



ACROCOMIA (MACAW PALM): A NEW OPPORTUNITY FOR INCLUSIVE BIODIESEL PRODUCTION IN BRAZIL?¹

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Resumo

O Brasil possui uma política pública de fomento à produção e uso de biodiesel, o Programa Nacional de Produção e Uso de Biodiesel (PNPB). O PNPB também busca promover a diversificação de matérias-primas e incluir pequenos produtores. O óleo de macaúba é uma matéria-prima potencial para atingir esses objetivos. No entanto, a cadeia de valor da macaúba no Brasil ainda está em desenvolvimento, com plantios comerciais em estágios iniciais de desenvolvimento. As plantações podem contar com árvores mais produtivas, maior número de árvores por hectare, padronização das linhas de cultivo e programação da colheita. Aliadas à inclusão produtiva, as plantações também contribuiriam para a segurança de renda e geração de empregos para os pequenos produtores. Assim, este artigo se concentra em analisar os desafios e oportunidades que envolvem a inclusão produtiva de pequenos produtores na cadeia de valor da macaúba brasileira com base na literatura e pesquisas de campo realizadas pelos autores no estado de Minas Gerais. Os principais resultados mostram oportunidades de inclusão, mas também alguns desafios a serem considerados com cautela. Esses desafios são: i) a mudança do agroextrativismo para plantações comerciais; ii) o tamanho da terra de alguns pequenos proprietários; iii) a lentidão na geração de resultados econômicos; e iv) experiências passadas negativas. Um modelo de governança tripartite, envolvendo Estado, empresários/investidores e pequenos produtores, tem potencial para destravar constrangimentos estruturais, proporcionar incentivos e garantir maior segurança na tomada de decisões para os stakeholders.

Palavras-chave: Macaúba. Biodiesel. Brasil. Pequenos produtores. Inclusão.

Abstract

Brazil has a public policy to promote the biodiesel production and use, the National Program for Biodiesel Production and Use (PNPB in Portuguese). PNPB also seeks to promote the diversification of raw materials and to include smallholders. Acrocomia oil is a potential raw material to meet these goals. However, Acrocomia's value chain in Brazil is still under development, with commercial plantations at the initial stages of development. Plantations may count on more productive trees, a greater number of trees per hectare, standardization of crop lines and harvest scheduling. Combined with productive inclusion, plantations would also contribute to income security and job generation for smallholders. Thus, this paper focuses in analyzing the challenges and opportunities surrounding the productive inclusion of smallholders in the Brazilian Acrocomia value chain based on literature and field research carried out by the authors in the state of Minas Gerais. The main results show opportunities for inclusion, but also some challenges to be considered with caution. These challenges are: i) the shift from agroextractivism to commercial plantations, ii) the size of the land of some smallholders, iii) the slow pace in generating economic results, and iv) negative past experiences. A tripartite governance model, involving the State, entrepreneurs/investors, and the smallholders has the potential to unlock structural constraints, provide incentives and guarantee greater security in decision-making for the stakeholders.

Key words: Acrocomia. Biodiesel. Brazil. Smallholders. Inclusion.

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1. Introduction

Productive inclusion of smallholders in value chains can be used as a strategy towards poverty alleviation and resilient and inclusive development (Gupta, Pouw, & Ros-Tonen, 2015; Liu, Cavaye, & Ariyawardana, 2020). In developing countries, poverty is generally concentrated in rural areas and many smallholders are vulnerable and face socioeconomic exclusion (Barbier & Hochard, 2018). The productive inclusion of this group of farmers contributes to reducing poverty by generating employment and income opportunities. Their inclusion is also an opportunity to incorporate into value chains local knowledge, low transaction costs and incentives to the private sector (Mishra & Dey, 2018).

In Brazil, the National Program for Biodiesel Production and Use (PNPB in Portuguese) seeks not only to expand the production of biodiesel, but also to promote regional and raw materials diversification, combined with the productive inclusion of smallholders (Córdoba, Selfa, Abrams, & Sombra, 2018). *Acrocomia*, also known as macaw palm, emerged as a potential raw material to meet these goals. However, the *Acrocomia* value chain in Brazil is still under development. The economic exploitation of this palm tree is fundamentally based on agroextractivism, and thousands of families engage in collecting *Acromia* in forest areas (Pageù et al., 2015). This format of exploration is temporary and has certain limitations. First, it is impossible to predict the quantity of available fruit. Second, there are logistical difficulties, as long distances must often be covered. Third, quality can be compromised, as overripe fruit found on the ground and fruit that is not ready for harvest are collected.

Plantations have the potential to ensure more productive palm trees, a greater number of palm trees per hectare, standardization of crop lines, harvest scheduling, income security and job generation for smallholders (Plath et al., 2016). In addition, the plantations are on the farmers' lands, which eliminates the logistical difficulties of agroextractivism. Nonetheless, commercial plantations are still at the initial stages of development and the shift from agroextractivism² is a complex process. The challenges of this transition are discussed in this paper, since failure may affect the productive inclusion of smallholders. Thus, the productive inclusion of smallholders in the biodiesel value chain based on *Acrocomia* in Brazil is largely dependent upon the success of the transition from agroextractivism to plantations, and to the farmers' adaptation to plantation systems of this crop.

Moreover, the development of new and innovative value chains requires new governance structures involving different sectors and stakeholders. Thus, we pose the question: How can the transition from agroextractivism to plantations with the inclusion of smallholders be accelerated? The focus of this work is to analyze the challenges and opportunities surrounding the productive inclusion of smallholders in the *Acrocomia* value chain in Brazil based on the available literature and field research carried out by the authors. We state that the successful productive inclusion of smallholder in the *Acrocomia* value chain is constrained by market incentives and strongly depends on governmental commitment and support to unlock structural constraints and provide incentives. Public support is especially relevant for the development of the chain in at least four dimensions: i) research, ii) financing (credit and subsidies), iii) development of technologies for genetic improvement, harvesting and processing, and iv) stable regulation. A tripartite governance model, involving the State, entrepreneurs/investors, and the smallholders has the potential to develop these four dimensions and guarantee greater security in decision-making for the stakeholders. Taking a multidimensional approach to meeting the needs of Brazilian smallholders is also key.

² The extraction of available resources from nature as a strategy to generate extra income (Wunder, 1999).



Providing access to education, infrastructure, technical assistance, inputs, technologies and markets must be complementary actions.

This paper is divided into six sections. Apart from this introduction, in the second section we explain our definition of productive inclusion and give some examples of smallholder inclusion in value chains. The characteristics of Brazilian smallholders are also presented. The third section presents general characteristics of Acrocomia in Brazil. The fourth presents the main findings of the field research carried out by the authors. In section five we discuss the importance of distributing the economic risks between the stakeholders, based on the literature and field research. Concluding remarks are presented in section six.

2. Acrocomia in Brazil

Acrocomia is a palm tree native to the tropical regions of the Americas. It is found from Florida to Paraguay and Argentina, but the largest natural populations of the different species of the plant are found in Brazil. Acrocomia mostly appears in pastures, disturbed areas, tilled land, and along roads. Advantages of the palm tree include its broad product range, which allows for the multipurpose use of high value-added products, and the already existing traditional use by local communities (Chuba, Silva, Santos, & Sanjinez-Argandoña, 2019). As the properties of Acrocomia oil are similar to those of palm oil, it can be used as an almost perfect substitute to the African palm tree oil in various markets, such as biodiesel, cosmetic, food industries and industrial applications (CIF, 2020).

For at least the past two decades, Brazilian federal and state agencies, entrepreneurs, and large businesses have supported the development of the Acrocomia value chain as an alternative crop for the biodiesel sector³ (Lopes, Steidle Neto, Mendes, & Pereira, 2013). Such support has been given to scientific research, the development of technological innovations and knowledge for domestication⁴, and the inclusion of different stakeholders, from farmers to investors (Bhering, 2007; Franco & Zimpel, 2020; Paes, Silva, & Lanza, 2011; Inter-American Development Bank, 2013; Pires, dos Santos Souza, Kuki, & Motoike, 2013). These deployment efforts are explicitly linked to - if not driven by - the National Program for Biodiesel Production and Use. This policy stipulated a fifteen percent biodiesel blending mandate in the domestic energy matrix until 2025 (Bergmann et al., 2013; Ribeiro, Moreira, Ferreira, & César, 2018).

The Minimum Price Guarantee Policy for sociobiodiversity products is an incentive for the agroextractivism of Acrocomia. Because of these policies, small farmers can use sales invoices to receive the difference between the market price and the established minimum price. The minimum prices established for Acrocomia are \$0.074 and \$0.082 dollars per kg, according to the region (National Supply Company, 2021). This policy instrument aims to provide a market reference for extractivists and reduce variations in income. The Law 19.485 (“Pró-macaúba”), instituted by the local government of the state of Minas Gerais, encourages the cultivation, extraction, commercialization, consumption, and transformation of Acrocomia. It also encourages the commercial plantation of macaúba, the creation of integration projects between farmers and the industry, and technical improvement (Minas Gerais, 2011).

³ Lopes et al. (2013) concluded that biodiesel plants based on *Acrocomia* with integrated oil mill and alkaline transesterification are profitable. However, domestication of the plant and improvements in the industrial process are fundamental.

⁴ Based on a systematic literature review, Vargas-Carpintero et al. (2021) presented the state-of-the-art in *Acrocomia*'s research and identified research gaps. They identified that research upon the species *Acrocomia aculeata*, widely present in Brazil, has increased over the last decade driven by the interest in bioenergy. Because of the research efforts, this species can be considered as semi-domesticated. The main research gaps found by the authors are related to genotype and environment interaction, planting material, crop management, and sustainable cropping systems.



Acrocomia is a species that has great cultivation potential in regions with unfavorable climatic conditions or poor-quality soils, such as the Brazilian savanna (Cerrado biome). In the Brazilian savanna, which covers 24% of the country's territory, the climate is usually dry, and the soil is largely degraded with signs of poor fertility (Andrade, Bolfe, Victoria, & Nogueira, 2017). This biome contains the largest pasture area in the country, and concentrates about 55% of all Brazilian cattle production. Studies show that at least 39% of the biome's pastures are degraded (Fernandes et al., 2018; Pereira, Ferreira, Pinto, & Baumgarten, 2018).

Hence, its cultivation in silvopastoral⁵ systems shows promising potential, allowing local producers to maintain cattle farming as a dominant economic activity while contributing to the livelihoods of rural farmers and to the recovery of the biome (Costa, Schoeneboom, Oliveira, Viñas, & Medeiros, 2018; Moraes et al., 2019). The diversification of goods can lead to a lower dependence on a single product market. In this sense, it is possible to earn extra income that will not harm the main business, but may in fact benefit it (César, Almeida, De Souza, Silva, & Atabani, 2015). As the Acrocomia harvest occurs after the coffee harvest, income opportunities are created in the off-season. Workers who chose to integrate the Acrocomia harvest in the off-season earned more than twice the minimum wage and more than for alternative jobs (Averdunk et al., 2014; Moreira et al., 2018).

3. Case study in Brazil: the potential of Acrocomia for productive inclusion of smallholders

To answer the question “how can the transition from agroextractivism to plantations with the inclusion of smallholders be accelerated?”, stakeholders from research and business initiatives involving Acrocomia in Brazil were interviewed. The field research was carried out in the state of Minas Gerais, home to native forests, agroextractivism, and pioneering plantations and smallholder productive inclusion initiatives. In addition, the productive structure in this state is based on dairy farming, which is one of the recommended forms for intercropping the plant, based on silvopastoral systems. The state also offers diversified business models, from cooperatives to strictly research-focused initiatives. Eighteen qualitative interviews based on semi-structured questionnaires were conducted in 2020 with researchers, businessmen, representatives from public and private sectors, smallholders and representatives from their organizations, such as cooperatives and unions⁶.

The aim of the interviews was to identify stakeholder perceptions of the incentives and barriers to supporting and participating in ongoing plantation initiatives. The interviews covered the productive and economic advantages, challenges, and the development and consolidation prospects of the value chain in Brazil in the foreseeable future (approximately 10 years). The interviews were transcribed and analyzed using the software MAXQDA, a qualitative data analysis tool. The software allows the encoding of excerpts from the interviews' transcripts. In the following sections we present the main findings from the interviews, together with findings from the literature to reflect on the arguments and detail some explanations.

3.1. From agroextractivism to commercial plantations

In Brazil, Acrocomia is already exploited by smallholders in agroextractivist systems. As it is already part of their culture, some interviewees indicated that it would not be difficult

⁵ One of the types of agroforestry systems. In this productive system, trees and pastures are placed in the same area (Lüdeke-Freund, Walmsley, Plath, Wreesmann, & Klein, 2012).

⁶ The research is approved by the Brazilian Research Ethics Committee under protocol number 44271321.4.0000.8142. To safeguard the rights of the participants and to comply with confidentiality obligations, neither the names of the initiatives visited nor the interviewees are mentioned in this paper.



to include plantation into current business models, in public or private projects. However, other interviewees mentioned the difficulties in moving to commercial plantations. Agroextractivism in Brazil is characterized as an activity performed by low-income farmers, usually in regions with the greatest pockets of poverty and social inequalities in the country (Carvalho & Gomes, 2009). Generally, these farmers make low capital investments and use simplified technologies, relying predominantly on manpower to extract and transport the fruit (Pageù et al., 2015). Historically, agroextractivism has represented a source of extra income without added production costs, and thus is an activity rooted in the culture and tradition of these populations (Lôbo et al., 2013). This type of exploitation is suited to the production system of small farmers, usually characterized by intense labor seasonality (Carvalho & Gomes, 2009). Thus, the opportunity cost of labor in agroextractivism is low.

A small farmer can collect on average one ton of *Acrocomia* per day in an agroextractivist system (Franco & Zimpel, 2020). However, the amount of time dedicated to collecting fruit by agroextractivism is directly influenced by the farming and breeding demands in the establishments. In other words, during soil preparation, planting, cultural treatments and harvesting, *Acrocomia* agroextractivism is not the focus of smallholders (A. N. Cardoso, Santos, Favaro, Diniz, & Sousa, 2020). In the field research many interviewees affirmed that a logistical issue has implications for the quality of the oil. As native *Acrocomia* is located out of the farmer's establishments, and often far away, in agroextractive harvesting all available fruit is collected at once: including fruit that has fallen to the ground and those that are not yet ripe. Thus, the fruit does not pass through a selection process before harvesting. This compromises the quality for higher value uses, such as for the cosmetic industry and biodiesel production.

Since 2007, commercial plantations have offered an alternative to the agroextractivist system in Brazil, without including small farmers⁷. *Acrocomia* plantations in smallholdings have been associated with socioeconomic advantages and opportunities for local development (Averdunk et al., 2014). Interviewees corroborated to this finding in the literature adding that it is possible to include vulnerable farmers since the crop requires little maintenance, low technology, presents high resistance, and grows in poor quality soils. However, the shift from agroextractivism to commercial plantations is not simple. First, it requires a change in the smallholders' usual exploitation system. It implies production costs, use of part of the land, time and work processes. Second, the size of some smallholdings reduces economies of scale and integration with pastures is inviable on properties that do not have sufficient space.

3.2. Size of the plot of land

Feasibility analysis strongly recommends integrating *Acrocomia* plantations with pastures (Averdunk et al., 2014; A. Cardoso et al., 2017). Two of the interviewees however explained that in the first three years of planting, the palm tree is extremely palatable to the herd. Thus, it is necessary to isolate the cattle until the fourth year. One of the alternatives employed by some of the small farmers was to plant food between the rows of plantations. The interviewed farmers were intercropping mainly with corn, watermelon, and peanuts. However, a very small property that survives exclusively on livestock⁸ would probably lacks the space to isolate cattle. In this sense, we may affirm that plantations in consortium to pastures is not suitable for smaller farmers⁹.

⁷ In our field research, carried out in 2020, only one initiative included smallholders in plantation projects. Another initiative was planning to start inclusion.

⁸ Brazilian family farming holds 31% of the number of cattle and is responsible for 64.2% of milk production (IBGE, 2017).

⁹ The average size of the properties of the interviewed farmers who planted macaúba was 57.5 hectares. Establishment sizes of the interviewed farmers varied from between 2 and 100 hectares.



3.3. Beginning of the plant's production phase

There is an important implication for *Acrocomia* cultivation at the beginning of the production phase of the palm tree. Newly planted *Acrocomia* trees only produce fruit after five years and reach full production in the tenth year (Visconti & Watson, 2013). The slow pace in generating economic results was one of the reasons highlighted by interviewees for decreasing smallholders' interest in planting the palm tree. We also identified in the field research that due to the palm's maturation period, contracts with partners and financiers are long-term. In the interviews, we identified that many of the smallholders in the studied region, in general older farmers, would not commit to these long contracts. One of the initiatives visited in the field research applied a 20-year contract to guarantee an adequate internal rate of return. Among the small farmers in the negotiation process, 16% did not commit to the partnership because of the long-term contract. The maturation period of the palm tree also impacts the financing of initiatives. In addition to the need for first movers to invest in a future market in the present (Poetsch, Hauptenthal, Lewandowski, & Oberländer, 2012), capital gains are long term. Thus, suitable and stable regulation which provides guarantees to all stakeholders is required.

Subsidies should be offered to families during the plant's non-productive period, particularly in cases where there are no other economic activities within the establishment. In addition to technical assistance, one of the initiatives visited provided a symbolic financial incentive for smallholders to take care of the plantation. Another of the visited initiatives planned to attract small farmers by offering financial subsidies and infrastructure for properties, such as access to water during *Acrocomia*'s non-productive period. In this second case, the benefits to producers would be provided by the government, while in the first case, the responsibility lies with the private sector, financed by resources from a development institution.

3.4. Past experiences

Several interviewees mentioned one particular negative experience in the region, in which an outside enterprise stimulated the production of castor bean but faced problems when outsourcing the processing. The enterprise abandoned the municipality and many farmers suffered losses. Because of experiences such as this, new initiatives stimulating plantations, especially from companies, cause distrust among farmers. Negative past experiences were also a barrier identified by Palmeros Parada, Asveld, Osseweijer, & Posada (2017).

To deal with small farmers resistance to adhere to *Acrocomia* plantations due to negative past experiences, the interviewees who were promoting inclusion were considering and/or applying the following strategies: i) gather support from local leaders, ii) provide demonstrations via prototype farms, iii) utilize their own processing plants, iv) implement purchase guarantees. The most important strategy identified was the involvement of local leaders, given the communities trust in them. Two interviewees leading *Acrocomia* plantations projects pointed out the high initial cost of identifying the leadership and forming partnerships. This initial effort however was seen to facilitate the adhesion process of smallholders from the surrounding areas, generating a snowball effect.

4. Distribution of economic risk

As previously discussed, the development of new value chains involves a series of challenges (some that translate into risks), and the productive inclusion of small farmers adds new challenges (and may increase the risks). This section analyzes the risks identified in the transition from agroextractivism to inclusive commercial plantations of *Acrocomia* in Brazil. The interviews showed that stakeholders have different perceptions of the risks involved. Some of these perceptions are presented and supported by the literature. The key stakeholders in this

discussion are the smallholders, entrepreneurs/investors, and local governments. On the one hand, the distribution of economic risks in Acrocomia's value chain may provide more security for smallholders. Thus, the distribution of economic risks may encourage small farmers to be included in the chain. On the other hand, the distribution of economic risks and tax incentives may make the financing of inclusive projects in this innovative value chain more attractive to entrepreneurs/investors.

Risk is a dimension that cannot be underestimated, and is seldomly overlooked in opportunity cost or economic feasibility analyses. Risk is a measurable uncertainty which considers that the actual result may differ from expected risk due to random and unforeseen factors (Buainain & Silveira, 2017). Risks in agriculture are traditionally high, and increasing due to climate change and socioeconomic factors (World Bank Group, 2016). Agriculture is intensive in capital, inserted in complex value chains and involves an extensive network of heterogeneous stakeholders. The distribution of economic risks provides opportunities to mitigate the usual and rising risks in agriculture (Meuwissen et al., 2001).

For smallholders there are basic risks related to contracts. Contracts are important to enable productive inclusion, but many farmers are resistant to sign them. One of the reasons for this resistance is the long-term nature of the Acrocomia plantation contracts, as discussed in the previous section. The interviewees revealed that many farmers consider long-term contracts too risky. Most farmers are used to temporary annual crop systems and agroextractivist systems and are afraid to commit to long-term obligations with unclear consequences. We see a relation between the resistance, the level of education, age and number of family members involved in production. The lower the education levels and the number of family members supporting the farm, and unsurprisingly the older the farm's decision-maker, the greater the resistance.

Production risks are perceived as relevant by both farmers and entrepreneurs/investors, albeit in different ways. In the field research we identified that Acrocomia is not covered by rural insurance in Brazil. For farmers, the existence of insurance could mitigate this type of risk (Junker & Schütz, 2011). This would not be the case for entrepreneurs/investors (C. E. Guanziroli & Basco, 2008). The production risks for these stakeholders are greater and involve at least two additional dimensions: i) the risk of production deviation and ii) the difficulty in monitoring how well the plantations are taken care of. Even with the existence of contracts, production deviations can occur. In Brazil, there are cases of production deviations by intermediaries even in value chains in which contractual integration is highly disseminated, as in the tobacco value chain (Buainain, de Souza Filho, Serigati, & Calixto, 2009). In this case, the companies involved were unable to recover the economic losses caused by these diversions. In addition, commercial plantations demand that crops are taken care of, which is not necessary in agroextractivism. In the interviews, it was possible to identify that incentive for farmers to take care of production is low. Also, in addition to operational and methodological difficulties, effective monitoring implies high costs for both entrepreneurs and the public sector (C. E. Guanziroli & Basco, 2008).

Market/price oscillations were not perceived by the interviewed farmers as risks, thus are not considered in their decision-making process. This may be related to the fact that agroextractivism generates extra income at a low cost. However, despite the existence of a minimum price program, these oscillations are identified by others to do pose a risk. Entrepreneurs/investors are aware of this risk, largely because of Brazil's experience with ethanol production, which was strongly stimulated in the early 2000s (German, Bonanno, Catherine, & Cotula, 2020). Many companies invested heavily in the sector, but with the emergence of the pre-salt and the gasoline price control policy, incentives to produce ethanol weakened (Salles-Filho et al., 2017). In the Acrocomia chain, which is in the initial stages of

development, interviewed entrepreneurs/investors mentioned the difficulties in anticipating scenarios and predicting the market price of the plant's products in the future.

The interviews highlighted that the initial investments in commercial plantations of *Acrocomia* are high and the financial returns are long term. One of the interviewees stated that private investors are mainly interested in the industrial segment, such as setting up processing mills. The agricultural part is of little interest to these stakeholders since it involves more risk, is capital intensive and the results are only reaped long term. This also highlights the high financial risk of these investments. In addition, one of the interviewees mentioned that many investors only agree to promote these initiatives if they have the contractual rights to intervene. In other words, if farmers did not reach the goals set, investors could intervene, and if necessary replace smallholders with large-scale farmers. This scenario would disrupt the commitment to the productive inclusion of smallholders.

There are also institutional risks for farmers and companies directly related to environmental laws. Some interviewees indicated that *Acrocomia* plantations are being registered as a crop, to enable small farmers to remove the crops from their properties in the future if desired. However, *Acrocomia* is a native Brazilian palm, so it would be potentially illegal to remove it if environmental laws were to change. This risk, therefore, depends directly on environmental policy decisions, which are unstable in Brazil. For entrepreneurs/investors, the changes in the biodiesel market are indicative of institutional risks. The reduction in the mandatory percentage of biodiesel blended with diesel is one of the changes introduced in 2020. The target blend dropped from 13% to 10%, despite the sector's objective to reach 15% of the blend by 2023 (De Oliveira & Coelho, 2017). In the field research it was possible to identify that the 15% target goal encouraged several enterprises to increase their production capacity. It also encouraged the diversification of raw material sources in the sector, such as *Acrocomia*.

The field research identified that local governments have little power to decisively intervene in the *Acrocomia* value chain, and that this is one of their main limitations. Despite this, farmers and companies tend to consider local governments as relevant, since they are responsible for the provision of local road infrastructure and technical assistance services to farmers. These services must be provided by the State and operationalized by city halls, which often do not have sufficient resources and technicians to meet the farmers' demands (Sette & Ekboir, 2013). This is a risk not only related to the *Acrocomia* value chain but for Brazilian agriculture in general.

None of the identified risks can be measured at the current stage of development of the *Acrocomia* value chain. Attempts to measure risks may also hinder the development of the value chain, as we identified a possibly exacerbated perception of the risks in the interviewees' narratives. The types of risks related to the different stakeholders are presented in Table 2:

Table 1 – Risks identified per category of stakeholders

Stakeholder	Risks	Risk implications
Farmers	• Associated to the contracts	The long-term nature of <i>Acrocomia</i> plantations' contracts is considered too risky.
	• Production	<i>Acrocomia</i> is not covered by rural insurance in Brazil.
	• Market/prices	Agroextractivism generates extra income at a low cost, so market/prices oscillations were not perceived farmers as risks.



	<ul style="list-style-type: none"> • Institutional/legal 	Environmental policy decisions are unstable in Brazil, so it is possible to be forbidden to remove the crops from the lands in the future.
Entrepreneurs/investors	<ul style="list-style-type: none"> • Production 	<ul style="list-style-type: none"> • <i>Acrocomia</i> is not covered by rural insurance; • There is possibility of production deviation by intermediaries; • There is difficulty in monitoring how well the plantations are taken care of.
	<ul style="list-style-type: none"> • Market/prices 	It is difficult to anticipate scenarios and predict the market price of <i>Acrocomia's</i> products in the future.
	<ul style="list-style-type: none"> • Institucional/legal 	The changes in the biodiesel market are indicative of institutional risks.
	<ul style="list-style-type: none"> • Financial 	Initial investments in commercial plantations of <i>Acrocomia</i> are high and the financial returns are long term.
Local governments	<ul style="list-style-type: none"> • Management/operational 	City halls often do not have sufficient resources and technicians to provide services they are responsible for (such as technical assistance for farmers).

Source: Elaborated for authors.

Risk management helps promote a balance between the distribution of risks and benefits (Wentholt, Rowe, König, Marvin, & Frewer, 2009), which is often unbalanced among stakeholders. Entrepreneurs/investors are still relatively unprepared to take on the risks for these new plantations of *Acrocomia*, despite the strengthening of the Environmental, Social, and Governance (ESG) discussion in Brazil (Miralles-Quirós, Miralles-Quirós, & Gonçalves, 2018). Moreover, the existing incentives are not enough to encourage investments in production chains that involve productive inclusion (Zapata, Vazquez-Brust, & José Plaza-Úbeda, 2010). One interviewee attributed the disinterest of the entrepreneurs in investing in these initiatives to the existence of less risky and simpler alternatives. We argue that the success in the development of this new value chain with productive inclusion of smallholders and allocation of risks could be enabled by governmental action combined with support from entrepreneurs/investors. The formation of cooperative groups between different stakeholders has the potential to contribute to economic development, overcoming poverty and empowerment for group members (Thorp, Stewart, & Heyer, 2005).

4.1. A tripartite route: the State, entrepreneurs/investors and smallholders

The development of new value chains in developing countries generally requires strong governmental support and guidance. Without this support, markets and entrepreneurs/investors may not be able nor interested in providing the conditions necessary to develop alternative crops, combined or not with inclusion. A tripartite governance model, involving the



smallholders, entrepreneurs/investors, and the State as a conciliator, has been suggested as a solution to guarantee both the distribution of risks among stakeholders and greater security in decision-making for entrepreneurs/investors and smallholders (Bathfield & Gasselin, 2016).

Tripartite governance is a complex model that “consists of a standards setting sub-system and conformity assessment sub-system, both of which are characterized by three tiers of authority and oversight” (Hatanaka, Konefal, & Constance, 2012, p. 66). This type of governance model could support the domestication of the palm tree and the shift to commercial plantations. State resources are scarce and allocations to science and research have suffered cuts in recent years (Petherick, 2017). Important research on *Acrocomia* development has been carried out by universities and research centers, but with a major lack of funding .

In terms of stimulating plantations and productive inclusion, certain financial innovations can be explored. One example is blended finance, which is a finance model involving resources from public, private and multilateral organizations (Tonkonogy, Brown, Micale, Wang, & Clark, 2018). These resources are characterized by low interest rates and can count on philanthropic capital. Blended finance aims to expand the resources available for sustainable projects in developing countries. This strategy is strongly recommended as a measure to contribute to the Sustainable Development Goals (SDGs) financing gap (Basile & Dutra, 2019). The development of the *Acrocomia* production chain with productive inclusion of smallholders fits into several of these goals, including poverty eradication (SDG 1), decent work and economic growth (SDG 8), reduction of inequalities (SDG 10) and action against global climate change (SDG 13).

In addition, the State can guide existing public policies, policy instruments and institutions to foster an *Acrocomia* value chain with the inclusion of small farmers. The National Program for Strengthening Family Farming (Pronaf) is the main credit policy for small farmers and could grant productive and investment credit for small farmers, as well as providing subsidies during the plant’s maturation period. The National Program for Biodiesel Production and Use (PNPB), considered to be the instrument for the inclusion of small farmers - the Social Biofuel Seal - could encourage initiatives under development to include these stakeholders. Institutions such as the Brazilian Agricultural Research Company (EMBRAPA), The Agronomic Institute of Campinas (IAC) and universities which have been studying *Acrocomia* for years can provide major support to the research and development of technologies for *Acrocomia*. State leadership and collaboration from entrepreneurs/investors could also contribute to developing and strengthening the value chain as well as the inclusion of smallholders.

The inclusion of smallholders into larger farmer associations, such as cooperatives, also facilitate risk sharing and pooling of resources, enabling collective learning in farm management and providing the opportunity to operate as a group to develop a balance of power vis-à-vis other stakeholders, thus increasing their bargaining power (Gupta et al., 2015; ILO, 2021). In the state of Minas Gerais, where we carried out the field research, Watanabe & Zylbersztajn (2012) concluded that the main obstacle for the development of a local biodiesel agro-industrial system is the lack of horizontal organization among small farmers. We confirmed the lack of horizontal organization between smallholders in our field research. To change this, incentives are needed. The government could take this responsibility by promoting cooperativism through public policies and effective incentives.

5. Conclusion

Productive inclusion is presented as an adequate concept to identify shortcomings and conditions needed for a beneficial transition from *Acrocomia*’s agroextractivism to commercial plantations in Brazil. The concept was not directly addressed in literature, so we developed our



own definition, combining stable and decent jobs and income generation with the importance of a fair distribution of economic risks. Although general, this was an effort to delimit and express a possible meaning of the concept.

Despite existing research on *Acrocomia* and its productive potential, the species is still predominantly exploited in agroextractivist systems by smallholders in Brazil. Initiatives to promote commercial plantations are under development, but the shift from agroextractivism to commercial plantations is complex. It requires a change in the smallholders' usual exploitation system, and implies production costs, use of part of the (often limited) land, with long return on investment expectations, and changes in work processes for farmers. Moreover, commercial plantations associated to pastures, which is the recommended productive system, is not suitable for smaller farmers.

After planting, the production phase of the palm tree takes at least five years, reaching full production in the tenth year. The slow pace in generating economic results means that long contracts are required, which is perceived by many smallholders as a risk. Previous negative experiences with private-oriented planting of castor beans are another reason that farmers are wary of planting *Acrocomia* on their land. In the field research we identified that the involvement of local leaders is key to instilling confidence in smallholders' decision-making.

The initial investments in plantations are high and the financial returns are long term because of the maturation period of the palm tree. This demands up-front capital and discourages private investors. In addition, changes in the Brazilian environmental legislation and ongoing changes in the biodiesel market increase uncertainty for stakeholders. It is also possible that these stakeholders overestimate the risks involved. Therefore, a transition to inclusive farming of *Acrocomia* can only be established when the State takes the responsibility to mitigate some of the barriers, including to improve regulatory and institutional guarantees to facilitate stakeholder decision-making.

This does not mean that the Brazilian government must provide all the solutions. On the contrary, the State does not have the capacity to develop the *Acrocomia* value chain alone, but must equip itself with the skills and necessary partnerships to leverage this objective. Despite the existence of the National Policy for Biodiesel Production and Use, no specific governmental action is in place to promote new and inclusive value chains. Brazil is moving towards exclusion, and the pandemic has intensified and accelerated this process. A successful and inclusive *Acrocomia* value chain could alleviate this problem and then should be a governmental objective, but this has yet to appear on the agenda. Changing this trajectory requires commitments and political choices. A tripartite governance model led by the State, with support from entrepreneurs/investors and the involvement of smallholders could potentially drive the development of this crop in at least four dimensions: i) research, ii) financing (credit and subsidies), iii) development of technologies, and iv) stable regulation.

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