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Where is the Innovation in the Brazilian Atlantic forest restoration initiatives? A preliminary study

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Contents

Abbreviations and acronyms

AFRP - Atlantic Forest Restoration Pact

BA – Bahia State

BNDES - National Bank for Economic and Social Development

EI - Innovation Ecosystem

ES – Espírito Santo State

FLR – Forest and Landscape Restoration

GDP - Gross Domestic Product

IBÁ - Brazilian Tree Industry Association

IUCN - International Union for the Conservation of Nature

MAPA - Ministry of Agriculture, Livestock and Supply

MG – Minas Gerais State

MT – Mato Grosso State

NGO – Non Governmental Organization

PE – Pernambuco State

PR – Paraná State

RJ – Rio de Janeiro State

SC – Santa Catarina State

SMA - Secretariat for the Environment

SP – São Paulo State

WWF – World Wildlife Fund

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"*I say: the real is not at the exit or at the arrival: it is available to us, it is in the middle of the crossing*" (Guimarães Rosa)

Summary

Concern about the value of forests and natural ecosystems has increased worldwide and has fostered large-scale international forest restoration agreements, promoting connectivity between ecosystems and landscapes, including people's well-being. In order to comply with international forest restoration agreements, it is necessary to overcome barriers such as high operational cost, low operational performance in restoration activities or insufficient forest seedlings to attend the market (Brancalion et al., 2012). Innovation is believed to be an important tool in finding solutions and reducing bottlenecks in FLR (Brancalion et al., 2012; Brancalion & van Melis, 2017). The research had as main objective to understand the role of innovation in FLR initiatives through interviews, questionnaire and literature review. The interviews and the questionnaire were carried out from July to September 2020 and descriptive statistics was used to analyze and interpret the results. As a result, 66 innovations were registered, 61% being classified as product or organizational innovations. The innovations are distributed in 9 Brazilian states, being São Paulo and Paraná states responsible to 50% of the records. The main bottlenecks identified in the forest and landscape restoration initiatives refers to the high cost and low operational performance, scarcity of seeds and forest seedlings and insufficiency in economic exploration/productive arrangements. We conclude that innovation is a common factor among the restoration initiatives of the Atlantic Forest Biome, the ecosystem and innovations are related and to scaling up FLR it is important to connect stakeholders and to create strategic alliances, even if from different segments in the search for collective evolution.

Riassunto

La preoccupazione per il valore delle foreste e degli ecosistemi naturali è aumentata in tutto il mondo e ha incoraggiato accordi internazionali di ripristino delle foreste su larga scala, che accadono attraverso la connessione degli ecosistemi, però senza ignorare il benessere delle persone. Nel 2011, nella Germania è stato firmato il Bonn Challenge, documento in cui il Brasile si è impegnato a ripristinare 12 milioni di ettari di foreste entro il 2030 e, per adempiere a questo impegno, è necessario ridurre le restrizioni e le barriere che esistono nei progetti di ripristino del paesaggio forestale (Forest and Landscape Restoration - FLR). Si ritiene che l'innovazione sia uno strumento importante in questo processo, pertanto, questa ricerca ha avuto come obiettivo principale quello di capire qual è il ruolo dell'innovazione nei progetti FLR nel Bioma della Foresta Atlantica in Brasile. Pertanto sono stati raccolti dati sugli ostacoli che limitano l'ampliamento del FLR, nonché certi indicatori socioeconomici, che poi sono stati relazionati alle innovazioni identificate nell'area della Foresta Atlantica brasiliana. La raccolta dei dati sulle innovazioni è stata effettuata tra luglio e settembre 2020. Sono state realizzate interviste, condotte tramite la piattaforma Zoom® impiegando la metodologia "snowball", mentre per i questionari è stato utilizzato il Google Forms®. Per l'analisi e l'interpretazione dei dati è stata scelta la tecnica della statistica descrittiva. I gruppi di stakeholder selezionati per partecipare alla ricerca sono composti da aziende, ONG, università, accademia, governo brasiliano (rappresentato da alcune istituzioni) oltre a proprietari terrieri. In tutto sono state catalogate 66 innovazioni, distribuite tra 9 stati brasiliani, con gli stati di San Paolo e Paraná che contribuiscono al 50% dei record. Innovazioni di prodotto e organizzative hanno rappresentato il 61% delle occorrenze totali. Inoltre, tra le principali barriere all'attuazione degli interventi di ripristino dei paesaggi forestali sono state identificate: il costo elevato rispetto a prestazioni operative basse, la scarsità di input e l'insufficienza dei modelli di ripristino per scopi economici. La ricerca ha permesso di concludere che l'innovazione è presente nei progetti di ripristino delle foreste nel Bioma della Foresta Atlantica brasiliana, ed è direttamente correlata alle condizioni dell'ecosistema o al coinvolgimento e impegno degli interessati locali.

1. Introduction

According to Global Forest Watch (2020), from 2001 to 2018, global forest coverage decreased by 9%, which represents 361 million hectares of forests. This reduction has resulted in the loss of service goods, ecosystem services and areas for the occupation of traditional populations (Lamb et al., 2005).

One of the strategies in place to increase forest cover is to incentivize countries to assume commitments on conservation, sustainable management and restoration of forests through international iniciatives. For example, in 2010, during the 10th Convention on Biological Diversity (CBD)[1] a Strategic Plan for Biodiversity was created to reduce the loss of biodiversity globally, nationally and regionally. The target was to restore 15% of all degraded lands by 2020 (Wilson & Cagalanan, 2016). In 2011, another initiative was launched during an event promoted by the German Ministry of Environment and the conservation organization IUCN (International Union for the Conservation of Nature) called Bonn Challenge and aims to restore 150 million defined hectares by 2020 (Bonn Challenge, 2020). Up to present 61 countries joined the goal through 74 pledges, being that the vast majority commitments are located in Africa and America (Bonn Challenge, 2020).

The effort to restore degraded areas on a global scale has promoted a change perception on forest restoration called Forest and Landscape Restoration (FLR) (Stanturf & Madsen, 2012) that promotes the restoration of ecological processes, creating connectivity between populations of species, ecosystems and people's well-being at the same time and space.

Forest and Ladscape Restoration is not about random and disconnected restoration, but rather the restoration of ecosystems, including local people, their aspirations, expectations, land tenure patterns and available financial resources. In other words, FLR has a comprehensive ecological, economic and socio-political approach (Stanturf & Madsen, 2012).

To combine all FLR factors concomitantly, promoting the connection between ecosystems, population of species and ensuring the people's well-

[1] CBD it's a convention that came up at Rio 92 Conference, with participation of 150 countries, the core is to encourage the sustainable development and is safeguarded by COP (Conferences of the Parties) (CBD, 2020).

being is challenging and complex. There are bottlenecks in different spheres, such as, for example, cultural barriers, diffuse laws and policies, technical-operational difficulties, gaps in scientific knowledge and in the supply chain (e.g. seedlings or tree species seeds) (Melo et al., 2013). According Brancalion & van Melis (2017), innovation is a tool that can perform an important role in FLR, reducing or eliminating existing bottlenecks.

Innovation has been part of human history and has played an important role in the industrial revolution (Brancalion & van Melis, 2017). Nowadays, it is correlated mainly to the technological sector (Nord & Tucker, 1987; Baregheh et al., 2009). However, innovation can be applied in several areas and has different definitions, each with its own sector (Baregheh et al., 2009).

Generally, innovation encompasses several segments such as social, economic and technical (Brancalion & van Melis, 2017). According to the World Bank (2006), innovation is the use of different knowledge to achieve economic and social results, which occurs through an ecosystem composed of diverse stakeholders with solid interactions, different purposes (Basole & Karla, 2011) and that make innovation possible (Fransman, 2018). The innovation can be classified into different categories, the main five being: products, processes, services, marketing and organizational (OECD, 2005).

Particularly, the forestry sector has no prominence in innovation compared to other segments such as pharmaceuticals or automobiles. Despite there are innovative companies or practices within the forest chain, they are still subtle initiatives with little representation (Hansen et al., 2014). In last decades, there has been a predominance of innovation forest product (Skog et al. 1995), mainly related to the transformation of wood into different models to attend the market. At present, this transformative innovation has already established itself and triggered incremental innovations, with the creation of small improvements in existing products. Sawmill surveys in the United States of America indicate that, nowadays, most innovations are linked to processes and not products (Crespell et al., 2006; Hansen 2006). In Europe the researchs are related to the innovation research approach (Hansen et al., 2014), while in Latin America there are innovation iniciatives of process and products to reduction operational

costs in the timber market, pulp & paper market and also sustainable initiatives using natural resources (Castro & Morrot, 1996; Magazine Reviews, 2020).

In Brazil, there are examples of innovation in FLR, such as payment ecosystem services, environmental compensation and agroforestry production. However, there are still social-economic, political and scientific-technical challenges, which is compounded by the country's territorial extension and diversity between regions (Durigan et al., 2010; Melo et al., 2013).

Brazil occupies the 5th place in territorial extension in the world (IBGE, 2020) and covers six different biomes: Amazon, Cerrado, Caatinga, Atlantic Forest, Pantanal and Pampa (MMA, 2020). Among all biomes, the Atlantic Forest was the one that suffered the greatest reduction of native vegetation cover (that now represents less than 14% of the original), as it has been explored since the country's colonization and, currently, 67% of the Brazilian population occupies this region (IBGE, 2020; MMA, 2020; Rodrigues et al., 2011).

Considering the worldwide importance of the Atlantic Forest Biome (1–8% of the world's total species (Silva & Casteleti, 2007), the current challenges (e.g. reduction of original coverage, population occupation) (Ribeiro et al, 2009) and gaps that still exist in designing and implementing appropriate initiatives of ecological restoration, the use of innovation to reduce existing bottlenecks and promote restoration projects more easily is understood as an important and promising strategy.

1.1 Problem Statement and thesis objectives

FLR has occupied spaces on international agendas and will gain more attention in 2021, with the beginning of the Decade of Ecosystem Restoration (IUCN, 2020), however it is challenging to fulfill international agreements, within the established deadline, considering the current capacity of the forest restoration chain in Brazil.

Generally, restoration demand in Brazil is linked to a mandatory law (Law 12.651, of may 25 2012), which stablishes norms on the protection of

vegetation, Permanent Preservation Areas (PPA)[2] and Legal Reserve (LR)[3] areas in the Brazilian territory. These areas are intended for preservation, with rare possibilities for sustainable economic use, but many forest fragments of PPA and LR are disconnected, being then contrary to the concept of FLR which is about restoring ecological processes, connecting landscapes and species and including people's well-being at the same time and space (Chaves, et al., 2015).

Besides that, the high operational cost and difficulties on recovering native vegetation, the low operational productivity of the operation envolved, and shortages in the supply chain for the supply of seeds and seedlings are some of the existing gaps that hinder scaling up FLR (Brancalion et al., 2012). Innovation is believed to be an important tool in the search for solutions and in the reduction of existing bottlenecks in FLR, which then becomes more effective and broadly applied, mainly linked to governance and operational cost-effectiveness (Brancalion et al., 2012; Brancalion & van Melis, 2017).

Therefore, considering the previous statements, the main goal of this research is to understand the role of the innovations that occurred in the FLR in Brazil, specifically in the Atlantic Forest Biome. The specific objectives are to catalog the innovations in forest and landscape restoration initiatives, the nature, type, geographical distribution, bottlenecks that fostered the emergence of innovations, and to understand the relationship between innovations and the ecosystems in which they are inserted.

2. Background

2.1 Forest Restoration

Forest restoration is a science that had as its main objective the restoration of forests in response to ecological issues. Nowadays, the forest restoration concept has been expanded, including the human well-being,

[2] PPA: the term definition is found in Law 12.651/2012, Art. 3 and refers to the protected area, covered or not by native vegetation, with the environmental function of preserving water resources, the landscape, geological stability and biodiversity, facilitate the gene flow of fauna and flora, protect the soil and ensure the well-being of human populations. (Planalto, 2020).

[3] Legal Reserve: the term definition is found in Law 12.651/2012, Art. 3 and refers to the area located inside a property with the function of ensuring the sustainable economic use of the natural resources of the rural property, helping to conservation and rehabilitation of ecological processes and promote the conservation of biodiversity, as well as the shelter and protection of wild fauna and native flora (Planalto, 2020)

promoting connectivity and perpetuation between ecosystems (Brancalion et al., 2010).

This new concept is known as Forest and Landscape Restoration (FLR) and has been gaining ground in conservation and/or sustainability programs in response to socio-environmental issues (Mansourian et al., 2017).

The concept of “Forest Landscape Restoration” emerged in 2000 at a forest meeting in Segovia, Spain (Sabogal et. al, 2015) and had the definition of recovering environments through a planned process considering the human well-being. In 2014, the FAO (Food and Agriculture Organization of the United Nations) established the term “Forest and Landscape Restoration”, which seeks to restore ecosystems, connecting species, landscapes and considering the human well-being. Therefore, forest landscape restoration encompasses a matrix of landscape options in forestry and agriculture (Laestadius et al., 2011), and trees outside and inside forests (Sabogal et. al, 2015).

Forest and Landscape Restoration (FLR) is believed to be able to connect socio-ecological systems (society-nature interaction) with sociotechnical systems (science-society interaction), in addition to being aligned with local or global policies.

FLR as become a global issue and has been implemented in many countries such as Brazil, United States of America, Mexico, El Salvador, among others (Aronson & Alexander, 2013; Suding et al., 2015; Chaves et al., 2015).

In order to attend the conservation, sustainable management and restoration of forests commitments established in international agreements, Brazil has created initiatives connecting various stakeholders in the search to promote forest restoration in the Atlantic Forest Biome. The Atlantic Forest Restoration Pact – AFRP[4] is one of the first Brazilian restoration initiatives and it is a multisectoral movement aims to restore 15 million hectares in the Atlantic Forest Biome by the year 2050 (AFRP, 2020).

4 AFRP created in 2009, it is an initiative between different segments with the aim of promoting FLR in the Atlantic Forest Biome, through the exchange of technical and scientific knowledge, promoting a network between sectors, assisting stakeholders in initiatives to raise financial resources and adjust public policies (AFRP, 2020).

2.1.1 Barriers for the Atlantic Forest Restoration

To promote initiatives aligned with the concept of Forest and Landscape Restoration is directly related to reconciling different goals, articulating and engaging multistakeholders inserted in diverse landscapes and in dissimilar economic, social and environmental contexts. An important strategy to assist FLR initiatives is to overcome barriers or bottlenecks, for example high operating costs or insufficient forest seedlings to meet forest restoration initiatives (Chazdon et al., 2017; Strassburg et al., 2019).

A barrier is considered as an obstacle of high difficulty to overcome and, bottleneck, a difficulty, to a lesser extent, that prevents the functioning of something (Dicio, 2020). In Brazil, it is possible to identify existing barriers in the areas: socioeconomic, socio-political and technoscientific, and in most cases, they are correlated with each other. According to Da Silva et al. (2015), the reduction of barriers will occur through the elimination of bottlenecks.

The existing barriers and bottlenecks in FLR projects in Brazil can be classified as being of three types: i) socioeconomic, ii) sociopolitical and iii) techno-scientific (Benini & Adeodato 2017, Benini et al. 2016, WRI Brazil 2020, Marconato 2015, Andrade et al. 2018, WWF Brazil 2014, Antoniazzi et al. 2016, da Silva et al. 2015). They are briefly summarized in the following, based on the above cited literature.

i) Socioeconomic:

- *Financing*: the amount of financing for forest restoration is scarce, adherence processes are bureaucratic and the rate of return on projects and risks is uncertain when compared to investments in the agriculture sector, for example.

- *Economic Viability*: low rate of return and unconsolidated market in forest restoration initiatives, such as the market of non-wood forest products

- *Market*: the production of forest seedlings does not have a consolidated demand, which causes seasonality in the supply of the product, as well as compromising the collection and commercialization of forest seeds.

ii) Sociopolitical:

- *Legislation*: a) some laws create difficulties in interpretation and application, as for example SMA Resolution 32[5] of 03 April 2014 from São Paulo State, which causes divergence in the choice and approval of forest restoration techniques in degraded areas or in degraded forest remnants; b) Because the legislation is ambiguous and contradictory in different levels (national, state and/or municipal), the public bodies responsible for approving and monitoring forest restoration projects make it difficult to use innovation or implement strategies with a better cost-benefit ratio; c) land tenure problems; d) difficulties in complying with legal regulations for seedling producers and forest seed suppliers, such as carrying out seed conformity tests in authorized laboratories, according to MAPA (State Ministry of Agriculture, Livestock and Supply) Normative Instruction nº 56 of 12/08/2011 (da Silva et al, 2015).

- *Social*: a) laws or projects are drafted without considering the landowners perspective, which generates low adherence and repulsion for forest restoration; b) low knowledge among landowners about the concept of restoration.

- *Governance*: a) the current restoration strategy focuses on adapting protection areas provided in Law nº.12,651/2012, that is, forest restoration takes place for legal assistance, which is punishable if it is not complied with; b) landowners are afraid of being fined by inspection agencies for adopting the methods set out in the law, but are not traditionally used for restoration in degraded areas or degraded forest remnants; c) disjointed and ineffective governance, such as the dissipation between regional units of the same institution responsible for inspecting and monitoring forest restoration projects for legal compliance (Law nº. 12.651/12).

iii) Techno-scientific:

[5] SMA Resolution nº 32: Establishes guidelines and criteria on ecological restoration in the State of São Paulo, and provides related measures (Cetesb, 2020).

- *Research*: a) gap in the knowledge about ecological process of native tree species, b) absence or inconsistency of indicators for assessment or monitoring of areas undergoing restoration; c) investment in technology and research to promote different restoration strategies and models that are economically viable (cost of implementation, maintenance) and that can promote economic profitability to landowners (business plans and models); d) gaps in knowledge about enrichment techniques, densification and agroforestry systems.

- *Operational*: a) high operational cost in the stages of soil preparation, fertilization, planting of forest seedlings and combating weeds; b) low operational performance and low mechanization of silvicultural activities; c) gap in the technical knowledge of collection, processing, storage and treatment of seeds; d) little dissemination of the technical knowledge of forest restoration produced by companies and research institutions.

- *Professionals*: a) low technical training to evaluate projects, monitor indicators or support rural extension; b) low availability of qualified labor for the implementation and maintenance of restored areas.

According Brancalion et al. (2012) the reduction of bottlenecks and barriers are important to increase the number of FLR initiatives. For that, it is recommended to expand and make financing more flexible, to act in the supply chain making it cohesive, broaden technical and scientific knowledge about native species and technical assistance to landowners, and the clear elaboration of laws and public policies that cover all the actors involved in the restoration. forestry. To envolve and engage stakeholders is also important (Andrade et al. 2018), mainly, the landowners (Marconato, 2015). The most of them are not motivated to restore forests in function of high-priced to implant native forests and scarces opportunities for economic use of these areas (Benini & Adeodato 2017). It is hoped that, with the reduction barrier related to operational costs in forest restoration, it will be possible to expand the adhesion of landonwers to forest restoration projects and increase the number of restored areas in Brazil (WWF Brazil, 2014; Benini & Adeodato 2017, p. 64).

2.2 Innovation

Innovation has been present since the beginning of human history and has been synonymous with changes, whether through the construction of something new, improvements or adaptations of something that already exists (Brancalion & van Melis, 2017; Baregheh et al., 2009).

There are several definitions for innovation, each one related to its sector (Damanpour & Schneider, 2006; Baregheh et al., 2009). In general, it is understood that innovation is the use of knowledge to achieve results in different sectors (World Bank 2006; Brancalion & van Melis, 2017). According OECD (2005) the innovations can be classify by type, being that the 5 main and most used are:

• *Product*: creation of a new good, new service or something already existing that has undergone significant improvements compared to the initial version;

• *Process*: creation of a new process or significant improvement compared to the previous one;

• *Service*: entry of a new or significantly improved compared to the previous one;

• *Marketing*: implementation of a new marketing method with strategy changes, product, price and promotion;

• *Organizational*: creation or improvement of organizational process present within companies, between companies or between sectors.

Schumpeter (1911) considers that innovation is occasional and starts from the interaction between ideas, processes and stakeholders (Rametsteiner & Weiss, 2006). Vuarin & Rodriguez (1994) they state the opposite, that innovation is something new and do not consider as an improvement on something that already exists (Moseley, 2000).

Thompson (1985) and Wong et al (2008) accord that the innovation occurs through the application of new ideas to beneficiaries associations. Wong et al. (2008, p. 2) defines innovation as: “the effective application of processes and products new to the organization and designed to benefit it and its

stakeholders” (as cited in Baregheh et al., 2009) and Thompson (1965, p. 2) defines: "Innovation is the generation, acceptance and implementation of new ideas, products or services processes” (as cited in Baregheh et al., 2009).

Plessis (2007) and Damanpour (1996) claim that innovation promotes benefits in institutions and is a output from actions taken in the quest to solve problems (Baregheh et al., 2009).

Innovation is broad and can be applied in different situations, whether for the development of a new product, service or processes in different areas (Baregheh et al., 2009).

Van de Ven (1986) and Rogers (1995) mention that the classification of something innovative is directly linked to who classifies it (Baregheh et al., 2009; Moseley, 2000).

Generally innovation is focused on bringing new products, processes, technology, and forms of organizations into economic and social use, which affects the system’s behavior and the performance of institutions (Brancalion & van Melis, 2017; Brancalion et al., 2019). Shortly, the definition of innovation goes beyond the technological concept, also encompassing other sectors, for example socioeconomic (World Bank, 2006).

Kubeczko & Rametsteiner (2006) mentions that innovation supports economic growth, makes a country more competitive and generates more employments. Innovation has been little explored in forest restoration (Brancalion & van Melis, 2017), the opposite occurs in the Brazilian agricultural sector, which has relevant innovations in the input industry to generate products with better efficiency, innovation in agricultural machinery with the use of embedded technology or innovation in equipment for storage of grains (IPEA, 2013).

In the social sphere, the application of innovation has a long history. However, the actual concept of social innovation gained prominence in the 70s from Taylor (1970) and Gabor (1970) and broading in the last 10 years (Santos et al., 2018).

Taylor (1970) mentions that social innovation is new social manner of acting in situations, whether through processes, organizations, among others, while, Gabor (1970) defends the social innovation is an instrument to find solutions (Cloutier, 2003; Santos et al., 2018).

In general, social innovation seeks to find more just and efficient solutions to socio-environmental issues in different sectors (Majumdar et al., 2015; Sharra & Nyssens, 2011).

BEPA (2011) defines social innovation as being new ideas, concepts or models that help in solving problems and promote the creation or expansion of relationships between people and/or sectors.

Innovation Ecosystem (EI) is another term that has also emerged in recent decades and has increased relevance in areas of knowledge around the world.

Russell et al. (2011) mention that the ecosystem refers to the inter-organizational, political, economic, environmental and technological systems of innovation, in which the catalysis, support and support for business growth occurs.

Ecosystems are composed of actors who have leadership roles, according to their organizational structures and are linked to each other Basole & Karla (2011) and, through their cooperative and competitive interactions, make innovation happen and co-evolve Fransman (2018).

According to Dedehayir et al. (2016), actors within the ecosystem need to have defined roles, with coordinated internal and external interactions and flows and resources between orchestrated partners. The partnerships established must attract and bring together relevant partners who are together, forming strategic alliances even if from different segments in the search for collective evolution.

There are several definitions of which stakeholders should be involved in an innovation ecosystem (Schelemm, 2014; Aulet, 2008; Krama, 2014; Spinosa & Krama, 2010). In general, academia (universities, colleges, schools, etc.), research institutes, funding agencies, policy makers, among others, are

necessary pillars for building an innovative environment (Spinosa et al., 2015; Varrichio et al., 2012).

Krama (2014), Spinosa & Krama (2010) and Spinosa et al. (2015) state that most of the EIs are located close to large urban centers. Furthermore, political factors are primary drivers for the constitution of an IE, whether through public policies or governance (Tavares, 2017).

According to OECD (2005), the innovations can be divided in three nature, being: i) new: occurs a complete break with existing products to satisfy a given need, or even by the creation of a new need that did not exist until then or that was latent (e.g. internet or telegraph); ii) changed: it is a new product that has a series of attributes or functions that did not exist before, despite having a set of characteristics identical to that of the previous product (e.g. laser printers); iii) improved: it is characterized by the alteration or incorporation of new elements in relation to the previous one, without, however, altering the basic functions of the product (e.g. digital automotive control systems).

The innovation process, usually, follow the steps: (1) “trigger” or “problem”: factor that imposes changes in the original situation or problem identification; (2) "in progress": analysis and selection of ideas, planning and development of the pilot project and (3) “adherence”: incorporation of the idea or improvement in the routine (Verworn et al., 2000; Verwon et al., 2006). The triggers of innovation are present in different sectors, such as economics, politics, social and are often interconnected (World Bank, 2006; Brancalion & van Melis, 2017).

Generally, innovations in the forestry/environmental sector have been directed towards the production process, usually with the aim of reducing costs and/or increasing productivity (Brancalion & van Melis, 2017). In Central Europe, for example, some examples of innovation occurred in the process change (outsourcing of harvesting and wood logistics). This initiative emerged in an economic scenario unfavorable to the owner and/or company, forcing the change of the process in search of profitability and permanence of the business. Further, the size of the property (in hectares) directly influenced the emergence and implementation of innovation. According to Rametsteiner & Weiss (2006), for the central region of Europe, innovations in properties >500ha were

identified. Small properties have a family structure and, normally, the forest (e.g. timber) is not the main source of income and represents a small part of the total area. So, energy is not directed to promote innovation in this sector (Rametsteiner & Weiss, 2006).

In Latin America, innovation occurs in different sectors, such as pulp and paper and forest sustainable management. In Costa Rica, some examples of innovation are in the carbon market, the NWFP market (Non Wood Forest Products) of native species and also the forest sustainable management, through low impact planning and techniques for removing wood from local species (Segura-Bonilla, 2003). Chile and Brazil are representative in the pulp and paper sector and can be cited as examples of innovations: research and development/ genetic improvement of tree species, development of industrial equipment to attend a better performance and use of technology or big data for planted forest management (Toivanen & Lima-Toivanen, 2009).

The forestry sector in Brazil has prominence to planted florests, as a pulp and paper company or timber market and although the country has a large natural forest cover, scarcely innovations are present in native forests, having as one of the challenges to transpose silvicultural knowledge between the segments of natural forests and planted forests (Renova, 2020).

Currently, it is possible to find examples of innovation in processes (for example, operational improvement and cost reduction), organizational (for example: creation of organizations, cooperatives), service (for example: PES, NFWP), among others (Brancalion & van Melis, 2017; Brancalion et al., 2012).

There are innovation cases in forest restoration, mainly in the categories of products and processes, with a focus on reducing costs and improving operational performance, such as direct-seeding using seeds of native tree species and grass/grain seeds. The use of agricultural equipment adapted for forest restoration and the collection and commercialization of tree species seeds are examples of innovation process and organizational, respectively (Brancalion & van Melis, 2017; Brancalion et al., 2012).

According Brancalion & van Melis (2017), innovation is the key to carrying out large-scale restoration projects, being in the operational area

(example: reducing costs for implementing and maintaining the forest); creation and expansion of new markets (example: PES & NFWP); building new partnerships between communities, companies and rural landowners; public policies and governance in general.

It is believed that social innovation can contribute to the scaling up of FLR and assist in the resolution of problems in forest restoration, through the articulation between actors inserted in the ecosystem, connecting them to each other, promoting an orderly articulation, with defined roles, building new models, ideas or concepts that suit everyone involved.

2.3 Research Objectives

The main objective of this research is to identify and to understand the role of innovation in Forest and Landscape Restoration Initiatives in the Atlantic Forest Biome in Brazil, in the last 10 years (2010 to 2020).

For this, the specific objectives are:

• Identify and catalog the innovations in Forest and Landscape Restoration initiatives in the Atlantic Forest Biome from 2010 to 2020;

• Collect information about the nature, type of innovations and ascertain the existing connection with socioeconomic indicators, legal assistance, investments, geographic region and forest coverage;

• Identify which were the bottlenecks in forest restoration that encouraged the creation and implementation of innovation.

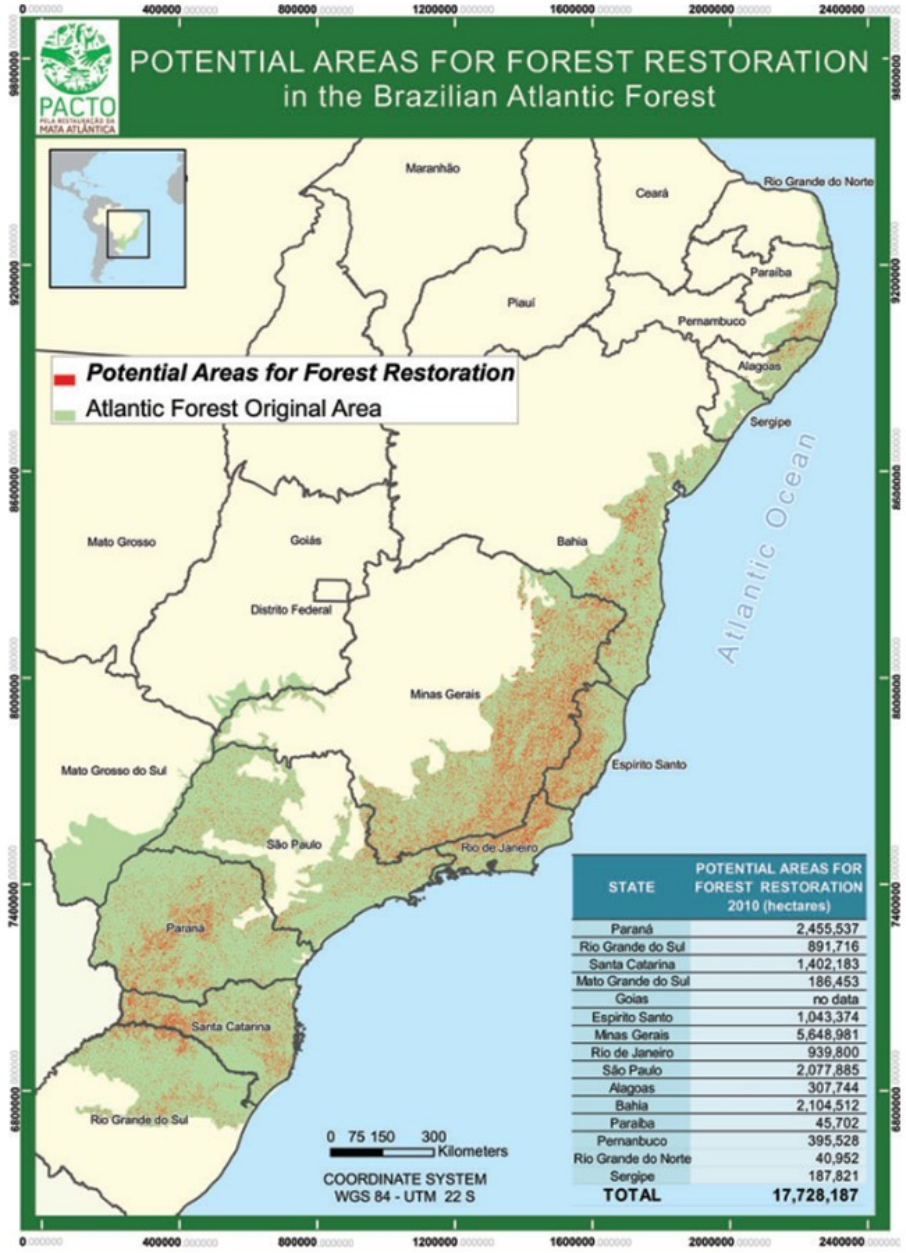
The basic assumption of my research is that “innovation is a common factor among the restoration initiatives of the Atlantic Forest Biome in Brazil and can assist in the process of forest restoration”. The thesis focuses on confirming (or not) this idea.

3. Materials and methods

3.1 Case study selection

The Atlantic Forest Biome was one of the largest tropical forests in the Americas, originally covering about 150 million ha, in highly heterogeneous environmental conditions (Ribeiro et al. 2009). It is one of the 25 biodiversity hotspots in the world (Tabarelli et al., 2005), extending along the Brazilian coast (92%) as shown in Figure 1 (Ribeiro et al. 2009). Currently, only 12% of its original cover remains, most of which are small isolated forest fragments, unprotected and/or severely altered (Fonseca, 1985; Silva & Tabarelli, 2000; Rodrigues et al., 2009; Ribeiro et al. 2009).

This biome has been degraded since colonization, over 500 years ago, through the removal of brazilwood and subsequent human occupation, replacement of forests by agriculture (Haddad et al., 2015). And, currently, it houses almost 120 million people (approximately 60% of the Brazilian population; Calmon et al., 2011; Ribeiro et al. 2009).



STATE	POTENTIAL AREAS FOR FOREST RESTORATION 2010 (hectares)
Paraná	2,455,537
Rio Grande do Sul	891,716
Santa Catarina	1,402,183
Mato Grande do Sul	186,453
Goias	no data
Espirito Santo	1,043,374
Minas Gerais	5,648,981
Rio de Janeiro	939,800
São Paulo	2,077,885
Alagoas	307,744
Bahia	2,104,512
Paraíba	45,702
Pernambuco	395,528
Rio Grande do Norte	40,952
Sergipe	187,821
TOTAL	**17,728,187**

Figure 01. Spatial distribution of Atlantic Bioma in Brazil, considering potential areas for forest restoration (search: https://www.pactomataatlantica.org.br).

The Atlantic Forest Biome is composed of several types of vegetational formations, identified at regional level, with similar geology and climate conditions, namely: Dense Ombrophilous Forest; Mixed Ombrophilous Forest; Open Ombrophilous Forest; Seasonal Semideciduous Forest; Seasonal Deciduous Forest and associated ecosystems (mangroves, sandbank vegetation, altitude fields, inland swamps and forest entrances in the Northeast) (MMA, 2020).

Currently, the largest number of forest remnants are on private properties (Rambaldi & Oliveira, 2003). So, to promote forest restoration initiatives connecting landscapes and forest remnants it is important to include landowners and to develop a solid network among stakeholders (Tabarelli et al., 2005).

3.2 Identification and classification of innovations

For this research, the innovation concept adopted was as being new or improvement products, process, technology and forms of organizations for economic and social use (Brancalion & van Melis, 2017; Brancalion et al., 2019). This innovation concept was addressed in literature review in item 2.2 - Innovation.

The social innovation concept adopted in the research was defined by BEPA (2011) as being new ideas, concepts or models that help in solving problems and promote the creation or expansion of relationships between people and/or sectors. This social innovation concept was addressed in literature review in item 2.2 - Innovation.

To classify the nature and types of innovations identified in the research, was adopted the concepts defined by OECD (2005), which are described in Table 01.

Table 1: Attributes, classifications and definitions of innovation (source: own elaboration based on OECD, 2005 and Moseley, 2000).

	Classifications	Definitions
Nature	*New*	it is characterized by a complete break with existing products to satisfy a given need, or even by the creation of a new need that did not exist until then or that was latent

	Changed	it is characterized by the fact that the new product, although having a set of characteristics identical to the one from which it was developed, presents a series of attributes to which functions previously nonexistent correspond
	Improved	it is characterized by the alteration or incorporation of new elements in relation to the previous one, without, however, changing the basic functions of the product
Types	*Product*	Introduction of a good or service that is new or significantly improved with respect to its intended characteristics or uses
	Process	Implementation of a new or significantly improved production or delivery process
	Service	Introduction of a new or significantly improved service with regard to its intended characteristics or uses
	Marketing	Implementation of a new marketing method involving significant changes in the design of the product or its packaging, positioning (placement), promotion or prices
	Organizational	Implementation of a new organizational method in the company's business practices, in the organization of work or in its external relations

In some situations it is difficult to classify the type of innovation and there are cases where the innovation is a combination of two or more types (Carvalho et al., 2011). In the research, for the innovations cases that presented one or more types, it was decided to select the type that showed the greatest prominence.

The definitions in Table 1 were used to classify the nature and type of innovations identified in the research.

The construction of the innovation database was made through the submission of questionnaires and interviews considering different stakeholders.

For the nomination of stakeholders participating in the research has used the base of members registered in the Atlantic Forest Restoration Pact - AFRP, because it is a national organizational initiative whose mission is to articulate and integrate actors involved in the restoration of the Atlantic Forest Biome (AFRP, 2020).

The AFRP member analysis was carried out through public information available on the institution's online platform and accessed in June 2020 (AFRP, 2020). Table 2 shows the categories of stakeholders that make up the AFRP, the number of representatives per category and the categories selected with their respective names adopted in the research.

Table 2: Stakeholder categories considered in the research (source: own elaboration based on AFRP, 2020).

		Research stakeholders	
AFRP members	**Nº of representatives**	**Selection**	**Research Denomination**
Associations and Collegiate	5	not select	-
Research Center	14	selected	Universities/Academy
Companies	83	selected	Companies
NGO's	112	selected	NGO's
Government	34	selected	Government
Protected Area	1	not select	-
-	0	selected	Landowners

“Associations and Collegiate” and “Protected Area” were not selected because they have low representativeness compared to the other categories.

Furthermore, the “Landowners” category was added, which does not appear on the AFRP Platform, however is understood to be an important actor, since the largest number of forest remnants are on private rural properties (Rambaldi & Oliveira, 2003).

A) Questionnaire

The questionnaire was designed to identify the occurrence of innovation, typology, stage, space distribution, among other aspects. The analysis of collected data and results were done through descriptive statistics.

The questionnaire has 22 questions (open and closed questions) and was divided into 4 subcategories, being: part 1 - Innovation Register, part 2 - Innovation, Barriers & Stakeholders, part 3 - Investments, Patents & Public Policies and part 4 - Project & Innovation.

Table 3 presents a description of what was approached in each subcategory of the questionnaire.

Table 3: Description of the questionnaire subcategories and their respective approaches (source: own elaboration).

Subcategory		Target
Part 1	Innovation Register	to catalog the innovation, the place where it occurred, how it happened, participants and segments involved.
Part 2	Innovation, Barriers & Stakeholders	to catalog the type of innovation, the existing barriers and bottlenecks, the categories involved and quantify the genres of the innovators.
Part 3	Investments, Patents & Public Policies	to collect information on investments, patents, factors that influenced innovation, innovation products and public policies.
Part 4	Project & Innovation	to collect information about the project where the innovation took place

To submit the questionnaire was used the Google Forms® platform and the questionnaire can be found in Appendix 1.

The access link to the questionnaire was disclosed through an email sent to institutions with national coverage and dissemination on social networks of forest restoration groups in Brazil (Facebook® and Instagram®), from July to September 2020. E-mails were sent to 11 institutions, 69% agreed to contribute to the questionnaire disclosure and 31% did not respond the request. The questionnaire was released on social networks every two weeks from July to September 2020, and for institutions only one email was sent requesting collaboration in July 2020 and no recall was carried out.

In all, 17 responses were obtained indicating innovations that occurred in the period from 2009 to 2020 from different regions of Brazil and only 1 innovation was identified outside the research period from 2010 to 2020, that occurred in 2009. However, this innovation was important for events and/or future developments. So, it was also decided to include in results.

In the questionnaire it was not possible to identify the stakeholders involved, that is, it was only possible to classify the innovations by geographic distribution in Brazil.

B) Interviews

For the interviews, non-probabilistic sampling ("snowball sampling") was used, because the population size is not known consequently was not be possible to determine the probability of selection for each participant in the research (Coleman, 1958; Goodman, 1961; Spreen, 1992).

Albuquerque (2009) mentions that this method uses chains of reference and is recommended in complex social networks, making it possible to integrate different profiles, different economic and social classes into the sample.

The interviews were done in 3 stages, being: Stage 1) choice of the initial interviewees ("seeds"); Stage 2) subsequent interviews as indicated by the first interviewees; Step 3) definition of the "saturation point", when the information collected presented little relevant additional information or mentioned the same examples of previous innovations. So, the end of the interviews, as the information collected is similar, not adding relevant information to the research (Faugier & Sargeant, 1997).

The stakeholder groups were selected as explained in item 3.2 Identification and classification of innovations.

Due to constraints in time, the selection of participants in Stage 1 ("seeds"), was done using a personal network of professionals and experts who are included in the stakeholder categories defined in the survey (companies, NGO's, university/academy, government, landowners).

In total 29 “seeds” were selected, 13 accepted to participate in the research, 16 did not respond or declined. Table 4 shows the total number of seeds with the distribution by stakeholder category.

In stage 1 were realized 13 interviews and 7 on stage 2. The interviews carried out in stage 2 present information similar to the stage 1, so the interviews ended in stage 2 as shown in table 4.

Table 4: Interviewees distribution by stakeholders and Stage 1 to 3 (source: own elaboration).

	Stage 1		Stage 2 & 3	
Stakeholders	**accepted**	**declined**	**accepted**	**declined**
NGO's	4	6	1	4
University/Academy	6	6	4	-
Companies	3	1	2	4
Government	0	3	0	1
Landowners	0	-	0	1

The interviews were conducted by Zoom®, with an average duration of 1 hour. In all, 20 interviews were conducted, being 12 in July, 6 in August and 2 in September 2020. The questions were open-ended with the aim of raising the most information about innovation, barriers and FLR iniciatives. The interview questionnaire is available in Appendix 4.

Each interviewer contributed, on average, 3 innovations, totaling 49 innovations recorded in 20 meetings. Of the total of 20 respondents, 17 participated in, at least, one of the innovations indicated by them.

NGO’s was represented by 5 interviews, companies by 5 interviews, universities by 10 interviews and there was no participation of “government” and “landowners”.

The collected sample presented 5 occurrences of innovations in a period different from that established in the research (from 2010 to 2020), with 2 occurrences in 2005, 1 in 2006, 1 in 2007 and 1 in 2009. In addition, 2 occurrences of innovations were cataloged, which are outside the scope of the

Atlantic Forest Biome, but are within the established data collection period. All 5 innovations were important for events and/or future developments, as they are different methods used in forest restoration, therefore, it was decided to include them in the results. For data analysis, descriptive statistics were used.

C) Creation of a catalogue of FLR initiatives

The catalogue was created through literature review (papers and gray literature) of FLR initiatives that took place from 2010 to 2020 in Brazil.

The catalog of forest restoration initiatives in the Atlantic Forest Biome was carried out through qualitative analysis of information presented in gray literature and websites considering the time horizon from 2010 to 2020. In addition, some initiatives that occurred in previous periods were selected, as they are relevant for the history of the forest restoration in Brazil. The search on websites was using as keywords “forest restoration projects”, “atlantic forest restoration projects”, “atlantic forest” and “restoration projects”.

Information was collected on restored area (hectares), year, geographical location, stakeholders participants, funding agency, investment value and issues. The list of cataloged initiatives can be found in the Appendix 3.

D) Innovation Ecosystem

The research sought to understand the drivers that constituted the ecosystems where the cataloged innovations occurred and their correlations, with the exception of the State of Mato Grosso, for being outside the Atlantic Forest Biome.

According to literature (Spinosa et al., 2015; Varrichio et al., 2012) there are necessary pilars for building an innovative environment and in general are composed by academy (universities, colleges, schools, etc.), research institutes, development agencies, policy makers, among others. Therefore, for the research it was determined as drivers that compose an innovative ecosystem: number of forest restoration research centers representing academia, investments or financing in research representing development

agency, environmental legislation representing policy makers, GDP and agricultural use representing economic factors, forest cover representing environmental factors and forest nurseries representing stakeholder in the restoration chain forestry.

For forest restoration research centers data were collected from websites and gray literature (SNIF, 2020). For investments or financing, forest nurseries and legislation was used gray literature (MCTIC, 2019; IPEA, 2015, Planalto, 2020, respectively). GDP, forest cover and land use were collected on websites (IBGE, 2020; Mapbiomas, 2020, respectively).

The number of forest nurseries was collected from a publication carried out in 2015 (IPEA, 2015) and the number of research institutions focused on forest restoration collected through the website and gray literature in the year 2020. For legislation, the number of laws decrees and state and municipal resolutions was considered from 2005 to 2020. In relation to investments was used as a metric the variation (in percentage %) of the weighted average between the national financial resource and the state financial resource allocated to research, considering the time horizon and data published in the period from 2010 to 2017. In order to understand the population's influence on the innovation ecosystem was considered as a driver the representativeness of the state GDP in relation to the national GPD (in percentage %). Finally, the influence of land use was considered by analyzing as drivers the agricultural land use (area percentage area occupied by agriculture and pasture in relation to the total area of the state considered data from 2019) denominated “farming” and forest coverage (the percentage variation of 2019 coverage in relation to year 2005) in the states where the innovations occurred.

5. Results & Discussion

Altogether, 17 responses were obtained from the questionnaire from July to September 2020 and 20 interviews were conducted between July and September 2020, being 13 on stage 1 and 7 on stage 2. As previously mentioned, the data collected in stage 2 was similar to that of stage 1, so the interviews in stage 2 ended (Table 4). The interviews distribution by stakeholder and by stage is described in table 4.

Interviews and questionnaires presented innovations in a period different from that determined in the survey (from 2010 to 2020). The table 5 presents the distribution of innovations collected in interviews and questionnaires distributed by year.

From total registered innovations, 6 were identified in a period less than 2010, 5 of which came from interviews and 1 from a questionnaire. Such innovations were important for events and/or future developments, as these are different methods used in forest restoration. Then, the innovations that took place from 2005 to 2009 were included in the results. All innovations identified in the survey are described in Appendix 2.

Table 5: Innovations identified in interviews and questionnaires distributed by year from 2005 to 2020 (source: own elaboration).

Year	Interviews	Questionnaire	Total
2005	2	-	2
2006	1	-	1
2007	1	-	1
2009	1	1	2
2010	5	-	5
2011	2	2	4
2012	-	1	1
2013	5	-	5
2014	3	1	4
2015	8	2	10
2016	4	1	5
2017	4	3	7
2018	3	4	7
2019	4	2	6
2020	6	-	6
Grand Total	**49**	**17**	**66**

As shown in table 5, the survey identified 66 innovations (Appendix 2), 49 of which came from interviews and 17 from questionnaires (Appendix 1), from 2005 to 2020.

In all 49 innovations identified in interviews, 37 emerged within FLR, 12 did not arise within projects, but were created to fill gaps in the forest restoration chain. The vast majority refers to the creation of networks to connect different

stakeholders (e.g. Atlantic Forest Restoration Pact - AFRP) and initiatives for diagnosis and management of areas to be restored (e.g. Rural Environmental Registry - CAR[6]).

The results from questionnaire, specifically, question nº 15 demonstrate that 10 innovations arose within restoration projects and 7 participants reported that the innovations did not arise within forest restoration projects, but were created to fill gaps in the catering chain (e.g. Cambuci Gastronomic Route[7]).

The questions nº 16 from questionnaire ("Was the innovation replicated in any forest restoration project?" - Appendix 1) and the question nº 12 from interview ("Has it been replicated in any Project?" - Appendix 4) demonstrated that 19 innovations were replicated in forest restoration projects, 14 were not replicated in projects and 33 it was not possible to obtain information.

From total registered innovations, 40 were indicated by participants in the innovations (61% of the total), 9 informed about the innovation, but did not participate (14% of the total) and, for the others, it was not possible to identify.

The interview question nº 7 ("Does innovation have a patent? If yes, what is the stage?" – Appendix 4) and the multiple choice question nº 10 from questionnaire ("What is the status of the innovation in relation to the patent?" – Appendix 1) aims to get the presence or absence of innovation patents. In total of 49 innovations identified from interviews, 6 have a patent and 43 do not have a patent. In the questionnaire it was possible to identify that 16 innovations do not have a patent and 1 participant does not have knowledge about the issue.

5.1 Distribution of Innovations by Brazil Region

The innovations were cataloged in 8 Brazilian states of a 17 in total where the Atlantic Forest Biome is distributed, and 1 innovation was identified in a state outside the biome studied.

6 CAR: It is a nationwide online platform, with the objective of integrating environmental information from rural properties (CAR, 2020).
7 Cambuci Gastronomic Route is an initiative between landowners and municipalities with the aim of promoting and encouraging the cultivation and traditions around fruits present in the Atlantic Forest (Instituto Aua, 2020),

From the total occurrences, 26 were identified only in the Southeast Region, 15 only in the South Region, 3 only in the Northeast Region, 2 only in the Midwest Region, 2 covered the Southeast and South Regions, 3 covered the Northeast and Southeast Regions and 15 records do not have a defined location, as they are network creations between sectors, online platforms or software, therefore these were defined as “National”.

Figure 02 presents the distribution of innovations by region and by year, considering the period from 2005 to 2020:

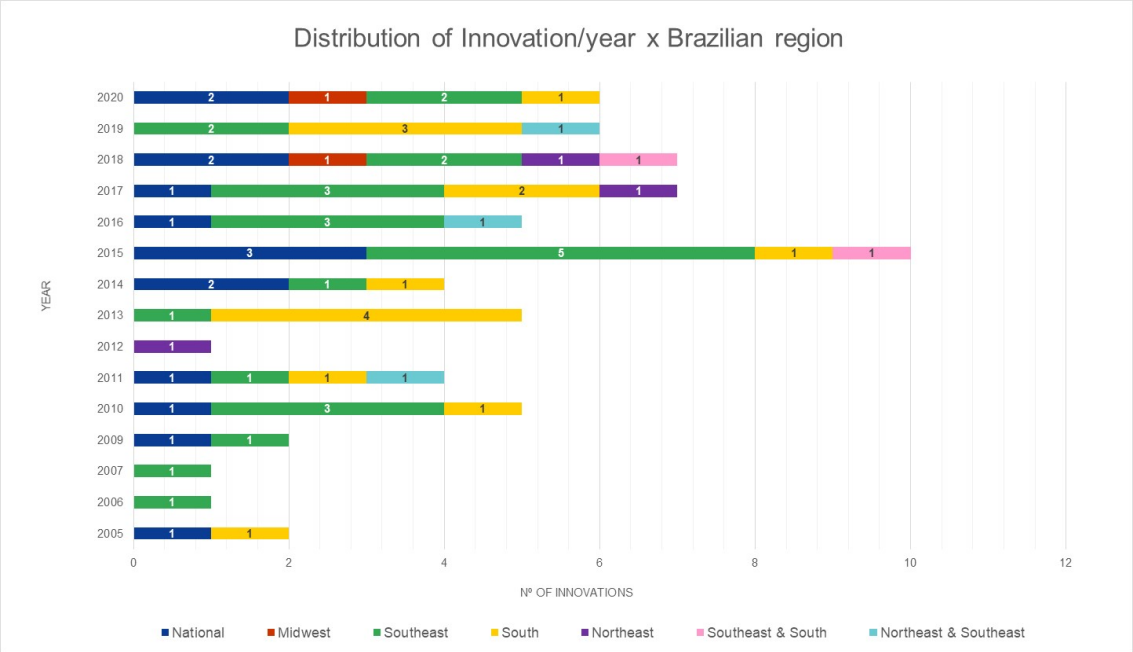


Figure 02. Distribution of innovations cataloged by Region of Brazil in the period from 2005 to 2020.

Among the years 2013 to 2015, the Southeast Region experienced a severe water crisis that began in the State of São Paulo in 2013 and extended to the other states of the Southeast region throughout 2014 and 2015 (Marengo & Alves, 2016).

From the 5 innovations identified in 2015 in the Southeast Region, 2 are related to the water issue (Reflorestar Project and PCJ Springs Policy) and, of the 5 forest restoration projects cataloged in 2015 (Appendix 3), 4 occurred in the Southeast Region with a focus on restoration of riparian zones.

International forest restoration commitments may have contributed to the increase in the number of innovations, for example Bonn Challenge, launched

in 2011. In 2015, in the Southeast and South Region, innovation related to meeting international agreements was identified (“ROAM” - Appendix 2).

In the Southeast Region, all states had records of innovation, the most representative being the São Paulo State (SP). In the South Region, only the States of Paraná (PR) and Santa Catarina (SC) presented records, with Paraná (PR) being the leader in the number of occurrences. In the Northeast Region, innovation records were cataloged only in the States of Bahia (BA) and Pernambuco (PE), with Bahia (BA) being the most representative. The Midwest Region contributed only with records from the State of Mato Grosso (MT).

Figure 03 shows the geographic location of the states that presented records of innovations.

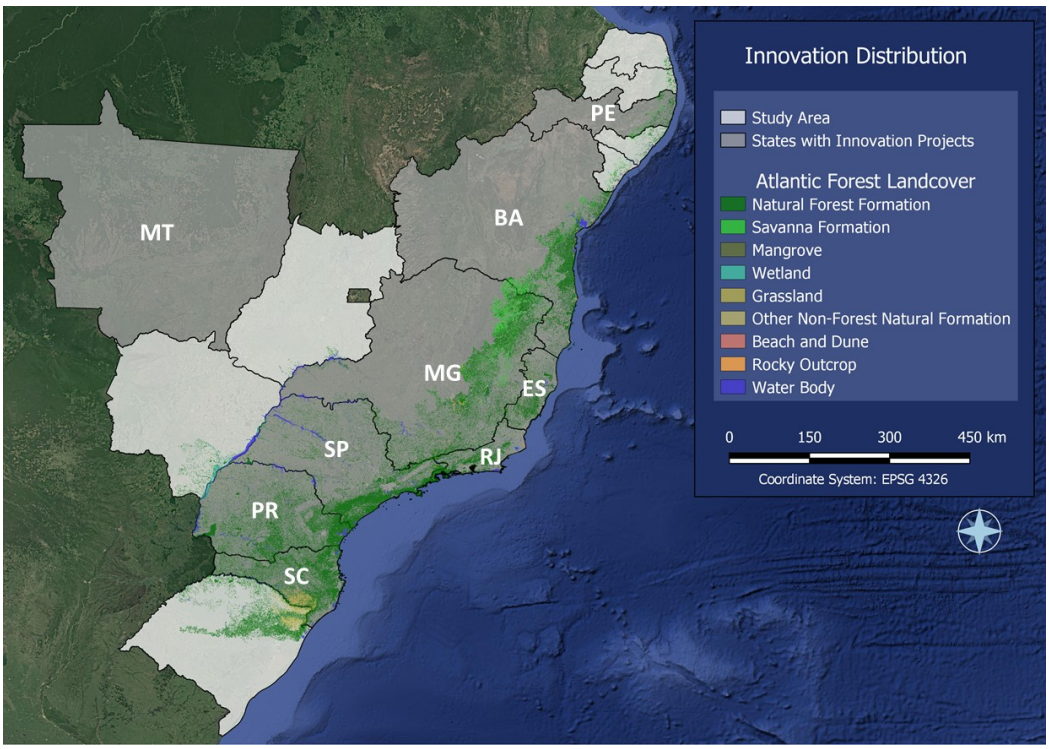


Figure 03. Geographic location of the Brazilian states that presented innovation records in the period from 2005 to 2020 (source: own elaboration).

5.2 Nature & Type of Innovations

Regarding the nature of the innovations, 9 were classified as “changed” and 57 as “improved”, that is, they refer to the creation of something new with similar characteristics to the previous one or the incorporation of new elements without changing the basic functions of the products, respectively (OECD, 2005;

Moseley, 2000). The types of innovations were segregated into: product, process, service, marketing or organizational (OECD, 2005), as shown in the figure below:

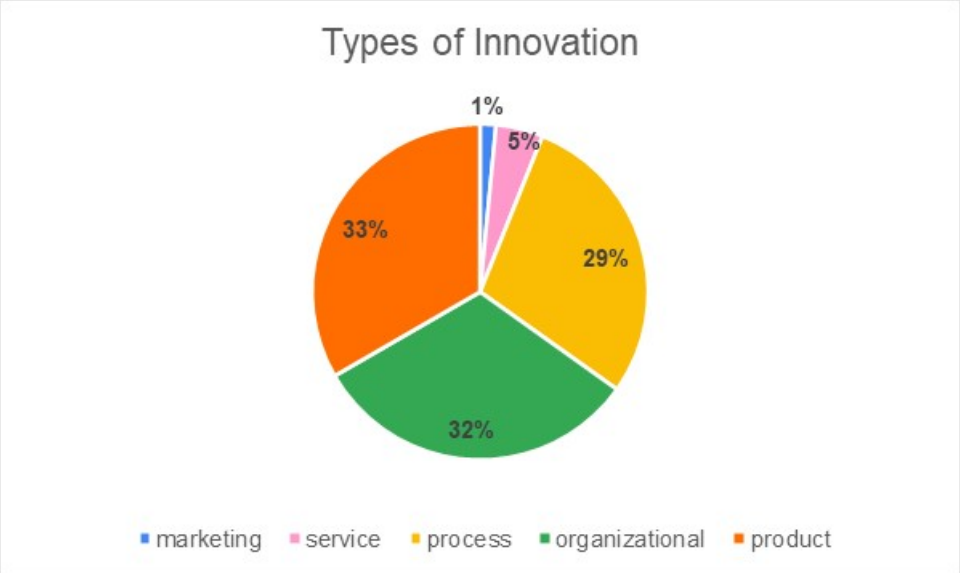


Figure 04. Distribution of innovation categories cataloged through interviews and questionnaires from 2005 to 2020.

The product category was the most representative, with 33% (22 records) followed by organizational innovation with 32% (21 records), process innovation with 29% (19 records), service innovation with 5% (3 records) and innovation of marketing with 1% (1 record).

From the 66 records cataloged, 11 are related to technology, such as creating online platforms, creating software, applications or equipment. Among the 11 records, 9 were classified as product, 1 as process and 1 as organizational.

From the 12 innovations were classified as organizational, 8 are related to initiatives to create a network between different stakeholders (e.g. Atlantic Forest Restoration Pact - AFRP).

Figure 05 shows the distribution of the innovation categories by stakeholders participating in the interviews, as well as the distribution of the same categories for the questionnaire. Interview data was segregated from companies, NGOs and universities. In the questionnaires, however, as it was

not possible to identify the participating sector, an analysis was carried out with all the data collected and was called “Stakeholders not identified”.

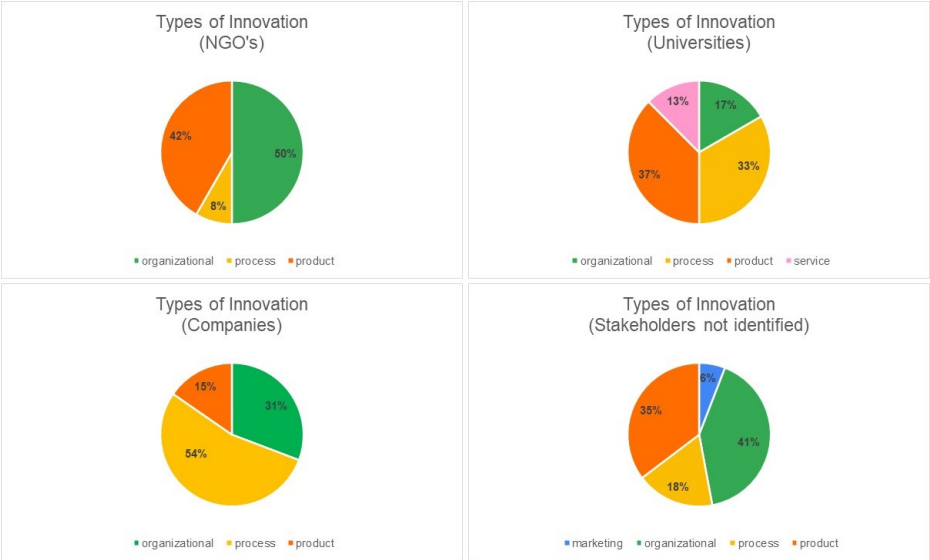


Figure 05. Distribution of innovation categories by sectors participating in the research in the period from 2005 to 2020

The interviewed representatives of companies indicated a greater number of records with a typology of process (54%), NGO’s representatives indicated a higher percentage of innovations with organizational typology (50%), with a main focus on the creation of networks between sectors.

The interviewed representatives of universities indicated a higher percentage of innovations with product typology (37%), followed by process (33%). The innovations classified as a process are related to new models of forest restoration for economic or social inclusion purposes, such as the use of non-invasive exotic species intercropped with native species in order to promote forest restoration and provide profits timber in the future. Product innovations emerged through a university research project and were patented.

From the innovations cataloged through the questionnaire, the main category was the organizational category (41%), followed by product (35%), process (18%) and marketing (6%).

5.3 Barriers

The interview question nº 5 (“What are the challenges (barriers) that drove innovation” – Appendix 4) and the multiple choice question nº 7 from questionnaire (“What problem(s) motivated the search for innovation?” – Appendix 1) aims to identify the barriers or bottlenecks that drove the innovations emergence.

The figure 6 represents the result collected in the interviews and questionnaires regarding barriers or bottlenecks.

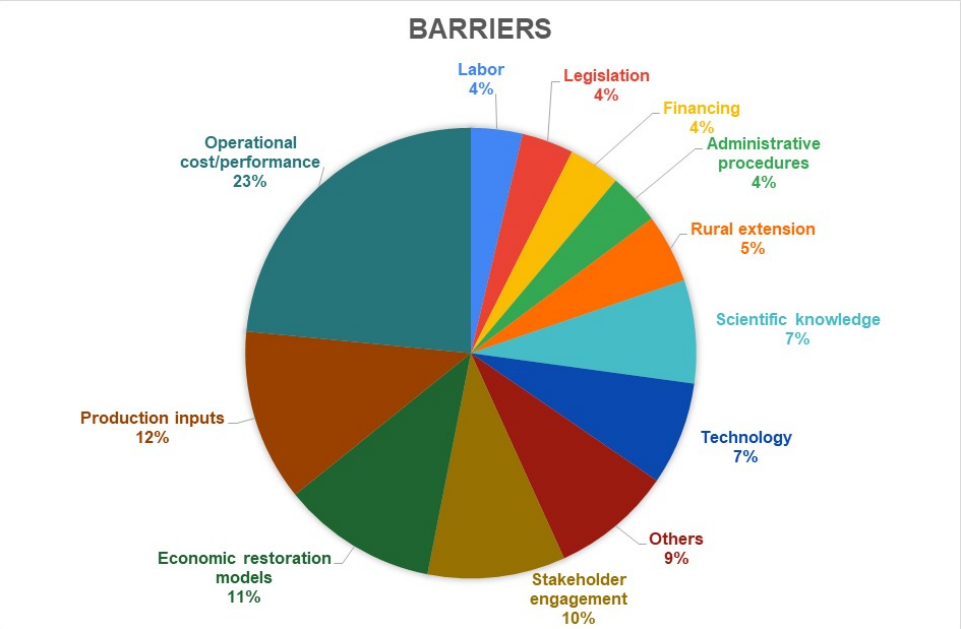


Figure 06. Existing barriers in FLR initiatives, considering data collected in questionnaires and interviews.

In total, 81 barriers occurrences were distributed in the categories mentioned above. The main barriers identified are related to the productive process (23% operational cost/performance). That is, the main barrier is related high operating costs and/or low operational productivity. Production inputs represent 12% of the sample and refer to the absence or insufficiency of specific inputs such as seedlings and seeds of native species, and economical restoration models contribute 11% of the sample and refer to the absence or insufficiency of forest restoration models for economic purposes (e.g. planting native species in consortium with exotic species or planting native species in consortium with species used in agriculture).

The interviews showed the same result, cost and/or operational performance (42%), followed by inputs (19%) and models of forest restoration for economic purposes (16%), and the questionnaire presented the main barriers as stakeholder engagement (18%), technology (11%) and scientific knowledge (11%).

Furthermore, results have shown that some innovations have presented strategies for overcoming barriers, for example “Forest Seed Networks - River Doce Basin” and “Chain between Forest Seed Networks” have built connections between seed collectors, NGOs and project executors to remove the production inputs barrier in the forest restoration chain, reducing seasonality in the supply and demand for forest seeds. Other example is "Network of Native Seedling Nurseries of Vale do Ribeira" through the articulation between actors and the disclosure of forest nurseries, the innovation has overcome the barrier of insufficiency or absence of inputs, as it has contributed to the offer of forest seedlings to meet forest restoration initiatives.

5.4 Stakeholders

From the total participants in interviews, 17 are male and contributed with 41 innovations being, 4 representatives of companies, 4 representatives of NGOs and 8 representatives of universities. 3 interviewees are of the feminine gender and indicated 8 innovations, 1 representative of NGO’s, 1 representative of companies and 1 representative of university. In the questionnaire, it was not possible to identify the participant's gender. However, through question 6 (“Indicate the categories participating in the innovation and the gender of the innovators” - Appendix 1) it was possible to identify the categories of participants involved in the innovations and genres.

Project Manager, Field Restorer and Landowner were the categories that had the highest number of occurrences of participation in innovations. Project Manager presented the predominant gender as “female predominance”, Field Restorer presented “male predominance” as the predominant gender and Landowner presented “male predominance”. Gender equality had the highest number of occurrences in the Field Restorer category and the lowest in the

Project Manager and Rural Community categories. There were no records for LGBTQIA + predominance.

5.5 The Innovation Ecosystems

Table 6 presents the data collected on websites and gray literature by driver by Brazilian state.

State	Forest Cover	Farming	Forest Nursery	Legislation	Research Investment	Research Institutes	GDP
São Paulo (SP)	4,14%	55,8%	111-369	27	20,7%	12	32,20%
Paraná (PR)	3,18%	61,9%	62-110	17	1,8%	11	6,40%
Espírito Santo (ES)	-1,10%	66,1%	62-110	1	0,2%	2	1,72%
Minas Gerais (MG)	1,13%	24,5%	46-61	7	1,3%	10	8,75%
Rio de Janeiro (RJ)	-1,83%	60,3%	62-110	6	2,2%	7	10,20%
Santa Catarina (SC)	-6,60%	38,0%	62-110	7	0,9%	6	4,21%
Bahia (BA)	-2,14%	10,5%	17-45	6	1,0%	7	4,08%
Pernambuco (PE)	13,61%	11,7%	1-16	5	0,4%	5	2,76%

Table 6. Drivers and state values (source: own elaboration).

Sources: Forest cover (Mapbiomas, 2020), Farming (Mapbiomas, 2020), Forest Nursery (IPEA, 2015); Legislation (Planalto, 2020), Research Investment (MCTIC, 2019), Research Institutes (SNIF, 2020), GDP (IBGE, 2020).

For the radar graph elaboration, it was necessary to build an intermediate references table with classification ranging from 0 to 5 (Table 07). For the reference's construction, lower values than zero were established as the lower limit and the higher values found in each driver as the upper limit. To build the ranges between the drivers, it was used the highest driver's values divided by 5 to have a proportional difference inside each driver, therefore the classification (from 1 to 5) for each driver is equidistant. Table 07 shows the final values used to build the radar charts by Brazilian state.

Table 07: Reference values used for the construction of radar charts

	Classification					
Drivers	0	1	2	3	4	5
Forest cover (%)	<0	0-1,60	1,61-3,21	3,22-4,82	4,83-6,43	6,44-8,04
Farming (%)	<0	0-13,2	13,3-26,5	26,6-39,8	39,9-53,1	53,2-66,4
Forest Nursery (nº)	<0	1-16	17-45	46-61	62-110	111-369
Legislation (nº)	<0	0-5	6-11	12-17	18-23	24-29
Research Investment (%)	<0	0-4,2	4,3-8,5	8,6-12,8	12,9-17,1	17,2-21,4
Research Institutes (nº)	<0	0-2	3-5	6-8	9-11	12-14
GDP (%)	<0	0-6,44	6,45-12,89	12,90-19,34	19,35-25,79	25,80-32,24

(source: own elaboration)

Table 8 was constructed correlating the tables 06 and 07, where the classification for each drivers was compared to the values for each state.

State	Forest Cover	Farming	Forest Nursery	Legislation	Research Investment	Research Institutes	GDP
São Paulo (SP)	3	5	5	5	5	5	5
Paraná (PR)	2	5	4	3	1	4	1
Espírito Santo (ES)	0	5	4	1	1	1	1
Minas Gerais (MG)	1	2	3	2	1	4	2
Rio de Janeiro (RJ)	0	5	4	2	1	3	2
Santa Catarina (SC)	0	3	4	2	1	3	1
Bahia (BA)	0	1	2	2	1	3	1
Pernambuco (PE)	5	1	1	1	1	2	1

Table 07: Classifications by driver by state (source: own elaboration).

The figure 7 shows the ecosystem present in the states where innovation records occurred.

The São Paulo State had the highest number of occurrences of innovations (23 records), followed by Paraná (14 records) and Espírito Santo (6 records).

Analyzing the graphs in figure 7, it can be seen that, generally, the ecosystems that support the emergence of innovations present a greater number of drivers with results equal to or close to 5.

São Paulo, Paraná and Rio de Janeiro were the states that presented the best ecosystems, considering the sum of the results obtained in each driver, being 33 for São Paulo, 20 for Paraná and 17 for Rio de Janeiro.

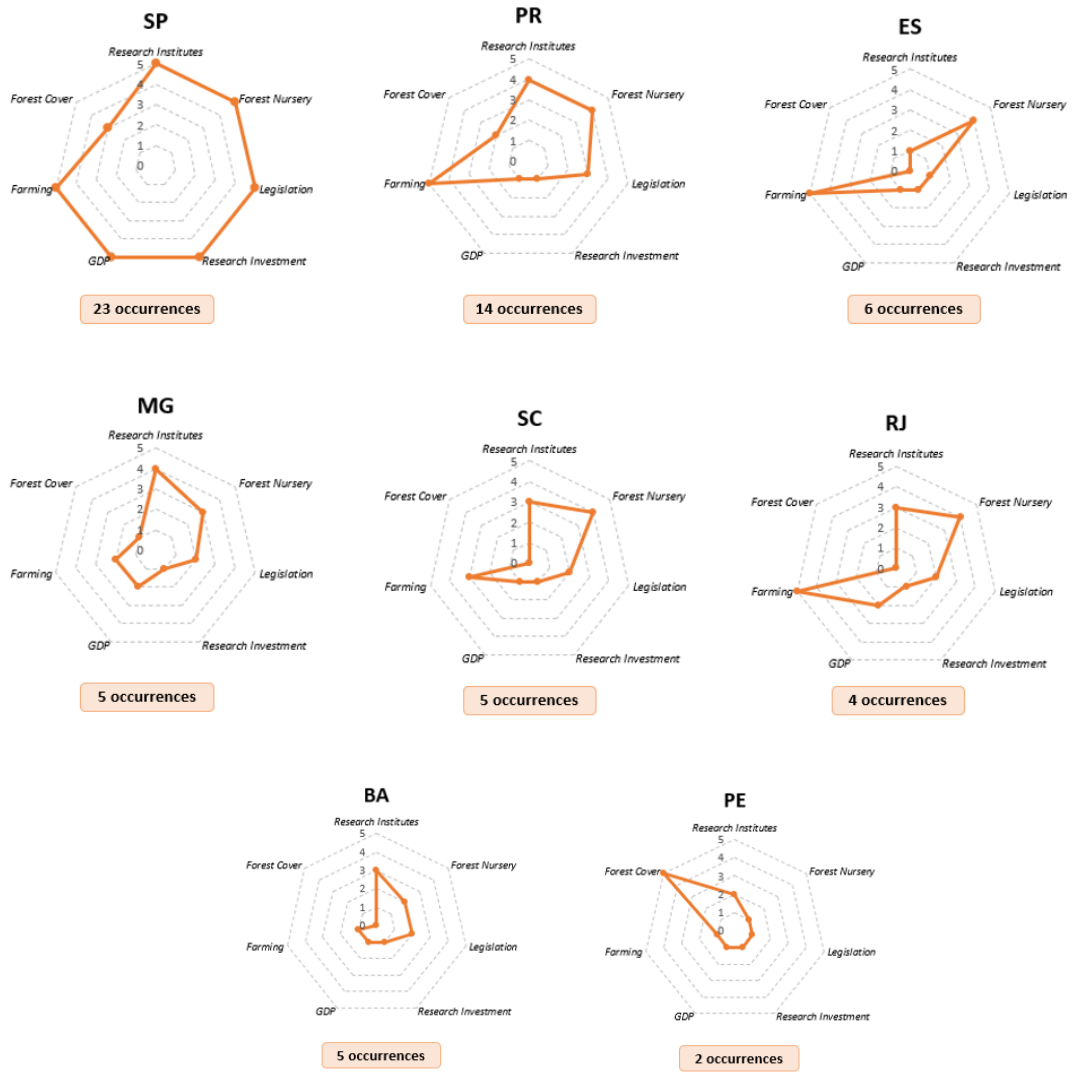


Figure 07. Innovation ecosystem by state in Brazil (SP: São Paulo; PR: Paraná; ES: Espírito Santo; MG: Minas Gerais; SC: Santa Catarina; RJ: Rio de Janeiro; BA: Bahia; PE: Pernambuco).

The Espírito Santo State registered a greater number of innovations compared to the Rio de Janeiro State due to the water crisis experienced in the period from 2013 to 2015, and the environmental crisis that occurred in 2015 with the rupture of the ore tailings dam that affected the Rio Doce Hydrographic Basin, compromising the water supply for population and industrial services.

The states of São Paulo, Paraná and Rio de Janeiro are large urban centers that house most of the Brazilian population and contribute 51% of the national GPD. In addition, there was a reduction of approximately 70% of the

original coverage of the Atlantic Forest Biome, which was mostly replaced by agriculture. This scenario can be explained due to the process of colonization and occupation of Brazil, which began in the 15th century. For these States, the main objective of forest restoration is to recover priority areas defined in national legislation (Law of Native Vegetation - Law 12.651/2012) called PPA (Permanent Preservation Areas) and LR (Legal Reserve). Most forest restoration projects have worked on restoring riparian zones and creating ecological corridors, building mosaics and promoting connectivity between fragments and landscapes. For the São Paulo State, the cataloged innovations are correlated to the service of forest restoration projects, in the search for solutions to reduce operating costs, improve processes and consequently mitigate the existing barriers in the restoration chain.

For the stakeholders participating in interviews, companies indicated a greater number of innovations, followed by universities and NGOs. Of the cataloged records, most of them refer to process innovations that arose through research projects, in partnership with companies and universities, in the search for more accessible solutions for forest restoration. Most of these innovations have been replicated in other forest restoration projects within the same state, as well as in other regions of the country.

It is noted that, in the São Paulo State, there is a good interaction between stakeholders involved in forest restoration, which enables the creation of a favorable ecosystem for the development of innovations. The academy/university is an important link in the chain, as it is connected to companies in search of more feasible solutions, and has developed research to assist in public policy strategies.

The Paraná State has goals similar to those of the São Paulo State. Innovations are also correlated with cost reduction and process improvement, with greater representativeness for product-type innovations. The academy/university contributed the most innovation records, followed by companies and NGOs.

The product innovations indicated and created by the university arose as a result of meeting demand in forest restoration projects. These products have been patented, but are not marketable. The process indications appeared in

research projects in the search for economic models for forest restoration, with integration between university and rural landowners.

In the Rio de Janeiro State, 2 occurrences of innovations resulted from interviews and 2 from questionnaires. In relation to the interviews, NGO's were responsible for the indication and participation of innovations that are of a process and organizational typology, with the creation of a restoration model using direct seeding and the creation of a seed network to meet demand in forest restoration projects.

The Espírito Santo State presented 6 occurrences of innovation, 5 of which were cataloged in interviews and 1 through a questionnaire. Of the interviews, the academy/university contributes the largest number, followed by NGO's. Innovations of organizational typology were highlighted and are related to the creation of networks between stakeholders to supply inefficient demand in the chain and attend forest restoration projects.

Five innovations were cataloged in the Minas Gerais State, all from interviews. NGO's were more represented, followed by academia/universities. The greatest number of innovations are of an organizational typology with the objective of building networks between stakeholders to search for more accessible solutions for carrying out forest restoration projects.

Santa Catarina contributed with 5 innovations, all through interviews, most of which were nominated by NGO's, followed by company and universities. The innovations were classified as organizational, product and service. Organizational innovations emerged through a partnership between NGO and forestry company to create forest restoration projects considering the inclusion and participation of local stakeholders.

Bahia participated with 5 records of innovations, 3 through questionnaires and 2 through interviews. NGO's and the university were the stakeholders participating in the interviews. In general, the greatest representativeness refers to organizational innovation, with the objective of creating networks between local stakeholders in the search for solutions for the production of forest seedlings, collection of forest seeds, planting of native seedlings or monitoring of protected areas.

In Pernambuco, 2 innovations from interviews were cataloged, with the participation of NGOs and universities. The innovations, classified as organizational and services, emerged in the search for partnerships to finance forest restoration projects and in the identification of priority areas for forest restoration.

Although the ecosystem favors the emergence of innovations, it is also possible that they occur through command and control measures, relevant facts or crises, for example the Arboretum Project that was created in 2011 through a Term of Conduct Adjustment between the Public Ministry of the State of Bahia and companies in the cellulose and paper sector.

Regarding innovations called “National” origin, most of them are related to product innovation, as they are about the creation of APP mobile, software, online platforms for different purposes, cataloging financial data, connecting stakeholders, among others.

The cataloged innovations, typology and other information are described in Appendix 2.

The interaction between local stakeholders encourages development and the search for improvements for forest restoration. So, promoting this integration enables the emergence of innovations, reduction of bottlenecks and, finally, the fulfillment of the goals assumed by Brazil for restoration of landscapes (FLR). There are countless initiatives in forest restoration in Brazil, be it research, projects of great repercussion, creation of systems for data integration or articulation between different sectors, in search of the same objective in increasing the restored areas in the country.

However, these initiatives are still not enough to transform the forest restoration chain, which is currently tenuous, with an uneven distribution in the country, for example, the disparity in the number of forest nurseries per State. Promoting local development helps to reduce costs, increases the offer of products and services, engages local actors, foster research, generate income, among others. Therefore, in order to improve the forest restoration chain, a multi-sectoral governance process at different levels is essential.

5.6 Forest and Landscape Restoration Initiatives

In all, 69 initiatives were cataloged, 14 of which occurred in the period before 2010 and 55 registered in the period between 2010 to 2020. In Appendix 3 it is possible to consult the list of all initiatives and the innovations identified in the research.

Most of the occurences have the main objective of restoring and protecting the springs, guaranteeing the quality of the water resource for population supply and compliance with environmental legislation the other occurrences refer to landscape restoration iniciatives (e.g. agroforestry system).

From the total number of initiatives cataloged, the São Paulo State had greater representativeness or participation, followed by the State of Rio de Janeiro and Minas Gerais. Figure 8 presents the distribution of forest and landscape restoration initiatives by Brazilian state.

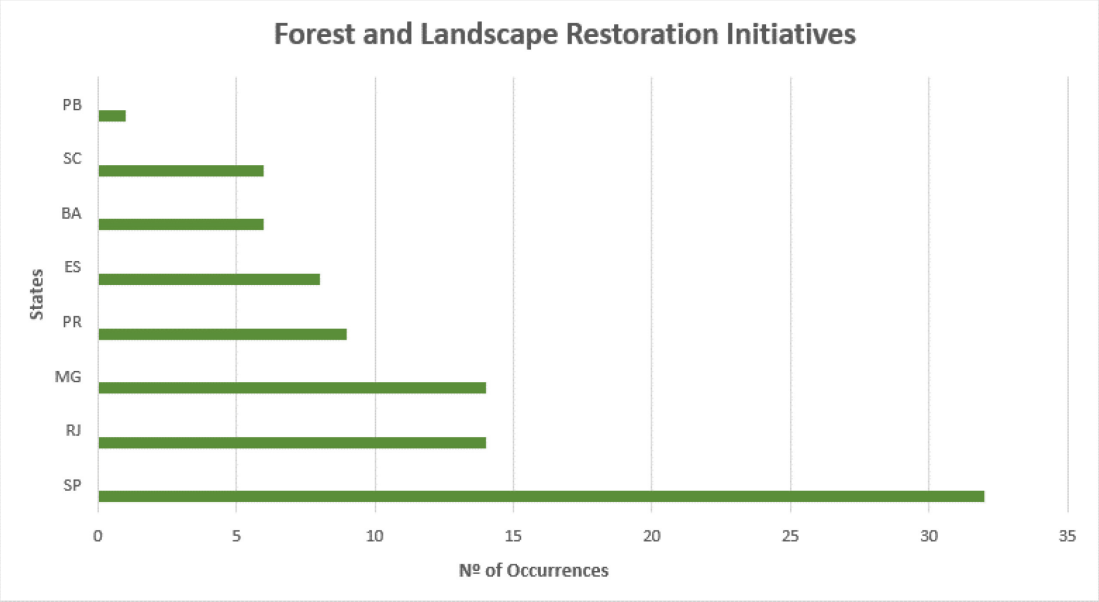


Figure 8. Number of cataloged forest restoration initiatives in Atlantic Forest Biome in Brazil.

The São Paulo State had the highest occurrence of cataloged innovations, as well as the largest participation in forest and landscape restoration initiatives. In addition, it presented the best ecosystem compared to the other states analyzed in this research.

For example, the innovation “direct-seeding of native forests (muvuca)” arose in 2006 through a research project and it is a model to restore degraded areas with the use of forest and agricultural seeds and which has a lower cost compared to the model use of native forest seedlings. Currently, this innovation has gained space in restoration iniciatives, such as “Seed Paths Initiative”, “Giant Guarani Program” in São Paulo State and “Renova Project” in states of Espírito Santo and Minas Gerais.

The innovation “Direct-seeding of native forests (muvuca)”, classified as process tipology, initiated other innovations to support gaps in the restoration chain (seed supply/ demand), such as “the creation of the network of seeds and seedlings in the rio doce basin”. This is an organizational innovation created to attend the Renova Project forest restoration project, which aims to restore 40.000 hectares.

Another example in São Paulo State refers to the “Environmental and Agricultural Adequacy Program” project created in 2000 and in progress, it is a forest restoration project to adapt rural properties in accordance with legal requirements and fostered the emergence of process innovations “Planting with green manure", "Staggered planting", "Planting with functional direct seeding" which are models/techniques of forest restoration.

In Paraná State, the organizational innovation “PBAI - Basic Indigenous Environmental Plan” is an example of connecting several stakeholders to attend the project and is an improvement of the organizational innovation created in the “Matas Sociais” initiatives.

The innovation “restoration models for economic purposes”, classified as process tipology, is present in several Brazilian states, such as the initiatives “Financing of the Legal Reserve Forest Restoration with Economic Exploration/Productive arrangements for forest restoration”, “12 million ha in 12 real Economic models to promote ecological recovery in Brazil” or “The management of juçara (Euterpe edulis) as a conservation strategy for the Atlantic Forest”.

It is possible to affirm that, the innovation ecosystem is related to the occurrence of the number of forest and landscape restoration initiatives and

innovations. In other words, regions that have good ecosystems, that is, a good articulation between stakeholders, provide an environment for carrying out forest restoration projects and innovations.

Therefore, considering that the relationships between stakeholders are important for the ecosystem, it is assumed that social innovation can contribute to the construction and strengthening of relationships through the involvement and engagement between actors, fostering organizational models that serve multiple purposes and that contribute to the scaling up FLR.

6. Conclusion

The survey cataloged 66 innovations in several Brazilian states, with the states of São Paulo and Paraná contributing 50% of the occurrences.

Product innovations represented 33% of the total, followed by organizational with 32%, process innovations with 29%, service with 5% and marketing with 1%.

The biggest bottlenecks or barriers in the forest restoration chain are related to high operating costs and/or low operating income, absence or insufficient supplies to meet the demands of projects and lack of restoration models for economic purposes.

The São Paulo State presented the best ecosystem compared to the others analyzed in the research. Still, it was the one that registered the largest number of forest restoration projects cataloged in gray literature, which demonstrates the importance of ecosystems in scaling up innovations and FLR.

In other words, social, economic and environmental factors are connected and correlated with each other. So, to promote the FLR, the involvement and engagement of stakeholders presents in a ecosystem is important.

The sample size was not sufficient to perform non-parametric statistical analyzes. However, through descriptive statistical analysis, it was possible to confirm that innovation is a common factor among the restoration initiatives of the Atlantic Forest Biome, has helped in the search for solutions and, consequently, in the increase of restored areas.

Brazil has great representativeness forest and landscape restoration initiatives. However, there are many adversities to be overcome, both locally and globally. The continuous search for solutions is important to overcome barriers and promote scaling up FLR, such as:

• to understand the role of stakeholders in forest and landscape restoration initiatives, how to involve and engage them;

• to understand the vision of landowners on forest restoration, how to insert and to engage them in the process, as they are key stakeholders, since the largest portion of the Atlantic Forest Biome is located on rural properties;

• to understand and identify the factors necessary for the construction of an ecosystem that enables the emergence of innovations and FLR initiatives;

• to understand what strategies are necessary to promote the metamorphosis of the forest restoration chain, transforming it into a solid segment, with planning and actions at different levels, connecting the global to the local.

Restoring is not only about transforming the landscape, but also building a multisectoral and complex network, which involves different spheres, such as political, economic and social.

The theme is global and will expand its relevance in international agendas with the beginning of the Decade of Restoration. Therefore, as important as restoring forests is building bridges, promoting a participatory approach.

Furthermore, this research can contribute by consolidating information about barriers and bottlenecks in the forest restoration chain, as well as building a catalog of innovations in forest and landscape restoration initiatives in the Atlantic Forest Biome.

In addition, the research has shown that the ecosystem and innovations are related, that is, a cohesive ecosystem promotes the emergence of innovations. The construction of this ecosystem is arduous and complex, as it involves multiple objectives and ideals. It is believed that social innovation can contribute to the structuring and ordering of the ecosystem by connecting

stakeholders and forming strategic alliances, even if from different segments in the search for collective evolution.

Hence, it is important to better understand who are the stakeholders in the forest restoration chain, their purposes, roles and interactions with each other at the local to global level.

Therefore, considering the global challenges of forest restoration, and the international goals assumed by Brazil, it is suggested that promoting FLR is directly related to the construction of an environment among different stakeholders with similar objectives. This ecosystem will enable the search for solutions to reduce barriers or bottlenecks in the forest restoration chain, through innovations, and, consequently, assist in scaling up forest and landscape restoration initiatives.

7. Bibliography

Albuquerque, E.M.de. (2009). Evaluation of the “Respondent-driven Sampling” sampling technique in estimating the prevalence of Communicable Diseases in populations organized in complex networks. Sérgio Arouca National School of Public Health – ENSP; Rio de Janeiro: Ministry of Health – Fiocruz, Master Thesis, 99p.

Andrade, A., Bargos, D.C., Fialho, T.M., Cristofaro, S. (2018). Challenges of the forest restoration chain in Vale do Paraíba Paulista. Society & Nature, 30(3), 257 – 277. 10.14393/SN-v30n3-2018-13

Antoniazzi, L., Sartorelli, P., Costa, K., Basso, I. (2016). Executive Summary Forest Restoration in Agricultural Chains for fitness to the forest code: Economic analysis of eight Brazilian states. Agroicone, INPUT. https://www.inputbrasil.org/wp-content/uploads/2016/12/Sum%c3%a1rio-Executivo-Restaura%c3%a7%c3%a3o-florestal-em-cadeias-agropecu%c3%a1rias-para-adequa%c3%a7%c3%a3o-ao-C%c3%b3digo-Florestal_Agroicone_INPUT.pdf

Aronson J, Alexander S. (2013). Ecosystem restoration is now a global priority: time to roll up our sleeves. Restoration Ecology, 21, 293–296. DOI: 10.1111/rec.12011

Aulet, B. (2008). How to build a successful innovation ecosystem. Xconomy.. https://xconomy.com/national/2008/10/14/how-to-build-a-successful-innovation-ecosystem-educate-network-and-celebrate/

Baregheh, A.; Rowley, J.; Sambrook, S. (2009). Towards a multidisciplinary definition of innovation. Management Decision, 47(8), 1323-1339. https://doi.org/10.1108/00251740910984578

Basole, R. C.; Karla, J. (2011). On the evolution of mobile platform ecosystem structure and strategy. Business & Information Systems Engineering. v. 3, n. 5, p. 313–322, 2011. https://www.researchgate.net/deref/http%3A%2F%2Fdx.doi.org%2F10.1007%2Fs12599-011-0174-4?_sg%5B0%5D=F9am3xLIywyXWaczvdiJzP7Oo2JlIJkC-VMuAbRrhSGc9DGOpLg9T3DOwpt2uXUZjIZKNYwgxu3WrOm62DzhWV1Esw.QJqBDjR4vQFF92SGuNW-by04aNBaCH2GD5NZw1xDUprUol7utuX8eXSey5IfP3Aq7yTByyOOK_jFuWY0falqrg

Benini, R. de M.; Adeodato, S. (2017). Economics of forest restoration. The Nature Conservancy Brasil. https://www.researchgate.net/publication/319044099_FOREST_RESTORATION_ECONOMY_RESTAURACAO_ECONOMIA_DA_FLORESTAL

Benini, R. de M., Sossai, M.F., Padovezi, A., Matsumoto, M.H. (2016). Forest Restoration Chain Strategic Plan: The Case of the Espírito Santo State. https://www.researchgate.net/publication/306200045_PLANO_ESTRATEGICO_DA_CADEIA_DA_RESTAURACAO_FLORESTAL_O_CASO_DO_ESPIRITO_SANTO

BEPA. (2011). Empowering people, driving change: Social innovation in the European Union. Bureau of European Policy Advisors. http://ec.europa.eu/ewsi/UDRW/images/items/docl_17731_35611801.pdf

Brancalion, P.H.S., Rodrigues, R.R., Gandolfi, S., Kageyama, P.Y., Nave, A.G., Gandara, F.B., Barbosa, L.M., Tabarelli, M. (2010). Legal instruments can contribute to the restoration of biodiverse tropical forests. Arvore Magazine, 34, 455-470. http://dx.doi.org/10.1590/S0100-67622010000300010

Brancalion, P.H.S., van Melis, J. (2017). On the Need for Innovation in Ecological Restoration. Annals of the Missouri Botanical Garden, 102, 227-236. https://doi.org/10.3417/2016034

Brancalion, P.H.S., Viani, R., Strassburg, B., Rodrigues, R.R. (2012). Finding the money for tropical forest restoration. Unasylva. 239. 41-50. https://www.researchgate.net/publication/259923201_Finding_the_money_for_tropical_forest_restoration

Brancalion, P.H.S.; Meli, P.; Tymus, J.R.C.; Lenti, F.E.B.; Benini, M.R.; Silva, A.P.M.; Isernhagen, I.; Holl, K.D. (2019). What makes ecosystem restoration expensive? A systematic cost assessment of projects in Brazil. Biological Conservation, p240.

Calmon, M.; Brancalion, P.H.S., Paese, A.; Aronson, J., Castro, P., da Silva, S.C., Rodrigues, R.R. (2011). Emerging Threats and Opportunities for Large-Scale Ecological Restoration in the Atlantic Forest of Brazil. Restoration Ecology, 19, 154-158. https://doi.org/10.1111/j.1526-100X.2011.00772.x

Carvalho, H.G. de, Reis, D.R., dos; Cavalcante, M.B. (2011). Innovation management. Technological University of Paraná. https://www.politecnica.pucrs.br/professores/giugliani/ENGENHARIA_DE_PRODUCAO_-_Gestao_do_Conhecimento/Trabalho_2014-01_-_Livro_Gestao_da_Inovacao_-_UFTPR-2013.pdf

Castro, A. G. de, Morrot, S. (1996). Perspectives of sustainable development for the forestry sector in Latin America. Advanced Studies, 10(27), 321-347. https://dx.doi.org/10.1590/S0103-40141996000200019

Chaves, R. B., Durigan, G., Brancalion, P. H.S., Aronson, J. (2015). On the need of legal frameworks for assessing restoration projects success: New perspectives from São Paulo state (Brazil). Restoration Ecology, 23, 754-759. https://doi.org/10.1111/rec.12267

Chazdon, R.L., Brancalion, P.H.S., Lamb, D., Laestadius, L., Calmon, M., Kumar, C. (2017). A policy-driven knowledge agenda for global forest and landscape restoration. Conserv. Lett. 10, 125–132. https://doi.org/10.1111/conl.12220

Cloutier, J. (2003). Qu'est-ce que l'innovation sociale?. Montréal: CRISES. https://www.researchgate.net/publication/272566640_Qu'est-ce_que_l'innovation_sociale

Coleman, J.S. (1958). Snowball Sampling: Problems and techiniques of chain referral sampling. Human Organization, 17, 28-36. https://doi.org/10.1177%2F004912418101000205

Crespell, P., Knowles, C., Hansen, E. (2006). Innovativeness in the North American softwood sawmilling industry. *Forest Sci.*, 52: 568–578. https://doi.org/10.1093/forestscience/52.5.568

Da Silva, A.P.M., Marques, H.R., Luciano, M.S.F., dos Santos, T.V.M.N., Teixeira, A.M.C., Sambuichi, R.H.R. (2015). Bottlenecks in the regulation of production and marketing of native seeds and forest seedlings in Brazil: contributions to the revision of the standard. Regional, urban and environmental bulletin. IPEA -

Institute of Applied Economic Research. http://repositorio.ipea.gov.br/handle/11058/6494

Damanpour, F. (1996), Organizational complexity and innovation: developing and testing multiple contingency models, Management Science, 42(5), 693-716. https://www.jstor.org/stable/2634460

Damanpour, F., Schneider, M. (2006). Phases of the adoption of innovation in organizations: effects of environment, organization and top managers, British Journal of Management, 17(3), 215-36. https://doi.org/10.1111/j.1467-8551.2006.00498.x

Dedehayir, O.; Makinen, S. J.; Ortt, R. (2016). Roles during innovation ecosystem genesis: A literature review, Technological Forecasting & Social Change. https://doi.org/10.1016/j.techfore.2016.11.028

Durigan, G., de Melo, A.,C.Galvão; Engel, V.L., Torezan, J.M., Marques, M.C.M., Martins, S.V., Reis, A., Scarano, F.R. (2010). Legal rules for ecological restoration: An additional barrier to hinder the success of initiatives? Arvore Magazine, 34, 471-485. https://doi.org/10.1590/S0100-67622010000300011

Faugier, J., Sargeant, M. (1997). Sampling hard to reach populations. Journal of Advanced Nursing, 26, 790-797. https://doi.org/10.1046/j.1365-2648.1997.00371.x

Fransman, M. (2018). Innovation Ecosystems. Increasing Competitiveness. Cambridge University Press. 340p. https://doi.org/10.1017/9781108646789

Fonseca, G.A.B. (1985). The vanishing Brazilian Atlantic Forest. Biological Conservation 34, 17–34. https://doi.org/10.1016/0006-3207(85)90055-2

Gabor, D. (1970). Innovations: Scientific, Technological and Social (1 ed). Oxford: Oxford University Press.Goodman, L.A. (1961). Snowball Sampling. The Annals of Mathematical Statistics, 32, 148-170. https://www.jstor.org/stable/2237615

Goodman, L.A. (1961). Snowball Sampling. The Annals of Mathematical Statistics, 32, 148-170. https://www.jstor.org/stable/2237615

Haddad, N. M., Brudvig, L.A, Clobert, J., Davies, K.F., Gonzalez, A., Holt, R.D., Lovejoy, T.E., Sexton, J.O., Austin, M.P., Collins, C.D., Cook, W.M., Damschen, E.I., Ewers, R.M., Foster, B.L., Jenkins, C.N., King, A.J., Laurance, W.F., Levey, D.J., Margules C.R., Melbourne, B.A., Nicholls, A.O., Orrock, J.L., Song, D., Townshend, J.R. (2015). Habitat fragmentation and its lasting impact on Earth's ecosystems. Sciences Advances. 1(2). DOI: 10.1126/sciadv.1500052

Hansen, E. (2006). The state of innovation and new product development in the North American lumber and panel industry. Wood Fiber Sci., 38: 325–333. https://wfs.swst.org/index.php/wfs/article/view/797

Hansen, E.; Nybakk, E.; Panwar, R. (2014). Innovation Insights from North American Forest Sector Research: A Literature Review. Forests 5, no. 6: 1341-1355. https://doi.org/10.3390/f5061341

IPEA - Institute of Applied Economic Research (2013). Innovation in Brazilian agriculture: a reflection from the analysis of cultivar protection certificates 42p. http://repositorio.ipea.gov.br/bitstream/11058/2209/1/TD_1866.pdf

IPEA - Institute of Applied Economic Research (2015). Diagnosis of the Production of Native Forest Seedlings in Brazil. 58p. http://repositorio.ipea.gov.br/bitstream/11058/7515/1/RP_Diagn%C3%B3stico_2015.pdf

Krama, M. (2014). Innovation and Urban Development Policy Based on Knowledge: Application to Innovation Ecosystems. Thesis. Catholic University of Paraná. http://www.biblioteca.pucpr.br/tede/tde_busca/arquivo.php?codArquivo=3113

Kubeczko, K., Rametsteiner, E., Weiss, G. (2006). The role of sectoral and regional innovation systems in supporting innovations in forestry. Forest Policy and Economics, 8, 704-715. https://doi.org/10.1016/j.forpol.2005.06.011

Laestadius, L., Maginnis, S., Minnemeyer, S., Potapov, P., Saint-Laurent, C., Sizer, N. (2011). Mapping opportunities for forest landscape restoration. Unasylva 238: 47 – 48. https://www.researchgate.net/publication/309623327_Forest_and_landscape_restoration_Toward_a_shared_vision_and_vocabulary

Lamb, D., Erskine, P.D., Parrotta, J.A. (2005). Restoration of degraded tropical forest landscapes. Science, 310, 1628. DOI: 10.1126/science.1111773

Majumdar, S., Guha, S., Marakkath, N. (2015). Social Innovation: Towards a Conceptualisation. Technology and Innovation for Social Change. https://doi.org/10.1007/978-81-322-2071-8_2

Moseley, M.J. (2000). Innovation and Rural Development: Some Lessons from Britain and Western Europe. Planning Practice & Research, Vol. 15, Nos. 1/2, pp. 95–115, 2000. https://doi.org/10.1080/713691880

Mansourian, S., Dudley, N., Vallauri, D. (2017). Forest Landscape Restoration: Progress in the Last Decade and Remaining Challenges. Ecological Restoration, 35(4), 281–288. DOI: 10.3368/er.35.4.281

Marconato, G.M. (2015). Sociocultural and Economic Barriers in Ecological Restoration. Thesis (Phd). Universidade Estadual Paulista, Faculdade de Ciências Agronômicas.

Marengo, J., Alves, L. (2016). Water Crisis in São Paulo in 2014: Drought and Deforestation. Geousp – Space and Time. 19. 485. 10.11606/issn.2179-0892.geousp.2015.100879.

MCTIC - Ministry of Science, Technology, Innovations and Communications. (2019). National Science, Technology and Innovation Indicators. http://antigo.mctic.gov.br/mctic/export/sites/institucional/indicadores/arquivos/Indicadores_CTI_2019.pdf

Melo, F.P.L., Pinto, S.R.R., Brancalion, P.H.S., Castro, P.S., Rodrigues, R.R., Aronson, J., Tabarelli, M. (2013). Priority setting for scaling-up tropical forest restoration projects: Early lessons from the Atlantic forest restoration pact. Environmental Science and Po Moraes licy, v33, 395-404. https://doi.org/10.1016/j.envsci.2013.07.013

Moseley, M.J. (2000). Innovation and rural development: Some lessons from Britain and Western Europe. Planning Practice & Research. 15, 95–115. https://doi.org/10.1080/713691880

Nord, W., Tucker, S. (1987). Implementing Routine and Radical Innovations, Lexington Books, Lexington, MA.

OECD - Organization for Economic Co-Operation and Development. (2005). Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data. 3rd ed. Paris: OECD / Eurostat. https://www.oecd.org/science/inno/2367614.pdf

Plessis, M.D. (2007), The role of knowledge management in innovation, Journal of Knowledge Management, 11(4), 20-29. https://doi.org/10.1108/13673270710762684

Rambaldi, D. M., Oliveira, D. A. S. (2003). Ecosystem fragmentation: causes, effects on biodiversity and public policy recommendations. Ministry of the Environment, Brasília.

Rametsteiner, E., Weiss, G. (2006). Innovation and innovation policy in forestry: Linking innovation process with systems models. Forest Policy and Economics, 8, 691-703. https://doi.org/10.1016/j.forpol.2005.06.009

Ribeiro, M.C., Metzger, J.P., Martensen, A.C., Ponzoni, F.J., Hirota, M.M. (2009). The Brazilian Atlantic Forest: How much is left, and how is the remaining forest distributed? Implications for conservation. Biological Conservation, 142, 1141–1153. https://doi.org/10.1016/j.biocon.2009.02.021

Rodrigues, R.R., Gandolfi, S., Nave, A.G., Aronson, J., Barreto, T.E., Vidal, C.Y., Brancalion, P.H.S. (2011). Large-scale ecological restoration of high-diversity tropical forests in SE Brazil. Forest Ecology and Management, 261, 1605–1613. doi:10.1016/j.foreco.2010.07.005

Rodrigues, R.R., Lima, R.A.F., Gandolfi, S., Nave, A.G. (2009). On the restoration of high diversity forests: 30 years of experience in the Brazilian Atlantic Forest. Biological Conservation,.142, 1242–1251. doi:10.1016/j.biocon.2008.12.008

Rogers, E. M. (1995) Diffusion of Innovations, 4th edn (New York, The Free Press)

Russell, M. G. et al. (2011). Transforming innovation ecosystems through shared vision and network orchestration. In: Triple Helix IX International Conference. Stanford, CA, USA. https://www.researchgate.net/publication/284726075_Transforming_Innovation_Ecosystems_through_Shared_Vision_and_Network_Orchestration

Sabogal, C., Besacier, C., McGuire, D. (2015). Forest and landscape restoration: concepts, approaches and challenges for implementation. Unasylva, 66, 3-10. https://www.researchgate.net/publication/293944519_Forest_and_landscape_restoration_Concepts_approaches_and_challenges_for_implementation

Santos, M., Vieira da Silva, K., Pacheco, A. (2018). From objectives to the emergence of social innovation: a case study in a solidary economy organization. P2P and innovation. 4. 119-140. 10.21721/p2p.2018v4n2.p119-140.

Schlemm, M. (2014). Paradigms for innovation. Driving policies and practices to the new stage. PesquisaCNPq.

Schumpeter, J. (1911). The Theory of Economic Development. Harvard Economic Studies, vol. XLVI. Harvard University Press, Cambridge, MA. English edition 1934.

Segura-Bonilla, O. (2003). Competitiveness, systems of innovation and the learning economy: the forest sector in Costa Rica. Forest Policy and Economics. Volume 5, Issue 4, 373-384p. https://doi.org/10.1016/S1389-9341(03)00036-4.

Sharra, R., Nyssens, M. (2011). Social Innovation: an Interdisciplinary and Critical Review of the Concept. https://www.researchgate.net/profile/M_Nyssens/publication/267790005_Social_Innovation_an_Interdisciplinary_and_Critical_Review_of_the_Concept/links/54bf8b340cf2acf661ce0f65.pdf

Silva, J.M.C., Tabarelli, M. (2000). Tree species impoverishment and the future flora of

the Atlantic Forest of northeast Brazil. Nature, 404, 72–74. https://doi.org/10.1038/35003563

Silva, W.G.S., Metzger, J.P., Simões, S., Simonetti, C., (2007). Relief influence on the spatial distribution of the Atlantic Forest cover at the Ibiúna Plateau, SP. Brazilian Journal of Biology, 67, 403–411. https://doi.org/10.1590/S1519-69842007000300004

Skog, K. E., Ince, P. J., Dietzman, D. JS, Ingram, C. D. (1995). Wood products technology trends. Changing the face of forestry. J Forest., 93(12): 30–33. https://www.fpl.fs.fed.us/documnts/pdf1995/skog95a.pdf

Spinosa, L. M., Krama, M. (2010). Innovation ecosystems and the urban environment: main challenges for their managers. https://www.researchgate.net/publication/280722195_Ecossistema_de_Inovacao_e_Meio_Urbano_principais_desafios_para_seus_gestores

Spinosa, L.M., Schlemm, M.M., Reis, R.S. (2015). Brazilian innovation ecosystems in perspective: Some challenges for stakeholders. Brazilian Journal of Strategy. 8, 386-400. https://www.researchgate.net/publication/291697374_Brazilian_innovation_ecosystems_in_perspective_Some_challenges_for_stakeholders

Spreen, M. (1992). Rare populations, hidden populations and link-tracing designs: what and why? Bulletin de Méthodologie Sociologique, 36, 34-58. https://doi.org/10.1177%2F075910639203600103

Stanturf, J.A., Madsen, P. (2012) What is Forest Landscape Restoration? Forest Landscape Restoration: Integrating Natural and Social Sciences, World Forests 15. https://doi.org/10.1007/978-94-007-5326-6_1

Strassburg, B.B.N., Beyer, H.L., Crouzeilles, R., Iribarrem, A., Barros, F., Siqueira, M.F., Sánchez-Tapia, A., Balmford, A., Sansevero, J.B.B., Brancalion, P.H.S., Broadbent, E.N., Chazdon, R.L., Filho, A.O., Gardner, T.A., Gordon, A., Latawiec, A., Loyola, R., Metzger, J.P., Mills, M., Possingham, H.P., Rodrigues, R.R., Scaramuzza, C.A.M., Scarano, F.R., Tambosi, L., Uriarte, M., (2019). Strategic approaches to restoring ecosystems can triple conservation gains and halve costs. Nat. Ecol. Evol. 3, 62–70. https://doi.org/10.1038/s41559-018-0743-8

Suding K, Higgs E, Palmer M, Callicott JB, Anderson CB, Baker M, et al. (2015) Committing to ecological restoration: efforts around the globe need legal and policy clarification. Science, 348, 638–640. DOI: 10.1126/science.aaa4216

Tabarelli, M., Pinto, L.P., Silva, J.M.C., Hirota, M., Bedê, L. (2005). Challenges and Opportunities for Biodiversity Conservation in the Brazilian Atlantic Forest. Conservation Biology, 19(3), 695–700. https://doi.org/10.1111/j.1523-1739.2005.00694.x

Tavares, H. (2017). Innovation ecosystems and network analysis: an analysis of the innovation projects of the metropolitan region of Curitiba. XVII Enanpur. http://www.anais.anpur.org.br/index.php/anaisenanpur/article/view/1970/1949

Taylor, J. B. (1970). Introducing Social Innovation. The Journal of Applied Behavioral Science, 6(1), 69–77. http://doi.org/10.1177/002188637000600104

Thompson, V.A. (1965). Bureaucracy and innovation. Administrative Science Quarterly, 10, 1-20.

Toivanen H, Lima-Toivanen M.B. (2009). Learning and global industry dynamics: the emergence of Brazilian pulp and paper industry. In: Malerba F, Mani S (Orgs) Sectoral systems of innovation and production in developing countries: actors, structure and evolution. Edward Elgar, Northampton, pp 99–130. https://www.researchgate.net/publication/263526055_Learning_innovation_and_public_policy_The_emergence_of_the_Brazilian_pulp_and_paper_industry

Van de Ven, A. (1986). Central problems in the management of innovation. Management Science, 32(5), 590-607. http://www.jstor.org/stable/2631848

Varrichio, P., Diogenes, D., Jorge, A., Garnica, L. (2012). Collaborative networks and sustainable business: a case study in the Brazilian system of innovation. Procedia-Social and Behavioral Sciences, 52, 90-99. https://doi.org/10.1016/j.sbspro.2012.09.445

Verworn, B., Herstatt, C., Nagahara, A. (2006). The impact of the fuzzy front end on new product development success in Japanese NPD projects. Proceedings of the R&D Management Conference 2006, Manchester. https://www.researchgate.net/publication/237415025_The_Impact_of_the_Fuzzy_Front_End_on_New_Product_Development_Success_in_Japanese_NPD_Projects

Verworn, B., Lütje, C., and Herstatt, C. (2000). Innovationsmanagement in kleinen und mittleren Unternehmen, Working Paper No. 7, Institute of Technology and Innovation Management, Hamburg University of Technology. (https://www.econstor.eu/handle/10419/55504

Vuarin, P., Rodriguez, M. (1994) Innovation and communication within LEADER, LEADER Magazine, 7, pp. 13–16.

Wilson, S.J., Cagalanan, D. (2016). Governing restoration: Strategies, adaptations and innovations for tomorrow's forest landscapes. World Development Perspectives, 4, 11–15. https://doi.org/10.1016/j.wdp.2016.11.015

Wong, A., Tjosvold, D. and Liu, C. (2008). Innovation by teams in Shanghai, China: cooperative goals for group confidence and persistence. British Journal of Management. www3.interscience.wiley.com/cgi-bin/fulltext/120123993/HTMLSTART

World Bank. (2006). Enhancing Agricultural Innovation: How to Go Beyond the Strengthening of Research Systems, 1st ed. The World Bank, Washington, D.C. ,www.worldbank.org/rural

WWF Brazil. (2014). Ecological Restoration in Brazil: Challenges and Opportunities. https://d3nehc6yl9qzo4.cloudfront.net/downloads/restauracao_ecologica_1.pdf

Websites

AFRP - Atlantic Forest Restoration Pact. https://www.pactomataatlantica.org.br/. Accessed: 10 April 2020.

AnaliSAF. https://analisafs.tnc.org/auth/login. Accessed: 17 October 2020.

Apremavi. http://apremavi.cargeo.com.br/login/?next=/. Accessed: 17 October 2020.

Arboretum Program for Conservation and Diversity Restoration Forest. https://programaarboretum.eco.br/. Accessed: 17 October 2020.

Aua Institute of Social Entrepreneurship. http://institutoaua.org.br/empreendimentos/rota-do-cambuci/. Accessed: 17 October 2020.

BNDES.https://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Galerias/Convivencia/Restauracao_Ecologica/Projetos/ListaProjetos. Accessed: 17 October 2020.

Bonn Challenge. https://www.bonnchallenge.org/content/challenge. Accessed: 10 April 2020.

Brazil Climate, Forestry and Agriculture Coalition. http://www.coalizaobr.com.br/. Accessed: 17 October 2020.

Cambuci Gastronomic Route. https://www.institutoaua.org.br/rotadocambuci/. Accessed: 17 October 2020.

CAR - Rural Environmental Registry. https://www.car.gov.br/#/. Accessed: 17 October 2020.

CBD – Convetion on Biological Biodiversity. https://www.cbd.int/. Accessed: 17 October 2020.

Cetesb - Environmental Company of the State of São Paulo. https://cetesb.sp.gov.br/. Accessed: 01 December 2020.

Dicio – Portuguese Online Dictionary. https://www.dicio.com.br/barreira/. Accessed: 10 April 2020.

Dronecoria. https://dronecoria.org/pt/inicial/. Accessed: 17 October 2020.

Forest Code in the State of SP - Fapesp Thematic Project. https://codigoflorestal.wixsite.com/tematico. Accessed: 17 October 2020.

Forest Dialogue. https://dialogoflorestal.org.br/. Accessed: 17 October 2020.

Forest Seed Networks - River Doce Basin. https://www.caminhosdasemente.org.br/redes-de-sementes/rede-de-sementes-e-mudas-do-rio-doce. Accessed: 17 October 2020.

Forest, Water and Climate Good Practices in Brazilian Biomes. https://repositorio.ufsc.br/xmlui/handle/123456789/134909. Accessed: 17 October 2020.

Global Forest Watch. https://www.globalforestwatch.org/. Accessed: 10 April 2020.

IBGE – Brazilian Institute of Geography and Statistics. https://www.ibge.gov.br. Acessed date: 17 October 2020.

IUCN - International Union for Conservation of Nature. https://www.iucn.org/theme/nature-based-solutions/initiatives/decade-ecosystem-restoration. Accessed: 17 October 2020.

Land Use Dialogue. https://dialogoflorestal.org.br/quem-somos/iniciativas/dialogo-do-uso-do-solo-brasil/. Accessed: 17 October 2020.

Magazine Reviews. https://www.revistaopinioes.com.br/. Accessed: 17 October 2020.

Mapbiomas Brazil. https://mapbiomas.org/estatisticas. Accessed: 17 October 2020.

MMA - Ministry of the Environment. https://www.mma.gov.br. Accessed: 10 April 2020.

Network of Native Seedling Nurseries of Vale do Ribeira. https://www.nativasvaledoribeira.com/. Accessed: 17 October 2020.

New Generation Plantations. https://newgenerationplantations.org/. Accessed: 17 October 2020.

Paraíba Valley Restoration Actors. https://restauracaovp.wixsite.com/atoresdarestauracao. Accessed: 17 October 2020.

Planalto. http://www4.planalto.gov.br/legislacao/. Accessed: 17 October 2020.

Reforest Program. https://www.es.gov.br/programa-reflorestar. Accessed: 17 October 2020.

Renova. https://www.fundacaorenova.org/ Accessed: 17 October 2020.

Restoration Opportunities Assessment Methodology (ROAM). https://infoflr.org/sites/default/files/2020-04/brazil_sub-national_roam_summary_english.pdf. Accessed: 17 October 2020.

Rural Environmental Registry (CAR). https://www.car.gov.br/#/. Accessed: 17 October 2020.

Seed Paths Initiative. https://www.caminhosdasemente.org.br/. Accessed: 17 October 2020.

SIF. http://sif.org.br/portfolio-items/gt-restauracao/. Accessed: 17 October 2020.

SNIF - National Forest Information System. http://snif.florestal.gov.br/pt-br/. Accessed: 17 October 2020.

TerraMatch. https://www.terramatch.org/. Accessed: 17 October 2020.

TNC – The Nature Conservancy. https://www.tnc.org.br/. Accessed: 17 October 2020.

WRI Brazil – World Resources Institute. https://wribrasil.org.br/en/node/44533. Acessed: 10 April 2020.

Appendix

Appendix 1 – Questionnaire

Innovations in Forest Restoration Projects in the Atlantic Forest Biome

Do you agree with the use of your answers for the survey in question?

☐ yes

☐ no

Are you interested in receiving the results of this survey?

☐ yes

☐ no

Innovation Register

1) What is the name given to the innovation presented?

2) Where did the innovation take place? (* Report: Municipality / State / Microbasin)

3) Please report on the innovation (* Please inform: a) how was the process; b) who were the participants; c) what it consists of)

4) Inform the year that the innovation occurred

Innovation, Barriers & Stakeholders

5) Select the categories in which the innovation relates (*It is possible to select more than one category):

☐ Creating or improving a new product

☐ Creating or improving a new service

☐ Creation or improvement of a new process / procedure

☐ Strategy creation or improvement

☐ Organizational creation or improvement

☐ I don't know

☐ Others:

6) Indicate the categories participating in the innovation and the gender of the innovators (*It is possible to select more than one category):

1. Nursery
2. Field Restorer
3. Researcher
4. Project Manager
5. Landowner
6. Rural Community
7. Others

☐ Male predominance

☐ Female predominance

☐ LGBTQIA + predominance

☐ Gender Equality

7) What problem(s) motivated the search for innovation? (*Select a maximum of 4 categories)

☐ Absence or insufficiency of technical assistance and rural extension

☐ Absence, insufficiency or lack of knowledge of scientific knowledge

☐ Absence or insufficiency of a specific input (eg seedlings, seeds, etc.)

☐ Absence or insufficiency of technology in the operational process

☐ Absence or insufficiency of qualified labor

☐ High operational cost and / or low operational productivity

☐ Restrictive, ambiguous or contradictory legislation

☐ Absence or insufficiency of financing for forest restoration

☐ Administrative process for assistance required by environmental agency or financier

☐ Absence or insufficiency of forest restoration models for economic purposes

☐ Absence or insufficiency in the engagement of participants

☐ Others:

Investments, Patents & Public Policies

8) What was the investment for the development of innovation? (*Inform the approximate amount - R$)

9) What stage is innovation currently in?

☐ Prototype in development

☐ Prototype under test

☐ In use

☐ In adaptation

☐ Being replicated to other projects

☐ Abandonment

☐ I don’t know

10) What is the status of the innovation in relation to the patent?

☐ Patent initiated

☐ Patent in progress

☐ Patent completed

☐ Free access

☐ No patent

☐ I don’t know

11) What factors positively influenced the development of innovation? (*It is possible to select more than one category)

☐ Engagement of local actors

☐ Financing (example: agricultural credit, R&D)

☐ Network of regional stakeholders

☐ Cross-sector partnerships (example: industry and agricultural sector)

☐ Scientific research

☐ Public policy

☐ I don’t know

☐ Others

12) Innovation has evolved to: (*It is possible to select more than one category)

☐ New business

☐ Restoration model

☐ Adjustment in legislation

☐ Change in the governance model

☐ New social behavior

☐ New project

☐ I don’t know

☐ None of the above

☐ Others

13) Which public policy (s) influenced the development of innovation? (*Inform the name or number of the policy / Law inform number and date)

14) In your opinion, briefly report how public policies influenced the development of innovation.

15) Did the innovation arise through any restoration project?

☐ yes

☐ no

16) Was the innovation replicated in any forest restoration project?

☐ yes

☐ no

☐ I don't know

Project & Innovation

17) What is the name of the project where the innovation came from? (*Inform year of start and end of the project)

18) Where is the project located? (*Inform the Municipality/State/ Region or Hydrographic Basin)

19) What is the scale of the project:

☐ Local

☐ Regional

☐ State

☐ National

☐ International

☐ I don't know

20) What is the approach of the restoration project where the innovation arose? (*Select the option most adherent to the main objective of the project)

☐ Agroecology

☐ Agrobusiness

☐ Biodiversity Conservation

☐ Generation and maintenance of ecosystem services (Climate, Water, Biodiversity)

☐ Management of Native Species

☐ Social

☐ I don't know

☐ Others

21) What is the category of the project where the innovation came from? (*Select the option most adherent to the type of project)

☐ Adequacy to Legislation

☐ Environmental compensation

☐ Payment Ecosystem Services

☐ Research project

☐ Social

☐ Others

☐ I don't know

22) In what project activity did innovation arise? (*Select only 01 alternative)

☐ Engagement and mobilization activities

☐ Training

☐ Management

☐ Monitoring

☐ Research

☐ Planting

☐ Seedling production

☐ Others

Appendix 2 – Innovations Catalogue (source: own elaboration).

Nº	Innovation	Innovation Description	Year	State	Region	Tipology	Patent	Barriers	Search
1	Partnership between NGO and private company	initiative between NGO and forestry company with the objective of creating forest restoration projects that meet the mission of both institutions	2005	PR, SC	South	organizational	No	Others (fulfillment of environmental restoration goals in accordance with the ethical values of both institutions)	-
2	Brazilian Forest Dialogue	independent initiative between different stakeholders that facilitates the interaction between representatives of companies in the forest-based sector, NGO's and social movements with the aim of building common vision and agendas between these sectors.	2005	National	National	organizational	No	-	https://dialogoflorestal.org.br/
3	direct-seeding of native forests (muvuca)	forest restoration model using a mix of native forest seeds, green manure and sand. In this model the distribution of seeds can be made by haul or with the use of agricultural equipment.	2006	SP; MG; RJ	Southeast	process	No	1) Absence, insufficiency or lack of knowledge of scientific knowledge□ 2) Absence or insufficiency of technology in the operational process	-
4	Restoration models for economic purposes	forest restoration model with the inclusion of non-invasive exotic species of wood for timber purposes	2007	SP	Southeast	process	No	Absence or insufficiency of forest restoration models for economic purposes	-
5	Atlantic Forest Restoration Pact	creation of a network between different stakeholders (NGOs, companies, government, landowners, research institutes) with the aim of restoring the Atlantic Forest Biome through actions and influencing public policies	2009	National	National	organizational	No	-	https://www.pactomataatlantica.org.br/
6	Cambuci Gastronomic Route	creation of a partnership between rural producers, government and NGO for the development of a gastronomic route of native forest species (Cambuci) promoting the conservation of the Atlantic Forest and the sustainable economic development of landowners. Innovation promotes the cultivation and commercialization of the fruit in a sustainable way and, with this, it is also an important development alternative for the municipalities involved.	2009	SP	Southeast	marketing	No	1) Absence or insufficiency of forest restoration models for economic purposes 2) Absence or insufficiency in the engagement of participants	https://www.institutoaua.org.br/rotadocambuci/
7	Planting with green manure	forest restoration model that consists of planting tree species and direct seeding with species with green manure function. It begins with the sowing of the mix of species of green manure and native shrubs in all planting lines, with the spacing of 1.0 m between the rows, and the sowing of the mix of cover species and native legumes every 3 , 0 m, generating about 1,111 individuals in the cover group per hectare. It is recommended to first sow green manure between the lines of the covering group, being introduced in two lines, one meter away from the covering species. Ideally, cover species should be planted when the green manure is about 50 cm high.	2010	SP	Southeast	process	No	High operational cost and / or low operational productivity	-

Nº	Innovation	Innovation Description	Year	State	Region	Tipology	Patent	Barriers	Search
8	Staggered planting	restoration model considering a staggered planting strategy of seedlings or seeds, where combinations of species are made in planting groups, planted at different times. At this moment, only the cover species will be implanted, and the species in the diversity group should be deployed in a second moment.□ □	2010	SP	Southeast	process	No	High operational cost and / or low operational productivity	-
9	Nucleation (1)	use of 50kg jute bags with forest seeds distributed over the area to be restored	2010	MG	Southeast	process	No	High operational cost and / or low operational productivity	-
10	Nucleation (2)	intensive systematic nucleation module (semi-mechanized using different systematized nucleation techniques)	2010	PR	South	process	No	High operational cost and / or low operational productivity	-
11	Use of technologies, tools and processes in forest plantations for restoration areas	use of operational techniques, inputs and technologies used in the planted forest sector for native forest restoration	2010	National	National	product	No	High operational cost and / or low operational productivity	-
12	Network of Native Seedling Nurseries of Vale do Ribeira	creation of a network between forest nurseries with the objective of strengthening and bringing them closer by promoting greater exchange of information, knowledge, dissemination in the market, strengthening of those involved. The initiative was attended by representatives from universities, government and nurseries.	2011	SP	Southeast	organizational	No	1) Absence or insufficiency of technical assistance and rural extension 2) Absence or insufficiency of a specific input (eg seedlings, seeds, etc.) 3) Absence or insufficiency of technology in the operational process 4) Absence or insufficiency of qualified labor 5) High operating cost and / or low operating productivity 6) Restrictive, ambiguous or contradictory legislation 7) Absence or insufficiency of financing for forest restoration 8) Administrative process for assistance required by environmental agency or financier 9) Absence or insufficiency of forest restoration models for economic purposes 10) Absence or insufficiency in the engagement of participants	https://www.nativasvaledoribeira.com/

Nº	Innovation	Innovation Description	Year	State	Region	Tipology	Patent	Barriers	Search
13	New Generation Plantations (Benchmark florestal)	it's a network and platform place for sharing knowledge about good plantation practices and learning from experience	2011	National	National	organizational	No	High operational cost and / or low operational productivity	https://newgenerationplantations.org/
14	Arboretum Program for Conservation and Diversity Restoration Forest	Partnership created between companies in the forestry sector and the government to create an organized forest restoration action in the Atlantic Forest Biome	2011	BA, ES	Northeast and Southeast	organizational	No	1) Absence or insufficiency of a specific input (eg seedlings, seeds, etc.) 2) Absence or insufficiency in the engagement of participants "	https://programaarboretum.eco.br/
15	Neoforest (Neofloresta)	creation of a company focused on innovation and forest restoration services	2011	PR	South	service	No	-	-
16	Cooplanjé Cooperative	creation of a forestry and reforestation cooperative in the Pataxó village of Boca da MataindÍgena. The cooperative produces forest seedlings and the indigenous people are responsible for the management, production of seedlings and forest plantations in degraded areas.	2012	BA	Northeast	organizational	No	Others (Employment and Income Alternative)	-
17	Private Investments in Landscape Restoration (PILAR)	economic analysis of the main tropical forest restoration models	2013	ES	Southeast	process	No	Absence or insufficiency of forest restoration models for economic purposes	-
18	Sowing tray	product created for indirect seeding, characterized by a rectangular plastic tray, with four " feet " of support in its four corners, has a flat surface bottom with holes for water drainage 2, inside, the lateral faces have vertical slots 4, and to facilitate their transport and handling, they have anatomical and resistant handles on the smaller sides of the tray	2013	PR	South	product	Yes	Absence or insufficiency of a specific input (eg seedlings, seeds, etc.)	-
19	Seed bank sampler	forest seed bank sampler. characterized by four smooth and flat stainless steel sheets 1, two of which are sheets a and b 2, with thinner ends 4, which fit into slots 5, located close to the ends of sheets c and d, building a frame with a collection area of 1 m ^ 2 ^.	2013	PR	South	product	Yes	Absence or insufficiency of a specific input (eg seedlings, seeds, etc.)	-

Nº	Innovation	Innovation Description	Year	State	Region	Tipology	Patent	Barriers	Search
20	Seed rain collector	characterized by four foundations composed of cylindrical bars with tips at the lower ends to facilitate the penetration of the bar into the ground 1. The upper end of the bars has a circular steel plate 2, and attached to the top of the bars, through the carabiners 3, is fixed a collecting frame 4, consisting of four cylindrical rods 5, interconnected through connectors of the type " knee 90 <198> " 6. This frame serves as a support for a removable bag in rectangular shape 7, made with anti-mesh material - aphids 7, and supported by the rods 5 which are inserted in the waistband present at the top of the pocket 7. In the center of the base of the pocket there is a convex and removable cover 8 attached by a nylon thread to a plastic ring 9.	2013	PR	South	product	Yes	Absence or insufficiency of a specific input (eg seedlings, seeds, etc.)	-
21	Seedling plate tray	production of forest seedling plates consisting of a rectangular tray 1, its design is designed for the storage of substrate for the production of seedlings germinated from seed rain collected in natural forests, as well as soil from seed banks in areas natural, has a removable bottom of the " drawer " type with a flat surface 2 with holes for water drainage 3, and inside the tray, the side faces have grooves in the vertical direction 4, the two smaller sides have anatomical and resistant handles 5 to facilitate BPPMF transport and handling, and the bottom of the tray has support brackets 6.	2013	PR	South	product	Yes	Absence or insufficiency of a specific input (eg seedlings, seeds, etc.)	-
22	Planning tool - multicriteria prioritization	creatio of a multicriteria spatial restoration prioritization approach for the Brazilian Atlantic Forest hotspot to investigate alternative restoration scenarios	2014	National	National	product	No	Others (make assertive decisions to choose where to restore / best cost-benefit ratio)	-
23	CAR: Rural Environmental Registry	It is a national electronic public record, mandatory for all rural properties, with the purpose of integrating environmental information on rural properties and possessions regarding the situation of Permanent Preservation Areas - APP, Legal Reserve areas, forests and forest remnants. native vegetation, Restricted Use Areas and consolidated areas, composing a database for control, monitoring, environmental and economic planning and combating deforestation.	2014	National	National	product	No	Others (Understand the "gap" of areas in debt before the Forest Code; better land management)	https://www.car.gov.br/#/
24	Use of herbicide to reduce weed competition	Use of herbicide in the initial stage of forest restoration to reduce weed killer	2014	RJ	Southeast	product	No	1) Absence or insufficiency of technical assistance and rural extension□ 2) Absence, insufficiency or lack of knowledge of scientific knowledge□ 3) Absence or insufficiency of qualified labor□ 4) High operating cost and / or low operating productivity	-
25	Armed refuge	armed refuge for wild fauna. characterized by an interlockable armed structure with different levels overlapping alternately and a biomantle cover□ 1. level one 2, consists of three rollers 30 cm in diameter and 1 m long, squared on their abaxial faces□ 2. levels two 3, four 3 and six 6 consist of rollers of 15 cm in diameter, however, levels two and four 3 have four 3 rollers each and level six 6 has five rollers, both 1 cm long . levels three 4, five 5 and seven 7 have rollers 20 cm in diameter and 1 m long, levels three 4 and five 5 have four rollers each and level seven 7 has 5 rollers. the last level consists of a 100% biodegradable biomantle cover 8.□	2014	PR	South	product	Yes	Absence or insufficiency of a specific input (eg seedlings, seeds, etc.)	-

Nº	Innovation	Innovation Description	Year	State	Region	Tipology	Patent	Barriers	Search
26	Brazil Climate, Forestry and Agriculture Coalition	creation of a network between different stakeholders (companies, business associations from various sectors, research centers and civil society organizations) with the aim of proposing actions and influencing public policies for the development of a low carbon economy.	2015	National	National	organizational	No	-	http://www.coalizaobr.com.br/
27	Mapbiomas	initiative of different stakeholders (public, private and non-governmental organizations) in order to prepare annual maps of vegetation cover and land use for the whole of Brazil, supply gaps of information on the dynamics of land cover and reduce uncertainties in land use. estimates of greenhouse gas emissions. The data are available for free and are accessed on an online platform.	2015	National	National	product	No	-	https://mapbiomas.org/
28	ROAM (Restoration Opportunities Assessment Methodology)	Diagnosis of areas with possibilities of forest restoration using the ROAM methodology	2015	SP, ES, SC, PE	Southeast and South	service	No	-	https://infoflr.org/sites/default/files/2020-04/brazil_sub-national_roam_summary_english.pdf
29	Integrated Restoration System (SIR)	web system with spatial database that allows and facilitates the management and monitoring of forest restoration projects	2015	National	National	product	No	1) Absence or insufficiency of technology in the operational process□ 2) Administrative process for assistance required by an environmental or financing agency	-
30	PCJ Springs Policy	creation of a policy that works as a support tool for the conservation of water, soil, native vegetation, wetlands, swamps, marginal lagoons and springs.	2015	SP	Southeast	product	No	1) Absence or insufficiency of technical assistance and rural extension□ 2) Absence or insufficiency of technology in the operational process□ 3) Absence or insufficiency in the engagement of participants	-
31	Planting with different vegetation strata	forest restoration model considering the inclusion of tree, shrub, epiphyte species building a structure in different strata	2015	SP	Southeast	process	No	High operational cost and / or low operational productivity	-
32	Social forests (Matas sociais)	partnership between forestry company, NGO and landowners to promote forest restoration using traditional models and agroforestry system	2015	PR	South	process	No	-	-
33	Reforest Program	creation of a forest restoration program (PES) using financial resources from royalties; the building of a partnership between landowners, government, universities and companies promoted greater participation of participants in the project	2015	ES	Southeast	organizational	No	-	https://www.es.gov.br/programa-reflorestar

Nº	Innovation	Innovation Description	Year	State	Region	Tipology	Patent	Barriers	Search
34	Organomineral fertilization	use of organomineral fertilizer for fertilization in forest restoration projects	2015	SP	Southeast	process	No	High operational cost and / or low operational productivity	-
35	Use of mycorrhiza and rhizobium	use of mycorrhiza and rhizobium for the production of forest seedlings in a nursery	2015	SP	Southeast	process	No	High operational cost and / or low operational productivity	-
36	Paraíba Valley Restoration Actors (Atores da Restauração do Vale do Paraíba)	network of articulation between stakeholders with the objective of promoting forest restoration in the Paraíba Valley, acting in several sectors of the chain.	2016	SP	Southeast	organizational	No	Absence or insufficiency in the engagement of participants	https://restauracaovp.wixsite.com/atoresdarestauracao
37	Land Use Dialogue	platform for participation of different stakeholders, with the purpose of gathering knowledge and leading processes that influence responsible businesses, improve the governance of territories and promote inclusive development in relevant landscapes.	2016	National	National	organizational	No	-	https://dialogoflorestal.org.br/quem-somos/iniciativas/dialogo-do-uso-do-solo-brasil/
38	planting with functional direct seeding	forest restoration model using a mix of native, agricultural and shrub forest seeds, selected according to ecological function.	2016	SP	Southeast	process	No	High operational cost and / or low operational productivity	-
39	12 million ha in 12 real cases Economic models to promote ecological recovery in Brazil	economic, legal and financing analysis of 12 cases of forest restoration in 3 different biomes	2016	SP; BA	Northeast and Southeast	process	No	Absence or insufficiency of forest restoration models for economic purposes	-
40	Use of pre- and post-emergent controlled-release fertilizers & pesticides	inclusion of existing products and processes in the planted forest and agriculture sector for forest restoration	2016	SP	Southeast	product	No	High operational cost and / or low operational productivity	-
41	Forest Code in the State of SP - Fapesp Thematic Project	creation of partnership between different stakeholders and database in order to identify the areas to be restored according to the implementation of the New Forest Code (Law No. 12,651 / 2012) in the state of São Paulo	2017	SP	Southeast	service	No	Others (understand the land situation in the state of São Paulo under the New Forest Code)	https://codigoflorestal.wixsite.com/tematico
42	RenovaBio	National Biofuels Policy, established by Law No. 13,576 / 2017, which establishes annual national decarbonization targets for the fuel sector, in order to encourage an increase in the production and participation of biofuels in the country's energy transport matrix .	2017	National	National	process	No	Absence or insufficiency of forest restoration models for economic purposes	-

Nº	Innovation	Innovation Description	Year	State	Region	Tipology	Patent	Barriers	Search
43	Arboreto Project	building a partnership between university, landowners and Rural Extension representatives with the aim of spreading forest knowledge to landowners and creating new models of forest restoration for economic purposes	2017	PR	South	process	No	Absence or insufficiency of forest restoration models for economic purposes	-
44	financing companies different segments for catering	partnership between NGO and international companies from different segments to raise funds for forest restoration	2017	PE	Northeast	organizational	No	-	-
45	Tool for monitoring vegetation areas	use of a tool (Global Forest Watch) for monitoring Legal Reserve areas and Permanent Preservation Areas	2017	PR	South	process	No	High operational cost and / or low operational productivity	-
46	Ox plow for preparing planting lines	The technique consists in opening the planting lines with an ox plow on a steep slope. The seedlings are planted in rows at the level that later function as small terraces favoring the infiltration of water in the soil and a better development of the seedlings.	2017	RJ	Southeast	product	No	Absence or insufficiency of technology in the operational process	-
47	Soil attributes as indicators of restored areas	Collection of microbiological biological chemical physical parameters and soil morphology at a depth of 0 to 10 cm to assess soil quality in a restored area.	2017	SP	Southeast	process	No	Absence, insufficiency or lack of knowledge of scientific knowledge	-
48	Educational Native Orchards Program (Programa Pomares Nativos Educativos)	creation of a network between city hall, schools, local residents for forest restoration through the implantation of orchards of native fruit trees and promoting environmental education.	2018	SP	Southeast	organizational	No	Absence or insufficiency in the engagement of participants	-
49	AnaliSAF	is a digital system that performs socio-environmental and financial analyzes of agroforestry systems (SAFs), with the objective of assisting rural producers, extension technicians, researchers and managers of SAFs in general, in improving their techniques and improving productive, social and environmental results of your plantations. The system was developed in partnership with NGO's, research institutions and the government.	2018	National	National	product	No	1) Absence, insufficiency or lack of knowledge of scientific knowledge□ 2) Absence or insufficiency of forest restoration models for economic purposes	https://analisafs.tnc.org/auth/login
50	TerraMatch	online platform that connects project financiers with institutions that carry out forest restoration	2018	National	National	organizational	No	-	https://www.terramatch.org/
51	Seed Paths Initiative (Iniciativa Caminhos da Semente)	is a network of people and organizations with the objective of scaling ecological restoration in Brazil with a focus on the direct sowing method (muvuca).□ □	2018	SP	Southeast	process	No	1) Absence or insufficiency of technical assistance and rural extension□ 2) Absence, insufficiency or lack of knowledge of scientific knowledge□ 3) Absence or insufficiency of a specific input (eg seedlings, seeds, etc.)□ 4) Absence or insufficiency of technology in the operational process□ 5) Absence or insufficiency of qualified labor□ 6) Restrictive, ambiguous or contradictory legislation□ 7) Absence or insufficiency in the engagement of participants	https://www.caminhosdasemente.org.br/

Nº	Innovation	Innovation Description	Year	State	Region	Tipology	Patent	Barriers	Search
52	Financing of the Legal Reserve Forest Restoration with Economic Exploration / Productive arrangements for forest restoration	identification and evaluation of economic models for restoring Legal Reserve areas	2018	SP; PR	Southeast and South	process	No	Absence or insufficiency of forest restoration models for economic purposes	-
53	Monitoring partnership	Partnership between institutions in order to monitor and protect native forest areas in the region where they operate (Pau Brasil National Park & Independent Environmental Protection Police Company of Porto Seguro-CIPPA / OS)	2018	BA	Northeast	organizational	No	High operational cost and / or low operational productivity	-
54	Dronecoria	construction of a drone for dispersing seeds in restoration projects. Built in plywood, with approximately 1.5 meters in diameter and six engines, the drone weighs 9 kg and has the capacity to load an additional 10 kg in seeds.	2018	MT	Midwest	product	No	High operational cost and / or low operational productivity	https://dronecoria.org/pt/inicial/
55	Chain between Forest Seed Networks	articulation between seed networks in the country by building strategic planning at the national level to meet local demands (exchange of information, seeds, seed collection, etc.), mitigating risks for seed collectors and meeting the goals of forest restoration.	2019	MG, ES, BA, SP, RJ	Northeast and Southeast	organizational	No	Absence or insufficiency of a specific input (eg seedlings, seeds, etc.)	-
56	Forest Seed Networks - River Doce Basin	creation of a seed network to support a forest restoration project	2019	MG, ES	Southeast	organizational	No	Absence or insufficiency of a specific input (eg seedlings, seeds, etc.)	https://www.caminhosdasemente.org.br/redes-de-sementes/rede-de-sementes-e-mudas-do-rio-doce
57	Online platform free for consulting restoration projects	improvement of online platform for registration and online consultation of forest restoration projects	2019	SC	South	product	No	-	http://apremavi.cargeo.com.br/login/?next=/
58	Restore	creation of software that makes the forest restoration project and allows monitoring by the user.	2019	PR	South	product	No	1) Absence, insufficiency or lack of knowledge of scientific knowledge□ 2) Restrictive, ambiguous or contradictory legislation□ 3) Absence or insufficiency of financing for forest restoration□ 4) Administrative process for assistance required by environmental agency or financier□ 5) Absence or insufficiency in the engagement of participants	-
59	Institutional Self-Management	adoption of the self-management system in all institutional spheres within the organization and joint decision-making with the participation of everyone in the circle.	2019	SP	Southeast	organizational	No	Others (The search for a new way to manage and execute institutional actions. Sharing actions and responsibilities, giving everyone a voice)□	-
60	Biodegradable packaging for planting seedlings	use of ellepot tube for the production of forest seedlings, incorporation of existing technology and used in other sectors	2019	SC	South	product	No	-	-

Nº	Innovation	Innovation Description	Year	State	Region	Tipology	Patent	Barriers	Search
61	Restoration Working Group	it is an initiative between universities and companies active in the forestry, mining and energy generation sectors, with the aim of promoting the exchange of knowledge and experiences in the technical area, seeking to reduce costs, improve processes, innovations.	2020	MG	Southeast	organizational	No	High operational cost and / or low operational productivity	http://sif.org.br/portfolio-items/gt-restauracao/
62	Online platform for consolidation of projects forest restoration	online platform (under development) created to centralize information on forest restoration projects carried out in Brazil with the aim of organizing and transparency of data	2020	National	National	product	No	Others (Consolidate all restoration projects already carried out and analyze whether they are adhering to international commitments)	-
63	Network of companies seeking financing	creation of a network between companies from different sectors to seek financing for forest restoration	2020	SP	Southeast	organizational	No	Absence or insufficiency of financing for forest restoration	-
64	Tool for monitoring restored areas	creation of APP (under development) to map costs and monitor operational performance in forest restoration projects	2020	National	National	product	No	High operational cost and / or low operational productivity	-
65	Seed capsules	creation of a capsule (in progress) for storage of seeds to be dispersed by drones in forest restoration plantations	2020	MT	Midwest	product	Yes	High operational cost and / or low operational productivity	-
66	PBAI - Basic Indigenous Environmental Plan	forestry sector company initiative in the construction of a forest restoration program (ecological corridor) including indigenous areas using, mainly, the conduction of regeneration; use of traditional knowledge of indigenous people to monitor restoration; assistance in the transfer of knowledge within the indigenous nucleus; restoration model by conducting regeneration (main) and planting only in conditions of difficult regeneration	2020	PR; SC	South	organizational	No	-	-

Appendix 3 – Forest and Landscape Restoration Initiatives (Adapted information from BNDES, 2020; WRI, 2020; TNC 2020).

year inicio	year fim	State	Project Name	Local	Area	Stakeholders	Financing	Project Objective	Research Cataloged Innovations
1862	-	RJ	Tijuca Forest	Rio de Janeiro	3.953 ha	-	-	riparian areas restoration and degraded area	
1991	in progress	PR	Itaipu Binacional Reforestation	several municipalities	20.957 ha	Itaipu Binacional	own resource	riparian areas restoration and degraded area; compliance legislation	
2000	in progress	SP	Protected Areas Restoration	several municipalities	6.500 ha	AES Holdings Brasil Ltda - AES-Tietê	own resource	riparian areas restoration; compliance legislation	31; 34; 35
2000	in progress	SP/MG/ES/BA/MS	Protected Areas Restoration	several municipalities	33.000 ha	Suzano S.A.	own resource	riparian areas restoration; compliance legislation	11; 63
2000	in progress	SP	Environmental and Agricultural Adequacy Program	several municipalities	10.000 ha	university, companies of sugar cane sector, landowners, service providers	sugar cane companies resource	riparian areas restoration; compliance legislation	4; 7; 8; 38; 40
2003	in progress	PR/SC/MS	Biodiversity Corridor	several municipalities	468000 (1)	Itaipu Binacional	R$ 4,8 million	construction of ecological corridor in degraded and riparian areas, promoting the connection between forest fragments	
2003	-	PR	State Program of Riparian Forest	several municipalities	60.000 ha	State governament	partnership between government and various institutions	riparian areas restoration; compliance legislation	
2005	2011	SP	Riparian Forest Recovery Program (PRMC)	several municipalities in the watersheds Alto Tietê, Paraíba do Sul e Piracicaba-Capivari-Jundiaí	-	São Paulo Department of Infrastructure and Environment (SMA)	Global Environment Facility (GEF) Financial	riparian areas restoration in joint action with the CATI Microbasin Program (Agriculture + Environment) and Integration with other projects and programs	
2005	in progress	MG	Waters Conservative Project	Extrema	6.135 ha	regional governmental and non-governmental institutions, and landowners	R$ 3,8 million	PES project: rural properties adaptation; maintain the quality of water sources	
2005	in progress	PR/SC	Matas Legais	several municipalities	3.106 ha	non-governamental institution (Apremavi) & Klabin	-	riparian areas restoration; degraded areras restoration; compliance legislation	1; 32
2009	2012	SP	Water Producers Project	Joanópolis, Nazaré Paulista	20.000 ha	governmental and non-governmental institutions, and landowners	Global Environment Facility (GEF)	PES project: conservation and riparian areas restoration	
2009	-	RJ	Water and Forest Producers Project	Guandu River Basin	5.000 ha conserved and 500 ha restored	governmental and non-governmental institutions, and landowners	-	PES project: conservation and riparian areas restoration	

year inicio	year fim	State	Project Name	Local	Area	Stakeholders	Financing	Project Objective	Research Cataloged Innovations
2009	2010	MG	Amanhagua	several municipalities	500 ha	non-governamental institutions	The Nature Conservancy (TNC)	PES project: conservation and riparian areas restoration	
2009	2015	MG	AMAJF (Association for the environment of Juiz de Fora)	several municipalities	400 ha	non-governamental institutions	The Nature Conservancy (TNC)	PES project: conservation and riparian areas restoration	
2010	-	SP/MG	New Green Project	Águas de Lindóia, Amparo, Itapira, Lindóia, Monte Alegre do Sul, Pedrea Bela,	175 ha	non-governamental institution (Copaíba Environmental Association)	R$ 1 million (Petrobrás)	riparian areas restoration; compliance legislation	
2010	2015	ES/MG	To Seed (Semear)	Aimorés (MG) / Colatina (ES)	155 ha	non-governamental institution (Terra Institution)	R$ 2,4 million (BNDES - National Bank for Economic and Social Development)	riparian areas restoration; protected areas restoration; compliance legislation	
2010	2014	SP	Riparian Forests Restoration of the Ribeirão Monte Alegre watershed	Monte Alegre do Sul	21 ha	non-governamental institution (Copaíba Environmental Association)	R$ 356.000 (PCJ Committee - Hydrographic Basin Committee of the Piracicaba, Capivari and Jundiaí	riparian areas restoration; compliance legislation	
2011	2015	SP/SC	Sustain the Forest: Preserving Forests, Developing Communities	Cananeia/SP, Cajati/SP, Barra do Turvo/SP, Caçador/SC	130 ha	non-governamental institution (TNC - The Nature Conservancy)	R$ 1,7 million (BNDES)	riparian areas restoration; protected areas restoration; compliance legislation	
2011	2015	SP	Life Corridors: Landscape Restoration and Income Generation in the Atlantic Forest of Western São Paulo	Mirante do Paranapanema, Teodoro Sampaio	200 ha	non-governamental institution (IPÊ - Ecological Research Institute)	R$ 3,6 million (BNDES)	riparian areas restoration and degraded area; compliance legislation	
2011	2015	PR	Cultivating Hope	Guarapuava, Inácio Martins	95 ha	non-governamental institution (Mater Natura – Environmental Studies Institute)	R$ 1,4 million (BNDES)	riparian areas restoration; compliance legislation	
2011	2014	BA	Monte Pascoal - Pau Brasil Ecological Corridor Project	Porto Seguro	220 ha	non-governamental institution (Environmental Group Natureza Bela)	R$ 3,6 million (BNDES)	protect area restoration	16; 53
2011	2014	SP	Forest Restoration of Springs and Streams of Oratório neighborhood	Socorro	9 ha	non-governamental institution (Copaíba Environmental Association)	R$ 105.000 (FEHIDRO - State Water Resources Fund / CBH -Mogi)	riparian areas restoration; compliance legislation	
2011	2014	SP	Riparian Forest Restoration of Ribeirão dos Cubas	Socorro	5 ha	non-governamental institution (Copaíba Environmental Association)	R$ 92.500 (FEHIDRO - State Water Resources Fund / CBH -Mogi)	riparian areas restoration; compliance legislation	
2011	-	BA/ES	Arboretum Program	Coastal Tabuleiro Forest (southern BA and northern ES)	48.000 ha	governamental institutions, universities, landowners	pulp & paper companies	riparian areas restoration; protected areas restoration; degraded areras restoration; compliance legislation	14
2011	-	SC	Social Networked Carbon	several municipalities	600 ha	governamental and non governamental institutions, universities, landowners	R$45.500	PES: riparian areas restoration; degraded areras restoration; compliance legislation	
2011	2015	RJ	Ecological Restoration on the Atlantic Forest FIOCRUZ Campus	Rio de Janeiro	344 ha	Oswaldo Cruz Foundation (FIOCRUZ) and Foundation for Scientific and Technological	R$ 2,5 million (BNDES)	protect area restoration	
2011	2014	BA	Riparian areas restoration in Bahia southern	Camacan, Uma	72 ha	Institute for Socio-environmental Studies of Southern Bahia (IESB)	BNDES	riparian areas restoration; protect area restoration	
2011	-	SP	Guaratinguetá Water Producer Program	Guaratinguetá	1.300 ha	governamental institutions	-	PES: riparian areas restoration; compliance legislation	

year inicio	year fim	State	Project Name	Local	Area	Stakeholders	Financing	Project Objective	Research Cataloged Innovations
2011	2013	RJ	Ecological Corridor - São João River Basin	São João Basin Areas	25 ha	regional governmental and non-governmental institutions, andl landowners	-	ecological corridor implementation to connect protect area	
2011	in progress	ES	Reflorestar Project	several municipalities	80.000 ha	governamental and non governamental institutions, universities, landowners	R$ 73 million (BANDES - Development Bank of Espirito Santo)	PES project: conservation and riparian areas restoration	33
2011	2013	PB	Borborema Restoration Project	Borborema	-	non-governamental institution (AS-PTA Family Farming and Agroecology)	-	restoration degraded area using agroecology	
2012	2015	SP	River Lashes	Jaú, Ibitinga	117 ha	non-governamental institution (Pró-Terra Institute)	R$ 2 million (BNDES)	riparian areas restoration; compliance legislation	
2012	2015	SP	Sowing Sustainability - Forest Recovery	São Luiz do Paraitinga, Natividade da Serra	160 ha	non-governamental institution (Akarui - Association for Culture, Environment and	R$ 1,4 million (BNDES)	riparian areas restoration; compliance legislation	
2012	2016	SP	Riparian areas restoration of Springs and Watercourses III	Socorro	5 ha	non-governamental institution (Copaíba Environmental Association)	R$ 80.000 (FEHIDRO - State Water Resources Fund / CBH -Mogi)	riparian areas restoration; compliance legislation	
2012	2015	RJ	Poço das Antas Biological reserve restoration	Silva Jardim	62 ha	non-governamental institution (AMLD - Golden Lion Tamarin Association)	R$ 1 million (BNDES)	protect area restoration	
2012	2015	RJ	Mountain Range Colors (Cores da Serra)	Miguel Pereira	73 ha	non-governamental institution (ITPA - Terra Institute for Environmental Preservation)	R$ 1,2 million (BNDES)	riparian areas restoration; compliance legislation	
2012	2016	SP/PR	Green Initiative	several municipalities	425 ha	non-governamental institution (Green Iniciative)	R$ 7,8 million (BNDES)	riparian areas restoration; compliance legislation	
2013	-	SP/MG	Sowing water project	SP: Bragança Paulista, Joanópolis, Mairiporã, Nazaré Paulista e Piracaia;	-	non-governamental institution (IPÊ - Ecological Research Institute)	-	riparian areas restoration; compliance legislation	
2013	2015	SP	The management of juçara (*Euterpe edulis*) as a conservation strategy for the Atlantic Forest	Ubatuba	200 ha	non-governamental institution (IPEMA - Institute of Permaculture and Ecovillages of the Atlantic Forest)	Petrobrás	restoration and conservation areas using agroecology	4
2013	2015	SP	Planting Waters	several municipalities	74 ha	non-governamental institution (Green Initiative)	Petrobrás	riparian areas restoration; degraded areras restoration; compliance legislation	
2013	2015	SP	Weaving the Waters Project	Caraguatatuba, São Sebastião	-	governamental and non governamental institutions, universities, landowners,	Petrobrás	riparian areas restoration; compliance legislation	
2013	2016	SP	Riparian forest restoration of springs and watercourses IV	Rio do Peixe Basin	4 ha	non-governamental institution (Copaíba Environmental Association)	R$ 83.500 (FEHIDRO - State Water Resources Fund / CBH -Mogi)	riparian areas restoration; compliance legislation	
2013	2016	SP	Riparian Areas Forest Restoration of Peixe River Basin in Serra Negra	Serra Negra	5 ha	non-governamental institution (Copaíba Environmental Association)	R$ 86.500 (FEHIDRO - State Water Resources Fund / CBH -Mogi)	riparian areas restoration; compliance legislation	

year inicio	year fim	State	Project Name	Local	Area	Stakeholders	Financing	Project Objective	Research Cataloged Innovations
2013	2016	SP	Riparian springs restoration and watercourses in the Peixe River Basin	Rio do Peixe Basin	11 ha	non-governamental institution (Copaíba Environmental Association)	R$ 185.000 (FEHIDRO - State Water Resources Fund / CBH -Mogi)	riparian areas restoration; compliance legislation	
2013	2017	SC	Restoring	Indaial	500 ha	Blumenau Regional University Foundation (FURB)	R$ 5 million (BNDES)	protect area restoration	
2013	2016	RJ	Rio D'ouro Forest	Nova Iguaçu	130 ha	non-governamental institution (Onda Verde Environmental Organization)	R$ 2 million (BNDES)	protect area restoration	
2013	2015	ES	Water Planters Project	Alegre	15 ha	governamental and non governamental institutions, universities, landowners	Petrobrás	riparian areas restoration; compliance legislation	
2013	2015	BA	Águas da Bahia Project	Itamaraju, Itanhém, Jucuruçu, Prado, Guaratinga	-	-	Petrobrás	riparian areas restoration; compliance legislation	
2013	2015	RJ	Caring for the Waters Project	Nova Iguaçu	60 ha	non-governamental institution (Onda Verde Environmental Organization)	Petrobrás	riparian areas restoration; restoration degraded area	
2013	2015	RJ	Guapiaçu Grande Vida Project	Guapiaçu River Basin	100 ha	-	Petrobrás	riparian areas restoration; restoration degraded area	
2013	2015	ES	Riparian Forest Recovery near Itaúnas State Park	Conceição da Barra	14 ha	non-governamental institution (CSCAJB - José Bahia Social and Cultural Center)	Petrobrás	riparian areas restoration; restoration degraded area	
2013	2015	PR	Riparian Forest Recovery and Installation of Agroforestry Systems in the RAPPs Project	Antonina	15 ha	non-governamental institution (ADEMADAN - Antonina's Association for the Defense of	Petrobrás	riparian areas restoration; restoration degraded area	4
2014	in progress	SP	Springs program	several municipalities	14.705 ha	governamental and non governamental institutions, universities, landowners	-	riparian areas restoration; compliance legislation	
2015	in progress	SP/MG/PR	Cities for Water Coalition	several municipalities	33.000 ha	governamental and non governamental institutions, companies, population	-	riparian areas restoration; compliance legislation	
2015	2017	SP	Springs forest restoration and affluent streams of Rio do Peixe	Rio do Peixe Basin	10 ha	non-governamental institution (Copaíba Environmental Association)	R$ 185.000 (FEHIDRO - State Water Resources Fund / CBH -Mogi)	riparian areas restoration; compliance legislation	
2015	in progress	RJ	Pact for Waters	several municipalities	22000 [(1)]	governamental institutions	R$ 210 millions	PES project: conservation and riparian areas restoration	
2015	2018	MG	Planting the Future	several municipalities	20000 [(2)]	governamental and non governamental institutions, landowners	R$ 396 millions	riparian areas restoration; restoration degraded area	
2015	2016	BA	Forest restoration Pau Brasil National Park	Porto Seguro	100 ha	non-governamental institution (Environmental Group Natureza Bela)	BNDES	protect area restoration	16; 53

year inicio	year fim	State	Project Name	Local	Area	Stakeholders	Financing	Project Objective	Research Cataloged Innovations
2015	in progress	PR	Matas Sociais	several municipalities	-	non-governamental institution (Apremavi) & Klabin	-	riparian areas restoration; degraded areras restoration; compliance legislation; agroforestry system	
2016	2018	SP/MG/RJ	Mantiqueira Conservative	several municipalities	1200000 (1)	governamental and non governamental institutions, landowners	-	PES: riparian areas restoration	
2016	in progress	ES/MG	Renova Project	several municipalities	40.000 ha	non-governamental institution (Renova Foundation)	R$ 1bi (Conduct Adjustment Term)	recover area affected by ore tailings dam rupture	3; 55; 56
2017	-	SP	São José Mais Água Program	São José dos Campos	42 ha	governamental and landowners	-	PES: riparian areas restoration	
2017	in progress	RJ/SP/MG	Recovery of Climate and Biodiversity Services in the Southeast Corridor of the Brazilian Atlantic Forest - Connection	sub-basins of the Pomba and Muriaé River (Zona da Mata Mineira)	5.500 ha	governamental and non governamental institutions, universities, landowners	US$ 11 million (GEF - Global Environmental Facility)	PES: riparian areas restoration and carbon storage	
2018	in progress	SP	Giant Guarani Program	Itatinga, Bofete, Pardinho	200 ha	governamental and non governamental institutions, university, landowners	R$ 3 million (BNDES)	riparian areas restoration; degraded areras restoration; compliance legislation	3
2018	in progress	SC	Restores Alto Vale	Alto Vale do Itajaí	162 ha	governamental and non governamental institutions, universities, landowners	R$ 4 million (BNDES)	riparian areas restoration; degraded areras restoration; compliance legislation	
2019	in progress	SP	Mogi Guaçu Roots	Socorro, Lindóia, Bueno Brandão	100 ha	non-governamental institution (Copaíba Environmental Association)	R$ 282.000 (WWF Brazil & International Paper)	riparian areas restoration; compliance legislation	
2019	-	MG	Permanent Preservation Areas Recovery Program	Galileia, Governador Valadares, Periquito	461 ha	non-governamental institutions (CIAAT - Information and Technical Advisory Center)	Renova Fundation	riparian areas restoration; compliance legislation	
2019	in progress	SP/MG/RJ/ES/PE	Seed Paths Initiative	several municipalities	-	non-governamental institution (Seed Paths Initiative)	-	riparian areas restoration; degraded areras restoration; compliance legislation	3; 51; 55
2020	in progress	RJ	Tomorrow Forests Program	several municipalities	1.100 ha	governamental and non governamental institutions, companies	Resources from Conduct Adjustment Term - TAC (Petrobrás)	generate positive impacts and reduce gas emissions	

Table caption:

(1) goal to attend
(2) include Atlantic Forest Biome and Cerrado Biome

Appendix 4 – Interviews Questionnaire

Questionnaire ("Interviews")

1) What innovation did you develop or know from 2010 to 2020 in forest restoration projects?

2) When and Where did it occur?

3) Who were the participants?

4) Do you know the percentual of gender involved?

5) What are the challenges (barriers) that drove innovation?

6) Did you invest in innovation? What the value?

7) Does innovation have a patent? If yes, what is the stage?

8) What factors positively influenced innovation?

9) Has innovation evolved into any new model, product, process, governance, project?

10) What public policies have influenced innovation?

11) Did the innovation arise from any restoration project?

12) Has it been replicated in any project?

13) What is the name and location of the project?

14) What is the project scale (local, regional, State, national, international)?

15) What is the main objective of the project?

16) In what project activity did innovation arise?