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Forest Bioeconomy as an Engine for Sustainable Development, Water Resources Management and Mitigation of the Effects of Climate Change

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Abstract

Brazil presents a great opportunity for the development of the bioeconomy, based on the management of natural forests, especially public forests, as well as the integration of the forestry component into agricultural systems, especially in private areas. Related to the management of natural forests, the importance of expanding the use of biodiversity products, especially non-timber, in a sustainable manner and with technological innovation, is highlighted. Currently, just 10 products accounts for more than 90% of non-timber forest production from native forests. A potential that is still underutilized, especially if we consider the Amazon biome. With regards to the integration of the forestry component into agricultural systems, the various forms of production developed around the world stand out, which are important alternatives for water conservation, sustainable development and mitigation of the effects of climate change. In Brazil, the Forest Law differentiates areas occupied by family farmers or traditional peoples and communities, encouraging the practice of agroforestry systems in Legal Reserve areas, as longer as they do not deviate from the existing vegetation cover and do not harm the environment. Therefore, agroforestry systems are presented as an alternative for their potential for income generation, water conservation, among other environmental services. In this sense, several practices are discussed around the world, such as: “domestic forest”, “forest gardens”, “climate smart agriculture” and “integrated landscape management. In general, it is observed that Brazil presents a great opportunity for the development of the bioeconomy, from the management of natural forests and the integration of the forest component to agricultural systems. Finally, these development opportunities for the Forest Bioeconomy stand out as paths for Sustainable Development, Water Resources Management and the Mitigation of the Effects of Climate Change.

Keywords: Adaptive and integrated management, Sustainable forest management, Economic Development, Climate change, Agriculture.

Introduction, scope and main objectives

Brazil presents a great opportunity for the development of the bioeconomy, based on the management of natural forests. Brazil is a country with 58% of the territory occupied by forests. According to data from the National Forestry Information System (SNIF), in 2019, Brazil had an area covered by forests estimated at 498 million hectares, 488 million by natural forests and about 10 million by planted forests (BRAZIL, 2019).

This amount has the potential to offer ecosystem services, timber and non-timber forest products, and thus contribute to food security and income generation for the communities living in these areas, as well as for the water conservation and mitigating the effects of climate change.

Brazil is home to a large part of the planet's biodiversity, presenting more than 20% of the total number of species worldwide, as the main nation among the 17 megadiverse countries. This scenario includes non-timber

forest production of natural forests commercialized in Brazil, which generates about US$ 300 million/year. Currently, just 10 products accounts for more than 90% of non-timber forest production from native forests. A potential that is still underutilized, especially if we consider the Amazon biome. On the other hand, the country needs to restore around 12 million hectares and this recovery can be done by combining agricultural and forestry systems.

In this paper we will discuss the use of forests based on their sustainable management, as well as in an integrated way with agricultural systems. The objective is to support proposals that can be implemented in Brazil.

Methodology

In order to survey the integration practices between agricultural and forestry systems in the world, a review of the literature produced relating these topics was carried out.

Study Area

Brazil has six biomes, Amazon (49.3%); Cerrado (23.9%); Atlantic Forest (13.0%); Caatinga (9.9%); Pampa (2.1%) and Pantanal (1.8%) (BRAZIL, 2019), distributed over the six regions composed of states are usually basis for political planning (Figure 1) and official statistics.

Figure 1: Map of Brazilian Biomes and distribution of Brazilian regions.
Source: Instituto Brasileiro de Geografia e Estatística (IBGE, 2020).

In Brazil, the forest production of natural forests comes from public and private forest lands. The National Register of Public Forests (CNFP) comprises all federal states, and municipal public forested lands. It includes areas designated to Indigenous Peoples, conservation units, and other public forests located in urban or rural areas. The distribution per biome of federal and state public forests included in the National Register of Public Forests - CNFP, in 2018, can be shown in Table 1.

Table 1: Federal and State Public Forests in Brazil

Biome	**Area (million ha)**	**Public Forests total area %**
Amazon	284,98	92,2
Caatinga	1,62	0,5
Cerrado	17,35	5,6
Atlantic Forest	4,03	1,3
Pampa	0,15	0
Pantanal	1,06	0,3
Total	**309,2**	**100**

Source: SNIF (Sistema Nacional de Informações Florestais) (2020).

Public forests account for 309.2 million hectares and are almost entirely present in the Amazon biome. Of the total public forest areas, about 50% are for community use and have great social and economic relevance since they generate wood and non-wood forest products. With regards to non-timber forest production, it has been increasingly evidenced, not only by community use, but also by its commercial value.

In Brazil, according to IBGE data, seven non-timber forest products stand out for their economic importance and which corresponds to more than 90% of the total production value, namely: açaí fruit, yerba mate, carnauba powder, Brazil nut, babassu almond, Araucaria seed, pequi fruit, Palm Heart, carnauba wax and umbu fruit. This production comes from public and private forests.

With regards to private forests, the areas of Legal Reserve stand out, which, according to the new Forest Code (Law 12.651/2012) are those areas located within rural properties, where natural vegetation must be maintained. These areas, mostly forests, have the function of promoting the conservation of biodiversity and can be used through sustainable forest management to produce goods and services. National data point to the existence of approximately 120 million hectares of Legal Reserves registered in approximately 6 million rural properties (BRASIL, 2019).

In addition, according to the new Forest Code (Law 12.651/2012) areas that need to be recovered, in some cases, can be recovered by integrating agricultural systems into forestry component.

Results

Rodrigues et al. (2009) highlight the importance of biodiversity conservation in the remnants of private properties that can present themselves as holders of biodiversity, if they are adequately protected and recovered, with actions, among others, for the management and enrichment of species.

Law 12.651 of May 25, 2012 differentiates the areas occupied by family farmers or traditional peoples and communities, allowing them to practice agroforestry in areas of Legal Reserve, as longer as it does not de-characterize the existing vegetation cover and does not harm the environmental function of the area. In this sense, agroforestry systems are presented as an alternative for their potential to generate income and promote various environmental services (Miccolis et al., 2016).

According to the World Agroforestry Center (ICRAF), agroforestry systems (SAFs) are systems based on dynamics, ecology and management of natural resources that, through the integration of trees on the property and the agricultural landscape, diversify and sustain production with greater social, economic and environmental benefits for all those who use the soil at different scales (Miccolis et al., 2016).

There are no fixed models for the establishment of agroforestry systems, however, there are guidelines for building adaptable solutions combining technical and empirical knowledge (Miccolis et al., 2017). Farmers often have extensive knowledge of propagation methods and suitability for specific light and soil conditions for a variety of crop and tree species that contribute to restoration projects (Vieira et al., 2009).

In this context, a strategy envisaged for the conservation of biomes is the expansion of areas covered with native species of economic value in territories occupied by family farmers or by traditional peoples and communities, through the implantation or enrichment of agroforestry systems. Thus, encouraging the agroextractive practice, it is expected to bring economic benefits to producers and ecologists in a broader way for all biomes.

According to Vieira et al. (2009) agroforestry systems can be used as a transition phase in forest restoration helping to connect farmers with restoration practice. The planting of annual crops combined with tree species contributes to the survival and growth of both types of species.

In this context, a series of concepts have been discussed and have been subsidizing practices around the world, such as: "domestic forest", "forest gardens", "climate smart agriculture" and "integrated landscape management". The term "domestic forest" highlights the close relationship that the domestication process establishes between a specific human group and its forest areas - which are managed to meet the diverse needs of that group. In these areas, various forest management practices and cultivation of forest species are developed in an integrated manner with agriculture - thus creating spaces with particularly characteristics.

Michon et al. (2007) analyzed several studies carried out by authors from Southeast Asia and Africa and found that the integration between forest management and agriculture was the reason for the development of "domestic forest". These spaces provide means of subsistence, as well as being related to the culture and socio-political relations of managers. In this way, it integrates production and conservation with social, political and spiritual dimensions.

This concept is similar to the concept of “forest gardens”, which are complex agroforestry systems, with different strata, characterized by high diversity, including perennials at all levels, from tall trees to short trees, shrubs, herbs, soil covers, tubers and creepers. Björklund et al. (2018) studied 12 experiences in Sweden and concluded that these spaces provide fresh products for consumption throughout the year, as well as becoming beautiful environments for interaction and learning. Similar practices are reported in the Cerrado of Minas Gerais, like the productive yards established in the lots of the American Agroextrivist Settlement, as described in the work by Carvalho and Bergamasco (2016).

The concept of “climate smart agriculture” brings another approach that has recently achieved great prominence, due to the challenges of adapting and mitigating climate change. According to Scherr et al. (2012), “climate smart agriculture” emerged bringing the message that agricultural systems can be developed and implemented to simultaneously: guarantee food security and rural livelihoods; facilitate adaptation to climate change; and provide mitigation benefits from these changes. The development of this concept was conducted by international institutions, particularly the United Nations Food and Agriculture Organization (FAO) and the World Bank. The Consultative Group on International Agricultural Research (CGIAR) led this discussion and the concept has now been incorporated into projects financed by the World Bank.

Climate smart agriculture has three objectives: to increase productivity to improve food security and rural development; decrease greenhouse gas emissions and increase carbon sinks; and expanding the capacity to act at various levels - from local to global (Campbell et al., 2014). In this way, FAO takes an ecosystem approach, working on a landscape scale and encouraging intersectoral cooperation. The World Bank, in turn, includes the concept of “integrated landscape management” (in Portuguese, integrated landscape management) as a

strategy for political action in favor of agricultural development and ecosystem conservation (Scherr et al., 2012).

Integrated landscape management approaches work deliberately to support food production, ecosystem conservation and rural livelihoods across entire landscapes. The ways of acting are already known under several terms, such as: ecoagriculture, landscape restoration, territorial development, model forests, integrated management of river basins, agroforestry systems and the ecosystemic approach to the management of agricultural systems, among many others (Scherr et al., 2012).

Considering the forms of action addressed and in view of the various concepts discussed worldwide, it is highlighted that, in addition to the importance of the agroforestry systems previously presented, it is necessary to speak about silvopastoral systems in the Cerrado biome. As defined by Porfírio-da-Silva (2004) "silvopastoral system is the intentional combination of trees, pasture and cattle in the same area at the same time and managed in an integrated manner, with the aim of increasing productivity per unit area". According to the same author, silvopastoral systems have economic and environmental benefits for producers and society. They are multifunctional systems, where there is the possibility of intensifying production through the integrated management of natural resources, avoiding their degradation, in addition to recovering their productive capacity.

The silvopastoral system exists in several countries with forest and savanna ecosystems and was formed by selective deforestation, conduction of natural regeneration and, less frequently, by plantations (Bruziguessi, 2016; Pywell, 2015; Shanley, 2005). In Brazil, the inclusion of native tree species in silvopastoral systems is still poorly studied.

Additionally, Law 12,651/2012 establishes the Program of Support and Incentive to the Preservation and Recovery of the Environment as a form of promoting ecologically sustainable development, including, among others, lines of action regarding the payment or incentive for environmental services in return , monetary or not, to activities for the conservation and improvement of ecosystems and that generate environmental services, such as, individually or cumulatively: a) the sequestration, conservation, maintenance and increase of the stock and reduction of the carbon flow; b) the conservation of natural scenic beauty; c) the conservation of biodiversity; d) the conservation of water and water services; e) climate regulation; f) cultural appreciation and traditional ecosystem knowledge; g) soil conservation and improvement; h) the maintenance of Permanent Preservation Areas, Legal Reserve and restricted use.

This last program presents as a line of action the payment or incentive to environmental services as monetary retribution to the activities of conservation and improvement of ecosystems. This scope includes the Water Producer Program, implemented by the National Water and Sanitation Agency (ANA) and partners. Figure 2 presents an overview with indication of potential intervention locations in typical properties in the southeast region of Brazil, with several actions to be performed, such as: reforestation, spring restoration, pasture improvement, riparian forest protection, degraded area recovery, etc.

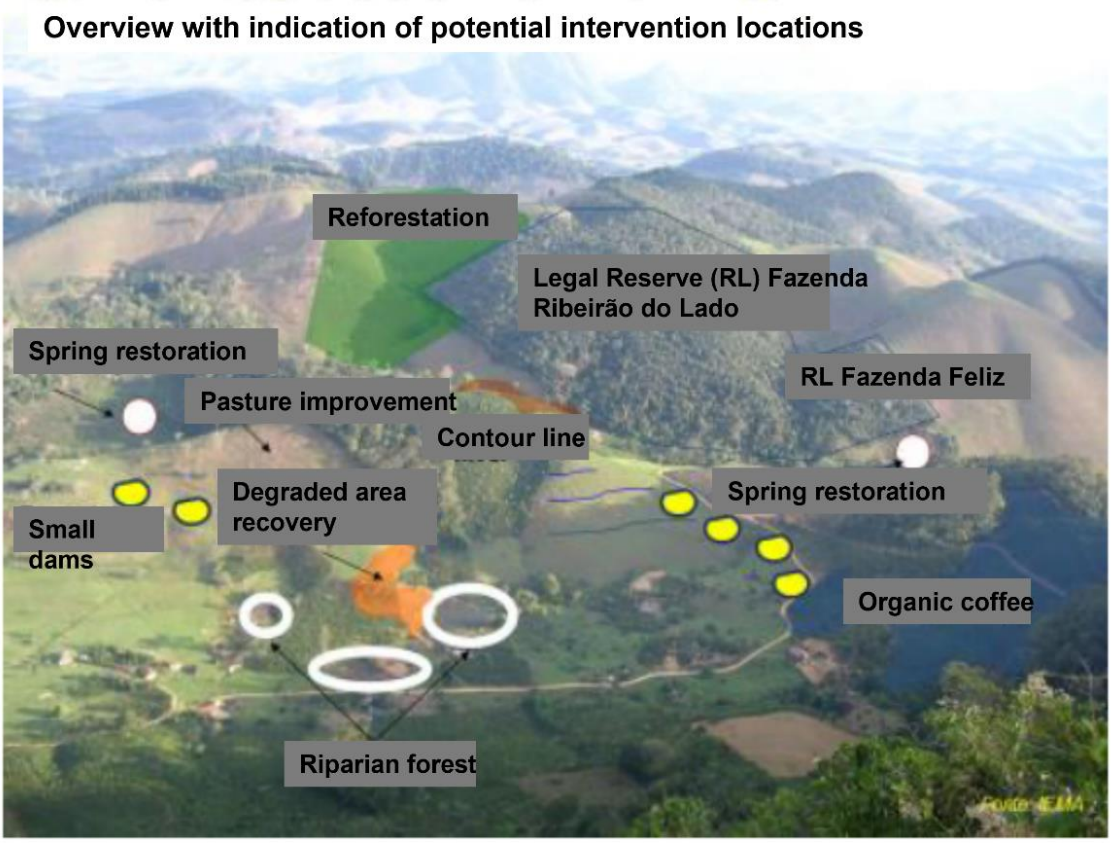

Figure 2: Informative Note – Water Producer Program (ANA, 2018).

Discussion

In general, it is observed that Brazil presents a great opportunity for the development of the bioeconomy, starting from the management of natural forests, especially public forests, as well as from the integration of the forest component to agricultural systems, especially in private areas. Regarding the integration of the forestry component into agricultural systems, several forms of production that are being developed all over the world stand out, highlighted here in this paper.

Additionally, Brazil presents a series of instruments, established by the 12,651/2012, that provide forest recovery, payment or incentive for environmental services, spring restoration, pasture improvement, riparian forest protection, degraded area recovery, among others.

Conclusions

In general, it is observed that Brazil presents a great opportunity for the development of the bioeconomy, from the management of natural forests and the integration of the forest component to agricultural systems. Finally, these development opportunities for the Forest Bioeconomy stand out as paths for Sustainable Development, Water Resources Management and the Mitigation of the Effects of Climate Change.

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