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CHALLENGES FOR THE FUTURE OF THE CROP-LIVESTOCK-FOREST INTEGRATION IN BRAZIL

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ABSTRACT

The sustainable intensification of production systems will play a prominent role in the future agenda of public research and development institutions. Brazil has made substantial progress over the past few years in the use of sustainable technologies and systems integration. In the last 30 years, the country has developed a sustainable production model that integrates agricultural, livestock, and forestry production in the same area. The Integrated Crops-Livestock-Forestry (ICLF), already occupies approximately 17 million hectares throughout the national territory and has been expanding. Research data show that it is possible to produce, sustainably and competitively, grains, pasture, wood, and meat in the same area. Thus, the ABC Plan and its second phase, the ABC + Plan, aims to continue strengthening strategic actions in sustainable technological solutions for production in the field and improving the income of rural producers, with a focus on facing agriculture and livestock changes of the climate, mainly in the implantation of ILPF.

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

INTRODUCTION

Estimates indicate that in 2050 agricultural production will need to grow globally by 70%, whereas in developing countries this growth will need to be approximately 100%, all of this to feed a growing population that some estimates indicate to be in the order of 2 billion people. In addition to increasing agricultural production, humanity has to face and develop innovative solutions to problems such as scarcity of agricultural land, soil erosion, water and soil conservation, climate change, carbon sequestration, among others.

With these challenges that humanity will have to face in the coming years, the Brazilian Agricultural Research Corporation (Embrapa), a world reference in agricultural research and technology, has been acting since 1973 to provide solutions for the sustainable development of agriculture, through generation, adaptation, and transfer of knowledge and technologies.

Embrapa leads a national agricultural research network that, cooperatively, researches in the different geographical areas (Figure 1) and fields of scientific knowledge. In addition to the forty-three Decentralized Research Units, the network consists of 17 State Research Organizations Agriculture (Oepas), universities and research institutes federal or state level, private companies, and foundations in a broader scientific-technological cooperation field.



Figure 1. Geographical areas of the forty-three Decentralized Research Units

Technologies developed by Embrapa help transform Brazilian agriculture. Until the 1960s, Brazil imported most of the food that is consumed. Investment in science, the network of institutions, the implementation of public policies, and the entrepreneurship of Brazilian farmers boosted the use of technology and the adoption of good practices in the field, with a huge impact on consumption options, in reducing costs with food and exports. All this history have three main landmarks: the no-till planting in 70's decades, following by the first and second harvests in the '90s, and the crop-livestock-forestry integrations nowadays, that put the country as a reference in science and technology for agriculture and as one of the largest food producers in the world, capable of exporting to around 200 countries.

However, Brazilian agriculture still faces many problems, such as deforestation to open new areas for agricultural production, negative image of agricultural activity inside and outside Brazil, high greenhouse gas emissions in the sector, and difficulties in international negotiations. related to the sector. As a result, at the 15th United Nations Conference on Climate Change, in 2009, Brazil committed to reducing greenhouse gas emissions by 36.1% to 38.9% by 2020, avoiding emissions on the equivalent of 1 billion tons of CO₂. Thus, the ABC Plan (Low Carbon Emission Agriculture - or Sectoral Plan for Mitigation and Adaptation to Climate Change for the Consolidation of a Low Carbon Economy in Agriculture) was launched in 2012, after 2 years of work with several specialists for its structuring.

With the ABC Plan, the country pledged to work to reduce the deforestation rate by 80% in the Amazon and by 40% in the Cerrado, to increase energy efficiency, with the use of biofuels, hydroelectric plants, and alternative sources of biomass. Also, the program established goals for the adoption of technological strategies in agriculture, such as the recovery of degraded pastures, crop-livestock-forest integration, no-till, biological nitrogen fixation (FBN), and waste treatment; and consequently, targets for reducing greenhouse gas mitigation for each of these technologies (Table 1).

Table 1. Technological Process, relative national commitment (increase in the area of adoption or use) and mitigation potential by reducing GHG emissions (millions of Mg CO₂e).

Technological Process Commitment	Appointment (increase in area / use)	Mitigation Potential (millions of Mg CO ₂ e)
Recovery of Degraded Pastures	15.0 million ha	83 to 104
Crop-Livestock-Forest Integration	4.0 million ha	18 to 22
No-Tillage System	8.0 million ha	16 to 20
Biological Nitrogen Fixation	5.5 million ha	10
Planted Forests	3.0 million ha	-
Animal Waste Treatment	4.4 million m ³	6.9

After 10 years of its execution, the ABC Plan has brought many positive results. As for the recovery of degraded pastures, more than 4 million hectares were recovered with the official credit of the ABC Plan, plus another 7 million hectares were recovered from different sources of financing or even resources from producers, reaching approximately 11 million hectares of recovered pastures, which approached the target set at the beginning of the 15 million hectares project.

Concerning the ICLF, 6.0 million hectares were implemented by the ABC program, exceeding the established goal by 2.0 million hectares, the evolution of the technology implementation in Brazil can be seen in figure 2. The no-till system, which aimed to reach 8.0 million hectares, exceeded the target and reached approximately 13.0 million hectares. Concerning biological nitrogen fixation, 10.0 million hectares were implemented with the technology, exceeding the target of 5.5 million hectares. Also, 3.0 million forests were planted. Finally, about the treatment of waste, the program reached 40.0 million m³ of treated animal waste, against the target of 4.4 million. The summarized results are shown in Figure 3.

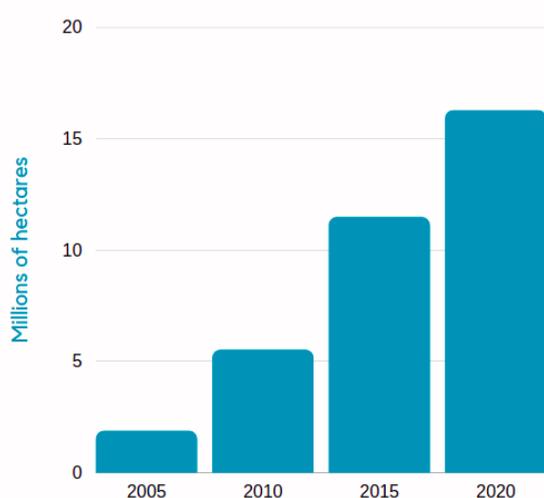


Figure 2. Growth of ICLF in Brazil.



Figure 3. Results achieved by the ABC Plan, after 10 years of execution.

Despite the positive results in almost all goals, greater investment is needed in training technicians, extension workers, project developers, and rural credit operators to work and take the technology to the farmers, technical assistance and information is essential on the practices and benefits of the ABC Plan programs, as well as informing farmers the most efficient way to use the financing available in their establishment.

The Plan ABC+ is the second phase of the Sectoral Plan for Adaptation and Low Carbon Emission in Agriculture, with targets until 2030, was launched by the Federal Government on April 2021 and stands for advancing sustainable technological solutions for production in the field and improving the income of rural producers, with a focus on tackling agriculture and climate change the ABC+ restructures the concepts and strategies of the ABC Plan. For the government, the plan maintains its commitment to sustainability in the production of food, fibers, and energy, promoting resilience and increasing the productivity and income of agricultural production systems, while also allowing the reduction of greenhouse gas emissions. In the areas of agricultural use, ABC+ aims to promote the recovery and conservation of the quality of soil, water, and biodiversity, valuing local specificities and regional cultures, expanding the set of initiatives of the ministry for the promotion of sustainable agricultural production, including strategies as adoption and maintenance of conservation practices; maintenance of integrated systems; genetic improvement and increase of biological diversity of cultivated variables; integrated risk management; climate forecasting and territorial zoning and early warning; analysis of socioeconomic, and environmental performance and technical assistance.

Considering all these aspects, Brazil must face the biggest challenges for increasing the area of CLF in Brazil, which encompasses the rural credit to ensure implementation capability by producers, technical assistance to guarantee that the best technologies are going to be used and spread, a flow marketplace and research & development. However, regarding research and development, other challenges need to be overcome, with include:

- Recover and incorporate degraded pasture areas in different biomes by adopting regionally typified ICLF systems;
- Establish the specificity of management in each Brazilian biome regarding the tree component and its interactions with pasture and crops in ILPF systems to strengthen the implementation of the forest component;
- Strengthening research in ICLF areas related to animal thermal comfort, carbon sequestration, nutrient cycling, and soil, and water conservation;
- Strengthen research to expand options for tree species and pastures validated in Brazilian biomes for use in ICLF;
- Enable simultaneous sowing of crops and pastures in ICLF;

- Add value to ICLF systems by measuring ecosystem services offered.

To overcome these challenges, some strategies must be taken, such as: strengthening international cooperation; strengthening educational and research institutions, investing in robust databases, ensuring more public and private investments, and structuring new partnerships, and strengthening already established partnerships, such as the public-private partnership Rede ILPF.

With the possible world food crisis, Brazil gains prominence and importance as a great producer and supplier of food for humanity. However, it must overcome many challenges to produce sustainably, respecting the environment and the human being. Thus, one of the most viable innovations is the integration-crop-livestock-forest (ICLF), which combines the different agricultural, livestock, and forest production systems, which can be done in intercropping, in succession or rotation, mutually benefiting the activities. ICLF is one of the main technologies adopted in the ABC Plan (Low Carbon Emission in Agriculture Plan), of the Federal Government, for mitigating greenhouse gas emissions in agriculture and for sustainable development, having been considered one of the most important technologies promising to achieve the goals of the ABC Plan established by the country.