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LCS Program - Low Carbon Soybean: a new concept of sustainable soybean[1]

In the past two decades, Brazil has consolidated as a paramount player in the global agribusiness. Considering the US $ 210 billion in total exports in 2020 (Brazil, 2021a), 48% came from the agricultural sector, totalling US $ 101 billion (Brazil, 2021b). That is the economic sector that has generated the largest surplus in the Brazilian economy, which, from a total of US$ 88 billion in 2020, the soybean complex contributed with US $ 34 billion, 1/3 of the sector's exports (Brazil, 2021b). Soybean is the leading grain crop in the country, reaching 135.5 million tons cultivated in about 38.47 million hectares in the 2020/21 season (Conab, 2021). These figures consolidate Brazil as not only the world's biggest exporter, but also the biggest producer (United States, 2021). In addition to positive effects on the trade balance, agribusiness, especially with soybean, generates jobs, income and contributes to lower-cost food, including animal protein.

Brazilian agribusiness has been under increasing international pressure regarding the presumed negative environmental impacts resulting from the soybean production chain, mainly attributed to greenhouse gas (GHG) emissions. Recently, accumulated emissions of 223.46 million tons of CO_2 equivalent (CO_2-eq.) were attributed to Brazilian soybean exports between 2010 and 2015 (Escobar et al., 2020), which is equivalent to burning approximately 73 billion litres of diesel and correspond the total consumption in the country over 15 months (ANP, 2019). Figures like these do not reflect the reality of Brazilian production systems and have been massively used, in a distorted way, as arguments in negative campaigns on the Brazilian soybean abroad, which may result in the creation of tariff barriers, devaluation of the product, and/or losses of market share.

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Scientific research has generated numerous technologies for tropical agriculture which decrease total GHG emissions in the Brazilian soybean production system, for example, the No-Tillage System (NTS), Biological Nitrogen Fixation (BNF), Crop-Livestock-Forest Integration (CLFi), biological inputs in partial or total substitution to chemical inputs, and the integrated management of pests, diseases, and weeds.

Preliminary scientific studies indicate that these technologies, used in an integrated way, may reduce the emissions of CO_2-eq in the soybean production system by at least 50% (Bayer et al., 2014). In addition, these technologies also increase yield, production stability, and rational use of inputs and land, which improves economic performance, reduces CO_2-eq emissions per ton of grains, and relieves the pressure on new areas (Telhado; Capdeville, 2021).

Facing such a scenario and contributing to decarbonizing the global economy and to the government and business goals aimed at the reduction of the GHG emissions, it is a priority to develop an internationally validated concept brand based on scientific criteria that are measurable, reportable, and verifiable. Third-party certification systems will ensure that products obtained with GHG emissions mitigating measures are differentiated.

What can be done by the soybean production chain?

The current scenario requires a fast response from the oilseed production chain, involving:

- Encouraging the adoption of practices and technologies that reduce GHG emissions - especially in the grain production process - differentiating and adding value to the final products.
- Development of metrics attesting to the sustainability of the Brazilian soybeans, employing qualitative and quantitative measurements of aspects of the final product (grains), obtained using agricultural practices and technologies that reduce GHGs emissions and, consequently, the global warming potential.

To implement these actions, Embrapa Soja with the support of Embrapa Gado de Corte is proposing the creation and establishment of a concept brand (“mark”) called Low Carbon Soybean (LCS) (Nepomuceno et al., 2021). This proposal aims at creating the LCS mark for certifying soybean grains, cultivated under NTS and using techniques or practices that effectively contribute to the reduction of GHG emissions, increasing environmental sustainability.

How to measure emission reductions?

The principles, criteria, and guidelines that parameterize the mitigation of GHG emissions at LCS will be scientifically grounded, following rules, standards, and methodologies recommended and internationally accepted by the scientific community.

The process of granting the LCS mark will be structured through private, voluntary, and third-party certification, outlined under a control system of MRV-type (measurable, reportable, and verifiable) (OECD, 2021).

The intensity of greenhouse gas emissions (IGHGE) will be based on the index originally proposed by Mosier et al. (2006), defined as the ratio between the CO_2-eq balance in a given agricultural system and yield, expressed as kg of CO_2-eq per unit of grains (Eq. 1). The calculation of CO_2-eq takes into account the different global warming potentials of GHGs, in which methane (CH_4) and nitrous oxide (N_2O) have a global warming potential (GWP) of, respectively, 28 and 265 times greater than CO_2 (IPCC, 2006; VALORES..., 2022). Therefore, the CO_2-eq balance represents the GWP of a given agricultural system, calculated as the difference between the CO_2-eq fixed and emitted, considering the soil C amounts and plant biomass C. In addition, the CO_2-eq released by agricultural operations and manufacturing processes, transportation of inputs, machinery, and equipment used in the soybean production system, will add up to the CO_2-inputs (Eq. 2).

This definition has wide use in studies on mitigation of GHG emissions, both in Brazil and other countries (Venterea et al., 2011; Bayer et al., 2014; Shen et al., 2018; Gong et al., 2021).

$$IGHGE = \frac{GWP}{Yield} \text{ (kg CO}_2\text{-eq/ton of soybean)} \quad \text{(Eq. 1)}$$

$$GWP = \Delta[(CO_2 \times 1) + (CH_4 \times 28) + (N_2O \times 298)] + CO_2\ inputs \quad \text{(Eq. 2)}$$

Where: Δ = CO_2-eq balance in the production system.

The reduction of the IGHGE in soybeans eligible for the LCS mark will be calculated based on one or more references (baseline), which will have a high impact on the magnitude of the changes in the IGHGE (Figure 1). Thus, the definition of reference conditions will be part of the concept-brand development process, with extensive discussion among specialists.

Due to the edaphoclimatic heterogeneity and diversity of soybean production systems in Brazil, it is necessary to regionalize the reference conditions by using the classifications of soybean macro-regions, which is the basis for cultivation value and cultivar indication tests (Kaster; Farias, 2012). In this context, the results of the project “Prospecting for demands and essential strategic planning for technology transfer and communication for soybean production in Brazil - PROSPECSOY” (Hirakuri et al., 2019; 2020) will assist in the characterization of reference conditions.

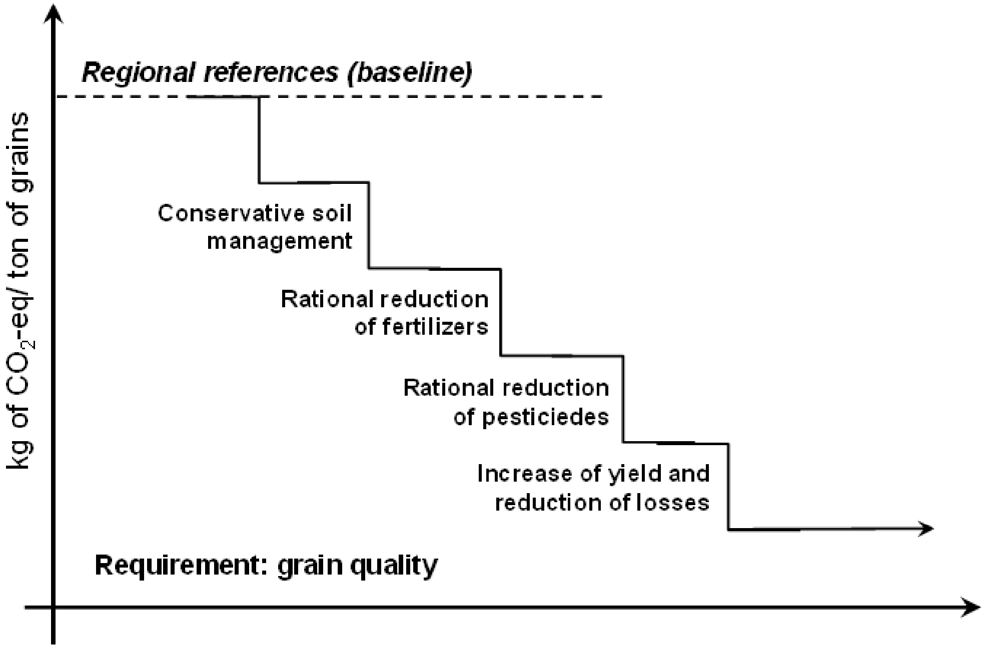

Figure 1. Model for reducing the intensity of GHG emissions due to adoption of sustainable practices in the soybean production system.

How will criteria for certification be defined?

For greater robustness and international acceptance, the principles, guidelines, criteria, agricultural practices, and indicators for the elaboration of a protocol to be followed for certification and concession of the LCS mark will be defined participatively, following international standards, in particular the ISEAL Code of Good Practice for Setting Social and Environmental Standards - Standard Setting Code (ISEAL, 2014). The discussion of protocols for attribution of trademarks is one of the bases to reach the principles of credibility in this Program (relevance, rigor, engagement, and transparency). That is why the methodological construction of the LCS concept must involve the survey, analysis, and compilation of scientific data in the literature, with the subsequent discussion and validation, through Workshops and meetings, under the mediation of a qualified professional and specialized consultancy in certification protocols.

What is the differential of the LCS label?

Although there are several marks and certification methodologies for sustainable soybean, as summarized in TNC (2012), the LCS is an innovative and differentiated concept brand compared with other initiatives for integrating the following characteristics:

- Focus on the soybean production system rather than the farm.
- Focus on the balance of GHG emissions.
- Possibility of not only guaranteeing the reduction of emissions but also quantifying them based on scientific criteria.
- Based on the concept of the intensity of emissions per ton of grains, valuating the soybeans more efficiently produced per unit of emitted CO_2-eq.
- Use of science-based criteria, guidelines, indicators, and public protocols internationally recognized.
- Voluntary and third-party certification, using an MRV-type (measurable, reportable, and verifiable) control system.

What is the team's experience and know-how?

The team's previous experience with similar concept brands (Alves et al., 2019) and more than 40 years of Embrapa Soja research on agricultural practices that mitigate GHG emissions support the proposal. The team relies on the experience of researchers responsible for the development of the brands Carbon Neutral Brazilian Beef (CNBeef) "Carne Carbono Neutro - CCN" (Alves et al., 2015) and Low Carbon Brazilian Beef (LCBB) "Carne Baixo Carbono - CBC" (Almeida; Alves, 2020), providing greater agility and assertiveness to the construction of the LCS Program. In turn, the long history of research focused on agricultural practices and technologies that combine higher yields and lower environmental impacts, based on several long-term experiments, enabled the consolidation of a robust database and knowledge representing the backbone of the creation and implementation of the LCS brand. Many of these results are published in recognized national and international scientific journals. The main covered topics are on soil management and crop rotation systems (Franchini et al., 2007; Barreto et al., 2009; Babujia et al., 2010; Franchini et al., 2012; Zotarelli et al., 2012; Briedis et al., 2018; Balbinot et al. 2020), biological nitrogen fixation (Hungria et al., 2013; Sá et al., 2017; Santos et al., 2019), co-inoculation with *Azospirillum* (Hungria et al., 2016), integrated pest management (Corrêa-Ferreira et al., 2000; Bueno et al., 2011; Bortolotto et al., 2015; Conte et al., 2020), and integrated disease management (Godoy et al., 2015; Seixas et al., 2020). It is also worth mentioning the participation of team members in the “Fluxus” project, supported by Embrapa, which assessed the GHG emissions and carbon sequestration in the soil in different regions and grain production systems across the country.

What are the steps for the consolidation of the LCS Program?

The construction of the LCS Program will involve the establishment of technical-scientific premises and protocols to create the process of third-party certification and the establishment of public and private partners supporting the initiative. The technical steps will involve:

- Literature review and database organization: survey, compilation, organization, and analysis of published research results directly related to mitigation of GHG emissions, especially publications in reputable and peer-reviewed journals. Data collected in literature, and obtained from experiments conducted by Embrapa Soja, will be compiled, organized, pooled, and analysed to meet the requirements for the development of the brand.

- Definition of the concept brand and scope: a technical note is already published (Nepomuceno et al., 2021), as well as the logo (“mark”) and its visual identity manual.

- Registration of the brand in the National Institute of Industrial Property (INPI): documentation already filed in the agency.

- Definition and publication of the LCS technical guidelines: will be formulated with the participation of experts in different fields and based on current scientific knowledge (compiled in step 1 and validated in step 5) and consultants. These guidelines will be periodically updated to follow the scientific and technological advances, market changes, and business models, as suggest the good practices for the development of standards (ISEAL, 2014).

- Validation of technical guidelines: this step will include simulations using methods applied to different scenarios that characterize the Brazilian soybean macro-regions, using the information and data previously compiled. They will also apply to distinct soybean production systems in long-term experiments conducted by Embrapa Soja and partners. This step will support the development of technical guidelines as well as certification protocols. In a second step, validations will be made in the field, applying the methods to commercial soybean crops in different Brazilian regions, in technological reference units conducted by Embrapa Soja.

- Preparation of the certification protocol: the collaborative construction of the certification protocol will take place in technical workshops among specialists. It will involve the preparation of two documents: the descriptive memorandum and the checklist and its annexes. The descriptive memorandum will be public and electronically available. The checklist (for the eligible soybeans) will be built in partnership with each certifier and will be restricted. Then, the protocol will be submitted to the Ministry of Agriculture, Livestock and Food Supply - MAPA (or appropriate entity) for registration. Like the technical guidelines, the descriptive memorandum, checklists, and annexes will be periodically updated to adapt to changes in future scenarios, as recommended by ISEAL (2014).

- LCS Program Communication: the Program will rely on an extensive communication agenda involving diverse national and international audiences, using mass communication strategies and targeted actions, content for media and digital platforms, in addition to national and international technical events and exclusive communication pieces, such as videos, banners, folders, apps, among other materials and media.

- Market: by creating opportunities for soybean growers to measure and valuate practices that reduce GHG emissions, the LCS concept brand opens up opportunities for different business models to distinguish and add value to soybean obtained under integrated sustainable practices and technologies that can potentially reduce global warming per ton of grain produced.

Version in Portuguese

The mark to be used, in the Portuguese version, will be as shown in Figure 2.

Figure 2. Version of the brand in Portuguese.

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