint Pro Carbono (FPC), designed to assess the carbon footprint of agricultural products within cropping systems, including key crops like soybeans and corn. This study presents the core features of FPC and insights from a case study involving soybean farmers in Mato Grosso, Brazil's leading soybean-producing state, responsible for a substantial production volume of 38 million tons in 2022.

2. METHODS

The FPC tool, aligning with ISO 14067 and GHG Protocol standards, evaluates GHG emissions' environmental impact in agriculture, aiming to identify intervention opportunities. It calculates the carbon footprint of agricultural products (in kg CO2eq/ton of DM) using a metric ton of product as a reference unit. Spatial coverage includes plot and farm levels, with temporal coverage spanning agricultural harvest or cropping systems. The tool's technology is current, with system boundaries covering processes from cradle to trader’s entrance gate. Background data is from ecoinvent v3.9, while foreground data can be primary or "penalized data" (which corresponds to the highest amounts consumed of each agricultural input observed in Brazilian soybean production). The function of the “penalized data” is to allow a farmer who does not yet have a complete set of primary data to enter the program, but with conservative data. Allocation procedures distribute shared resources and their environmental loads among agricultural products based on resource effect duration and the number of commercial crops grown. Environmental impact assessment uses Climate Change and Global Warming Potential based on IPCC (2021). Uncertainties are addressed via parameter distributions and a Monte Carlo simulation. Farmers input data via an information system, providing details on productive areas, yields, inputs, energy use, and post-harvest processes. Land Use Change emissions use BRLUC v2.0 (Garofalo et al. 2022), and agricultural phase GHG emissions follow IPCC (2019), Tier 1 guidelines.

3. RESULTS AND DISCUSSION

The carbon footprint of agricultural products is visualized by farmers through an integrated information system (Figure 1). GHG emissions are systematically categorized by source (e.g., land-use change, limestone application, nitrogen fertilizers, etc.) and by their biogenic and non-biogenic nature, along with their respective uncertainties. Furthermore, a comprehensive technical report is generated to provide in-depth analysis. Figure 2 illustrates the average carbon footprint of soybeans produced by ten farmers during the 2022-2023 harvest, juxtaposed with both the typical and penalized typical profiles, offering valuable insights into emission variations.

4. CONCLUSIONS

FPC has demonstrated its user-friendly nature, providing accurate reports on the carbon footprint of soybeans with minimal data input. Its intuitive interface facilitates informed decision-making, guiding management strategies to effectively reduce GHG emissions.

5. ACKNOWLEDGEMENTS

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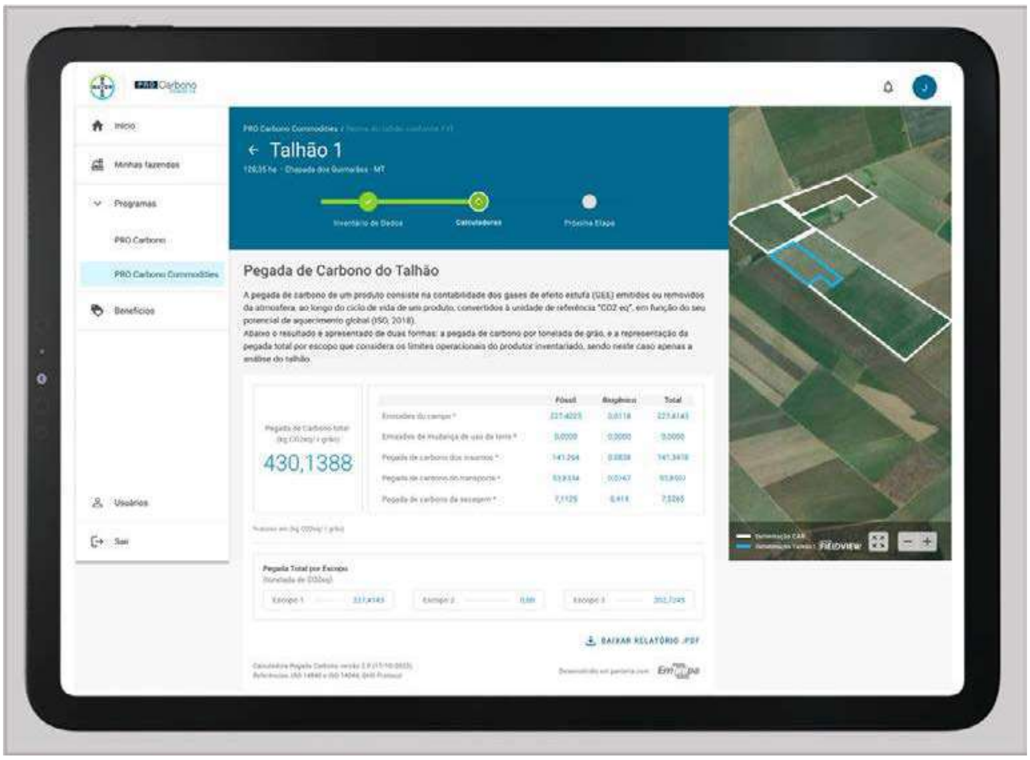

Figure 1. Illustration of the results presented in the Footprint Pro Carbono information system.

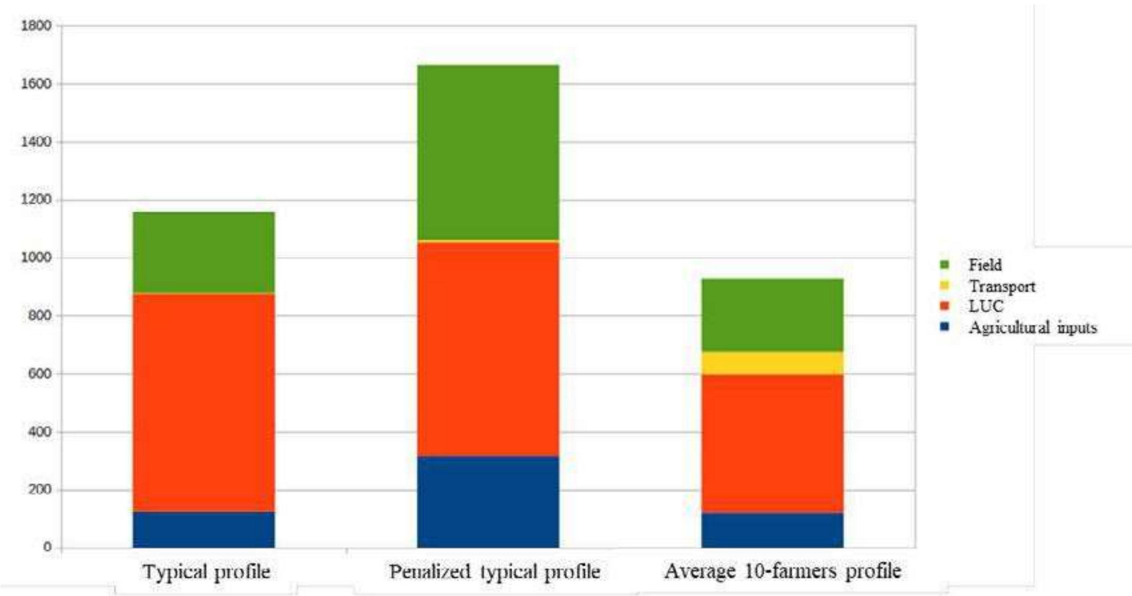

Figure 2. Soybean carbon footprint: 10 farmers from Mato Grosso, season 2022-2023; the typical Brazilian profile and the penalized typical Brazilian profile.