



# II WORLD CONGRESS ON INTEGRATED CROP-LIVESTOCK-FORESTRY SYSTEMS

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## CARBON MARKET POTENTIAL IN CROP-LIVESTOCK-FOREST INTEGRATION SYSTEMS

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### ABSTRACT

The crop-livestock-forest integration is an opportunity to deal with today's challenges. With an increasingly globalized and dynamic world, thinking about innovative environmental solutions requires a systemic approach that manages complexities in a sustainable, responsible and ethical manner. ILPF has enormous potential for grouping a set of agricultural and ecological processes that work synergistically for sustainability. One of the greatest potentials for the ILPF is the conversion of degraded pastures, which allows an increase in production, productivity and income to the producer without the need to open new areas of native vegetation. All of this, in line with an unprecedented environmental preservation, re-signifies the very concept of sustainability that can make Brazil become the first agro-environmental power on the planet.

**Key words:** Carbon market; crop-livestock-forest integration; agricultural sustainability

### INTRODUCTION

Brazil is an agricultural power. Leader in the world production of oranges, grains, cattle, chicken, corn, and pigs that might contribute to the world food security. This Brazilian agricultural power has been developing in the last forty years, where Brazil enhances agricultural production by 390% while increasing the area by only 25 million hectares reaching a yield of 200 %, as shown in Figure 1.

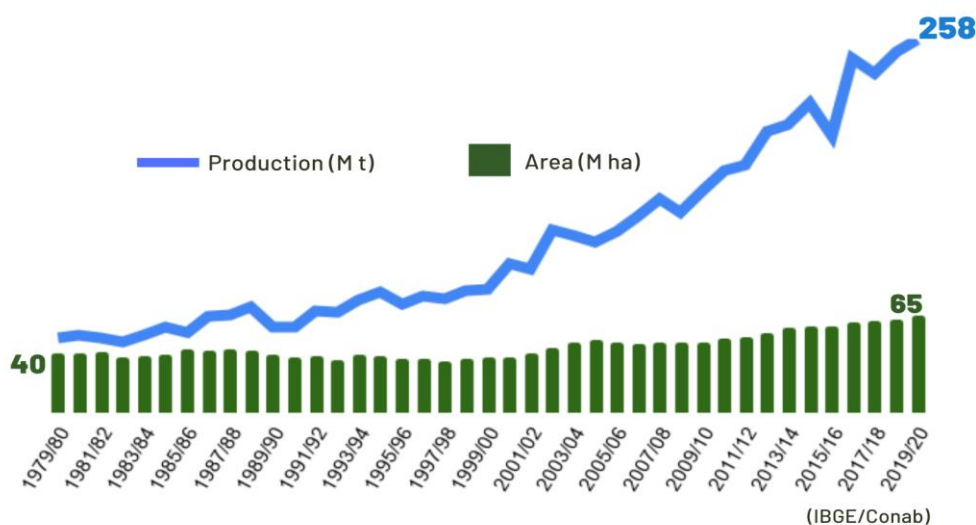
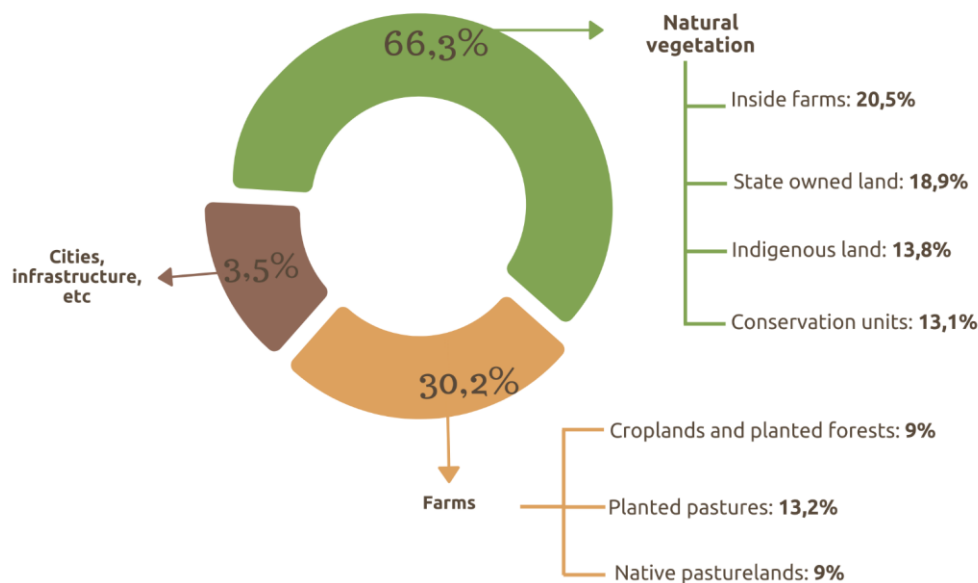


Figure 1. Brazilian agriculture forty years of evolution.

There are many ways to develop expressive agricultural numbers, however, Brazil developed agriculture based on science, entrepreneurship, private sector cooperation, public policies, and rural

credit. This results in competitive agriculture while preserving nature, nowadays Brazil holds 66 % of its territory (Figure 2) with various natural vegetation uses, which comprises: conservation units, state-owned land, indigenous land, and preserved vegetation inside private farms, that is, many farmers should produce while keeping protected areas. Even so, Brazil can improve a lot, there are huge opportunities. Brazil has today 180 million hectares of pastures, which encompasses the territory of the UK, Germany, France, Spain, and Portugal together, and at least 50% of this area are degraded (Figure 3). That is, Brazil has an area equivalent to Norway and Sweden to improve moving towards global food security, sustainable development, and a comprehensive and integrated view on the use of resources. To accomplish that we need to understand that a complex world needs integrated solutions because to deal with globalization, population growth, natural resource depletion, climate change, and degraded soil vs productive land requires a systemic approach that manages these complexities in a sustainable, responsible and ethical manner.



SOURCE: EMBRAPA, 2017

Figure 2. Brazil percentage of main land uses.

### *Integrated Crop-Livestock-Forestry as a Systemic Solution*

The Crop-Livestock-Forest Integration (ICLF) is a set of technological and management solutions that integrates different components of agricultural, livestock and forest production in the same area, in a consortium, rotated or in succession, in which a component promotes effects on others and vice versa. ICLF was designed to recover degraded pastures and to prevent deforestation. Not only, ICLF is one of the main technologies adopted in the Low Carbon Emission in Agriculture Plan (ABC Plan) and contributes to the preservation and improvement of the physical, chemical and biological properties of the soil.

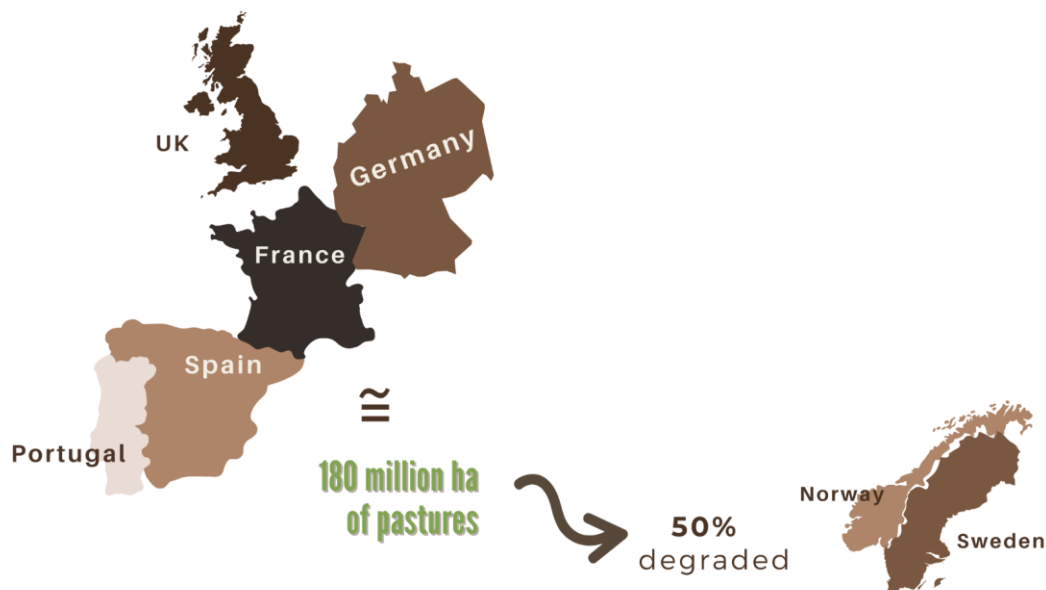


Figure 3. Pasture area in Brazil and its comparative size.

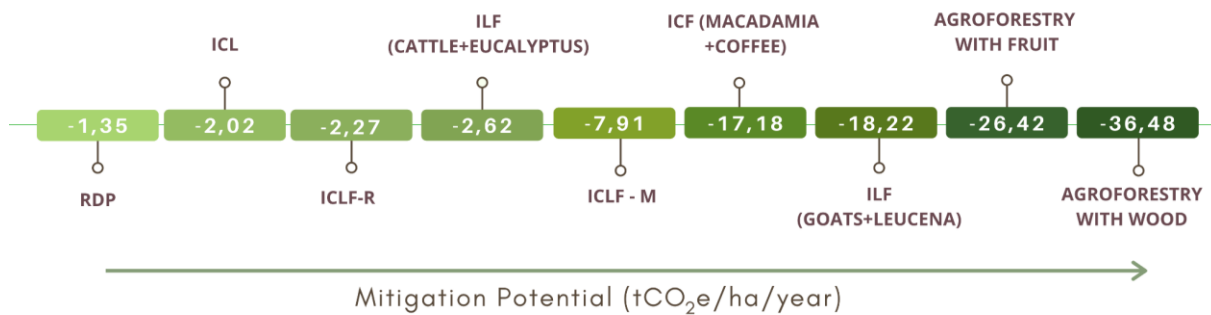
Thus, this technology provides an increase in productivity and income from activities agriculture, as well as the reduction in the deforestation of new forest areas and the reduction of greenhouse gas emissions, due to the great potential to sequester carbon due to accumulations of forage, forest and organic matter in the soil.

The ICLF is an environmentally promising technology in the set of possible sustainable intensification strategies for Brazil, with the potential to recover vast areas of degraded pastures, while mitigating GHG emissions (CORTNER et al., 2019). Thus, promoting a better use of areas, avoiding the deforestation of native vegetation for agricultural production (FERRANTE; FEARNESIDE, 2019; RAJÃO et al., 2020; SANAULLAH et al., 2020). Besides that, the ICLF is also related to the promotion of zero hunger and sustainable agriculture and action against climate change, which are part of the United Nations' 17 Sustainable Development Goals (SDGs), thus being a collaboration mechanism with global actions to end with poverty, protect the environment and the climate, and guarantee peace and prosperity for society.

By avoiding the pressure to open new areas for agricultural expansion, it allows a reduction of more than 80% of the area needed to produce the same amount of meat and reduces GHG emissions by 44% compared to degraded pasture (CASTELÕES, 2015). It can also provide a greater tendency to protect against fire, due to crop rotation and pasture consumption by animals (BALBINO et al., 2012).

When compared to the other technologies of the ABC Plan, the ICLF is the most promising. With a mitigation potential of 5 Mg CO<sub>2</sub>e ha<sup>-1</sup>, ICLF surpasses the No-Till System, which has a mitigation potential of 2.25 Mg CO<sub>2</sub>e ha<sup>-1</sup>, and biological nitrogen fixation, with 1.8 Mg CO<sub>2</sub>e ha<sup>-1</sup> (REIS et al., 2016). This is because the ICLF system promotes an increase in carbon in the soil, thus acting as a carbon sink and reducing CO<sub>2</sub> emissions into the atmosphere (CARVALHO et al., 2010).

The main advantage of the system for mitigating GHG emissions is the inclusion of the tree component. Studies show that in the ICLF system a single tree accumulates an average of 30.2 kg of C. year<sup>-1</sup>, which is equivalent to the sequestration of 110.5 kg of CO<sub>2</sub>.year<sup>-1</sup> from the atmosphere for each tree inserted in the system, considering that all tree components (leaves, branches, bark, stem, excluding only the roots) storing carbon (DE SOUZA et al., 2019). Recent data surveys and modeling show great mitigation potential for different combinations and technologies of ICLF systems (Figure 4).



Source: Rodrigues et al. in prep.

Figure 4. CO<sub>2</sub> balance among different ICLF systems and degraded pasture recovery.

### *Integrated Crop-Livestock-Forestry as a Regional Development Approach*

The Government of Brazil instituted a new National Policy for Regional Development (PNDR), through Federal Decree no. 9.810 of May 30, 2019, with the purpose of reducing economic and social inequalities. To do so, creating opportunities for economic development, income opportunity and improving the quality of the population will be the challenge for governmental and non-governmental actions. In view of this reality and what the decree proposes, it is necessary to develop productive processes in a sustainable manner, especially in regions with strong specialization in production of agricultural or mineral commodities. The PNDR guidelines recognize the regional capacities, specificities and local leadership in the formulation of strategies for development, bringing regional development from local actions. The ICLF ahead this reality is suitable for deployments for different ways of strengthening the systems existing local productive resources and according to agricultural skills.

The technology stands out for the production of several products, such as grains, meat, milk, fiber, wood and energy, among others. ICLF shows itself as an alternative for production in the same area (in consortium, rotation or succession), however, through this development from local actions, it is challenging to get the producer to carry out various activities in the same area. However, this diversification becomes important, as it will promote the increase in regional production through the greater rotation of products in local commerce, increasing the income not only of the producer, but the local economy, promoting the dynamization of various sectors of the regional economy.

Currently there are properties of different sizes and abilities using conventional systems, requiring regional studies on the feasibility of combining from different species to different local realities, identifying the difficulties of commercialization of agricultural, livestock and forest products and / or great distances between consumer regions and processing agro-industries, hampering the success of the system.

It is necessary to expand and adapt public policy mechanisms so that farmers are able to overcome economic and operational barriers, the need for technological knowledge, investment in the training of technicians and in the training of higher education professionals and vocational schools in this area.

It is important to offer producers suitable alternatives that can increase the sustainability of production systems and for that, economic and productive viability is fundamental. The increase in regional productivity can be achieved by integrating properties, through the sale or exchange of products, whether agricultural, livestock or forestry. This can be a suitable integration model for small size properties and medium, which lack economies of scale and labor-related advantages. Thus, ICLF technology is an important path for development mainly by combining environmental, economic and productive sustainability.

Therefore, it should be encouraged that the regions define priorities for this technology, according to its territory, as a way of promoting the implementation aimed at the main regional challenges. This is of fundamental importance to provide the construction of regional projects, allow the promotion of credit and seek the capture of other resources, promote technical assistance and rural extension, foster monitoring, among other aspects that provide regional development.

### *How we Want to Be in 2030*

The area of ICLF has been increasing throughout the years, by 2030 we want to reach 50% more productive systems developed including 3 million hectares of certified and monitoring ICLF systems. And a total of 30 million hectares with ICLF and productive pastures that are going to double the Brazilian production of grains, meat, and milk, because we believe that it is possible to produce and preserve.

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