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Low Carbon Brazilian Beef Protocol

Roberto Giolo de Almeida ⁽¹⁾; Rodrigo da Costa Gomes ⁽¹⁾; Manuel Claudio Motta Macedo ⁽¹⁾; Ademir Fontana ⁽¹⁾; Davi José Bungenstab ⁽¹⁾; Marília Ieda da Silveira Folegatti ⁽²⁾; Alexandre Berndt ⁽³⁾

⁽¹⁾ Embrapa Beef Cattle, Campo Grande, MS; ⁽²⁾ Embrapa Environment, Jaguariúna, SP; ⁽³⁾ Embrapa Southeast Livestock, São Carlos, SP.

Introduction

Carne Baixo Carbono® (CBC) trademark, whose equivalent in English is the “Low Carbon Brazilian Beef – LCBB”, is owned by the Brazilian Agricultural Research Corporation (Embrapa) and was registered with the National Institute of Industrial Property (INPI) in 2021. This brand is associated to a production protocol that involves good agricultural and meatpacking industry practices, in addition to traceability. It was developed following the CBC guidelines published in 2020 (Almeida; Alves, 2020).

The LCBB Protocol, which is voluntary, aims to promote beef from farming systems capable of mitigating greenhouse gas (GHG) emissions generated by the cattle during its production period. This mitigation is possible through more efficient agricultural practices, such as reduced slaughter age and increased soil carbon stocks. To this end, a set of criteria was selected for use in a certification process, through third-party audits following the Measurement, Reporting, and Verification (MRV) principle.

These criteria are within the scope of low-carbon cattle farming, to monitor pasture recovery, pasture intensification, intensive finishing and integrated crop-livestock (ICL) systems, as conceived by the Brazilian Sectoral Plan for Adaptation to Climate Change and Low Carbon Emissions in Agriculture (ABC+ Plan) of the Brazilian Ministry of Agriculture, Livestock and Food Supply (MAPA).

The CBC Protocol also follows the United Nations (UN) Sustainable Development Goals (SDGs):



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Zero Hunger and Sustainable Agriculture (SDG 2), Responsible Consumption and Production (SDG 12), and Climate Action (SDG 13). It is also aligned with the international “4 per 1000” initiative (soils for food security and climate).

Scope of the LCBB Protocol

The CBC Protocol consists of three documents: a Descriptive Memorial, an Operational Manual, and a Checklist. These criteria must be met both on the farm and at the meatpacking plant, all of which are monitored by a third-party certification body.

The criteria to be followed on farms are described in the Checklist, organized into five modules: compliance, soil, pasture, animals, and intensive finishing. There are 67 criteria in total, 20 of which are mandatory for implementing the Protocol (Grossi et al., 2023). The criteria to be adopted in slaughterhouses are described in 21 articles in Chapter XI of the Descriptive Memorial.

The criteria or indicators were selected based on the CBC guidelines, their relevance and possibility of use by the farmer and meatpacking industry, as well as for their identification and verification in the monitoring process by the certifier.

The CBC Protocol was developed with a view to continuous improvement, aiming to meet the criteria over time, in an increasing sequence of priorities and difficulty levels. This aims to improve productivity (land-saving effect) with a lower environmental impact and, if possible, even stabilize soil carbon content and stocks. Furthermore, the possibility of reviewing and incorporating criteria every two years is foreseen, as scientific progress and national and international legal and market demands happen.

Implementation of the LCBB Protocol

Initially, farmers must access the Agritrace Animal Traceability platform website of the Brazilian Confederation of Agriculture and Livestock (CNA) (Agritrace, 2025), which contains certification programs that involve voluntary animal traceability protocols, abiding to MAPA Decree No. 7.623/2011. On this platform, farmers have access to the CBC Protocol documents and must register to join the certification program and choose their preferred certifying body and meatpacking plant, in agreement with the licensed partner company, Marfrig Global Foods. It is recommended that farmers seek the advice of a professional on agricultural sciences, to help develop a plan for implementing the protocol at the farm, for subsequent verification by the certifying body.

In the Compliance module (17 criteria), documents are required that prove that there are no pending legal environmental issues, in addition to the inclusion of the farm in the Rural Environmental Registry (CAR), as well as documents that prove that there are no pending social and labor issues in public lists of the Ministry of Labor and Employment of Brazil.

The areas of the farm to be used in the CBC protocol must be identified through georeferencing and characterized according to the forage species/cultivar(s) present in each area. These areas must be consolidated, meaning they must not have been deforested after July 22, 2008, in accordance with the Brazilian Forest Code. The use of fire as a management practice in these areas is also prohibited. In the event of an accidental fire, there must be a legal record of the fire and a recovery plan for the affected area to ensure continued use of the protocol. A financial and zootechnical index management system is also required for the monitoring process.

Adapting infrastructure for agricultural operations, replacing natural water sources with tanks and/or drinking troughs, as well as protecting water sources, are some of the requirements to be met during the gradual advancement of the protocol's use, following an order of priorities every two years.

The use of good agricultural practice protocols is recommended, focusing on animal welfare, including animal handling, facilities, and staff training (Boas práticas [...], 2025).

Participation in other certifications and projects linked to MAPA's ABC+ Plan are valued conditions that are rewarded when using the CBC Protocol.

In the Soil module (13 criteria), conservation practices for erosion control and the principles of the no-tillage system must be considered. To enter the CBC protocol, soil sampling (georeferenced) is required in the 0-20 and 20-40 cm depth layers for physical and chemical characterization and, primarily, to estimate the initial soil carbon content and stocks of the area to be used. It is recommended that the same characterization be performed on an area with native vegetation (not anthropized) with the same soil type as the area to be used, to record a reference stock in cases of carbon reduction due to extreme weather events.

Soil carbon monitoring occurs through sampling every two years, and the interpretation of soil analyses for carbon content and stocks is based on textural classes, with reference value ranges indicated for each Brazilian biome. With the adoption of the CBC Protocol, soil carbon levels and stocks are expected to increase to saturation levels, or at least remain within an adequate range, unless an extreme weather event occurs that could cause a justifiable decrease (Fontana et al., 2024).

Liming and use of fertilizers should be based on soil analysis and expected pasture production. In cases of integration with crops, no-tillage principles should be adopted.

Liming and nitrogen fertilizers are the main causes of GHG emissions from cattle feeding. Therefore, careful consideration must be given to determining the quantities, type of fertilizer, and timing of application to avoid losses and, thus, reduce emissions. Soil preparation with tillage, for incorporating these inputs should only be carried out at the beginning of the protocol implementation, during pasture recovery or at implementation of integrated systems, and should be avoided afterwards, as this practice also contributes to the loss of organic matter or soil carbon (Martha Júnior et al., 2007).

Soil management with additional use of bioinputs is encouraged, with examples such as: phosphorus solubilizers, nitrogen-fixing microorganisms and root growth promoters, composting and recycling of organic products are recommended, as long as they are based on research and registered with MAPA.

In the Pasture module (10 criteria), attention should be paid to the choice of grass, according to its adaptation to the local soil and climate conditions, as well as the appropriate practices for its implementation and management (Barrios et al., 2024).

However, the main requirement of this module concerns the appropriate grass management height. Management heights vary for each species/cultivar; in rotational grazing, with predetermined entry and exit heights for animals, and in continuous grazing, with minimum and maximum heights, as indicated by the company holding the cultivar registration or in accordance with scientific studies developed by research institutions and MAPA recommendations (Costa; Queiroz, 2017; Genro; Silveira, 2018).

It is necessary to monitor the recommended pasture management heights, so that soil coverage and forage availability are sufficient for the incorporation of carbon into the soil and for animal production, with minimum values of 70% and 2,000 kg/ha of dry matter, respectively, during the grass growing season (rainy season).

In the case of pasture intensification (without integration), the use of nitrogen fertilizers and supplemental cattle feeding are important management tools, as they allow for greater forage availability and increased meat productivity. In areas of lower productivity and to adjust the farm's stocking rate, pasture deferral also serves as a way to plan forage supply during the dry season.

In the case of integrated crop-livestock systems, it is possible to use new pasture from the second crop onward, with the potential for higher

productivity in the fall-winter season compared to conventional cattle farming. It is also possible to produce preserved forage for use during the dry season, with the same area being used for pasture after the crop harvest.

In the Animal module (11 criteria), the production phase covered by the CBC protocol is from 10 to 30 months of age, as the "China Steer" standard, so named as it is for export to that country. The animals must be individually identified and entered in the National Database (BND-SISBOV). Calves purchased from third parties must also have official individual identification and documentation proving they did not originate from an area where deforestation occurred after 2008. Animal health management must consider the region's livestock management calendar, based on recommendations from official health agencies and Embrapa's calendar for cattle reproduction, health, and handling management (Frias et al., 2024).

The Intensive Finishing module (16 criteria) addresses concentrate feeding for grazing cattle during the dry season as well as feedlot feeding practices. High concentrate feedlot diets, concentrate feeding for grazing cattle with inclusion rates above 0.8% of body weight as well as additives proven to reduce enteric methane emissions in both feedlots and pasture are encouraged. Improvements to facilities are necessary to ensure animal welfare and full compliance with environmental legislation. Requirements related to herd health status were included to strengthen welfare, ethics and safe food production.

To ensure the majority of cattle are fed on pasture, at least two-thirds of the slaughter weight must be obtained by grazing (Medeiros et al., 2015).

The mandatory criteria for implementing the CBC Protocol on farms contain six criteria from the Compliance (C) module, five from the Soil (S) module, one from the Pasture (P) module, four from the Animal (A) module and four from the Intensive Finishing (T) module, described below:

Criterion C1: compliance with environmental legislation;

Criterion C2: compliance with labor legislation, absence of pending issues in the public lists of the Ministry of Labor and Employment;

Criterion C3: absence of signs of mistreatment and injuries caused by inadequate handling of animals;

Criterion C6: zootechnical performance management system that includes at least the individual identification and age of entry and exit of animals in the CBC Protocol;

Criterion C11: georeferencing of the CBC area(s);

Criterion C13: safe water supply system that guarantees adequate supply and quality for animals;

Criterion S1: absence of management techniques that expose the soil to rain and wind erosion, use of fire, etc.;

Criterion S2: absence of signs of erosion due to inadequate soil and pasture management;

Criterion S3: presence of terraces to contain floodwaters when the slope demands it;

Criterion S9: initial soil sampling, repeated every two years;

Criterion S10: soil density at the start of use of the protocol;

Criterion P5: adjustment of the stocking rate according to the availability of forage in the pasture area(s);

Criteria A1, A2 and A3: referring to pasture supplementation strategies;

Criterion A4: carcass weight produced in intensive finishing (feedlot) of up to 1/3 of the total slaughter weight;

Criterion T8: health status (less than 8% of animals with nasal discharge, coughing and difficulty breathing, ocular discharge, diarrhea, tympanism and laminitis);

Criterion T9: mortality rate in intensive finishing less than 1%;

Criterion T15: compliance with environmental legislation regarding the disposal of feedlot waste;

Criterion T16: compliance with environmental legislation regarding confinement operations.

Regarding the criteria for slaughterhouses, 21 articles are listed in the Descriptive Memorial, focused on animal welfare and good practices during the process of loading, transporting, unloading, sorting and slaughtering animals, and processing carcasses and meat.

Emissions Estimation and LCBB Certification

To calculate the system's carbon emissions reduction potential, the use of Embrapa's low-carbon calculators is also mandatory. The estimated result must be lower than the baseline, which corresponds to the average emission intensity of Brazilian or regional beef cattle farming. These calculations are based on the Life Cycle Assessment (LCA) methodology, which considers GHG emissions from the extraction of natural resources,

through all transformation and transportation processes, to the production and use of agricultural and livestock inputs in animal production and industrial inputs in the meatpacking phase, and finally to the production of beef. Land Use Change (LUC) emissions will be estimated using two approaches: site-specific estimation of soil carbon stocks and the BRLUC model (BRLUC 2.1).

Considering only enteric methane emissions, which account for 60 to 70% of total emissions, estimates indicate that the LCBB Protocol leads to a reduction between 10% and 35% in emission intensity. Furthermore, through good pasture management, the LCBB contributes to annual soil carbon accumulation rates between 200 to 400 kg/ha, which corresponds to offsetting enteric methane emissions equivalent to 0.5 to 1.0 head/ha.

The certification process establishes annual third-party audits, with audit certificates issued every two years. The first audit, the entry audit, requires the 20 criteria listed above, and new criteria must be progressively implemented cumulatively until all criteria are met in the fourth audit, in the sixth year of the Protocol's implementation.

General Considerations

By adopting best practices and monitoring indicators, both on the farm and at the slaughterhouse, it is possible to produce beef more efficiently and with a lower environmental impact. This includes lower GHG emissions compared to the average for Brazilian or regional beef cattle farming, and greater soil carbon sequestration (until saturation). This is a continuous improvement strategy, aiming to provide a quality product with greater added value to the consumer. In a broader context, this also aims to improve the credibility and competitiveness of the Brazilian beef industry.

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Embrapa Gado de Corte
Av. Rádio Maia, 830, Campo Grande-MS - 79106-550
www.embrapa.br/gado-de-corte
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