

POLICY ARTICLE

How policies constrain native seed supply for restoration in Brazil

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Large-scale ecological restoration programs across the world involve a voluminous demand for native seeds of diverse native plant species. In this article, we explore how institutional systems have operated and impacted native seed supply in Brazil. Native seed supply for restoration is essentially a community-based activity which faces broad barriers to operating within regulations because of requirements for excessive and costly technical documentation, scarcity of seed laboratories, and lack of instructions for native seed quality testing. Although decentralized seed networks have stimulated arrangements for local organizations to promote seed supply, policies constrain the development of local capacities and the ongoing sustainability of these organizations. These conditions have resulted in a vast network of informal collectors and producers who are largely “invisible” and unknown to the regulatory authorities. Policies have decentralized responsibilities from the state without devolving decision-making power to the multiple stakeholders engaged in policy elaboration. The policies maintain the centralized regulation of native seed supply. After examining Brazilian seed networks’ experiences and conducting discussions with stakeholders and experts, we suggest adapting the current regulations to more local level contexts, encompassing the following strategies: (1) ensuring native seed origin and identity; (2) relaxation of the laboratory accreditation process for native seed quality assurance; (3) fostering seed markets for restoration; (4) research to provide technological innovation; (5) supporting local, diverse, and small seed-based businesses.

Key words: native seed production, native seeds, seed networks, seed policy

Implications for Practice

- Seed policies in Brazil should distinguish between procedures to regulate commercial production of native seed for restoration and procedures to regulate seed supply for improved plant material for the forestry industry.
- Mandatory seed quality testing in accredited laboratories prevents formal recognition of local native seed suppliers and therefore simpler quality assurance is required.
- Multiple stakeholder participation in policy decision-making processes is essential to better adapt regulation to local realities.
- Governmental support is essential for structuring a consistent restoration market and technological innovation.

Introduction

Large-scale ecological restoration programs across the world involve a huge demand for native seeds of diverse native plant species (Merritt & Dixon 2011; Nevill et al. 2016). Locally adapted native seeds have been highlighted as a key element for successful long-term restoration programs (Broadhurst et al. 2008; Thomas et al. 2014); however, low genetic diversity and poor quality of native seeds remain widespread in these projects (Jalonen et al. 2017; Lillesø et al. 2018). Consequently, standards for ensuring native seed quality have been developed

by voluntary or mandatory certification schemes which require standard procedures to gain market credibility (Nyoka et al. 2014).

In tropical countries, seed programs have emerged to overcome native seed scarcity (Smith 2017), while national agencies have established regulations to ensure seed species identity, origin, and quality (Koskela et al. 2010). This approach has transformed local smallholders or communities into seed producers with no specialized skills to implement official procedures, resulting in a large amount of informal production (Dedefo et al. 2017). A decentralized native seed supply strategy in Brazil has been established by seed networks to promote production arrangements and provide opportunities for local communities (Piña-Rodrigues et al. 2007). Seed networks connect actors who have access to sources of local native

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species seed to landholders who need to implement mandatory restoration (Urzedo et al. 2016). Under Brazilian environmental regulations (Brazil 2012), international agreements (e.g. The Paris Agreement), landholders are required to restore 12 million hectares by 2030 (Brazil 2017). However, rigorous regulations have controlled native seed production and commercialization and resulted in disincentives and technical bureaucratization (Schmidt et al. 2018).

In this article, we first evaluate how seed policies have been developed for native seed supply in Brazil. Second, we assess which aspects of current policies have driven forces to constrain production and organizational systems for large-scale restoration. We then suggest key strategies to adapt current regulations to a more realistic context for supporting Brazilian restoration programs. We first analyze data from official documents and a literature survey to identify the main historical events related to native seed laws and regulations in Brazil. With this background, a workshop session on “Seeds for large-scale restoration: a matter of seed networks” was held at the Seventh World Conference on Ecological Restoration in Brazil in 2017 (SER17). In this session, 69 participants (42.3% women) from 11 countries (72.46% from Brazil) discussed and identified the main strategies for redesigning institutional systems for scaling up native seed supply.

Policies for Native Seeds: A Historical Overview

The earliest policies related to the supply of tree seeds in Brazil were aimed at seed supply for plantations and the commercial forestry sector. In order to reduce pressures on native vegetation in the mid-1960s the Brazilian Government established a Forest Code (Brazil 1965) regulating forests on private rural landholdings. A tax incentive (Brazil 1966) was created to upscale the forestry sector through timber industry investments and public research funds. This culminated in the mid-1970s, in a highly productive timber industry based on exotic *Eucalyptus* and *Pinus* species (FAO 1979). With this economic success, tree seed supply became a key element for ensuring quality for the emerging market (Ferreira 2016). Thus, the first seed and seedlings law was established to control production and marketing based on commercial industry demands (Law n°. 6,507/1977) supervised by the Ministry of Agriculture (MAPA). In fact, the process attempted to apply standards of seed quality applicable to agricultural crops rather than standards to meet the genetic diversity appropriate for restoration.

Native seed production received national attention only from the 1990s with mandatory restoration projects in rural private lands required by the Forest Code (Brazil 1965). In 2001 and 2002, the first governmental funding was provided by the Ministry of the Environment (MMA) to promote a seed network program to operate a decentralized seed supply process. Based on this governmental initiative, eight seed networks were established in different Brazilian regions funded by more than US\$ 3.7 million (Fig. 1) coordinated mainly by governmental agencies and universities.

Considering the insufficient legal approach for tree seed, many forestry organizations and national agencies recognized

the needs for specific regulations. Only in 2003, when the National Seeds and Seedlings System (SNSM) was published, were specific regulations for forest seed production implemented (article 47 in Law n°. 10,711 and chapter XII in Decree n°. 5,153/2004). Subsequently, advisory committees established by MAPA proposed more detailed processes for forest and native seed identification, origin, and quality control (Normative Instruction no. 56/2011 substituted by no. 17-19/2017).

Native Seed Policy in Brazil

Current native seed regulations have been defined by MAPA with general standards, often based on large-scale agricultural and forestry approaches instead of considering the environmental needs for native forest species. According to the seed laws, seed producers, collectors, laboratories, and technicians must have accreditation on the National Registry of Seed and Seedlings (RENASSEM) on SNSM (<http://sistemasweb.agricultura.gov.br/renasem>) involving a mandatory procedure for production, inspection, labeling, and marketing of seeds (Fig. 2). Collectors are responsible for seed harvesting activity, while the producer is legally responsible for all steps in the entire supply chain and must provide required legal documents, including the seed source (origin) and species identity based on certification by a mandatory specialist technician (costing from US\$ 257 per month). The list of species names is required to be submitted on a National Register of Cultivars (RNC) platform which has not been updated for the species' scientific names, creating communication problems.

For quality control, traded seed lots must be labeled with the results of germination and purity testing in accredited laboratories following the Rules for Seed Analysis (MAPA 2009). Seed testing results can take from weeks to months depending on the laboratory, time of year, species, and logistics (Tilley et al. 2011). In addition, the producer must provide an invoice with a standard label and commercial terms provided by the responsible technician. Finally, this documentation must be systematized as an annual production report to be submitted to MAPA. This also requires a seed production plan for the following year, consisting of a list of species and quantities to be produced.

Native seed policies are confronted by the informality of the seed supply network as it operates in practice, leading to a wide debate about applying regulations. First, there is a lack of knowledge about native seeds. In Brazil, there are only 51 forest species with validated seed testing protocols issued by MAPA (Normative Instructions n° 44/2010, 35/2011, 26/2012) and nonofficial instructions for about 300 forest species (MAPA 2013), while in the US protocols have been developed for over 3,000 native species (Oldfield & Olwell 2015). Second, currently there are 225 accredited laboratories but only 16 operate with native and forest seed quality testing. These are mainly located in the south and southeast regions of Brazil. Third, native seed production is not regular, and producers have faced insufficient time frames for the collection, processing and administrative process required to comply with regulations and the high costs required to hire a mandatory specialized technician.

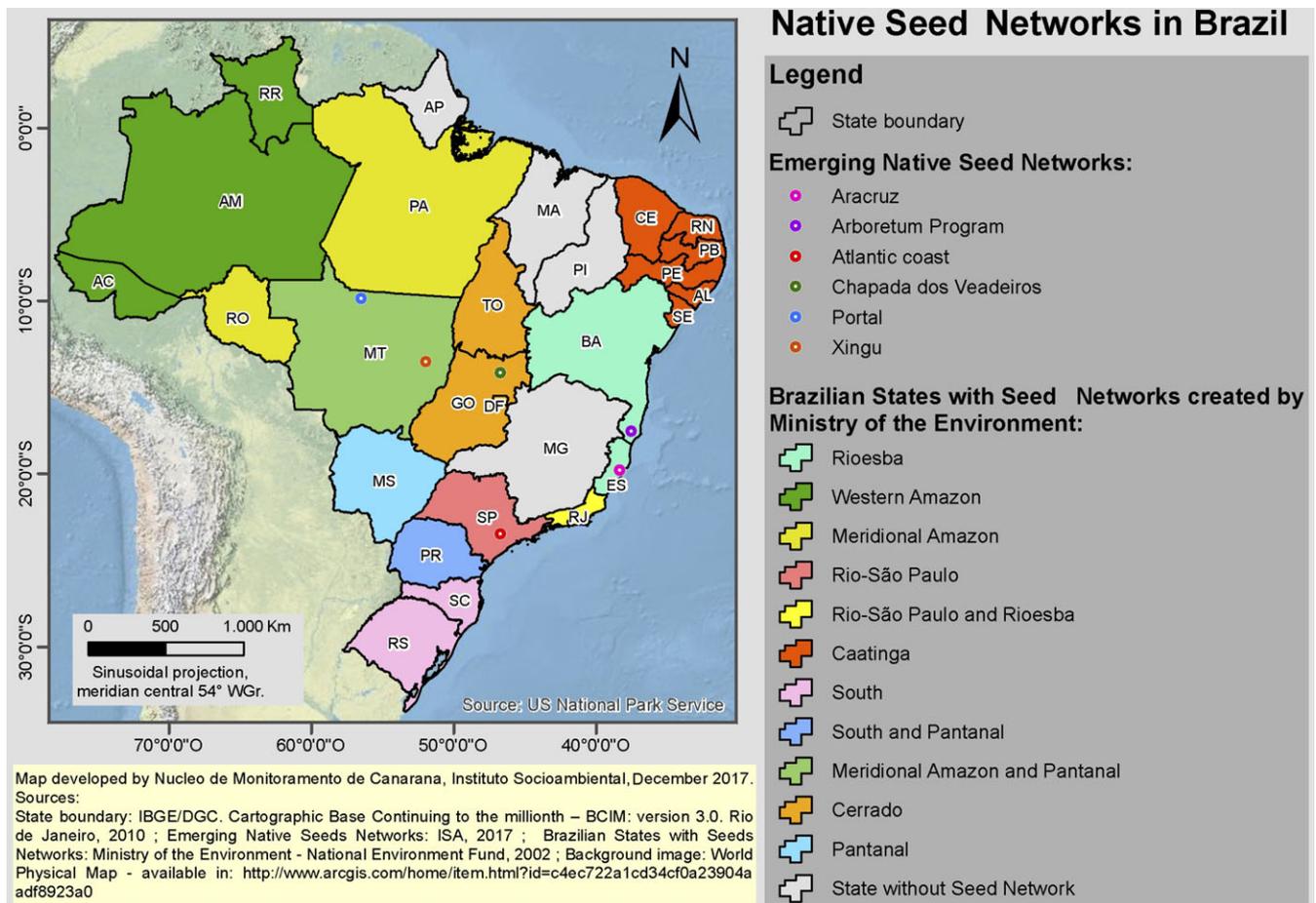


Figure 1. Seed networks financed by the Ministry of the Environment from 2001 to 2006 and emerging seed network in the different Brazilian states from 2007.

This centralized and bureaucratized process hinders the national seed production system based on community collection and high species biodiversity. Although the real number of informal native seed and seedling producers is unknown, there is clearly a high degree of informality in the sector. An indication of the number of collectors who are “invisible” is that the SNSM database recognizes only 264 seed collectors in 79 out of the 5,570 municipalities in Brazil (IBGE 2018). In contrast, case studies in the Brazilian Savanna and Amazon alone identified almost 600 collectors organized in community-based systems (Schmidt et al. 2018). The overall number of “invisible” collectors would clearly be much greater. The informality reduces the capacity of collectors to access support, information, and markets (Dedefo et al. 2017). In many other developing countries, particularly in Africa and Asia, restrictive seed laws have led to seed collection through informal channels (Nyoka et al. 2014; Lillesø et al. 2018).

Internationally, decentralized processes have supported native seed and seedling supply from community-based associations, cooperatives, and enterprises (Gregorio et al. 2004). However, plant reproductive material supply in Brazil remains limited by the restrictive seed regulations, fragile restoration

markets, and quantity of seed that can be collected. Although the Technical Commission on seeds and seedlings was officially established in 2004 to support participatory decision-making processes, MAPA agents are the only stakeholders responsible for accepting suggestions for new regulations. On the other hand, some recent advances in regulation were achieved (Normative Instruction no. 17-19/2017) based on the Technical Commission’s suggestions. Among the changes were: (1) native seed testing in nonaccredited laboratories to be permitted until 2020; (2) exemption from mandatory quality testing for recalcitrant seeds; and (3) permission to trade mixed native seeds for direct seeding subjected to the identification of species composition.

Native Seed for the Ecological Restoration in Brazil

The first seed network program in Brazil was quickly fragmented mainly because member organizations had no sustainable legal operation and business management systems to supply seed connected with regional restoration markets. Seed networks have fulfilled their mission of creating technical parameters, an online system of information (around

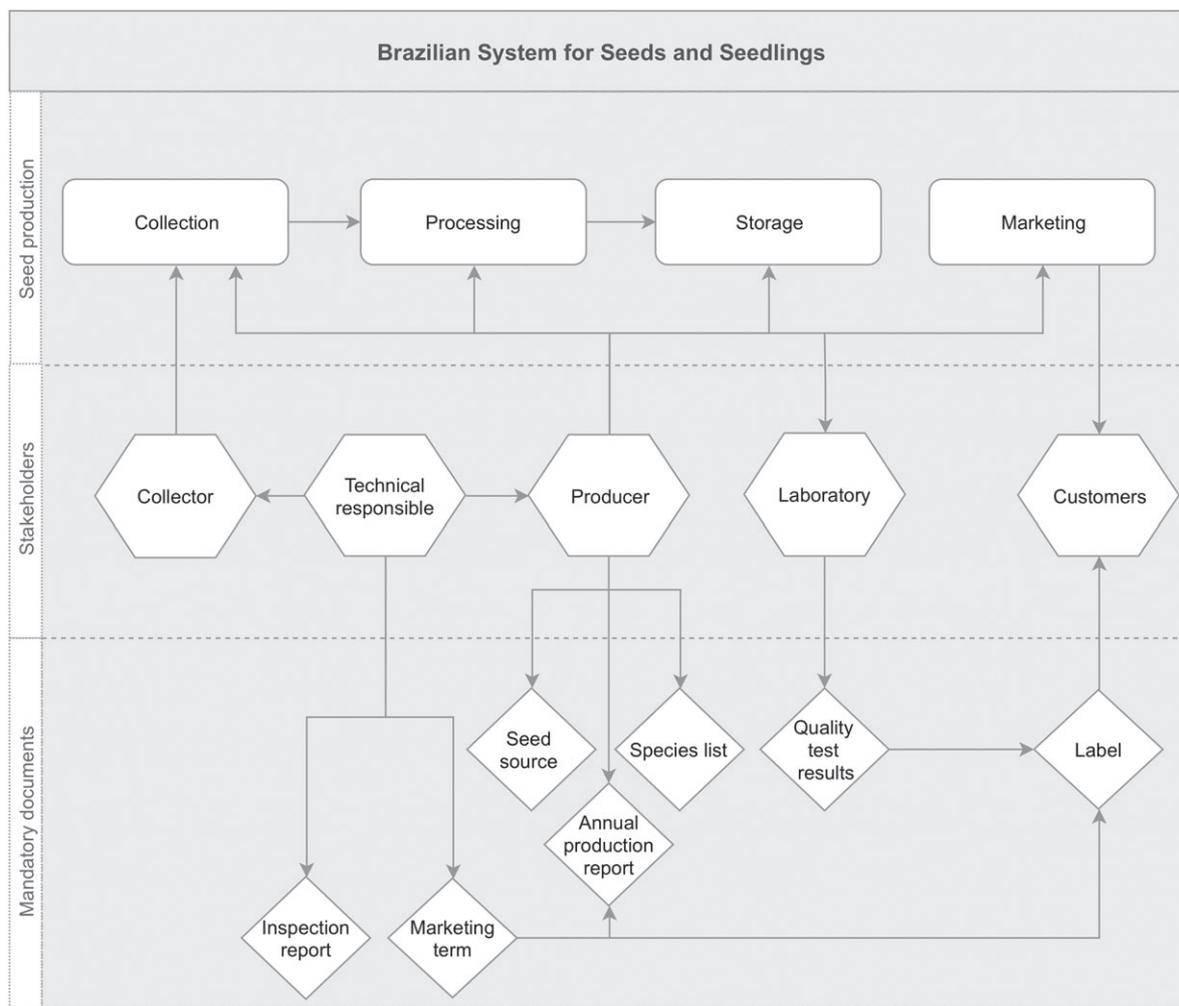


Figure 2. Procedures required by the Brazilian National System for seed and seedlings to formalize seed production and trading based on identity, origin, and quality mandatory requirements (Law n°. 10,711/2003, Decree n°. 5,153/2004, and Normative Instruction no. 17-19/2017).

10,000 trees of 1,200 native species mapped), training stakeholders (more than 2,500 people), and diagnosing seed marketing (Piña-Rodrigues et al. 2007). However, these actions did not result in the organization of an effective seed production and marketing system, and therefore all actions began to be dissolved without governmental funding support after 2010. Because the funding support program did not propose business practices, seed networks emphasized their expertise related to seed technology and training.

The restoration market is designed mostly to address mandatory restoration. Following several years of lobbying and debate, a recent change in the national environmental regulation (Law n°. 12,651/2012) reduced the area that must be restored nationwide from 50 to 12 million hectares and destabilized the demand for native seed and seedlings (Soares-Filho et al. 2014). For instance, in São Paulo State, native seed supply declined more than 20 times from 2005 to 2014 (Fig. 3).

On the other hand, the Native Vegetation Protection Policy (Decree n°. 8,972/2017) and the international agreements on climate change (e.g. The Paris Agreement) promoted

enthusiasm and opportunities for promoting restoration programs in Brazil. Under the national policies and commitments the national restoration target must be achieved by 2030 (Brazil 2017) and this political demand has promoted an emergent seed and seedling market. Unlike the first national program for seed networks (Table 1), the emergent organizations have been focused on community-based systems which are strongly aligned with local and regional markets, with commercial partnerships and financing projects (Urzedo et al. 2016; Schmidt et al. 2018). Although local-level coordination creates a consistent market that can make regional native seed production financially viable, the local organizations require high investments for the first years for building capacities, infrastructure, and techniques (Smith 2017).

Perspectives and Strategies for Policy Enhancements

The development of policies and programs requires greater devolution of decision-making power for collective negotiation between multi-stakeholder groups for native seed supply

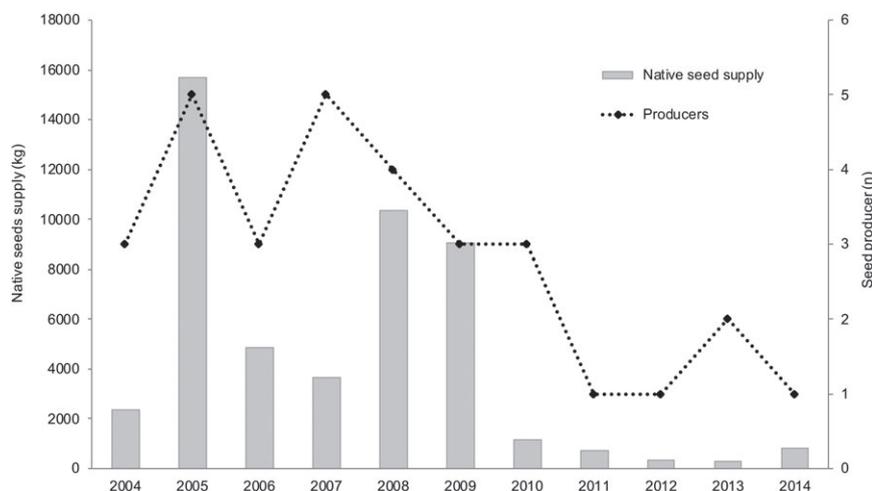


Figure 3. Native seed supply and producers in Rio de Janeiro and São Paulo State (Brazil) between 2004 and 2014 (Source: Rio-São Paulo Network).

Table 1. Comparative characterization of different seed networks' approaches for promoting actions to native seed supply in Brazil.

	<i>Early Seed Networks</i>	<i>Emerging Seed Networks</i>
Main stakeholders	Governmental research Governmental agencies Public universities	Non-governmental organizations Governmental agencies Associations and cooperatives
Funding	Specific governmental announcement	Diversified financing projects Seed trade
Main actions	Seed technology research Forest seed commissions Training courses	Community-based organization Seed production Commercial arrangements
Outcomes	Technical protocols Quality control tests Seed regulations	Household cash income Community livelihoods Restoration implementation

and markets. Figure 4 reports the main strategies stated and discussed by stakeholders, practitioners, and specialists for upscaling native seed supply to support the achievement of Brazilian restoration targets by 2030. We suggest adaptation of the current regulations mainly to support actions and capacity building for achieving the restoration target by 2030. Therefore, five key strategies are described below which are based on the seed networks' experience and the views of participants in the workshop session at SER17.

Seed Origin and Identity

It is recommended that high genetic diversity of plant materials be applied for restoration projects (Thomas et al. 2014). The current requirement for georeferencing the seed collection areas is a relevant mechanism to provided information of the plant material origin which has also supported the planning of local activities. This requirement draws attention to the importance of selecting the seed source, avoiding highly fragmented vegetation, degraded lands, and isolated trees. Moreover, restoration projects focused on the formation of seed orchards could provide more reliable plant material sources mainly for species that are less available in the seed market, such as late-successional

plant species. Although current species identification and source information required by the Brazilian law is relevant for restoration, the RNC must update constantly the species' scientific names on the platform to prevent miscommunication.

Relaxation of the Laboratory Accreditation Process for Native Seed Quality Assurance

The standard protocol for seed quality testing in accredited laboratories for each species is a high-cost operation and a restrictive requirement for this emergent industry (Abbandonato et al. 2017). The laboratory accreditation process has required mandatory infrastructure, teams of technicians, a standard management system, and competence for testing and calibration (ISO 2017). For spreading access to native seed testing, we suggest the registration of laboratories on the SNSM without the current mandatory and highly bureaucratic requirements. Consequently, universities and research institutes could play a key role for seed quality testing and assisting local producers, considering also specific incentives for operating this demand. We highlight the role of the purity test to identify the pure seeds, other crop seeds, inert matter, and weed seeds in a test

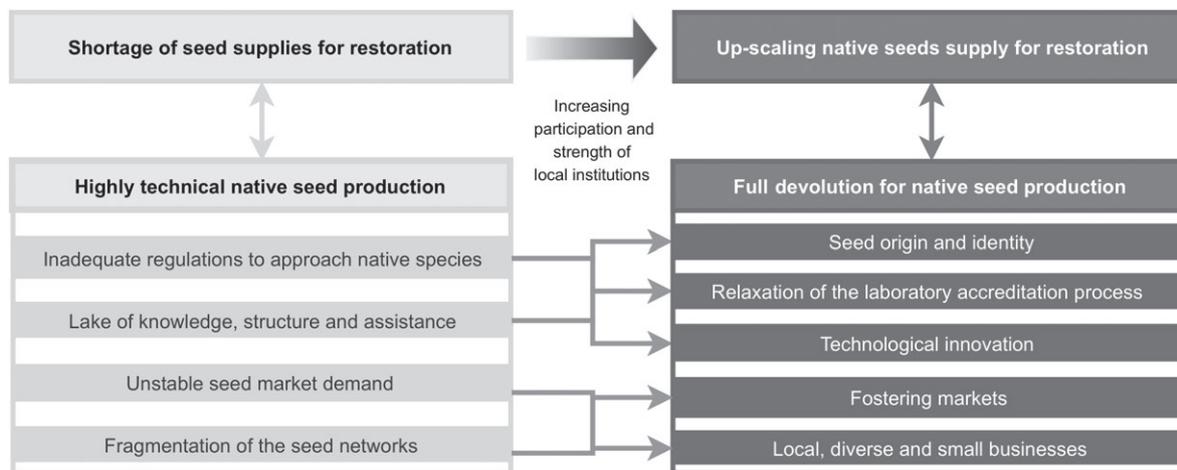


Figure 4. Main reasons for the shortage of supply native seed supply in Brazil based on the current technical approach considered in regulations; and an alternative full-devolution approach based on strategies to promote producer's formalization and large-scale production.

sample, particularly to avoid invasive species when restoration is developed by direct seeding. Moreover, alternative seed testing has to be officially recognized for supporting faster, cheaper, and easier procedures such as tests in nurseries focusing on emerging seedlings and the Pop Test (Tilley et al. 2011).

Research to Provide Technological Innovation

Quality seed testing remains poorly investigated for a huge number of species around the world (Dayrell et al. 2016). The research must focus not only on native tree species but also on seed technology and protocol developments for the native grass and shrub species. Emerging research topics to improve seed use for restoration such as seed coating (Pedrini et al. 2017) and faster testing such as using tetrazolium (Marin et al. 2017) are still necessary. Moreover, seed processing equipment is needed to achieve large-scale production (Smith 2017). Scientific and technical information must be accessed by suppliers to promote large-scale production with quality considerations (Lillesø et al. 2018). Thus, training programs and guideline development for practitioners, producers, and other stakeholders in native seed supply are essential. From this perspective, a seed database should be available on open access online platforms for seed stakeholders.

Foster Markets for Native Seeds for Restoration

Efforts to diversify and scale up native seed production depend to a large extent on adequate and reliable funding for development and ultimately on the market (Oldfield & Olwell 2015). As the native seed market is strongly associated with legal restoration requirements, governmental agencies have a central role to promote inspections for demanding restoration in rural properties. Moreover, we propose a program plan which would purchase seed to support small farmers and local communities to achieve their restoration requirements.

Support Local, Diverse, and Small Businesses

For long-lasting systems, policies and programs must support producers to develop strategic business planning with a focus

on financial operations, covering access to funding support and investments and commercial arrangements with partnerships. Governmental agencies have a key role in promoting funding support and credits to the small producer. Possible regulatory changes which could be considered include specific conditions for small producers (<500 kg seed yearly) who could be exempted from paying registration fees as is already legally recognized for small forest seedling producers (<10,000 seedlings yearly).

Conclusions

National policies have been developed to regulate forest seeds for well-developed forestry industry in Brazil focused on specific and improved plant materials, while native seed supply is aimed at restoration operated by community-based systems with a high diversity of plant materials. Regulations constrain native seed production and trade mainly because of the highly technical approach to determine seed origin, identity, and quality assurance. A similar pattern has limited seed programs in other developing countries where informal suppliers are responsible for most of the seed production (Dedefo et al. 2017). Excessive bureaucratization is one of the key barriers to upscaling native seed supply which has also challenged seed trade in developed countries (Abbandonato et al. 2017). The issue is not about deregulating seed quality control, but adapting or removing unnecessary bureaucratic barriers.

Although seed networks in Brazil have contributed to capacity development in local communities for production with social outcomes, policies restrict the development of long-lasting regional markets. These initiatives are vulnerable when faced with the challenges of structuring a viable commercial supply for restoration markets. This situation is not unique to Brazil, as seed organizations in many developing countries have also failed when exposed to business operations (Lillesø et al. 2018). Therefore, governmental and nongovernmental organizations play a key role for assisting and supporting local capacities for long-lasting initiatives. For better addressing collaborative

mechanisms with a stable market, seed programs need to receive incentives and mandatory restoration must be implemented. For achieving the Brazilian restoration goals, we consider that regulations must be adapted to the seed collectors' and producers' contexts with multi-stakeholder participation in different levels of the decision-making process.

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