Embrapa

Business Context

Embrapa is the Brazilian Agricultural Research Corporation, a state-owned research business affiliated with the Brazilian Ministry of Agriculture. Founded in 1973, Embrapa plays a crucial role in advancing agricultural productivity, sustainability, and innovation across various sectors, contributing significantly to Brazil's agricultural growth and global agribusiness leadership.

In the first phase of the assessment, Empraba just applied the TEEBAgriFood evaluation framework and business guidelines to Nuu Pão de Queijo, a small and medium enterprise that produces *pão de queijo*, a typical cheese bread. During the second phase, the case study was expanded to the dairy farming chain.

The context selected for the Embrapa pilot study is the Cerrado Mineiro region of Minas Gerais, a Brazilian state responsible for producing over 25% of the national raw milk output. The majority of milk production is concentrated in the Cerrado Mineiro region, which is situated within Brazil's expansive Cerrado biome. This tropical savanna not only yields substantial amounts of the country's beef, soybeans, and coffee but was also designated by the WWF as the most biologically rich savanna in the world. The main land use in Cerrado Mineiro is agriculture and grazing and more than 75% of producers are family farmers. The region is also recognized as an Immaterial Heritage of Brazilian Culture with a 'Geographical Indication' for the well-known *queijo de Minas artesanal (QMA),* a typical cheese made from raw milk.

Figure 1. Map of Pilot Site – Cerrado Maneiro, Minas Gerais, Brazil.

Assessment

WHY? What is the objective of the assessment?

The main objective of the assessment is to evaluate the impacts and externalities caused by the dairy farming chain on social, human, natural and produced capitals, and to compare these among family and non-family farmers. Empraba expects to use the results to highlight opportunities to reduce GHG emissions during cheese production.

The assessment's opportunities identified are to highlight the interconnections and dependencies within the milk value chain system, including an accounting system for the input of ecosystem services. The anticipated benefits are to have robust arguments to convince producers about the advantages of adopting soil and water conservation practices while adding value to their local product, opening new markets, and gaining consumer trust. The risks and challenges of the case lie in the availability of large reliable datasets to generate robust information. The target audience is mainly producers and the Brazilian Ministry of Agriculture.

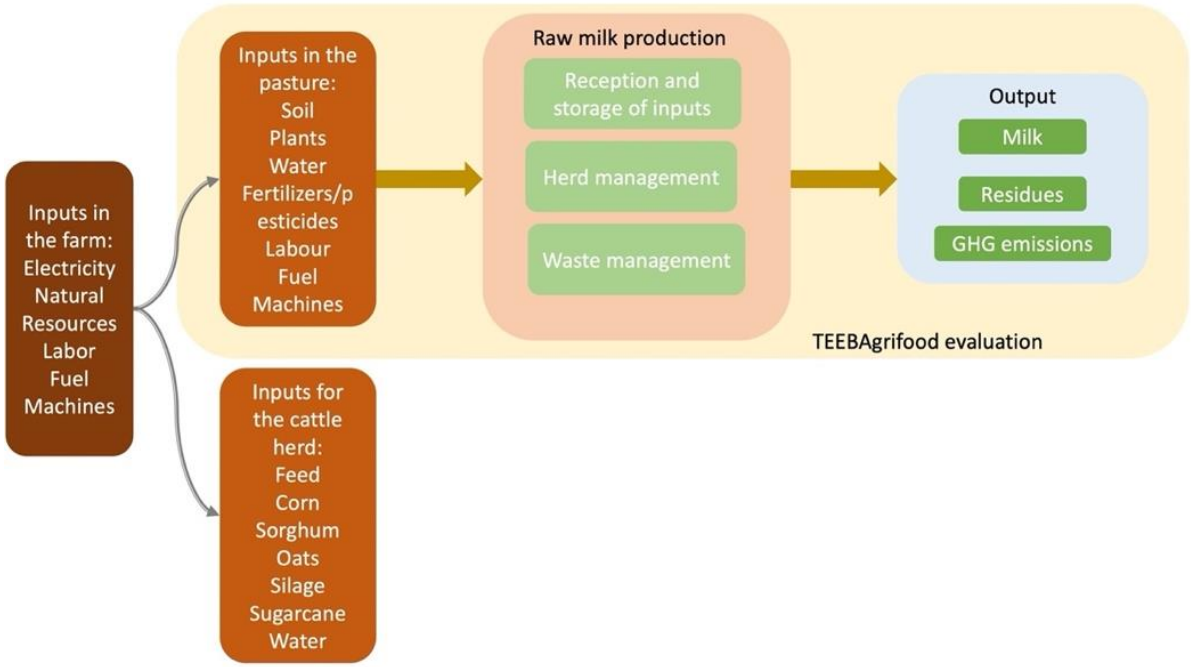
WHAT? What is the scope of the assessment?

The baseline for the analysis is the 2017 Agricultural Census, produced by the Brazilian Institute of Geography and Statistics (IBGE), the Map Biomas and the Digital Atlas of Brazilian Pastures. The geographical boundary is the Cerrado Mineiro region. The research draws upon both peer-reviewed academic literature and direct measurement at the property scale.

Empraba started by mapping the different stages of the milk production process into an input-output model so that key impacts and dependencies could be accounted for. The results are presented in Figure 2 below. The graphic shows the scope of the TEEB-Agrifood assessment, which covers farm and pasture related inputs while excluding cattle related inputs.

In terms of pasture related inputs, they consider electricity consumption, natural resources use (soil, plants, water), fertilizer, pesticides, labour, fuel and machines, and animal food for the cattle herd. The farm activities considered included reception and storage of inputs, herd management and waste management. In terms of outputs, they focus on milk production, waste residues/materials and greenhouse gas emissions (GHGs).

Figure 2. Input-output model of milk production



HOW? What will be measured and valued?

Based on the input-output model, Empraba selected four key material issues to focus on for the valuation: land use, fertilizer dependency, GHG emissions, and food security. The table below displays the associated impact drivers, change in capitals, and impacts on society and the methods selected to assess them.

Table 1. Impact/Dependency pathways

Material issue	Impact driver/ dependency	Indicator	Change in Capital	Method to measure change	Impact on society	Valuation technique
Land use	Land use change & conservation practices	% land use (pasture, agriculture, natural areas)	Natural Capital: Soil degradation (i.e. soil loss)	Estimate based on degraded pasture area (ha)	Loss of soil from reduced erosion control	Quantitative: Degraded pasture area (ha) & loss of associated revenue & t/ha per year of soil loss
			Human Capital: Knowledge & skills in conservation practices	Evaluation of the number of farms that use conservation practices	Reduced carbon emissions, less water used and more milk	Assessed through the other issues.

Use of Fertiliser	Degraded soil / healthy soils	Amount of fertilizers applied				
GHG emissions	Land use change / livestock activity	GHG monitoring or indirect calculated by the average number of cattle/ area	Reduced CO2 from soil sequestration	Quantitative : tons carbon stored	Reduced climate change	Quantitative only (tons carbon stored)
			Reduced methane emissions	Quantitative : tons per year	Reduced climate change	Quantitative only (tons of methane saved)
Food security	Climate variabilities / change in suppliers	Average no. of livestock	Produced capital: Milk produced	Volume of milk produced (Litres)		

Notes:

1) Data for Impact Drivers: For Land Use comes from MapBiomass, for Fertilizer use, GHG emissions and Food security, data comes from Censo Agropecuário IBGE.
2) Data for measuring changes in capital comes from secondary data (e.g. IBGE)

WHAT NEXT? What were the results of the assessment?

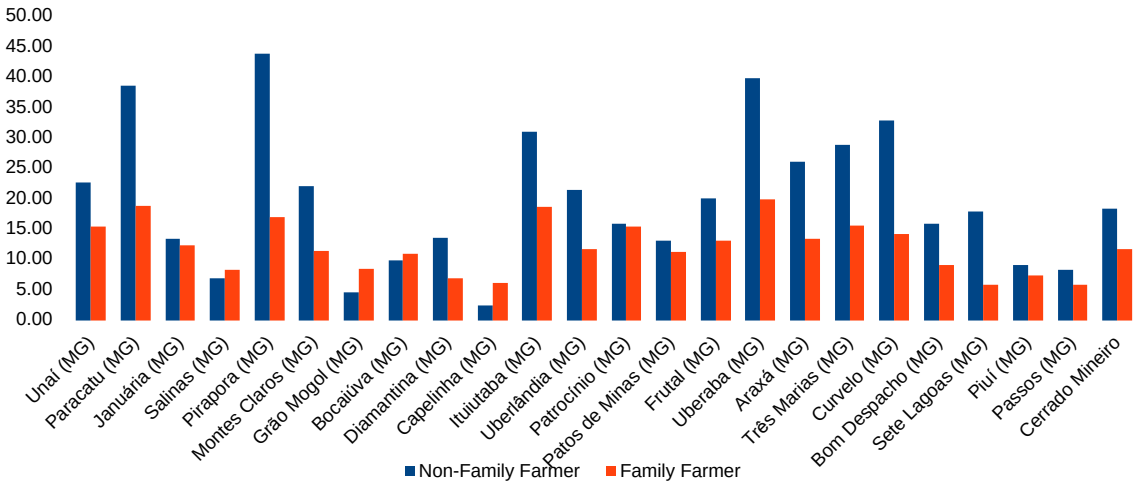
At present, only partial results have been obtained from three of the four impact pathways. The assessment is still ongoing and only the secondary data has been analysed. The next phase will include a field verification process and model calibration.

Land Use

Empraba used data from the 2017 agricultural census to assess the land use impact pathway. They first obtained data for the total extent of land per microregion, aggregating the results into family farmers and non-family farmers. Across the entire region, non-family milk farms cover 17.5 million hectares of land, while family farms cover 4.6 million hectares.

Empraba then analysed the average area of degraded pastures per agricultural establishment within each micro-region in the Cerrado Mineiro. The results split by family and non-family farms are displayed in the chart below.

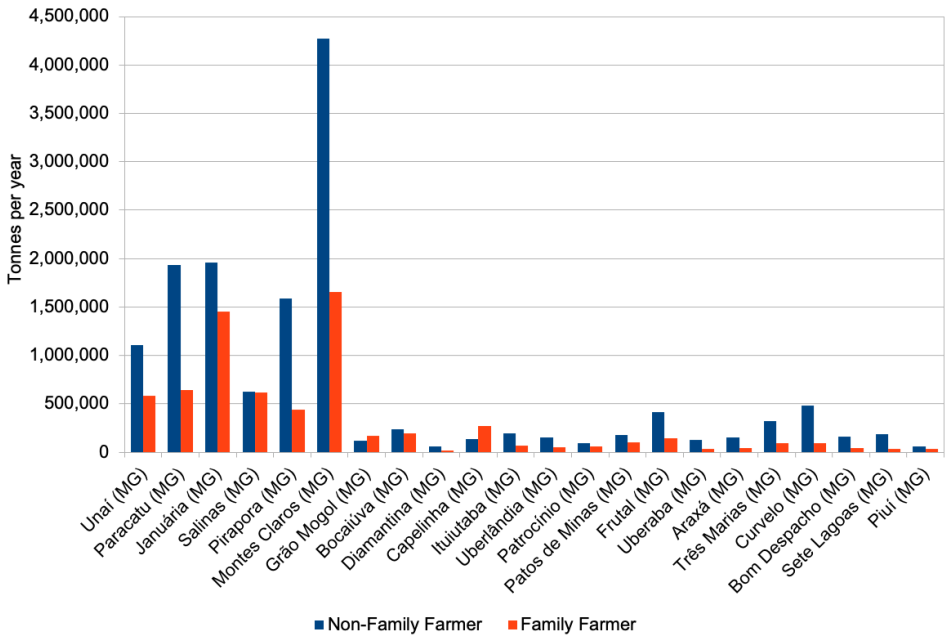
Fig 1: Average area of degraded pasture per agricultural establishment in each micro-region



Source: *Agricultural Census (IBGE, 2017)*

Based on the extent of degraded pastures in family and non-family farms in the micro-regions, Empraba assessed the impact to society from this change in natural capital. They estimated the total amount of soil loss per microregion by using a coefficient obtained from the literature for average quantity (tonnes) of soil lost per hectare of degraded pastureland. The results from these calculations are displayed in the chart below. The chart highlights that non-family milk farms are contributing to significantly more soil loss in each microregion. Across the whole region, the estimated soil loss per year from non-family farms amounts to 14.6 million tonnes, while family farms are causing 6.9 million tonnes of loss.

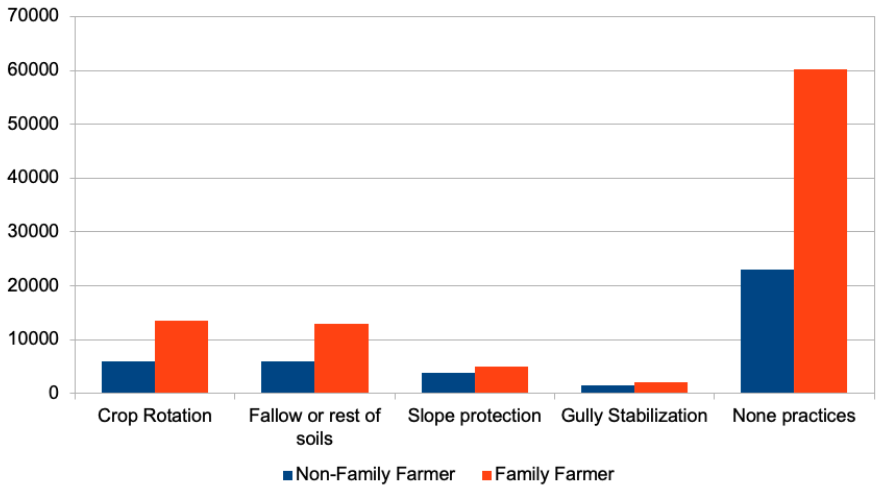
Figure 2. Soil loss in different establishments within the Cerrado Mineiro *micro-regions.*



Source: *Calculated from Gomes et al (2019)*

Figure 3 shows the number of farms that implement specific conservation practices. This is considered an indicator of human capital in that the those farms applying some form of conservation practice in theory have the knowledge to implement scuh measures. Clearly there is a considerable amount of further education that could be undertaken to help inform and improve the majority of farms that have no current conservation practices.

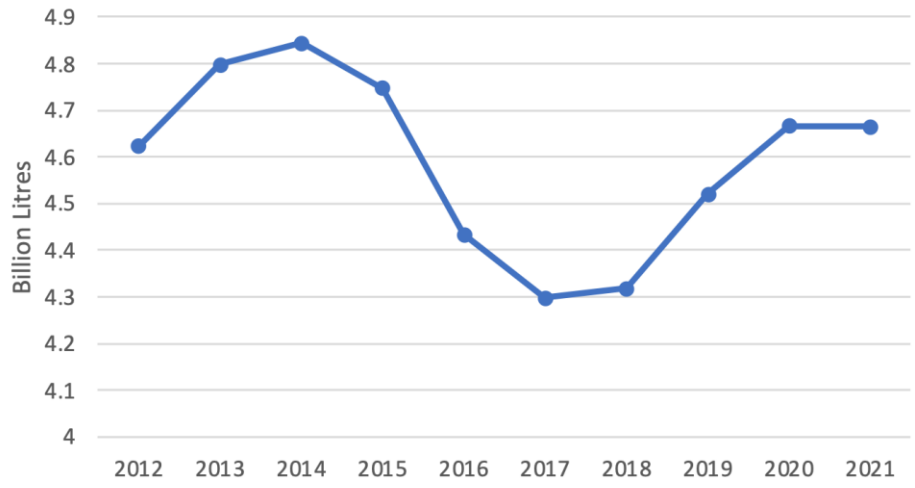
Figure 3 Number of establishments that use conservation practices



Food Security

To assess the food security impact driver, Empraba simply calculated the total annual volume of milk produced in the Cerrado Mineiro from 2012 – 2021 as a proxy indicator. The results are displayed in the chart below. Production peaked in 2014 at 4.84 billion litres and then fell until the low in 2017 of 4.3 billion litres. By 2021 milk production had recovered to 4.66 billion litres per year.

Figure 4. Milk production in the Cerrado Mineiro (2012-2021).



GHG Emissions

To assess GHG emissions, Empraba estimated the % of carbon stock classes in the 0-20 cm layer in relation to the total area of degraded pastures. They also estimated the quantity of methane emitted by family and non-family farms in the Cerrado Mineiro using a coefficient from the number of milking cows reared by each type of farm. Family farms rear 576,197 cows per year, which converts to an estimated 33.6Gg per year. Non-family farms rear 664,619 cows per, and this converts to 36.9Gg per year.

Overall conclusions

The study is ongoing with a focus now on field verification and calibration of the models and calculations. The initial findings indicate that the milk production process's externalities potentially have the most significant adverse impact on natural capital – in relation to soil loss and GHG emissions. Nevertheless, the restoration of degraded pastures in Cerrado Mineiro holds promise, with, based on Empraba calulations, the potential to mitigate 5.8 million tons of carbon annually.

To counteract the degradation of natural capital, a viable strategy involves investing in human capital. This entails providing capacity-building opportunities to producers, empowering them with skills and knowledge related to improved soil and water conservation.

Furthermore, the assessment underscores the necessity for effective coordination among federal, state, and municipal governments. Collaborative efforts are crucial to induce and implement programs that encourage the adoption of soil and water conservation practices tailored to the distinct profiles of individual producers.

In the near future, the long case study will be published and its results will inform other Embrapa and Ministry of Agriculture project activities.

Learn more about Embrapa here. https://www.embrapa.br/en/international
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