Productive inclusion of smallholders in the Brazilian biodiesel value chain:

a path of challenges and opportunities

Gabriela Solidario de Souza Benatti

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CÁTEDRA ITINERANTE INCLUSÃO PRODUTIVA RURAL

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gssbenatti@gmail.com

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93120-020 São Leopoldo/RS
Tel.: (51) 3568.2848
contato@oikoseditora.com.br
www.oikoseditora.com.br

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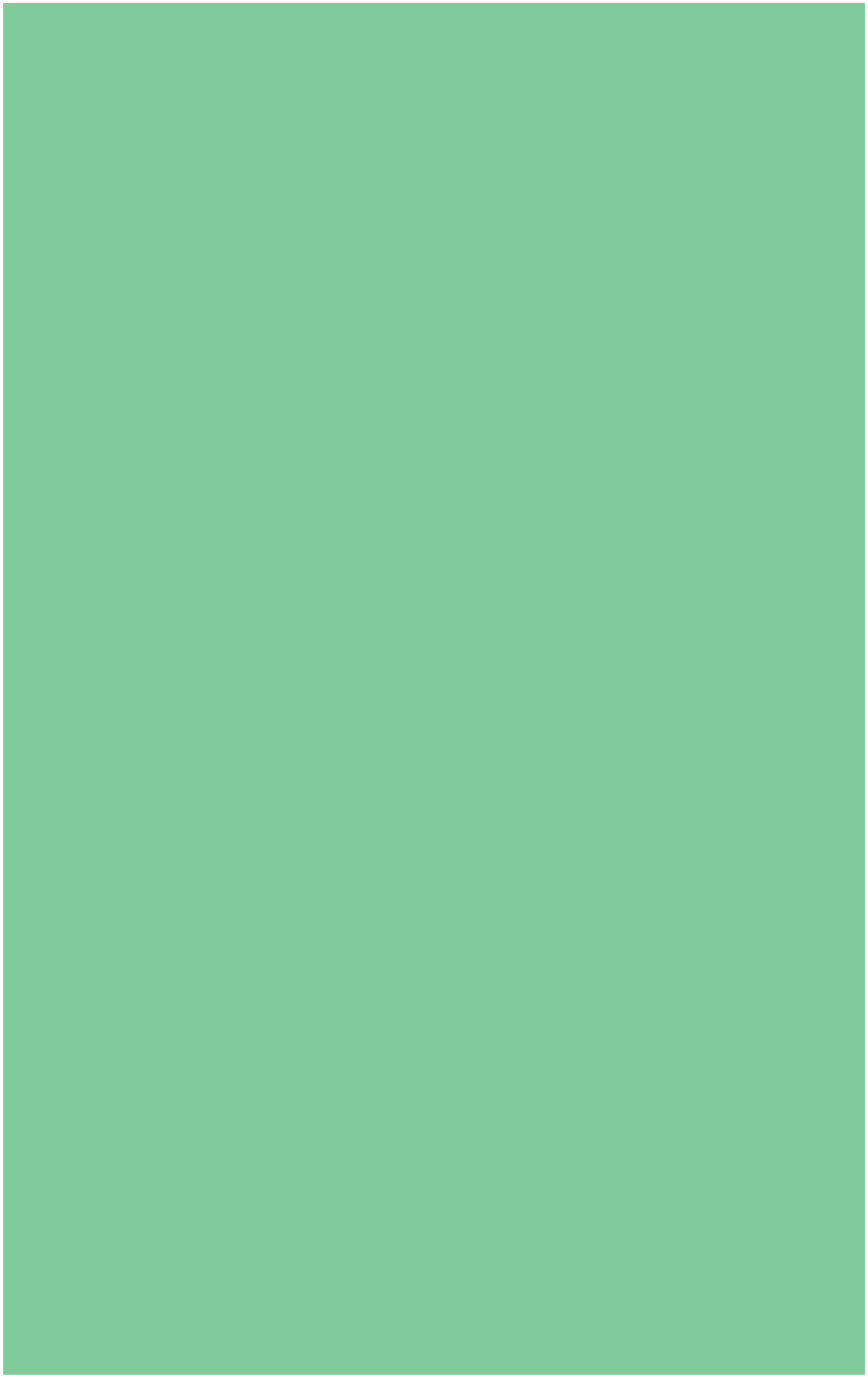
... É preciso ter esperança, mas ter esperança do verbo esperançar;
porque tem gente que tem esperança do verbo esperar.
E esperança do verbo esperar não é esperança, é espera.
Esperançar é se levantar, esperançar é ir atrás,
esperançar é construir, esperançar é não desistir!
Esperançar é levar adiante, esperançar é juntar-se
com outros para fazer de outro modo...

(Freire, 1992, p. 110-111)



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Prefácio

Este *e-book* tem como base a tese de doutorado de Gabriela Solidario de Souza Benatti, fruto de uma parceria acadêmica entre a Universidade Estadual de Campinas (Unicamp) e a Delft University of Technology (TU Delft), na Holanda. Desenvolvida no âmbito do Programa de Pós-Graduação em Desenvolvimento Econômico, pelo Centro de Economia Aplicada, Agrícola e do Meio Ambiente (CEA) da Unicamp, a pesquisa culminou em uma tese escrita integralmente em inglês, seguindo as exigências previstas no contrato de dupla titulação estabelecido entre as duas instituições. O último ano do doutorado foi realizado inteiramente na TU Delft, com a defesa ocorrendo em 29 de abril de 2024, em Delft, na Holanda.

Reconhecida pelo seu mérito acadêmico e relevância social, a tese foi premiada como a melhor tese de doutorado na segunda edição do Prêmio Ignacy Sachs, organizado conjuntamente pela Cátedra sobre Inclusão Produtiva Rural do Núcleo Cebrap Sustentabilidade. O prêmio, promovido anualmente, visa reconhecer os trabalhos acadêmicos que contribuam para expandir o conhecimento disponível à sociedade brasileira sobre como ampliar as oportunidades de inclusão econômica e produtiva de famílias vulneráveis que habitam o Brasil rural e interiorano e suas interdependências com o tema das mudanças climáticas.

O Cebrap Sustentabilidade, criado em 2020 como Núcleo de Pesquisa e Análises sobre Meio Ambiente, Desenvolvimento e Sustentabilidade, reafirma o compromisso histórico do Centro Brasileiro de Análise e Planejamento (Cebrap) de produzir conhecimento de excelência científica sobre questões fundamentais para a sociedade contemporânea. Atuando

em consonância com os avanços científicos nacionais e internacionais, o núcleo busca promover formas inovadoras e sustentáveis de abordar os desafios ambientais do século XXI, contribuindo de forma decisiva para debates sobre democracia, desigualdades e sustentabilidade.

Como um projeto do Cebrap Sustentabilidade, a Cátedra desempenha um papel importante na produção de conhecimento baseado em evidências robustas, focadas em superar os desafios de acesso a trabalho e renda enfrentados por populações vulneráveis no meio rural brasileiro. Com uma abordagem sistêmica e multidimensional, a Cátedra busca incidir em políticas públicas, estratégias do setor privado e ações da sociedade civil que contribuam para a superação dos bloqueios para a inclusão produtiva, diante dos desafios estruturais do país e em contextos desafiadores à inclusão, como as mudanças climáticas.

A intensificação das mudanças climáticas tem feito com que este tema passe a fazer parte da agenda de um conjunto de atores públicos, privados e de organizações da sociedade civil. No entanto, nem sempre as interfaces entre clima e desigualdades ganham o mesmo destaque. A obra de Ignacy Sachs foi pioneira ao chamar a atenção para o fato de que o enfrentamento da questão ambiental representa uma oportunidade estratégica para também gerar formas de inclusão social e econômica. Entretanto, o que se observa hoje é que muitas das soluções que vêm sendo adotadas podem ter um impacto negativo para as desigualdades, seja sob a forma de uma concentração econômica e de terras, de diminuição de postos de trabalho, ou com mudanças nos modos de vida de populações tradicionais. É preciso dar visibilidade para estes tipo de impactos. E é igualmente importante produzir conhecimentos sobre como conciliar as agendas do clima e da inclusão produtiva rural. Por esta razão, o foco do II Prêmio Ignacy Sachs foi justamente dar visibilidade a pesquisadores e trabalhos acadêmicos dedicados a estes desafios. Desejamos uma boa leitura!

Cebrap Sustentabilidade
Cátedra de Inclusão Produtiva Rural

Resumo

Esta tese de doutorado mergulhou no desafio complexo da inclusão produtiva da agricultura familiar na cadeia produtiva do biodiesel no Brasil. O foco está na Política Nacional de Produção e Uso do Biodiesel (PNPB) e em seu instrumento de promoção da inclusão da agricultura familiar: o Selo Biocombustível Social (SBS). A inclusão produtiva a agricultura familiar nas cadeias de valor pode ser uma estratégia para a redução da pobreza e o desenvolvimento resiliente e inclusivo. No entanto, o conceito de inclusão produtiva não está claramente definido na literatura e ainda não é uma prioridade na maioria das políticas voltadas para a transição para uma bioeconomia. Um dos resultados desta tese é definir o conceito, que se adequa às discussões sobre cadeias de valor inclusivas da bioeconomia. Ao estudar as lições do PNPB, identifiquei que a dualidade entre necessidades imediatas e objetivos de longo prazo é um dos principais desafios. Se essa dualidade não for considerada de maneira responsável no design e implementação da política, pode prejudicar a inclusão produtiva. O PNPB e o SBS são iniciativas estratégicas na promoção de cadeias de valor inclusivas da bioeconomia com conquistas importantes em relação à inclusão da agricultura familiar. No entanto, existem limitações em relação aos resultados esperados, dadas a complexidade do desafio de inclusão produtiva, o contexto brasileiro e a própria política. Os quase 20 anos de existência da política acumularam lições relevantes

sobre a inclusão produtiva da agricultura familiar. Nesse sentido, com base nessa experiência, a principal pergunta desta tese de doutorado é: *Como a governança pode contribuir para a inclusão da agricultura familiar em cadeias de valor da bioeconomia no Brasil?*

O **Capítulo 1** estabelece a base para esta tese de doutorado, buscando conceptualizar o termo inclusão produtiva para fornecer a definição aplicada neste estudo. Desse modo, compreende-se inclusão produtiva como a promoção de empregos estáveis, decentes, com geração de renda digna e com riscos econômicos distribuídos de maneira justa entre os atores envolvidos. Uma das descobertas é que as pesquisas sobre cadeias de valor da bioeconomia inovadoras priorizam o foco no desenvolvimento tecnológico e avaliações de viabilidade econômica. No entanto, explorar os impactos nas comunidades locais, estruturas sociais e dinâmicas culturais é essencial para tornar o processo responsável e evitar resultados negativos, como a exclusão. Na trajetória do PNPB, por exemplo, algumas experiências não consideraram especificidades dos contextos locais e os impactos de longo prazo, levando ao fracasso de iniciativas com impactos nas comunidades locais. Esse contexto posiciona esta tese como uma resposta à ênfase predominante nos aspectos tecnológicos e econômicos tanto no desenvolvimento de cadeias de valor quanto nas discussões e pesquisas sobre transição energética. A agricultura familiar brasileira é diversa e heterogênea, enfrentando desafios específicos e multidimensionais que o design e a implementação de políticas devem considerar para alcançar resultados efetivos de inclusão produtiva.

No **Capítulo 2** é discutida a importância de abordar padrões históricos de injustiça e desequilíbrios de poder para atingir os objetivos de inclusão produtiva da agricultura familiar. Uma vez que promover a inclusão produtiva exige enfrentar desafios multidimensionais, este é um

objetivo de longo prazo que não deve ser deixado para trás ao longo do tempo. Para isso, é necessária estabilidade regulatória. Somente políticas de desenvolvimento que perduram têm o poder de produzir uma transformação social eficaz ao longo das gerações. No entanto, deve haver espaço também para flexibilidade e adaptabilidade para permitir ajustes ao longo do tempo. A experiência do PNPB mostrou a importância da flexibilidade e da adaptabilidade para fomentar resultados aprimorados de inclusão produtiva. O PNPB também revelou a importância da participação da agricultura familiar desde o design da política, levando ao redesenho da dinâmica contratual inicialmente planejada. Após negociações, decidiu-se que todos os contratos precisam ser endossados pelo sindicato dos trabalhadores rurais do município onde ocorre a produção da matéria prima para produção de biodiesel. Isso é uma salvaguarda das organizações da agricultura familiar contra a vulnerabilização desse grupo.

No **Capítulo 3** foi identificada uma série de desafios para a inclusão produtiva da agricultura familiar na cadeia produtiva da macaúba, que apresenta grande potencial para se tornar matéria prima na produção de biodiesel no Brasil. A transição de processos de extrativismo para plantações nas terras da agricultura familiar, por exemplo, é complexa. Plantios em consórcio com pastagens não são adequados para propriedades muito pequenas. Contratos de longo prazo não interessam a muitos agricultores familiares e experiências negativas do passado vivenciadas por muitos agricultores dificultam o interesse nas plantações. Também há uma falta de evidências na literatura acadêmica sobre os aspectos sociais do desenvolvimento da cadeia de valor da macaúba. Como contribuição para o campo, foi organizada uma lista de riscos para atores-chave: agricultores, empreendedores/investidores e governos locais. Foi destacada a importância de um modelo de governança multissetorial para promover um equilíbrio entre a distribuição de riscos e benefícios. O Estado é fun-

damental para conectar os interessados, intermediar as conexões e orientar as políticas existentes para fomentar a inclusão da agricultura familiar em cadeias de valor da bioeconomia.

O desenvolvimento de capacidades estatais é o tema do **Capítulo 4**. É discutida a importância de políticas de alta qualidade e capacidades estatais para apoiar os objetivos de inclusão produtiva da agricultura familiar. Usando o PNPB como exemplo, destacam-se as capacidades institucional, política, regulatória e de coordenação como fundamentais. Com o reconhecimento de que desafios e capacidades se modificam ao longo do tempo, as capacidades devem evoluir para fornecer as soluções necessárias e resultados esperados. O capítulo destaca a necessidade de avançar no processo de transição energética, priorizando o objetivo de inclusão produtiva ao longo do tempo, como um objetivo de longo prazo. Mecanismos de governança adaptativa e participativa são fundamentais.

Finalmente, o **Capítulo 5** fornece uma apresentação abrangente dos resultados do estudo, reconhecendo limitações e oferecendo recomendações para futuras pesquisas. O capítulo sintetiza os principais achados dos três capítulos anteriores, destacando o papel da governança responsável para o sucesso da inclusão produtiva da agricultura familiar. Para responder à pergunta geral de "Como a governança pode contribuir para a inclusão da agricultura familiar em cadeias de valor da bioeconomia no Brasil?", três dimensões são identificadas. Primeiramente, uma visão orientada por missão de inclusão produtiva é necessária para estabelecer uma direção clara. Em segundo lugar, a governança adaptativa é fundamental para garantir a realização efetiva dos objetivos de inclusão produtiva ao longo do tempo. Terceiro, a participação das partes interessadas nos processos de tomada de decisão possibilita a identificação de desafios, necessidades e previne desequilíbrios de poder.

Chapter 1

General Introduction

1.1. Introduction

The energy transition is a global imperative in the 21st century, driven by an increasing awareness of environmental challenges and the urgent need to reduce greenhouse gas emissions (Cantarero, 2020). In this context, pursuing renewable and sustainable energy sources has become a worldwide concern. However, it is essential to approach this transition inclusively, ensuring its benefits reach not only nations in the Global North but also those in the Global South. This is important since strategies that do not reach the Global South countries may lead to the intensification of existing inequalities (Backhouse et al., 2022). Moreover, the energy transition across all regions is crucial for achieving the Sustainable Development Goals (SDGs) (Goldthau et al., 2020). The transition must be inclusive to vulnerable stakeholders, an aim brought to discussion through the narrative of the just transition. A just energy transition means social equity is at the same level as economic and environmental goals (Wang and Lo, 2021).

Biobased value chains have the potential to play a pivotal role in a just energy transition. These value chains cover the entire lifecycle of biobased products, from biomass cultivation to the production of biofuels or biochemicals (Asveld et al., 2011; Asveld et al., 2023). Biodiesel value chains, derived from renewable sources such as vegetable oils, emerged as promising alternatives to fossil fuels in the energy transition narrative. Its production and use have the potential to significantly reduce CO2 emissions and other harmful pollutants detrimental to the environment (Khan et al., 2021). Furthermore, biodiesel contributes to energy security by reducing dependence on imported fossil fuels in many countries. Diversifying the energy matrix through biodiesel can create economic opportunities, particularly in rural and agricultural areas (Cavalcante Filho et al., 2021).

When considering biodiesel as a key element in the energy transition, it is crucial to recognize its significance in Global South countries like Brazil. These nations face unique challenges, including balancing economic development with environmental preservation and poverty reduction. But there are also opportunities. Biodiesel, produced from biobased value chains widely available in countries of the Global South, can establish a valuable synergy, generating jobs and strengthening local economies (Postal et al. 2020). In this sense, if responsibly and sustainably designed and implemented, biodiesel value chains have the potential to positively contribute to an inclusive energy transition. Thus, considering socio-environmental impacts, involving local communities, and promoting responsible agricultural practices is necessary.

Embedded in this discussion, this doctoral dissertation is part of the results of the project entitled "Inclusive Biobased Innovation: Securing sustainability and supply through farmers' involvement"[1]. The project started from the premise that challenges for the transition to biobased value chains, such as feedstock availability and quality, and sustainable biomass production, require the pro-active inclusion of farmers. Small-scale farmers may face specific challenges in being included in value chains without support from stakeholders such as the state or the private sector. In the Global South, for example, poverty is often concentrated in rural areas, and many smallholders face socioeconomic exclusion (Guanziroli et al., 2019).

[1] A joint research project by the Section Biotechnology and Society (Faculty of Applied Sciences, Delft University of Technology) and the Division of Business Management and Organization (Department of Social Sciences, Wageningen University). This project received funding from NWO (the Netherlands Organisation for Scientific Research) under grant number 313-99-328, and from Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP/BIOEN) under grant number 17/08501-0.

By inclusion in a value chain, I refer to productive inclusion. The concept of productive inclusion adopted in this thesis is the promotion of stable and decent jobs and income generation, with economic risks distributed fairly among stakeholders. This definition combines elements found in literature, as presented in the next section of this introduction. Productive inclusion of smallholders in value chains can be a strategy for poverty alleviation and resilient and inclusive development. However, it has yet to be central in narratives and actions related to the energy transition, and this is one of the key problems addressed in this doctoral dissertation.

The thesis discusses the topic of how a biobased value chain, when under an appropriate governance model, can play a fundamental role in an inclusive energy transition. The focus is on Brazil, specifically within the biodiesel value chain, drawing from the experience of the National Program for the Production and Use of Biodiesel (PNPB), a recognized example by FAO for the inclusion of smallholders (United Nations, 2012). This research combines literature reviews with qualitative interviews conducted in Brazil in 2020.

To give a context regarding the topic of this thesis, in this chapter I also highlight the main challenges for smallholder productive inclusion in biobased value chains that were identified in literature and confirmed in interviews, and strategies to overcome them. In Section 1.4, the main research question and the sub-questions of this doctoral dissertation are presented. All content chapters are under review for peer-reviewed academic journals.

1.2. Productive Inclusion – towards a definition of the concept for this thesis

The concept arose in conjunction with the definition of financial inclusion. Discussions on financial inclusion focused on offering affordable banking services like microcredit to economically disadvantaged populations (Dev, 2006). Following this debate, the topic of productive inclusion started to be approached indirectly as part of discussions about employment, income, poverty, and economic development. Studies showing how initiatives aiming at providing those elements to vulnerable populations (Varella et al., 2017; Lima, 2022; Murrugarra and Isik-Dikmelik, 2020; Winkel et al., 2020) underscore the complexity of defining the concept due to the variety of aspects involved.

Given this complexity, productive inclusion has few structured and clear definitions[2] in the academic literature and is in general used without explicit definition. Zapata et al. (2010), for example, explore "how institutional arrangements need to evolve if they are to foster the productive and sustained inclusion of small farmers" (p. 01). However, a definition of productive inclusion is not provided by the authors. Without an explicit delimitation of the concept, the authors mention "[...] to promote the integration of small farmers into productive value chains" (Zapata et al., 2010, p. 02). This sentence leads to the understanding that productive inclusion means the integration of small farmers in economically productive agricultural activities. But it remains unclear. In another example, Fidelis et al. (2020) discuss about "socio-productive inclusion" of informal waste collectors in Brazil, but there is also no definition

[2] Those definitions vary depending on the needs, priorities, and opportunities existing in different contexts and historical moments.

provided for this concept. Therefore, I have attempted to make a definition of productive inclusion that would include the outcomes in transition pathways for a biobased economy.

Productive inclusion can be defined, for example, as an engagement with the economy that allows individuals or households to attain a standard of living above a specific poverty threshold (Mariotti et al., 2016). This definition aligns productive inclusion with productive employment, defined by the International Labour Organization (ILO) (Ripley and Hartrich, 2017) as employment that provides satisfactory compensation to the laborer, allowing both the worker and their dependents to attain a standard of living above the poverty line. This definition emphasizes the importance of both quantity and quality in the economic engagement process. It also highlights that inclusion in the economy should not lead to increased vulnerability or exploitation.

Following the ILO definition, our literature review highlighted that grey literature presents more efforts in conceptualizing productive inclusion. Murrugarra and Isik-Dikmelik (2020), within the scope of the World Bank, elaborated on the concept, focusing on strategies. For the authors, productive inclusion strategies are defined as "[...] public policies aimed at improving household income generation capacity and asset building by jointly addressing productive and social constraints for the poor and vulnerable population" (Murrugarra and Isik-Dikmelik, 2020, p. 08). The authors explain that while in some European countries productive inclusion can be associated with the inclusion of individuals in the labor market, in some East and South Asian countries it might mean the transition from extreme poverty to a more stable condition of life. In this second case, a more stable condition of life would be reached through a package of benefits and services.

In this sense, as a societal intervention (Silva, 2017), productive inclusion can be understood as a strategy to mitigate the risk of extreme poverty among vulnerable population segments. Social protection is usually divided into three dimensions: social assistance, social insurance, and labor market interventions (Mariotti et al., 2016). This perspective addresses the connections between social protection and other social welfare components (Brunori and O'Reilly, 2010). However, transitioning from social assistance programs to labor market interventions does not guarantee a sustained exit from poverty over time (Galasso, 2015).

From these discussions, at least three dimensions can be highlighted for the definition of productive inclusion. One dimension is the goal of productive inclusion interventions. In this sense, it is possible to depart from its opposite: social exclusion. The ILO and the Pan American Health Organization (PAHO) (ILO and PAHO, 1999), define social exclusion as a multidimensional process that encompasses both the absence of resources and opportunities and the lack of a sense of social belonging. Thus, productive inclusion could aim at promoting opportunities for entry into the labor market and ensuring decent living conditions.

The second dimension is the potential target audience of productive inclusion actions. This aspect refers to a segment of the population that is in some way excluded. In impact literature, interventions aimed at promoting inclusion of different audiences were found, such as people in situations of poverty and extreme poverty (Duvendack and Mader, 2020; Guzowski et al., 2021; Zain et al., 2021) and the rural population (Devaux et al., 2018; Donovan and Stoian, 2023; Donovan et al., 2020).

Lastly, the third dimension is related to how productive inclusion of the target audience occurs. In this sense, this dimension can be related

to the vision of inclusion present in the scope of the IBIS project previously mentioned: considering the needs, values, perceptions and knowledge of local stakeholders from the initial phase of policymaking. This vision is also connected to the concept of decent work (ILO, 2019), once it fosters freedom for stakeholders to voice their concerns, participate in collective organizations, and engage in decisions that affect their lives. Decent work also underscores the importance of affording equal opportunities and equitable treatment to all (Xu et al., 2022).

Based on these literature contributions, an adequate definition of productive inclusion considers its goal to overcome social exclusion through decent work aimed at target audiences. The target audiences are socially excluded in some way, considering the multidimensionality of poverty. Considering this, Vahdat et al. (2019) proposed the following definition: promotion of stable and decent job and income generation for populations facing poverty and/or social vulnerability, to facilitate the overcoming of chronic processes of social exclusion.

In this doctoral dissertation, I aimed to add the importance of a fair distribution of economic risks (Asveld, 2021; Stern & Stiglitz, 2021), as this is a relevant topic when considering biobased value chains. Hence, I come to the following definition: **the promotion of stable and decent jobs and income generation, with the economic risks fairly distributed among the stakeholders**. Brazilian smallholder farmers are the target audience of productive inclusion discussed in this thesis. I am analyzing their productive inclusion in the biodiesel value chain based on the experience of the National Program for Biodiesel Production and Use (PNPB).

1.3. Productive inclusion in biofuel policies

Value chains can transform livelihoods, especially in developing countries (Asveld et al., 2021; FAO, 2021). Productive inclusion of smallholders can be a strategy for poverty alleviation and resilient and inclusive development (Gupta et al., 2015; Mishra and Dey, 2018). In developing countries, poverty is generally concentrated in rural areas and many smallholders are vulnerable and face socioeconomic exclusion (Barbier and Hochard, 2018). Most smallholders depend on outdated technology and are excluded from dynamic value chains (Ma and Sexton, 2021; Ola and Menapace, 2020). The productive inclusion of this group of farmers, especially when combined with social protection policies, may contribute to reducing poverty by generating employment and income opportunities (Vicol et al., 2018; Vos and Cattaneo, 2021). However, due to structural challenges, smallholder inclusion can be a major challenge (Manda et al., 2020). To improve this, it is key to understand smallholders' specific needs and local contexts.

The effective productive inclusion of smallholders in biofuel policies worldwide faces significant challenges due to the historical inequalities smallholders face (Tagwi and Chipfupa, 2023) such as technological (Fulano et al., 2021; Quayson et al., 2020), financial (Mamuye, 2021), infrastructure (Horvath, 2021), market access (Celestin, 2019), and complexity of regulations (Carias et al., 2022). These farmers generally have limited resources and may struggle to meet the requirements for biofuel production, certification, and commercialization. The lack of support can hinder their inclusion in biofuel value chains (Tagwi and Chipfupa, 2023). Given this context, which strategies are in place to overcome the challenges and enable smallholder productive inclusion in biofuel value chains?

The lack of access to innovations and technical guidance is recognized as a significant challenge for many smallholders, especially in the biofuels value chains, that involve feedstocks not necessarily part of the production culture of these farmers (Horvath, 2021). Furthermore, the lack of access to modern technologies and technical guidance hinders efficiency and productivity (Quayson et al., 2020; Serote et al., 2021). Continued and transformative technical assistance and training programs are usually recommended and implemented to help farmers acquire the necessary knowledge and skills to meet the requirements for biofuel production, certification, and commercialization (Fulano et al., 2021; Shapiro-Garza et al., 2020). However, adequate technical assistance is also a challenge, as mentioned in all content chapters of this thesis (2 to 4). Another strategy is the establishment of financing mechanisms, such as credit and subsidies compatible with smallholders' realities (Imran, 2023; Mamuye, 2021). Additionally, partnerships between small farmers and the private sector were suggested to be a way for technological transfer (Syarifudin, 2021), although implementing this seems still limited in countries of the Global South (Kuhl, 2020). Agricultural extension provision and technological transfer are common practices among farmers' organizations (Bizikova et al, 2020), which could also contribute to the overall goals of inclusion.

Inadequate infrastructure represents a challenge for smallholders to have access to markets (Horvath, 2021). Lack of access to roads, proper storage, processing facilities, and efficient transportation can hinder the integration of these farmers into biofuel value chains (Fan and Rue, 2020). This challenge was approached in Chapter 3. Collaborative efforts with farmers' organizations are mainly applied as a strategy to enable storage and processing facilities (Bizikova et al, 2020). Contract farming is generally seen as an inclusive approach to promoting market access

(Celestin, 2019). This strategy actively integrates smallholders into the production process and holds the potential to establish a more stable and reliable route for them to sell their feedstocks and enhance their overall economic viability (Ba et al., 2019). Contract farming also, in general, provides smallholders access to technical assistance and better production inputs and infrastructure, and may involve logistical support (Sant'Anna et al., 2022). Cooperatives and associations, which can aggregate the production of smallholders and scale up the amount of feedstock to be sold, constitute efficient organizational strategies (Bizikova et al., 2020). Additionally, instruments that promote local consumption and/or product valorization, such as certification schemes, can help to increase demand for smallholder production and create new markets (Furumo et al., 2020). As detailed in Chapter 2, contract farming and the creation of a certification scheme were the main strategies promoted by PNPB to include smallholder farmers in the biodiesel value chain.

The complexity of regulations is an additional barrier to including small farmers in biofuel policies (Carias et al., 2022). The legal and regulatory framework surrounding biofuel production encompasses a range of regulatory aspects, including certification, commercialization, quality, and sustainability standards (Sakai et al., 2020). For smallholders, these requirements can be costly, complex, and overwhelming (German et al., 2020), which may generate resistance to participating in biofuel value chains. The lack of access to information, documentation, clarity, and accessible support mechanisms further compounds the challenge, leaving small farmers disadvantaged (Meemken, 2019). To address this challenge, simplifying regulatory processes, developing adaptation periods for farmers to adjust to regulations, providing clear guidelines, and offering capacity-building programs are examples of strategies to enhance smallholders' understanding and adherence to regulations (Carias et al.,

2022). Additionally, policies that promote the participation of smallholders in the development of regulatory frameworks can help to ensure that their needs and perspectives are taken into account (Vamuloh et al., 2020). This challenge regarding contract and regulation complexities in the Brazilian case is elaborated in Chapters 2 and 3, while the importance of having stable yet flexible regulations is discussed in Chapter 4.

Table 1.1 presents a summary of the challenges for smallholder productive inclusion and strategies adopted by PNPB

Table 1.1: Main challenges for smallholder productive inclusion and PNPB strategies to overcome them

Challenge	PNPB strategy
Complexity of regulations	• Technical assistance provision; • Participation of smallholders in the development of regulations, contracts, and certifications; • Stability and flexibility of regulations.
Infrastructure and technology	• Investment in rural infrastructure, such as processing units and storage infrastructure; • Coordination with already existing credit and technology policies; • Incentives for participation in farmers' organizations, such as cooperatives.
Market access	• Contract farming; • Creation of the Social Biofuel Seal (SBS).
Power imbalances	• Spaces of participation, such as forums, associations, social movements, etc.; • Participation in policy design and implementation.

Source: Own elaboration

These challenges, persistently present throughout the PNPB's two-decade existence, also emerge in more innovative initiatives, as detailed in Chapter 3. The plantation of acrocomia, a native palm tree, with the productive inclusion of smallholders in Brazil is considered promising, particularly highlighted by Averdunk et al. (2014). Given that acrocomia is already a revenue source for some smallholder farmers in Brazil, it emerged as a potential feedstock to meet diversification and local development goals pursued by the PNPB since its inception. However, including smallholders in acrocomia production in Brazil is complex. Data from field research in Brazil identified a series of critical issues, acknowledging the previously mentioned challenges. Notably, acrocomia plantations require a shift in the smallholders' conventional exploitation system, involving changes in production costs, land utilization, and work processes. Additionally, prior adverse experiences and contractual complexities were identified as challenges to smallholder productive inclusion.

In light of this, for biobased value chains to be inclusive, it is essential to consider the challenges to be faced and the capabilities stakeholders need, particularly those engaged in feedstock production (Asveld et al., 2023). But who should be the main responsible for supporting smallholders and promoting productive inclusion?

1.3.1. Fostering responsibility

Addressing the main challenges of smallholders' productive inclusion requires stakeholder responsibility and social participation, especially given the uncertainties (Asveld et al., 2023). Through social dialogue and collective negotiation, efforts are made to ensure that initiatives consider the needs and perspectives of smallholder farmers

(Ros-Tonen et al., 2019). Stakeholder responsibility can be discussed at the governance level (Gurzawska, 2020). Local institutions, their dynamics, and qualities are important elements for understanding the various forms that inclusion can take, as well as the importance of reflecting on new strategies for promoting productive inclusion through time.

The state plays a fundamental role in designing and implementing biofuel policies. Stringent regulations have accompanied the promotion of these policies through governmental action, mainly in the Global South (Bastos Lima, 2021). Examples of regulations are mandates, environmental and labor standards, as well as inclusion requirements (Ebadian et al., 2020; Saravanan et al., 2020). The extent of state involvement corresponds to the level of influence in enforcing these requirements. Brazil has witnessed the most substantial steering, primarily attributed to the state's significant financial backing of bioenergy initiatives (Buainain et al., 2023).

The states in the Global South have also played a primary role in advocating for its bioeconomy agenda (Bastos Lima, 2021). Governments have actively worked to align private and civil society actors with their bioeconomy agendas through the provision of subsidies, communication strategies, and regulatory frameworks (Palmer et al., 2022). On the one hand, this responsibility shows the commitment to achieving the goal. On the other hand, it might indicate insufficient private sector proactivity (Bastos Lima, 2021). In recent years, there has been a growing emphasis on private social responsibility, reflecting heightened societal expectations regarding the responsibilities of private companies. Establishing an inclusive value chain requires both awareness of responsibility and active engagement from the involved companies (Asveld et al., 2021).

In this context, multistakeholder governance (Gleckman, 2018; Yunus, 2019), as discussed in Chapters 2 and 3, played a significant role in smallholder inclusion within PNPB in Brazil. The government sets the guidelines, regulations, and incentives. The private companies provided smallholders access to markets and technical assistance. While the smallholder farmers contributed with feedstock provision and local knowledge. However, as elaborated in Chapters 2 and 4, PNPB reached limited results for inclusion. This highlights the need to rethink the governance model.

In this perspective, the state would act as an "entrepreneurial state" (Mazzucato, 2022). This approach involves setting clear and ambitious goals and underscores an active and innovative role of the state, going beyond traditional regulatory functions and engaging in risk-taking (Mazzucato, 2022). This innovative role of the state should be accompanied and facilitated by mission-oriented visions (Dosi et al., 2023). In the case of the problem addressed in this thesis, a mission-oriented vision to address the challenges of smallholder productive inclusion in biobased value chains. This discussion is elaborated in Chapters 4 and 5.

1.4. Research Questions

This thesis consists of three research papers providing answers to the overarching research question: How can governance contribute to smallholder inclusion in biobased value chains in Brazil?

After this introduction, **Chapter 2** is dedicated to analyzing the experience of the Social Biofuel Seal (SBS) in Brazil. The sub-research question is: *how can appropriate policies be designed to promote smallholder productive inclusion in the transition to the bioeconomy?*

A starting point of this chapter is the importance of the transition to a socially responsible bioeconomy. I emphasize that historical patterns of injustice, unbalanced power relations, and inequality may shape or be reproduced by public policies if there is no commitment to a just transition. The SBS is presented as an attempt of the Brazilian government to reduce smallholders' vulnerabilities by promoting an inclusive biodiesel value chain. Lessons from the SBS based on its policy design and implementation are discussed based on literature and qualitative interviews. I argue that one of the greatest difficulties was managing the duality between the immediate and long-term goals, which impacted the achievement of smallholder productive inclusion goals.

In light of the challenges to smallholder productive inclusion, in **Chapter 3** the aim is to identify opportunities and challenges for the inclusive development of the acrocomia value chain for biodiesel production in Brazil. Acrocomia emerged as a potential feedstock to meet PNPB goals of biodiesel production and smallholder inclusion. For this, a transition from agroextractivism activity to plantations is needed, and this is not a trivial shift. The sub-research question of the chapter is: *how can the transition to plantations with the inclusion of smallholders be accelerated?*

To answer this question, I conducted field research in Brazil, and combined the findings with data available in the literature. Acrocomia is an innovative value chain for biodiesel production. If compared to the soybeans value chain, it brings environmental and social advantages. For some smallholders, agroextractivism involving acrocomia already contributes to their income. There is technological research that enabled plantations of the palm tree. Plantations on smallholder lands are already underway. Four critical topics to be considered and potential strategies

to accelerate smallholder productive inclusion were identified. Those strategies involve local leaders, providing practical demonstrations of plantations to smallholders, and offering purchase guarantees to instill trust.

Chapter 4 is based on the theoretical approach of State capabilities. It is argued that effective governance in support of productive inclusion necessitates not only focused policies but also distinct attributes within the administration responsible for their implementation, qualities categorized as State capabilities. The sub-research question is: *to what extent can State capabilities play a role in nurturing an inclusive energy transition?*

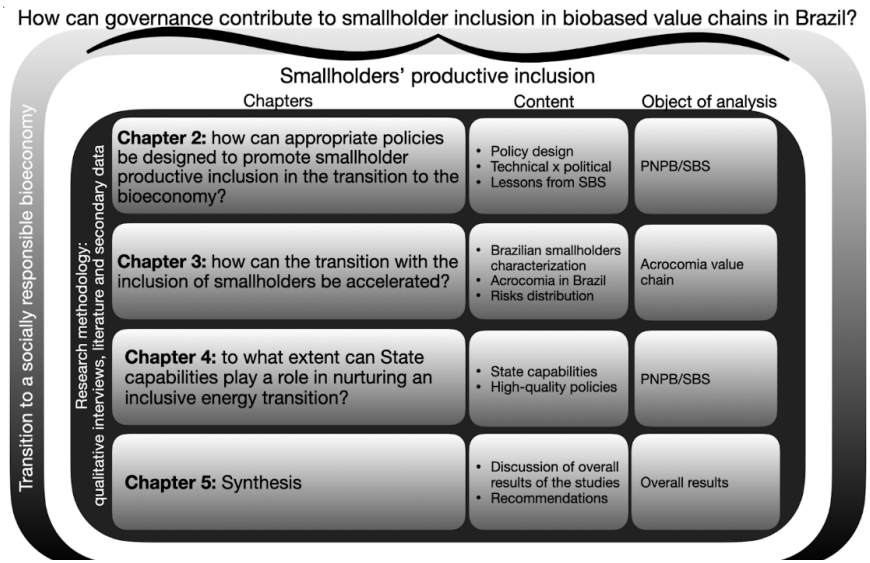
As an example of a policy that combines energy transition with productive inclusion of vulnerable groups, the PNPB is analyzed through the lens of State capabilities. Based on the literature review, six essential characteristics of public policies were identified. The analysis, which included perceptions of stakeholders captured from qualitative interviews, assessed whether each characteristic contributed or not to smallholder productive inclusion within PNPB. Institutional, political, regulatory, and coordination capabilities are highlighted as fundamental. However, the required capabilities vary over time. As capabilities are built to overcome one barrier, another one arises. Given this context, advancing the development of capabilities in the energy transition process without leaving the goal of inclusion behind is crucial.

Chapter 5 discusses the study's overall results, recognizes limitations, and presents recommendations for future research.

1.5. A reader's guide

Figure 1.1 summarizes the outline and scope of the thesis.

Figure 1.1: Thesis outline



Chapter 2

Fueling change: policy design for smallholder productive inclusion in the transition to the bioeconomy

2.1. Introduction

The transition from a fossil-based to a biobased economy is expected to contribute to more environmentally sustainable development, based on the use of renewable resources (Bastos Lima, 2018). The transition involves complex tasks. For a bioeconomy to be successful, it must incorporate technological innovation as well as social responsibility. This involves carefully considering how technologies, policies, and regulations are integrated into society and understanding their impacts (Sakai et al., 2020; von Cossel et al., 2019). In this sense, the transition involves technology, infrastructures, institutions, and behaviors (Lima, 2022). If the transition is to be inclusive, social responsibility is key, mainly regarding biomass producers (Asveld et al., 2021).

The contexts in which many farmers involved in biomass production find themselves can challenge the development of inclusive biobased value chains (Robaey et al., 2022). Particularly in the Global South, which is a hub for biomass production (Postal et al., 2020), smallholder farmers are a vulnerable group. As a large, spatially dispersed group with heterogeneous characteristics, they face diverse challenges. Examples of challenges are access to lands or irrigation systems (Bromley and Anderson, 2012), difficulties of collective organization in unions and cooperatives (d'Orfeuil, 2012), and poverty (Minas et al., 2020).

Productive inclusion of smallholders in biobased value chains is therefore an essential requirement. Productive inclusion has few structured and clear definitions in the academic literature and the term is in general used without explicit definition. Zapata et al. (2010), for example, explore the role of institutional arrangements to foster smallholder farmers productive and sustained inclusion. However, an explicit delimitation of the concept of productive inclusion is not

provided by the authors. In another example, Fidelis et al. (2020) discuss about "socio-productive inclusion" of scavengers in Brazil, but there is also no definition provided for this concept.

Grey literature includes publications that address the conceptualization of productive inclusion. For example, Murrugarra and Isik-Dikmelik (2020) focused on strategies for the definition. The authors explain how the concept might have different interpretations among countries, going from strategies of labor market insertion to social assistance aiming to fight poverty. According to the authors, productive inclusion strategies consist of public policies aimed at enhancing income and asset accumulation. These strategies tackle both productive and social challenges encountered by society's vulnerable groups.

Vahdat et al. (2019) defined productive inclusion as the promotion of stable and decent jobs and income generation for populations facing poverty and/or social vulnerability, to facilitate the overcoming of chronic processes of social exclusion. Aiming to develop our own definition of the concept, which would suit the discussions elaborated in this study, we added the importance of a fair distribution of economic risks. This is necessary because for many smallholders, the involvement in a value chain, mainly if it is commodity-based, may bring negative forms of flexibility, power imbalance, and insecurity (Pegler, 2015; Ros-Tonen et al., 2019). Hence, by productive inclusion, we refer to *the promotion of stable and decent jobs and income generation, with the economic risks fairly distributed among the stakeholders.*

In the Global South, it is typical to see interventions designed to foster inclusive value chains – like contract farming – relying on collaborations between the private sector and smallholders (Ros-Tonen et al., 2019). While stakeholder alliances are needed to improve inclusion outcomes, promoting productive inclusion through public policies in

such a context remains challenging due to historic and multidimensional inequalities and power imbalances (Silveira and Johnson, 2020).

Given the complexity involved, this manuscript aims to answer the question: how can appropriate policies be designed to promote smallholder productive inclusion in the transition to the bioeconomy? To answer this question, we analyze the experience of the Social Biofuel Seal (SBS) in Brazil, a voluntary certification scheme created to promote the development of the biodiesel value chain with the inclusion of smallholders. The analysis is based on a literature review and on interviews the authors carried out with biodiesel mills, representatives of the national union of smallholders' cooperatives, and policymakers involved in the design of the SBS. We argue that one of the greatest difficulties in promoting inclusion through public policies in the transition to the bioeconomy is managing the duality between the immediate and long-term goals. In the case of the SBS, the pressure of the biodiesel market – immediate – hampered the smallholder inclusion and regional development strategies – long term.

As there is increasing interest in policy design for inclusion, and formulation of "new policy design" involving complex policy mixes (Peters, 2020; Mortati et al., 2022), this paper aims to contribute to the reflection on this topic when discussing the development of inclusive value chains. Transition policies aimed to promote the bioeconomy address sectors that already have well-established institutions, policies, and dynamics, and transforming it is not a simple task. However, the literature provides limited evidence on the design of inclusive policies for the transition to an inclusive bioeconomy (Lima, 2022). Hence, we aim with this manuscript to contribute to the field, by sharing evidence on the topic.

We argue that a socially robust agenda and regulatory stability are fundamental to designing appropriate policies for promoting smallholder productive inclusion in the transition to the bioeconomy. Moreover, in the policy design, productive inclusion should be understood as a process. Since promoting productive inclusion involves facing multidimensional challenges, it is a long-term goal that must be sustained over time. This depends on the support and commitment of a large part of society, and not only of specific interest groups.

In the next section of this manuscript, we present the research methods. In section 3 we identify challenges related to the inclusion of smallholders in value chains. Those challenges are mainly addressed by literature in the field of inclusive value chain development. We also describe the Brazilian social certification for biofuel production – the Social Biofuel Seal (SBS) – as an example of an intervention for the development of an inclusive value chain. The aim of section 4 is to highlight the importance of a policy design that results in productive inclusion by balancing long-term and immediate goals. We present the experience of the SBS design process within the National Policy of Biodiesel Production and Use (PNPB) and the main lessons for smallholder productive inclusion based on the chosen design and implementation process. In the last section, we provide criteria on how to design appropriate policies for the promotion of smallholder productive inclusion in the transition to the bioeconomy.

2.2. Methods

This research merges a literature review with qualitative interviews. Interviewees were identified through purposive sampling, which is a selection method based on criteria established by the researcher (Jupp,

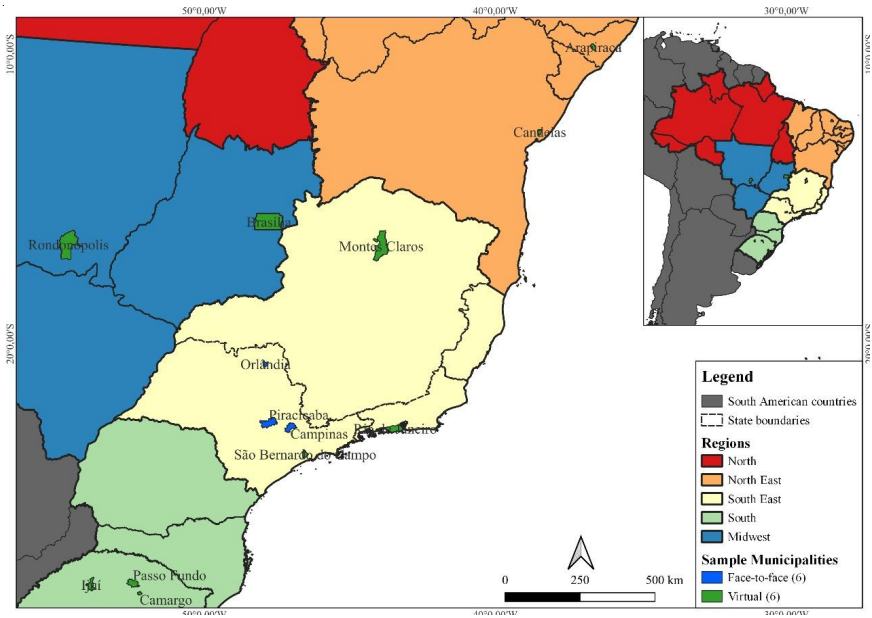
2006). The main goal of purposive sampling is to focus on particular characteristics of participants, which supports the comprehension of the research problem. Typically, the sample size is small, especially when compared to probability sampling (Guarte and Barrios, 2006). To safeguard participant rights and adhere to confidentiality obligations, neither the names of the initiatives visited nor the interviewees are mentioned in this research.

We conducted twenty-nine qualitative interviews, selecting participants based on six criteria: i) experience related to the design, operation, analysis, and monitoring of the SBS; ii) relevant academic contribution related to the SBS; iii) role as beneficiary of the program, iv) role as representative of a group, v) geographical distribution, and vi) interest and availability to participate in the research. Table 2.1 organizes the interviewees' profiles and the number of interviewees for each profile. Figure 2.1 presents a map showing the geographical distribution of the interviewees.

Table 2.1: Interviewee Profiles and Number of Interviews Conducted

Profile	Number of interviews
Academics	6
Specialized consultancy on the SBS	5
Policymakers	5
Biodiesel mills	11
Smallholders' cooperatives	2

Figure 2.1: Geographical distribution of interviewees in Brazil



Source: Own elaboration

Data were collected from 2019 to 2021 using semi-structured questionnaires. This approach enabled flexible exploration of participants' experiences, perceptions, and reflections on smallholders' productive inclusion via the SBS. All interviews were conducted in Portuguese. Each interview averaged one hour, with questionnaires adapted to fit the participants' profiles. Overall, questions covered topics such as motivation, policy design, challenges, risks, benefits, market dynamics, production, logistics, and contracts. After a round of pilot interviews, the questionnaires were tested and reformulated. We conducted one pilot interview for each profile, totaling five. The results are incorporated into the study, so they are included in Table 2.1. Five interviews were conducted in person. Due to the Covid-19 pandemic, twenty-four interviews were conducted online. Accessing smallholder

farmers online was not possible, limiting their broader participation in this study. The content of all interviews was transcribed to allow content analysis.

Secondary data about the SBS's results were gathered from the Brazilian Ministry of Agriculture's official reports and grey literature. The authors acquired a database from an SBS specialized consultancy containing data from 2018 to 2020 about ten biodiesel mills. Literature research utilized three electronic databases: Scopus, Scielo, and Web of Science.

2.3. The transition to a socially responsible bioeconomy

This section aims to explain the necessity of transitioning to a socially responsible bioeconomy and to introduce contract farming as an example of strategy. To this end, we discuss literature findings, focusing primarily on the field of inclusive value chain development. Section 2.3.2 outlines the Social Biofuel Seal (SBS) as a strategy to foster a socially responsible bioeconomy through contract farming, discussing its impact on smallholder productive inclusion using literature and secondary data.

2.3.1. Why a socially responsible bioeconomy is necessary and how to achieve it?

The transition to a socially responsible bioeconomy based on a strong regional development strategy is a complex task. In biobased value chains, there is a challenge to find a balance between opportunities for inclusion and available resources, market demands, and market pressure for production efficiency (Hall et al., 2009). It is important to note that biomass producers are often located in the Global South, where conditions for inclusion can be suboptimal (Postal et al., 2020). Cultural

values and practices among farmers and other stakeholders in biobased value chains also vary a lot, even inside a country, a factor that may be a challenge for inclusion (Asveld et al., 2021).

Biobased value chains involve commodities, such as soybeans (EIA, 2022; Kristöfel et al., 2014), that are highly competitive and dynamic. The competition in a large and dynamic market leads to the concentration of resources, markets, and capital. In addition, those markets demand standards, and some international standards, such as quality and sustainability, are costly and difficult for vulnerable farmers to meet (Loconto and Dankers 2014). Consequently, this context leads to the exclusion of vulnerable groups and power imbalances (Ferris et al., 2014; Manda et al., 2021).

To promote the transition to the bioeconomy, countries are developing and implementing different types of strategies (Lima, 2021b; Tzankova, 2020). However, historical patterns of injustice, unbalanced power relations, and inequality may shape or be reproduced by those initiatives (Hospes and Clancy, 2011; Tey, 2021). It is also possible that those policies create new inequalities if do not reflect the reality of the vulnerable stakeholders (Stoian et al., 2016). This is the reason why a transition to a socially responsible bioeconomy is necessary.

One example of strategy is contract farming, a significant component in the governance of global biobased value chains and a relevant institutional innovation since the beginning of the 2000s (Pacheco et al., 2020). In biomass value chains, contract farming aiming at being inclusive consists of a strategy to include smallholder farmers as feedstock providers. However, this type of instrument can also hide and/or aggravate injustice if the already existing challenges are not addressed (Donovan and Poole, 2014; Stevis and Felli, 2020). Power imbalances, for example, may persist between small farmers and companies that

organize and manage contract schemes, which may put smallholders at a disadvantage (Minot and Sawyer, 2016).

In Brazil, a strategy was developed in 2004 to reduce smallholders' poverty by promoting an inclusive biodiesel value chain through a broad public policy (Duarte et al., 2021). The National Program for Biodiesel Production and Use (PNPB), incorporated goals for diversifying the energy matrix and innovated by associating this with the goal of including smallholders as feedstock suppliers through contract farming (Pedroti, 2011). The instrument created to achieve the inclusion goal was the certification scheme named Social Biofuel Seal (SBS). The instrument wasn't entirely successful in reaching the goals of inclusion due to three main factors: i) a mismatch between long-term and short-term goals, ii) a lack of a stable regulatory regime, and iii) a lack of a socially robust policy agenda, as we explain below.

2.3.2. Social Biofuel Seal – the Brazilian certification for a biobased inclusion

Within PNPB, the SBS was created as a voluntary certification to promote the productive inclusion of Brazilian smallholders in the biodiesel value chain. The biodiesel mills can earn the Seal, which is determined by a minimum feedstock purchase percentage from smallholders. The SBS biodiesel production constitutes an average of 16% of the entire biodiesel production in Brazil and generated an estimate of 42,000 jobs (Cavalcante Filho et al., 2021). The SBS grants tax benefits to biodiesel mills and a guarantee of purchase and technical assistance to the smallholders.

The rules of the SBS include: (i) the establishment of formal contracts between biodiesel mills and smallholders for the feedstock purchase; (ii) the provision of technical assistance to the contracted

smallholders; and (iii) the promotion of capacity building for the contracted smallholders. The seal is granted by the Brazilian government. It is also endorsed by the union of rural workers of the municipality where production occurs (Abramovay and Magalhães, 2007).

In its origins, PNPB sought to foster initiatives with alternative feedstocks, suitable for the smallholders' production systems, such as castor beans (Marcossi and Moreno-Pérez, 2018). However, the limited scientific and technological development of some feedstocks were a challenge (Souza, 2018). In the pioneer projects within the Program, productivity was low and significant losses were generated (Flexor et al., 2018; Kato, 2012). Soybeans dominated the market and the goal of diversifying feedstocks was unfeasible in the short and medium term (Ramos, 2017; Souza and Seabra, 2014).

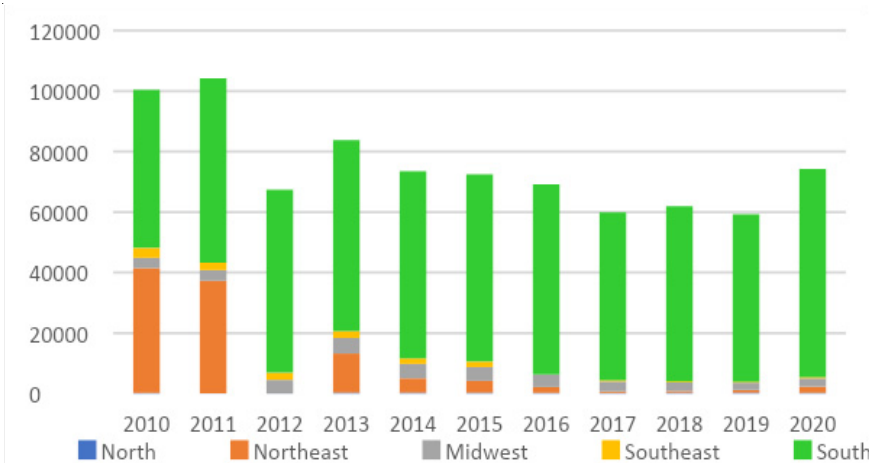
Soybean dominated the market for at least five reasons: (i) it could be produced on a large scale system, (ii) it had high productivity and technical efficiency, (iii) it could be obtained in several regions, iv) there were prospects of expanding production in the near future, and v) it had competitive advantages over alternatives such as castor beans or palm oil (Souza et al., 2018). The stakeholders involved in the soybean value chain recognized the opportunities and quickly adhered to them (Flexor et al., 2018; Bergmann et al., 2013).

As feedstock diversification was established as a long-term goal, the government worked to develop new value chains and strengthen the already existing. In this process, approximately 20,000 out of a total of 2,600,396 smallholder units in the North and Northeast regions were included in the SBS in 2005 (Buainain and Batalha, 2007). In 2008, the Seal registered 17,400 families in these two regions (MAPA, 2020). As the inclusion of smallholders from the North and Northeast was a priority due to the vulnerability of those regions, increasing the results was

important. Thus, the SBS was redesigned and between 2009 and 2011 the number of included families increased (MAPA, 2021).

From 2012, however, inclusion started to decrease in the North and Northeast. Between 2017 and 2019 only 940 families were included (MAPA, 2021). The decrease was associated to constraints such as logistics and the lack of capital and organization of some farmers (Leite et al., 2013). The SBS redesign facilitated the inclusion of smallholders in the South region, mainly because they were already organized in cooperatives, already producing soybeans, and because there were many biodiesel mills already installed in the region, facilitating the logistics (Ribeiro et al., 2018). This indicates the limitations of PNPB to leverage the development of the poorest regions (da Silva César et al., 2019; Silva et al., 2017). From Graphic 2.1 it is possible to confirm the number of families included in the SBS between 2010 and 2020, according to the region:

Graphic 2.1: Number of included smallholder families in the PNPB by region of Brazil from 2010 to 2020



Source: Own elaboration based on data from the Ministry of Agriculture (MAPA, 2021)

In practice, the incentives and broad goals focused on regional development were not enough to reach the desired productive inclusion outputs (Krawchenko and Gordon, 2022). However, even with limited outputs regarding the desired outcomes, the SBS makes a difference regarding productive inclusion and is an important policy regarding this matter. In the next section, we elaborate on the challenges for smallholders' productive inclusion based on the lessons of the SBS design. This will be done based on literature findings and the results of interviews.

2.4. The policy design and the balance between technical and political aspects

Stakeholders engaged in policy design are focused on solutions to different dimensions of the problems (Andrews et al., 2017). In reality, what usually happens is that i) the focus is more on the solution itself than on the identification of the root of local problems, and ii) many of the contemporary policy problems are poorly identified (Dunn, 2018), making it difficult to identify proper solutions to the existing (and in general wicked) problems (Andrews et al., 2017). Moreover, the technical and political dimensions involved in the policy design may constitute a fundamental dilemma. Trying to balance those dimensions may involve the development of ambitious goals that are difficult to reach. In some cases, improving the performance of existing policies instead of designing ambitious interventions with no connections to real local problems would be more effective (Peters, 2020). In other cases, a novel policy design is needed.

Policy design involves effort in defining scope, goals, and target groups and linking them to policy instruments created to reach the set aims (Howlett, 2014). An adequate policy combines reflections about

options for effective policy and the expected outcomes (Peters, 2020). The design process should involve recognizing the existence of a public problem, understanding its origins and dynamics, and outlining a solution (Lima et al., 2021).

In this sense, policy design connects problems with solutions and demands balancing political and technical goals to create intended policy outcomes to society. The political dimension refers to the institutional nature of the context in which policies are decided, so it relates to power relations between stakeholders, networking, and consensus building (Lima et al., 2021). The technical dimension brings to the policy design focus on aspects such as technologies, market prospects/interests, prices, and financing (Capano and Howlett, 2021).

In the context of the transition to a bioeconomy, public policies play an important role in guiding the direction of socio-technical innovations, reducing uncertainties for stakeholders, and guaranteeing a fair distribution of the benefits (Purkus, 2018). Usually, policies aimed at stimulating transition constitute a new set of interventions that do not replace older ones, resulting in an incremental policy design that increases the complexity of the policy mix (Feindt et al., 2020). In other words, transition policies often address sectors, such as agriculture and energy, that already have well-established institutions, policies, and dynamics. This means that the policy context is shaped by institutional trajectories, path dependencies, and policy legacies (Daugbjerg and Feindt, 2017). Transforming it is not a simple task as this involves historical and structural aspects.

2.4.1. The designing process of the inclusive biodiesel value chain in Brazil: can we find clues to face the challenges for productive inclusion?

Based on the content of interviews with policymakers, we identified that there was a duality between technical and political dimensions in the design of the PNPB, and consequently of the SBS. One of the interviewed policymakers explained that the social aspect of PNPB represented a legitimacy factor for the newly elected government at the time. Meeting the expectations of the social groups that supported the government[3] was seen as fundamental for promoting a socially fairer development model, aligned with the strong social responsibility discourse (Flexor, 2010). In this sense, policymakers sought to differentiate PNPB from the previous government's project, called Próbiodiesel. According to 2 interviewees, this project was criticized for prioritizing capital and leaving the social aspect behind. In its novel design, policymakers tried to combine immediate needs (market-oriented/technical) with long-term goals (development/political).

Zapata et al (2010) argue that one of the greatest difficulties in designing PNPB was to combine production by large and small-scale farmers. We argue that one of the greatest difficulties was managing the duality between the immediate and long-term goals, which might even be conflicting. In this sense, an appropriate balance and coordination between long-term and immediate goals is fundamental. By appropriate we mean a balance that does not hinder the goal of productive inclusion.

In the design of PNPB, it was decided that the blends of biodiesel with fossil diesel would be implemented in ascending mandates, reaching

[3] Such as the landless workers' movement (MST), that provided important support for the election of the government.

5% from 2004 to 2013. Within this period, and while the mandate goals were being met, it was necessary to structure the smallholders' supply chains. One policymaker stressed that in the North and Northeast regions, there was a challenge in dealing with a lack of structure and informality. Moreover, the SBS contracts would add more complexity to smallholders from those regions and it was a barrier for them to be included (da Cunha et al., 2019; Sampaio and Bonacelli, 2018). This is evidence that the settled goals were non-realistic in some contexts.

The main responsible institution for designing and operationalizing PNPB and SBS, the Ministry of Agrarian Development (MDA), was created in 1999, only five years before PNPB. Two interviewed policymakers explained that some areas of this institution were still under development, and lacking capabilities for designing policies for improved results on inclusion. While building its own capabilities, MDA had to structure the new value chain for biodiesel production and connect different stakeholders. The policymakers sought to identify key actors for the productive and technological debate and cooperated with several universities and the Brazilian Agricultural Research Corporation (Embrapa). All interviewed policymakers stressed that those experienced institutions supported research to establish the most feasible feedstocks for meeting the technical and political goals of PNPB. Different experiments and business models were developed with castor beans, palm oil, canola, and jatropha, to mention a few examples (Souza et al., 2018).

In some regions, the crops selected for production were not a traditional part of the growers' culture. Two policymakers mentioned the case of castor beans in the North of Brazil. There was resistance from many smallholders because they had no knowledge of this feedstock. In the Northeast region, the castor bean production chain already existed, and the smallholders were already producing, so one policymaker

explained that PNPB created market opportunities. This outcome shows that barriers to inclusion were raised when a new value chain with feedstocks unknown to the producers was to be established.

Hospes and Clancy (2011) argue that the SBS should promote the proliferation of small-scale industrial units, but the chosen design stimulated the creation of high-tech industrial mills to produce biodiesel. Based on the interviews with policymakers, we contend that the chosen design was a responsible decision, based on the context. One policymaker explained that at the time PNPB was created, most of the smallholders' small-scale industrial units were not operating due to the lack of management skills of smallholders. It was unclear how to ensure the production of the required amount of biodiesel to meet the set mandates (da Cunha et al., 2019; Sampaio and Bonacelli, 2018). According to interviews, given the context, policymakers considered that the best design would be a contract-farming among big mills and smallholders, having smallholders as feedstock providers. In our analysis, maintaining this model over time was the problem. The development of small-scale industrial units could be a long-term policy goal.

To guarantee that smallholders would be able to supply feedstocks and to comply with the SBS rules, private mills had to provide technical assistance. But we observe, based on the perceptions captured in the interviews, that the technical assistance was superficial, not transformative. Given the design of the policy and the biodiesel market governance based on auctions, the contracts between mills and smallholders were short-term, and therefore not sufficient to produce transformation. But the market mechanisms did not allow for a long-term contractual model, since the production of biodiesel by the mills was dependent on how much was sold at auction, with a production period of two months. Moreover, one of the interviewed mills explained

that contracts with smallholders had to be signed before the auctions. This meant that the mills were dealing with high risk, and long-term contracts would make the risks even higher. For these reasons, we believe that the type of technical assistance needed by smallholders goes beyond the PNPB scope and should not be entirely the responsibility of mills.

On one hand, it is important to make the design process of a policy inclusive. On the other hand, as it involves very different interests, complexity is increased (Pacheco et al., 2020). Until the creation of the SBS, for example, the relationship between smallholders' unions (and rural social movements in general) and large agroindustries was marked by intense conflict. Given this history of a conflicting relationship, policymakers explained that social movements were hostile to the SBS design. Smallholders' organizations were strongly critical of cooperation with large companies and fought the process of integration. An important outcome of the negotiations was that smallholder's contracts always have to be approved by a representative collective organization to safeguard against smallholder vulnerability (Lima, 2022).

Despite the participation of different stakeholders in the design of the policy, not all actors have equal power in setting the agenda or influencing decision-making (da Cunha et al., 2019). In the Brazilian biodiesel sector, the decision-making power is concentrated among the dominant interests, represented by the Ministry of Mines and Energy (MME), the National Agency of Petroleum, Natural Gas and Biofuels (ANP), and Petrobras. These actors allocate the largest amount of resources in other areas of operation, such as oil, gas, and electricity, and their preferences become decisive parameters in the political arena (Sampaio and Bonacelli, 2018).

The increase of the biodiesel mandates since the creation of PNPB is one example of the power imbalance between stakeholders, as there

was pressure from the biodiesel mills to increase the blend percentages. In 2015, the policymakers decided to increase the mandates, setting 7% for January 2016, 8% for January 2017, 9% for November 2017, and 10% for March 2018. The blend was boosted in accordance with the demand from the business sectors that argued that the biodiesel manufacturing units were lying idle. The production capacity of smallholders, ongoing technical tests on biodiesel motors, and possible impacts on prices were placed second. In this sense, even with the involvement of different stakeholders in the design of the policy and with the broad goals relating to regional development, the big biodiesel corporations historically had more power to interfere in the decision-making process. The blend reached 13% in 2021 but had to be reduced to 10% in the same year, mainly to stop increases in diesel prices[4] (Biodieselbr, 2021).

2.5. Conclusions on criteria to design appropriate policies for smallholder productive inclusion in the transition to the bioeconomy

The main lessons of the SBS that we could identify from the visited literature and qualitative interviews we performed are that limitations to smallholder productive inclusion are largely associated with limitations of developmental interventions and policy design and implementation. In the policy design and implementation, productive inclusion should be understood as a process, and therefore a long-term goal and

[4] The reduction of diesel prices was a strong demand from truck drivers, who carried out several strikes across the country, suspending the supply of various goods, such as food to supermarkets and fuel to gas stations. Biodiesel had an increase in the price mainly due to the high price of soybeans on the international market, which was influencing the price increase in the domestic market (Biodieselbr, 2021).

multidimensional task. In the table below we present the main lessons of the SBS and what is important in policy design:

Table 2.2: Lessons about inclusive biobased intervention from the SBS in Brazil and considerations for policy design

Lesson from SBS	Considerations for policy design
Market/technical goals, which are immediate needs, had more influence in policy design and decision-making processes.	Provide an apropriate balance between immediate needs and the long-term goals by setting a socially robust policy agenda.
Contracts added more complexity to smallholders' business and acted as a mechanism for selecting the farmers.	The contracts should be not only purely commercial and about feedstock supply. Contracts should allow the development of smallholders' capabilities and be adaptive to different needs.
Logistics is an important cost and may drive the inclusion or exclusion of smallholders.	Design a business model that considers the importance of logistics for private companies and also for smallholders, once they have to transport feedstocks. Other stakeholders might also be considered.
Resistance to inclusion happened due to lack of more consideration about local concerns and needs.	Policy design should be committed to the realities of smallholders, their problems and needs. Participatory processes and consensus building should avoid this limitation.

A value chain based on small-scale industrial units is not always feasible.	The commitment to reality is key. However, the development of small-scale industrial units owned by smallholders could be a long-term policy goal.
Technical assistance was superficial.	Technical assistance for smallholders should be transformative, which demands long-term contracts.
Existence of power imbalances and institutional lack of capabilities posed challenges to the achievement of inclusion goals.	This is a historical-structural dimension. Overcoming those barriers needs a commitment to socioeconomic development and capability development.

The structural transformations needed for effective smallholder productive inclusion in the transition to the bioeconomy will only be achieved when the problem to be addressed is properly identified, a problem that, in general, is complex and multidimensional. It is important to build a strategic coalition of interests that is capable of identifying the wicked problem and developing an appropriate policy agenda that is socially robust.

An appropriate policy agenda will only be long-lasting if it is supported by society for its cause and motivation. Society's commitment to the topic would contribute to the advocacy of a more equitable distribution of benefits and a more equitable power balance between stakeholders. In the case of PNPB, there was a commitment of the state to sustainable and inclusive development. The participation of different stakeholders in the design process was pushed by the state, and not driven and enforced by society. In scenarios like this, it is easier that political

instability leads to instability of policies, and a change of government may lead to a change in priorities and participation.

This is why regulatory stability is needed. For reaching regulatory stability, policy design must include as many stakeholders as possible, be supported by evidence, have good monitoring and evaluation indicators, and have a guarantee of funding that is not easily exchanged or discontinued (Barão et al., 2022). Only developmental policies that endure have the power to produce effective social transformation over generations. But this will only be possible with civil society support through time. Moreover, fragmented policies that focus on only one dimension of inclusion will not deliver the results needed, once inequality challenges are multidimensional. A strategic regional development strategy focused on socioeconomic change is needed (Krawchenko and Gordon, 2022).

In addition, as socio-economic development constantly create new externalities, it is important to incorporate flexibility and adaptability to enable policy change over time (Feindt et al., 2020). As the reality – and the problems – change, the policies should be able to be timely reshaped to provide the needed solutions.

Ultimately, the transition to a bioeconomy in an inclusive and just way demands the displacement of old practices, which may interfere with the established practices of stakeholders. This means that policies and economic incentives are not enough. Stakeholder alliances are needed for advancement in new technologies and interventions, and an understanding of the necessary socio-political aspects and local realities is still required. The transition to an inclusive bioeconomy should not be an off-the-shelf intervention that countries follow by meeting established criteria, but an effort that involves identifying local problems with the stakeholders, searching for solutions together, and building the capability to reach specific goals. This should be a continued process through time.

Chapter 3

Acrocomia (macaw palm): a new opportunity for inclusive biodiesel production in Brazil?

3.1. Introduction

Productive inclusion of smallholders in value chains can be used as a strategy towards poverty alleviation and resilient and inclusive development (Gupta et al., 2015). 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, especially when combined with social protection policies, may contribute to reducing poverty by generating employment and income opportunities (Vicol et al, 2018; Vollmer, 2017).

In Brazil, the National Program for Biodiesel Production and Use (PNPB) seeks to promote the diversification of feedstocks for biodiesel production combined with the productive inclusion of smallholders. Acrocomia, also known as macaw palm, emerged as a potential feedstock to meet these goals. Besides presenting high oil productivity per tree, this palm tree is already part of the local culture in different regions of the country. In this sense, this is a possibility for improving the already existing strategy of exploitation of the palm tree to meet the biodiesel market demands for oil with social responsibility. As the acrocomia value chain in Brazil is under development, there is room to shape it in an inclusive way. The aim of this paper is to identify opportunities and challenges for the inclusive development of the acrocomia value chain for biodiesel production in Brazil.

The economic exploitation of this palm tree is fundamentally based on agroextractivism, which is the extraction of available resources from nature as a strategy to generate extra income (Wunder, 1999). Seasonal changes lead farmers to move to regions in search of occupation and income. In many areas, one alternative is agroextrativism, and thousands of families engage in collecting acrocomia 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 on the farmers' lands eliminate the logistical difficulties of agroextractivism. Nonetheless, commercial plantations are at the initial stages of development, and the shift from agroextractivism 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 the farmer's 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 to plantations with the inclusion of smallholders be accelerated? The focus of this work is to analyze the challenges and opportunities for 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. Providing access to education, infrastructure, technical assistance, inputs, technologies, and markets must be complementary actions.

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

3.2. Material and Methods

This research combines a literature review with qualitative interviews. This approach allowed us to gather perceptions and generate new insights on the development of an innovative value chain with inclusion of smallholders. Interviewees were identified through purposive sampling, which is the selection based on criteria settled by the researcher (Jupp, 2006). The main goal of purposive sampling is to focus on

particular characteristics of participants, which supports the comprehension of the research problem. Usually, the sample is small, mainly if compared with probability sampling (Guarte & Barrios, 2006). 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.

Eighteen qualitative interviews based on semi-structured questionnaires were conducted in 2020. The criteria for selection of stakeholders for interviews were: i) relevant research on the development of acrocomia value chain, ii) participation/leadership in projects/business of acrocomia plantations, iii) non-participation in projects/business of acrocomia plantations, iv) interest and availability to participate in the research. The profiles of interviewees were: researchers, businessmen, representatives from public and private sectors, smallholders, and representatives from their organizations, such as cooperatives and unions. Each interview lasted an average of one hour, and questionnaires were adapted according to the profile of the participants. Questionnaires are available on the appendices.

One interview was conducted online, in the phase of testing questionnaires. The content of this pilot interview is included in this research. Seventeen interviews were performed face to face, in a field research. The field research was carried out by four researchers in March 2020, in the Brazilian state of Minas Gerais, home to native acrocomia forests and pioneering plantations. Projects and business of acrocomia plantations where characterized by the presence and absence of smallholder productive inclusion. The state also offered diversified business models, from cooperatives to strictly research-focused initiatives.

The following sections are inspired by the thematic analysis of the interviews, combined with findings from the literature. The literature

research was conducted using three electronic databases: Scopus, Scielo, and Web of Science. Secondary data was collected from the official sources of the Brazilian State, such as the Brazilian Institute of Geography and Statistics.

3.3. Smallholder productive inclusion in biobased value chains

There is potential to include smallholders in biobased value chains, developing roles such as producers, traders, processors, retailers, and consumers (Mishra & Dey, 2018). Most of these actors are poor, depend on outdated technology and are excluded from dynamic value chains (Ma & Sexton, 2021; Ola & Menapace, 2020). For them, productive inclusion in value chains is an opportunity for poverty alleviation (Ros-Tonen et al., 2019; Vos & Cattaneo, 2021) and accruing higher income levels. Value chains can transform livelihoods, especially in developing countries (Asveld et al., 2021; FAO, 2021). However, due to structural challenges, smallholder inclusion in dynamic agro-industrial value chains is a major challenge (Manda et al., 2020).

The term productive inclusion is not directly addressed in the literature and the difficulty to define it is recognized (Souza, 2013). The few structured definitions available focus on tangential aspects such as employment, income and poverty (Mariotti et al., 2016). In this sense, Vahdat et al. (2019) carried out a systematic literature review and, based on the main findings, developed a definition for productive inclusion: "promotion of stable and decent job and income generation for populations facing poverty and/or social vulnerability, in order to facilitate the overcoming of chronic processes of social exclusion" (Vahdat et al., 2019, p. 21). In this paper we adopted this definition, adding the importance of a fair distribution of economic risks (Asveld, 2021; Stern

& Stiglitz, 2021). Thus, by productive inclusion we refer to the promotion of stable and decent jobs and income generation, with the economic risks fairly distributed between the stakeholders.

Brazil has some examples of interventions developed to promote smallholder productive inclusion in biobased value chains. One example is the National Program for Biodiesel Production and Use (PNPB). Created in 2004, the objective was to include biodiesel in the energy matrix, promoting the development of vulnerable regions, diversifying feedstocks, and including smallholders in the value chain (Marcossi & Moreno-Pérez, 2018). The first projects carried out in the North and Northeast regions focused on the development of the castor bean value chain by promoting commercial plantations (Conejero et al., 2017).

The example of PNPB shows that interventions aimed to promote productive inclusion and alleviate poverty may face several controversies. In the North of Brazil, the pilot intervention faced resistance from local social movements, which did not approve the business models that were based on integration with private companies. In addition, castor beans were not traditionally grown in the area and proved to be economically unviable for biodiesel production (Conejero et al., 2017). Castor bean produces a highly valued oil, which is expensive and not the most suitable for the biodiesel value chain. Besides, the limited scientific and technological development to promote large-scale commercial production and supply for the biodiesel market added several challenges to the intervention. Productivity was low and significant losses were generated. The intervention was controversial because it intensified the vulnerability of the smallholders involved (Flexor et al, 2011; Kato, 2012).

Therefore, the main reasons for the failure to develop the castor bean value chain for biodiesel with the inclusion of smallholders relate to at least 5 dimensions: i) historical-structural problems in the regions, ii)

fragile scientific-technological development, iii) economic viability, iv) limited availability of financial and human resources, and v) weak monitoring. Among the historical structural problems is the agrarian structure. In the Northeast, 65% of the total establishments had less than 10 hectares, and were classified as smaller than the minimum size to support at least one family (IBGE, 2017). Furthermore, climatic risks, especially in the semi-arid region, resulted in major fluctuations in the total planted area between the different crops (Mattei, 2004). Scientific and technological development was unable to develop the necessary responses to face the climate risk and increase productivity (Sampaio, 2017). Regarding economic viability, low production scales and high production costs, logistical difficulties, and high price volatility were evident. The lack of cooperatives between farmers limited access to technologies, knowledge, inputs, and markets. The presence of middlemen for market access imposed economic dependence. The Ministry responsible for the operationalization of the policy was newly created and had too few resources and employees to provide technical assistance services. This also resulted in weak monitoring, which hindered the consolidation of routines and knowledge building (Marcossi & Moreno-Pérez, 2018; Sampaio, 2017).

Since, the PNPB goal to diversify feedstocks for biodiesel production was a failure, and soybean dominated the market. A dynamic soybean value chain with significant scientific and technological development was already established (Marcossi & Moreno-Pérez, 2018), which hampered the competitiveness of new feedstocks. Despite the initial setbacks, the interest in the development of alternative feedstock as a long-term strategy must not be neglected. Acrocomia, also known as macaw palm and locally known as "macaúba", emerged as a potential to meet diversification, local development, and inclusion goals. Given the

risks and uncertainties involved in the development of a new value chain, it is necessary to look at the lessons learned from other interventions, as those promoted by PNPB, and strengthen public policies. An important condition to deal with the risks and uncertainties involved is to understand local contexts and include local stakeholders (Asveld, 2021).

3.3.1. Who are the smallholders in Brazil, and why is it relevant to include them?

In Brazil, smallholders are mostly recognized as family farmers. In the international context there is no single definition of family farming, although some general parameters are used to guide the delimitation of the concept, at least for public policy purposes (Guanziroli et al., 2020). Brazilian family farmers as a target group for public policies is a category defined by Law 11.326, created in 2006.

As a result, family farming in Brazil must follow four main parameters: i) the labor employed in the establishment must be predominantly familiar; ii) the farm must be set up as a small property, with a maximum of four fiscal modules[5]; iii) the family's income must originate predominantly from the family establishment; and iv) the management of the establishment must be carried out by the family (Presidency of the Brazilian Republic, 2006). The table below presents some data on Brazilian family farming:

[5] Fiscal module is a unit of measurement, in hectares. The value of each module is determined by municipality considering the local characteristics, such as predominant and relevant type of exploitation (fruit and vegetable, permanent culture, temporary culture, livestock or forestry). The value of fiscal modules in Brazil ranges from 5 to 110 hectares (National Institute of Colonization and Agrarian Reform, 2021).

Table 3.1: Brazilian Family farming in numbers

Number of establishments	3,897,408 (77% of total rural establishments)
Area (hectares)	80,891,084 (23% of the total area of agricultural establishments)
Average size of establishments	20.76 hectares
Occupation of labor	10.1 million people (67% of total occupation of rural labor)

Source: Brazilian Institute of Geography and Statistics, 2017.

Brazilian family farmers constitute a heterogeneous group related to several dimensions, such as education, professional experience, access to technologies, capital, and markets. In addition, there are structural differentiations regarding organization (individual production, cooperative or associative) and access to land (Guanziroli et al., 2019). In this sense, some smallholders are integrated into dynamic and technologically demanding value chains, while others live in vulnerable situations with no access to basic resources. These heterogeneities also reflect the different levels of development between Brazilian regions and their historical-structural characteristics (Maia et al., 2020; Medina et al., 2021). Consequently, different solutions are required according to the characteristics of farmers.

Brazilian smallholders were historically excluded from policies and interventions, since the agricultural modernization process in the 1970s favored medium and large-scale rural farmers (Guanziroli et al., 2013; Gutberlet, 2010). With the strengthening of rural workers' unions and social movements after the end of the dictatorial period in the middle of

the 1980s, smallholders began to voice their demands (Ghinoi et al., 2018). The first national program aimed at small farmers was only launched in 1996 (Flexor & Grisa, 2016; C. Guanziroli et al., 2013). Since then, many policies have been developed. However, the inclusion of such a large and heterogeneous group remains one of the main challenges for policymakers.

3.4. 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 multipurpose use, and the already existing traditional use by local communities (Chuba et al., 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). As mentioned previously, acrocomia is part of the diversification strategies for family farmers, who practice the agroextractivism of the fruits. The Brazilian Agricultural Census (IBGE, 2017) presents some data about the acrocomia agroextractivism in the country:

Table 3.2: Acrocomia agroextractivism in Brazil – number of rural establishments involved, amount produced and amount sold (2017)

	Total	Family farming
Number of establishments practicing acrocomia agroextractivis	480	340
Amount produced by the acrocomia agroextractivist practice (ton of fruits)	133	104
Amount sold (ton of fruits)	64	61

Source: Brazilian Institute of Geography and Statistics, 2017, table 6949.

The Minimum Price Guarantee Policy for sociobiodiversity products is an incentive for the agroextractivism of acrocomia in Brazil. Because of this policy, 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).

Besides the strategies to promote the productive inclusion of smallholders into the acrocomia value chain by fostering agroextractivism, plantation strategies are also being developed. Brazil leads the genetic research of the plant, mainly the diversity of Acrocomia aculeata, and

the research led to relevant advances in the improvement of the species, considered as semi-domesticated (Bergmann et al., 2013; Ribeiro et al., 2018). For at least the past two decades, Brazilian federal and state agencies, entrepreneurs, and large businesses supported the development of the acrocomia value chain as an alternative crop for the biodiesel sector[6] (Lopes et al., 2013). Such support has been given to scientific research, the development of technological innovations, knowledge for domestication[7], and the inclusion of different stakeholders. (Bhering, 2007; Franco & Zimpel, 2020; Paes et al., 2011; IDB, 2013; Pires et al., 2013). In 2009, a germplasm bank was created by the Federal University of Viçosa, in the state of Minas Gerais, containing genetic material of the aculeata species from almost all regions of Brazil. This germplasm bank is one of the largest collections in South America (Vargas-Carpintero et al., 2021).

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 et al., 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 et al., 2018).

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

[7] Based on a systematic literature review, Vargas-Carpintero et al. (2021) presented the state-of-the-art in acrocomia's research worldwide and identified research gaps. The main research gaps are related to genotype and environment interaction, planting material, crop management, and sustainable cropping systems.

Hence, its cultivation in silvopastoral systems[8] 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 et al., 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 et al., 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).

3.5. Case study in Brazil: the potential of acrocomia for productive inclusion of smallholders

To answer the question "how can the transition with the inclusion of smallholders be accelerated?", the field research was performed and the perceptions of interviewed stakeholders analysed. In the next subsections we explore four critical topics to be taken into account. First, we explore the complex transition from agroextractivism to commercial plantations of acrocomia. It sheds light on the challenges and opportunities associated with this transition. Other critical topics discussed include land size constraints, the extended time required for the palm tree to yield fruit, and the lingering skepticism of smallholders due to negative experiences with similar initiatives in the past. We also

[8] One of the types of agroforestry systems. In this productive system, trees and pastures are placed in the same area (Lüdeke-Freund et al., 2012).

identify potential strategies to accelerate smallholder inclusion, such as involving local leaders, providing practical demonstrations, and offering purchase guarantees to instill trust.

3.5.1. 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 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 (Cardoso et al., 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 farmers[9]. Acrocomia plantations in smallholdings have been associated with socioeconomic advantages and opportunities for local development (Averdunk et al., 2014; Vargas-Carpintero et al., 2022). 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.

3.5.2. Size of the plot of land

Feasibility analysis strongly recommends integrating acrocomia plantations with pastures (Averdunk et al., 2014; Cardoso et al., 2017).

[9] When the field research was performed, only one initiative included smallholders in plantation projects. Another initiative was planning to start inclusion.

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 livestock[10] would probably lack the space to isolate cattle. In this sense, we may affirm that plantations in consortium with pastures are not suitable for smaller farmers[11].

3.5.3. 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

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

[11] 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.

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 et al., 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.

3.5.4. 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 et al. (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 plantation 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.

3.6. 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 (Manda et al., 2020). The distribution of economic risks provides opportunities to mitigate the usual and rising risks in agriculture (Stern & Stiglitz, 2021).

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 the 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 (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 et al., 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 (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 (La Rovere et al., 2011; German et al., 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 indicatives 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 feedstock 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 3.3:

Table 3.3: Risks identified per category of stakeholders

Stakeholder	Risks	Risk implications
Farmers	Associated to the contracts	The long-term nature of acrocomia plantations' contracts is considered too risky.
	Production	Acrocomia 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.
	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	Production	Acrocomia 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.
	Market/prices	It is difficult to anticipate scenarios and predict the market price of acrocomia's products in the future.
	Institucional/legal	The changes in the biodiesel market are indicatives of institutional risks.
	Financial	Initial investments in commercial plantations of acrocomia are high and the financial returns are long term.
Local governments	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: Own elaboration based on interviews.

Risk management helps promote a balance between the distribution of risks and benefits (Lund et al., 2020), 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 et al., 2018). Moreover, the existing incentives are not enough to encourage investments in production chains that involve productive inclusion (Zapata et al., 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. Institutional arrangements, such as the formation of cooperative groups between different stakeholders has the potential to contribute to economic development, overcoming poverty and empowerment for group members (Robaey et al., 2022).

3.6.1. 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 (Millard, 2017). 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 et al., 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[12].

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 et al., 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

[12] Diagnosis based on interviews.

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 facilitates 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[13] (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

[13] Some authors identified that the poorest farmers are not included in cooperatives (Bijman &Wijers, 2019. In some cases, the inclusion of the most vulnerable smallholders may not be viable andcompromise the efficiency of the cooperative as a business (Fischer & Qaim, 2014). For the smallholders, the transaction costs of participating in cooperatives are sometimes excessive (Thorp et al., 2005). It is important to recognize whether this is a social assistance or productive inclusion issue. Combined and systemic solutions may also be a possibility. In Brazil, approximately 5% of smallholders are members of agricultural cooperatives (Herrera et al., 2018). The culture of cooperativism is strong in the South, where smallholders have greater access to capital, technologies, and public policies when compared to other regions. Cooperativism in the North and Northeast regions, which are more vulnerable, is still weak and under-explored by public policies (Herrera et al., 2018).

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.

3.7. Conclusions

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 with pastures, which is the recommended productive system, are 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 if the State takes the responsibility to mitigate some of the barriers and 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.

Chapter 4

Paving the path to an inclusive energy transition through State Capabilities

4.1. Introduction

The ever-increasing impact of climate change highlights the need for essential economic transformations. Various strategies are being proposed to forge a more sustainable future, encompassing the adoption of novel technologies (Bradu et al., 2022; Galiana & Green, 2009) and the reconfiguration of production systems (McGreevy et al., 2022). Amidst the anticipated shifts associated with this energy transition, a pivotal question emerges concerning whether the process will be just (Wang & Lo, 2021), creating opportunities for the inclusion of vulnerable groups.

In this paper, we delve into the notion of productive inclusion, which we define as the advancement of stable and dignified employment opportunities coupled with income generation, all while allocating economic risks equitably among stakeholders. Inclusion can be seen as a fundamental prerequisite for equitable approaches to addressing climate change (Huntjes & Zhang, 2016). It often unfolds as a process of dynamic interaction among diverse stakeholders, shaping decision making in governance (ibid.), the design of technological innovations (Marques et al., 2020), and the establishment of value chains that are economically just (Devaux et al., 2018). Scholars in this field frequently emphasize that it is necessary to complement stakeholder engagement strategies with targeted policies. Our objective is to demonstrate that effective governance in support of productive inclusion means it is necessary not only to have focused policies, but also distinct resources within the administration responsible for their implementation. These are qualities we categorize as state capabilities (Andrews, Pritchett, & Woolcock, 2017; Rodrik, 2018). As elucidated in the subsequent sections, the role of the state, in conjunction with its capabilities to

execute strategic initiatives, is pivotal in realizing the goals of productive inclusion.

The role of the state as a key participant in advancing socioeconomic and sustainable development is a subject of continuous scholarly discourse (Dosi & Tranchero, 2021). These deliberations frequently center around diverse perspectives and dichotomies, such as the contrast between liberal and statist viewpoints (Chikozho & Mapedza, 2017), developmental and orthodox approaches (Carroll, 2017), and the juxtaposition of private sector efficiency and perceived state inefficiency (Mazzucato, 2013). While these frameworks offer insights into varied standpoints, it is imperative to recognize the potential for oversimplifying the intricate dynamics that underpin the state's role in sustainable development. The discourse on state capabilities arises as an alternative to many of these binary portrayals, shedding light on the nuanced nature of the state's contributions and acknowledging variations in performance across diverse contexts and epochs (Kliksberg, 2001).

Resonating with the discourse surrounding the functions of institutions in the Global South, particularly since the 2008-2009 crisis, the discourse on the significance of state capabilities has gained momentum (Cingolani, Crombrugghe & Thomsson, 2015). There has been a resurgence of the state's role across numerous nations in the Global South, seeing not only state-owned enterprise infrastructure and operations being enhanced, but social disparities being mitigated because of robust public policies that demand robust state capabilities (Gomide, 2016). The state capabilities paradigm emerged as a mechanism to facilitate the formulation and execution of novel developmental strategies (Boschi, 2018).

An all-encompassing energy transition ushers in fresh challenges and potentially requires novel capabilities to be developed. Drawing from Brazil's experience with the National Program for the Production and Use of Biodiesel (PNPB), a governmental initiative that intertwines energy transition with the empowerment of smallholder farmers, this study endeavors to stimulate thought on the subject. The central research inquiry is as follows: To what extent can state capabilities play a role in nurturing an inclusive energy transition?

This paper does not seek to assess the PNPB exclusively. PNPB serves as case study for broader deliberations on state capabilities. These capabilities can provide insights to other nations, particularly those where bioeconomy value chains may assume a pivotal role in sustainable development. It elucidates how state capabilities can bolster an equitable energy transition by fostering productive inclusion.

The second section is dedicated to present the research methodology, in the third section we elaborate on the discourse surrounding state capabilities. The method is based on a comprehensive literature review and qualitative interviews, thereby facilitating an in-depth comprehension of the intricacies and underlying facets of the PNPB and the importance of state capabilities. In the fourth section we discuss how capabilities were developed to enable Brazil's strategy of an inclusive energy transition, drawing insights from the PNPB's experience. Subsequently, the fifth and final section of this manuscript encapsulates some concluding observations. We accentuate the profound importance of democracy, state capabilities, and mission-oriented governance in cultivating an energy transition that is resolutely inclusive. Our conclusion underscores the paramount importance of a robust yet adaptable institutional and regulatory framework – adept at

nurturing the proliferation of renewable energy sources, their accessible integration within society, and incentivized inclusivity. Productive inclusion stands as a catalyst for transformation. Strategic planning must meticulously balance environmental and socio-economic repercussions, transcending mere technical-environmental objectives.

4.2. Materials and Methods

This research combines a literature review with qualitative interviews. This approach allowed us to gather empirical evidence and generate new insights on the development of state capabilities within PNPB and to compare it with the characteristics of high-quality policies identified in the literature review. Notably, empirical information gathered was not available in existing literature, and as a result, our qualitative interviews provided a nuanced understanding of the roles of policymakers alongside the intricate network of stakeholders involved in shaping PNPB. Interviewees were identified through purposive sampling, which is the selection based on criteria settled by the researcher (Jupp, 2006). The main goal of purposive sampling is to focus on characteristics of participants that will ensure their understanding of the research problem. Usually, the sample is small compared with probability sampling (Guarte & Barrios, 2006). We conducted 26 qualitative interviews with participants selected according to: i) experience in design, operation, analysis, and monitoring of the PNPB; ii) relevant academic contribution in analysis and assessment of PNPB; iii) relevant academic contribution related to the state capabilities approach, and iv) interest in and availability to participate in the research. The interviewees are academics and policymakers.

We used semi-structured questionnaires, which were tested and reformulated after a first round of four pilot interviews. The content of the pilot interviews is included in this study. Questionnaires and the interviews were in Portuguese. A translated version of the questionnaires is available in Anex 2. Each interview lasted an average of one hour, and questionnaires were adapted according to the profile of the participants. Interviews happened between June 2021 and February 2022. All the interviews were conducted via video conference, and recorded with the participants' consent. The content was transcribed to allow content analysis. Secondary data was collected from the official reports of the Brazilian Ministry of Agriculture and grey literature. The literature research was conducted using three electronic databases: Scopus, Scielo, and Web of Science.

The transcripts of the interviews were analyzed using thematic analysis. The coding framework was developed based on the research question and on the set of six characteristics of high-quality policies identified in the literature review: a) stability over time, b) adaptability, c) coherence and coordination with already existing policies, d) public consideration, e) quality of implementation and execution, and f) efficiency. The identified themes were reviewed and refined through an iterative process of analysis and discussions among the co-authors.

4.3. From state capabilities to high-quality policies

The concept of state capabilities is broad, marked by strong multidisciplinarity. In this paper, we understand state capabilities as "the set of instruments and institutions that the State has to establish objectives, transform them into policies, and implement them" (Souza, 2016, p 51). The specific capabilities of the state are related to the

structures and learnings that are developed along the historical trajectory that is particular to each state. The set of capabilities is not fixed or timeless, but is built and modified over time, and can also be destructed.

Furthermore, the development of capabilities is not linear and responds to a broad set of political, economic, and institutional constraints. It can also be influenced by society's demands, opportunities, and investments. Hence, state capabilities vary in time, space, and area of activity (Scartascini & Tommasi, 2014; Gomide, 2016). This means that a state may previously have had significant administrative capability, lost because of changes in the political system and weakening bureaucracy.

When determining which capabilities are desirable, at least three key factors need to be considered. First, it is crucial to align the capabilities with the state's overall development goals and priorities. Having a set of clear goals enables states to develop concrete mission-oriented actions (Mazzucato, 2018). Second, the determination of desirable capabilities must consider the context-specific needs and challenges faced by the state (Gong & Hassink, 2020). This allows for the identification of local problems and opportunities, as well as the pursuit of strengthening or developing specific and relevant capabilities. Third, careful coordination of stakeholders and consensus building is important. Policies that are developed through collaborative processes and involve input from a range of stakeholders are more likely to be supported and sustained over the long-term (Peters, 2015).

The state capabilities relate to the abilities of its bureaucracy and personnel in implementing official goals, balancing stakeholder interests, and addressing context-related challenges (Boschi & Gaitán, 2008; Boschi & Diniz, 2011). Developing these integrated skills requires

an institutional political framework that enables relative autonomy in addressing diverse interests. Moreover, it requires a technically competent and empowered bureaucracy capable of implementing development policies coherently and autonomously (Almeida, 2014). The state's performance quality relies heavily on efficient management of financial, human, and technological resources (Fernández & Puente, 2014; Souza, 2016).

Discussing the role of the state in public policies, Brinks, Levitsky & Murillo (2019) argue that states must have the capability to plan feasible long-term policies and implement and enforce them over time. These capabilities are primarily centered around ensuring good decision-making processes. The authors emphasize that well-developed state capabilities are reflected in the creation of impactful public policies. Factors influencing policy effectiveness and quality are often intricate and interconnected (Head, 2022; Sabatier, 2007). These factors encompass, for example, stakeholder engagement, policy coherence, and resource allocation. Therefore, cultivating robust decision-making processes that transcend specific administrations and foster the continuity and improvement of policies and state capabilities is crucial.

Literature highlights, for example, the importance of setting clear goals: specific, measurable, achievable, relevant, and time-bound (Salvador & Sancho, 2021). This helps to ensure policy focus, clear direction and stability over time. Furthermore, high-quality policies are evidence informed (Radaelli, 2021). This requires availability and access to reliable and relevant data to inform policy decision making. Evidence-based policies are more likely to succeed in achieving their goals and maintain stability over time (Bovens & 't Hart, 2016).

Based on the literature findings, we can assert that high-quality policies encompass at least a set of six essential characteristics:

A. Stability over time refers to the ability of policies to endure and remain effective over the long term (Peters, 2015). It is important because stable policies provide predictability and consistency for stakeholders, which can help to build trust and confidence in government decision making (Cairney, 2019). Moreover, stable policies can promote efficient resource allocation and enable organizations and individuals to plan for the future (Ren et al., 2023). Stability over time also depends on political and institutional factors, such as the level of political consensus around the policy and the degree of bureaucratic capability to implement and enforce the policy over time (Béland, 2019). Policies subject to frequent changes in political leadership or lacking sufficient bureaucratic capability may be less stable over time (Rosenbloom, Meadowcroft & Cashore, 2019).

B. Adaptability refers to policies that are designed with built-in mechanisms for review that can respond to the learning process, changing circumstances, and new information, while still maintaining their overall goals (Tittonell, 2020; Brinks, Levitsky & Murillo, 2019). This can include the use of adaptive management techniques, such as setting up regular reviews and evaluations and incorporating feedback mechanisms to monitor policy effectiveness and adjust policies as necessary (Besley et al., 2022; Mukherjee, Coban & Bali, 2021). Collaboration and partnerships with stakeholders can help to ensure that policies remain relevant and adaptable. Stakeholders can provide feedback on policy implementation and suggest changes to address emerging issues or challenges

(Mukherjee, Coban & Bali, 2021; Paquet, 2022). However, adaptability and stability can be perceived as conflicting concepts due to their inherent characteristics and implications. Adaptability often involves embracing change, while stability emphasizes the preservation of established norms, structures, and processes. Balancing these two characteristics requires careful consideration and strategic decision making (Craig et al., 2017).

C. Coherence and coordination with existing policies refer to the degree to which a new policy aligns with and complements other policies and initiatives (Cejudo & Trein, 2023; Shawoo et al., 2023). Policies that are not coherent or coordinated with other policies may create inefficiencies, duplication, or even conflicting goals. Coherence refers also to the degree to which a policy is consistent and integrated with other policies and goals within the same policy domain (Glass & Newig, 2019; Trein et al., 2021). Coordination refers to the degree to which policies and actions across different policy domains are aligned and work together towards common goals (Trein et al., 2021). Achieving coherence and coordination requires a holistic and integrated approach in which policymakers consider the interconnections between different policy domains and work to align policies (Cejudo & Trein, 2023; von Lüpke, Leopold & Tosun, 2023). This process involves identifying and addressing gaps or overlaps in existing policies, as well as establishing mechanisms for coordination and collaboration across different government agencies and sectors (Glass & Newig, 2019).

D. Public consideration refers to the degree to which policies pursue the public interest, or at least the demands of the policy's target audience (Brinks, Levitsky & Murillo, 2019). Public consideration is important for ensuring that policies reflect different stakeholders' needs and priorities and for securing public support for policy initiatives (Head, 2022). Public consideration also refers to participation in policy design and implementation, transparency and accountability. These features are associates with higher quality of policies (Glass & Newig, 2019; Kujala et al., 2022). There are different approaches to public consideration, such as public hearings and consultations (Androniceanu, 2021), citizen assemblies (Elstub & Khoban, 2023), and deliberative forums (Boswell, Dean & Smith, 2023). The choice of approach will depend on the policy context, the level of public interest and engagement, and the resources available for public engagement (Glass & Newig, 2019).

E. Quality of implementation and execution is an essential dimension for successfully delivering intended benefits to target groups and achieving their goals (Hupe & Hill, 2022). Clear and realistic timelines, efficient resource allocation, and well-defined stakeholder roles and responsibilities are key strategies for effective implementation and execution (Karabulut, 2023; Sabatier, 2007). While well-designed goals are important, if policies are not effectively implemented and executed, their outcomes may deviate from the intended objectives (Knill, Steinebach & Zink, 2023). The availability of resources, including financial, human, and technological,

plays a significant role in successful implementation (Glass & Newig, 2019). Additionally, coordination and collaboration among stakeholders involved in policy implementation, such as government agencies, non-governmental organizations, and private sector organizations are key factors (Hupe & Hill, 2022). Policies often require specialized knowledge and skills, and leveraging the expertise and resources of different actors through coordination and collaboration can enhance the effectiveness of policy implementation and execution (Anderson, 2023). Coherence and coordination with already existing policies is also relevant.

F. Given the existing resources and context, efficiency refers to the ability to achieve the policy goals (Manzoor, 2014) and can be understood as achieving the best possible output given a specific reality. Efficiency can include the efficient use of public funds, personnel, and other resources to achieve desired policy outcomes (Lapuente & Van de Walle, 2020). Efficient policies help to ensure that policy goals are achieved within a reasonable time frame and avoid unnecessary delays or waste. It is important to highlight that this dimension should be balanced with other factors such as equity, effectiveness, and public participation (Andrews & Pritchett, 2017; Callahan, 2019).

In the table below the six dimensions are summarized:

Table 4.1: Characteristics of high-quality policies

Characteristic	Description
Stability over time	The ability of policies to endure and remain effective over the long term.
Adaptability	Policies that are designed with built-in mechanisms for review that can respond to the learning process, changing circumstances, and new information, while still maintaining their overall goals.
Coherence and coordination with existing policies	The degree to which a new policy aligns with and complements other policies and initiatives
Public consideration	The degree to which policies pursue the public interest, or at least the demands of the policy's target audience.
Quality of implementation and execution	Successfully delivering intended benefits to target groups and achieving goals set.
Efficiency	Achieving the best possible output given a specific reality.

Public policies with the characteristics mentioned above are associated with adequate and well-developed state capabilities. A professional bureaucracy in a democratic political system is indispensable (Lapuente & Suzuki, 2020; Scartascini & Tommasi, 2014) for the identification of problems, the formulation of solutions, the execution of actions, and the delivery of results. This process involves institutions, organizations, stakeholders, and instruments that must be coordinated to result in policies aimed at development. Poor choices

and underperformance can only exacerbate the problems public policies are trying to face (Head, 2022).

The existence of public bureaucracies and channels that connect the state to civil society contributes to the legitimacy, acceptance, and effectiveness of developmental actions (Boschi & Gaitán, 2008). The task of formulating and implementing public policies falls primarily to governments, articulated to at least two state institutions: the executive branch and the state bureaucracy. State capability approach by no means imply that the state should or is able to act alone. On the contrary, public and private institutions and organizations must operate in a systemic and complementary way to achieve the desired goals. Despite its fundamental role, the state is not alone in the creation and management of public policies, (Leite, 2011). The inclusion of different stakeholders in policy decision-implementation requires ability from the state to translate political rhetoric into consistent actions, and this goes beyond actions guided by political-electoral gains (Centeno, 2017; Lanzara, 2020).

Summing up, building state capabilities involves at least three main dimensions: 1- competent professionals; 2- efficient management techniques that produce coordinated and result-oriented actions; and 3- coordination of the relationship between different stakeholders, such as public and private sector organizations and civil society (Acemoglu, Ticchi & Vindigni, 2011; Fukuyama, 2013). In this way, institutions are fundamentally linked to the generation of capabilities for formulating and implementing policies and, at the same time, supporting coalitions and building consensus toward a development agenda (Castro & Boschi, 2020). The characteristics of institutions and the type of political organization present in different countries have a great deal of influence on this process (Gomide & Pires, 2014).

4.4. Capability building for Brazil's inclusive energy transition

State action was decisive for the development and expansion of renewable energy production in Brazil. The production of biofuels and its inclusion in the Brazilian energy matrix required the development of specific state capabilities. It consisted of a gradual learning process in diverse fields, from primary production to the distribution and consumption of fuels, technological, regulatory, economic, and financial aspects, and articulations between the public and private sectors (Rodríguez-Morales, 2018). The National Program for the Production and Use of Biodiesel (PNPB) was created in 2004. It aimed at fostering the sustainable production and use of biodiesel, with a focus on social inclusion and regional development (Garcez & Vianna, 2009).

In Brazil, the formulation, execution, and implementation of public policies present significant challenges due to the scale and complexity of the country. Regional disparities and long-standing socioeconomic inequalities are examples of this complexity (Hochman et al., 2007). Public participation is also a challenge, potentially resulting in policy failures (Coelho et al., 2006). Indeed, the country has a history of policies that failed to reflect the needs and concerns of the population, marginalized minorities, exacerbated inequalities, and generated new vulnerabilities for social groups and territories across all sectors (de Sousa, 2020; Hall et al., 2009).

In the case of agriculture, smallholder farmers constitute a historically marginalized segment, lacking the support of national public development policies until the mid-1990s. The agricultural modernization process in the 1970s, led by the military dictatorship, included only medium and large-scale rural farmers (Guanziroli et al,

2013). The inclusion of smallholders as a target group of public policies is tied to the Brazilian political context, in particular to the democratization process after 1988. PNPB, by aiming to promote smallholder inclusion, changed the approach of policies in the energy sector.

Although the number of smallholders engaged with the PNPB was smaller than expected (Cavalcante Filho, Buainain & Cunha, 2021), positive outcomes of productive inclusion were observed (da Silva et al., 2022; Ribeiro, 2019). A new option for distributing what the smallholders produced was created. In many cases before the PNPB arrangements smallholders were reliant on local intermediaries, often causing farmers to sell their products below market value. A foundation for the provision of technical assistance was established, even if irregular in quality and consistency. A monitored contractual setup was instituted through farmers' organizations, representing a significant step. Moreover, the presence of biodiesel companies in the biodiesel production chain led to increased raw material prices, benefiting producers not directly involved in the biodiesel chain (Campos & Carmélio, 2009). Therefore, the program empowered smallholders and allowed for the development of some capabilities among these farmers.

In the next subsections, we will discuss the development of state capabilities for an inclusive energy transition based on the experience of PNPB in Brazil and in the light of the six essential characteristics of public policies that we presented in the third section of this paper. The experience of the PNPB highlights the crucial role of promoting public consideration and informed decision making to ensure inclusive outcomes. The analysis also emphasized that inclusion demands attention to long-term goals, which involve structural changes. In this context, to promote inclusion it is essential for the state to possess the

capability to develop policies that are both robust and flexible, even if this takes time. Flexibility allows for adjustments based on lessons learned, the demands of involved stakeholders, and a balance of technical perspectives, ensuring that short-term goals, such as market objectives, are also met. A governance approach that is adaptative is required for capability development through time, recognising the learning process and new challenges. This approach would accelerate an inclusive energy transition.

4.4.1. Stability over time

Stability is particularly important for the inclusion of Brazilian smallholder farmers, who, in general, lack the resources to adapt to frequent policy changes and are averse to risk. This is a relevant consideration stated by nineteen of the interviewees. Within PNPB, the instrument for promoting inclusion is the Social Biofuel Seal (SBS), instituted in 2004. The criteria for granting the SBS to biodiesel mills was defined in 2005, establishing that the mills must meet the following requirements: (i) acquire raw material from smallholders, in a minimum percentage defined by law; (ii) establish a contract with smallholders or cooperatives/associations of smallholders, specifying commercial conditions that ensure income; (iii) and guarantee technical assistance to smallholders (Brasil, 2004; Isolani & Tonin, 2013).

The resilience of the PNPB, which remains operational in 2023 despite various changes and challenges, was attributed to its robustness by four interviewees. The policy engages different bureaucracies, regulations, and stakeholders, and according to interviewees this has helped to ensure its resilience over time. On the one hand, as identified in the interviews, it can be challenging to align the different visions

and interests of the bureaucracies and stakeholders. This was a considerable challenge to the Brazilian state, in a context of democracy in expansion. On the other hand, it was this robustness that facilitated the policy establishing a biodiesel value chain that includes smallholder farmers, their cooperatives, and private industries. According to interviewees' perceptions, this context helped to promote investment and growth in the sector, while also supporting the livelihoods of smallholder farmers.

The key regulations involve quality standards, certification systems, tax incentives, and social and environmental criteria for biodiesel production (Cavalcante Filho, Buainain & Cunha, 2021). The policy establishes a minimum blend percentage of biodiesel in diesel fuel, which has been gradually increased over time. In the first semester of 2023, the minimum blend percentage is 13% (ANP, 2023). The policy also establishes quality standards for biodiesel that are regulated by the National Agency of Petroleum, Natural Gas, and Biofuels (ANP). These standards include requirements related to the physical and chemical properties of biodiesel, as well as those related to its production, distribution, and use (de Oliveira et al., 2021). The PNPB also establishes a certification system for biodiesel production, which is regulated by the ANP, the already mentioned SBS. The Seal is a certification given to biodiesel mills if they prove they have purchased raw materials from Brazilian smallholder farmers. There are also tax incentives regulated by the Ministry of Finance for biodiesel mills that own the SBS (Brasil, 2004).

According to ten interviewees, private sector engagement has been a crucial strategy for ensuring stability, particularly in meeting market demands. According to those interviewees, initially, smallholder farmers showed some resistance to partnering with private companies. However,

this arrangement has facilitated the inclusion of smallholder agriculture in the program, considered otherwise impossible by three interviewees. One interviewee pointed the pivotal role of the Ministry of Agrarian Development in facilitating the relationship between smallholder farmers and private companies.

Another reason for the stability of the PNPB and the guarantee of inclusion is the periodic review and updating to ensure its effectiveness and relevance. This is related to the adaptability of the policy that we elaborate in the next subsection.

4.4.2. Adaptability

The SBS has undergone several reformulations since its creation with the aim of facilitating and expanding inclusion, a fact confirmed by eight interviews. According to them, the changes through time reflected the learnings and, in general, led to the development of state capabilities. Three interviewees highlighted that the biodiesel value chain was established through the PNPB in Brazil, so the structuring of the chain, connection between stakeholders, and inclusion were being developed simultaneously. Therefore, in a context of the creation of different capabilities, the key to ensuring inclusion over time was adaptability.

One interviewed policymaker gave the example of the calculation of the minimum percentage of purchases from smallholders established by the SBS. Initially, the requirements for feedstock purchasing from smallholders focused on the northeast and semi-arid regions, establishing a minimum percentage of 50%. The minimum percentage for the southeast and south regions was set at 30%, and 10% for the north and midwest regions. In 2009, these were altered for the first time.

According to the interview, the adaptation was necessary due to the structural and production difficulties faced by smallholders in being included in the biodiesel production chain. The minimum percentages of northeast and semi-arid regions were reduced to 30% and increased to 15% in the north and midwest regions to improve inclusion outcomes. The northeast and semi-arid regions are characterized by unfavorable climatic conditions and limited resources, which can impact the ability of smallholder farmers to supply large volumes of feedstock.

With the aim of improving the SBS and inclusion within the instrument, the Technical Chamber of Evaluation and Monitoring was created in 2014. The Technical Chamber evaluated the demands and proposals presented by the stakeholders directly involved with the SBS. Moreover, research and evaluation was performed to improve the SBS criteria (Grisa et al, 2017). In 2018, the minimum percentage requirement for the south region was adjusted to 40%. This result was due to the capabilities that farmers themselves had already developed in this region (Cavalcante Filho et al, 2019).

4.4.3. Coherence and coordination with already existing policies

The coordination with other policies was also key for smallholders' inclusion. One interviewed policymaker explained that the efforts primarily focused on production, commercialization, and technical assistance. As part of this effort, the Biodiesel Production Poles Project established Working Groups to facilitate the participation of smallholders in producing feedstocks for the biodiesel value chain. According to this policymaker, the project aimed to ensure that smallholders could actively contribute and benefit from the program.

In addition, six interviewees pointed out that the SBS benefited from the capability developed as a result of experience with the Food Acquisition Program (PAA), created in 2003. The PAA, developed by the Ministry of Agrarian Development, was the first program commercializing products from smallholder farmers. It encompassed mechanisms for public purchases from smallholders, initiatives for food and nutritional security, and the formation of public stocks. The operationalization of the SBS leveraged the knowledge and infrastructure established by the PAA, reinforcing the commitment to inclusivity (Brasil, 2010).

Furthermore, for smallholders to be included in the SBS they must have the Declaration of Eligibility for the National Program for Strengthening Family Farming (Pronaf) (Brasil, 2004). The declaration is proof of eligibility to policies targeted at smallholders in Brazil (Valadares, 2021). By being included in the SBS, smallholders can access an additional credit line from Pronaf for the cultivation of oilseeds (Neto et al., 2020). Regarding the technical assistance that must be offered to smallholders under the SBS, these are based on the guidelines of the National Policy for Technical Assistance and Rural Extension (Faria et al., 2019). Through these coordinated efforts, the Brazilian State equipped smallholders with a set of capabilities for production and created a conducive environment for their inclusion in the biodiesel value chain.

4.4.4. Public consideration

As highlighted by the 26 interviewees, the PNPB aimed to be an inclusive policy from its inception. In addition to the formal institutional channels that brought together representatives of various interests related to biodiesel, the presence of informal participation

mechanisms was also observed, for example lobbying practices promoted by different interest groups (Pedrotti, 2013).

One interviewed policymaker explained that PNPB involved various sectors of the economy and required inter-institutional articulation and coordination. The policy involved more than ten Ministries, such as the Ministry of Agriculture, Livestock and Supply (MAPA), the Ministry of Agrarian Development (MDA), the Ministry of Mines and Energy (MME), the Ministry of Planning (MP) and the Ministry of Finance (MF). It was a challenge to coordinate the different institutions, each of which had different interests (Leite, 2011). To address this challenge, an Interministerial Working Group was created. According to Sampaio & Bonacelli (2018, p. 151), PNPB:

> [...] demanded complex institutional engineering in the creation of mechanisms that count on the participation of several actors, ministries, companies and producers and were permeated by the political/state capability of articulation between the different public and private social segments.

Even with those formal and informal channels of participation, in some cases, there was a prioritization of short-term goals by those responsible for the implementation of PNPB, while the goals of inclusion were left in the background. This led to certain lessons learned regarding the importance of public consideration. In some regions, the crops selected for production were not a traditional part of the local culture (Kato, 2012). In those cases, eight interviewees pointed that smallholders were resistant to adopting the production of an unknown crop. This was the case with a pilot intervention involving castor beans in the northeast of Brazil (Flexor et al, 2018).

In this case, the experience of PNPB shows that when a new value chain is established, with feedstocks unknown to the farmers, barriers

to inclusion are erected and new vulnerabilities created (Silva et al., 2016). The main lesson is that even if an economic feasibility analysis is performed, the outcome in terms of productive inclusion relies on consideration being given to public views. In the case of the SBS, consideration to the views of the feedstock providers: smallholders.

Eight interviewees pointed out that where the castor bean value chain was already existing before the establishment of PNPB, and the smallholders were already involved in the value chain, PNPB created market opportunities.

Another relevant aspect related to the importance of public consideration is the existence of conflicts and power imbalances among stakeholders. Until the creation of the SBS, the relationship between smallholders' unions (and rural social movements in general) and large agroindustries was marked by intense conflict (Grisa et al., 2017). Through the interviews, we identified that smallholder organizations were strongly critical of cooperation with large companies and fought the process of integration. The state intermediated the relations and it was possible to build a consensus. The output was the agreement that smallholder contracts always have to be approved by a representative collective organization to safeguard against smallholder vulnerability (Lima, 2022). In this process, one interviewee highlighted that the Sectorial Thematic Chamber of Oleaginous and Biodiesel represented an important channel for public consideration within PNPB actions.

4.4.5. Quality of implementation and execution

Eight interviewees stressed that, as an innovative policy, the implementation and execution of the PNPB and the SBS were not simple, demanding the creation of important capabilities. By means of

the interviews, we could establish that it was necessary to open new spaces for participation and dialogue with society, as well as establish new routines and interactions within the state bureaucracy itself. In other words, there was a need to develop bureaucratic, technical, and political capabilities to promote inclusion.

One interviewee explained that to achieve the policy goals of inclusion, several instruments were created, articulating incentives and rules for production and commercialization. Among these instruments, the interviewee considered that financing of biodiesel production activities stands out. Financed aimed to support different points of the value chain: agriculture, production of crude oil and biodiesel, storage, logistics, and acquisition of machinery and equipment (Grisa et al., 2017). As part of this strategy, the interviewee explained that the Biodiesel Poles Project was initiated in 2006.

The Biodiesel Poles Project's main strategy was to focus on micro-regions and qualify them technically for participation in the biodiesel value chain (Sillva, 2016). The Biodiesel Production Poles are geographical regions composed of several municipalities where there are smallholders who cultivate oilseeds or potential producers of feedstock for biodiesel production within the scope of PNPB (Maia, 2017). One interviewee explained that for the development of the Biodiesel Production Poles, the activity and/or interest of mills holding the SBS was relevant, as well as the presence of stakeholders interested in the development of the biodiesel value chain (such as investors, public managers, etc.).

PNPB introduced sources of feedstock that were not explicitly included in the design of the policy, such as beef tallow. Five interviewees highlighted the fact that prior to the implementation of

the policy there was practically no market or large-scale destination for beef fat. According to the perspectives of these interviewees, the consolidation of the biodiesel chain guaranteed a demand for bovine tallow, including price appreciation. This generated opportunities for the productive inclusion of a number of smallholder farmers that previously did not have access to the market.

4.4.6. Efficiency

Efficiency from the traditionally applied perspective, referring to the ability to achieve objectives using the least possible amount of resources (Griffin, 1995), is commonly utilized in policy evaluations. However, as we are not evaluating the PNPB based on its objectives in this study, we adopt an understanding of efficiency within the policy context as the capacity to achieve the best possible output given the limitations and specific contexts. From the interview accounts, we then interpret efficiency in the PNPB as the State's ability to balance creativity with pragmatism.

Three interviewees highlighted that it was necessary to be pragmatic in defining a feasible format for the productive inclusion of smallholders. The smallholders' agroindustries were facing operational challenges due to the lack of necessary skills of farmers to manage these businesses. The pragmatic approach adopted by policymakers recognized this limitation and aimed to leverage existing capabilities. The solution found was to centralize biodiesel production in large oilseed companies that were already operating in the country and had the capacity to meet market demand. In this sense, there was significant efficiency in developing the biodiesel production chain as inclusively as possible, given the complexities involved.

Based on our understanding of efficiency, PNPB seems to have efficiently fulfilled the goal of expanding the market for smallholder feedstock in the biodiesel value chain. In this particular matter, we consider the design of the SBS as ingenious. It requires biodiesel mills to buy at least a minimum percentage of feedstock from smallholders but does not oblige the mills to use the acquired feedstock from smallholders to produce biodiesel. In this way, SBS promotes the productive inclusion of smallholders in the biodiesel value chain, ensures demand for smallholder production, and at the same time ensures flexibility for the mills to use the feedstock in ways they decide are more strategic.

Efficiency in inclusive outcomes could be enhanced by focusing on long-term objectives to overcome structural barriers that still hinder an expansion in productive inclusion of smallholders. The development of smallholder agroindustries is one example of long-term strategy.

4.5. Fostering an inclusive energy transition through the development of state capabilities

Productive inclusion is not a priority in the debate on energy transition. The focus is on developing technologies that can replace fossil fuels with renewable sources, ensuring energy efficiency and provision. While there are few concrete initiatives focused on both the technological aspect and productive inclusion, Brazil has a national policy example that has brought many lessons. Thus, this paper discusses the development and importance of state capabilities for policies that aim to combine energy transition with productive inclusion of vulnerable groups, based on the experience of PNPB in Brazil.

The research has shown that combining productive inclusion with the goal of energy transition has added a series of complexities to this innovative policy. The necessary state capabilities were not ready for the policy to be put into operation, and there was a need to develop these capabilities concurrently with the policy's development. This is a major challenge, but the PNPB reveals that it is not only states with specific and strong state capabilities that can develop transition policies with productive inclusion. In many countries of the Global South, the "state capability trap" (Andrews et al., 2017) hinders the development of new capabilities due to existing institutions and practices.

To avoid this trap, it is necessary to put in place an adaptive, collaborative, and results-oriented approach to the development of state capabilities[14]. Therefore, countries where there are nonexistent or weak capabilities do not need to wait for the perfect moment or a perfect set of capabilities to consider productive inclusion in transition initiatives. However, institutional and organizational capabilities are crucial for avoiding the trap.

Andrews at al. (2017) propose a three-stage model for the development of state capabilities that can help countries deal with the potential trap. The first stage is to diagnose existing state capabilities and identify the gaps and challenges that need to be addressed. This involves conducting a detailed analysis of existing institutions, policies, and practices. Focusing on existing problems and not on (possible) solutions is key. Often, policymakers focus only on solutions without fully understanding the underlying problems that need to be addressed.

[14] The Problem-Driven Iterative Adaptation (PDIA), for example, is an innovative approach to the development of state capabilities that focuses on solving specific problems and promoting organizational learning (Andrews, Pritchett & Woolcock, 2017).

To avoid this problem, an evidence-based approach that involves collecting and analyzing data, conducting research, and consulting with experts and stakeholders should be adopted. The wicked problems that are identified should be split into a set of smaller problems. The second stage is to select the capabilities that need to be developed to solve the identified problems. Defining clear and measurable goals for the development of these capabilities is crucial. The third stage is to implement the policies and practices necessary to develop the selected capabilities. This involves creating effective institutions, improving technical capacity, reducing corruption, and strengthening political will.

The case of PNPB demonstrated that the creation of policies requires both institutional capability and the development of political capabilities, which are only possible with the existence of democracy and spaces of social participation. While Brazil has developed capabilities that modernized rural areas in the past, these capabilities did not ensure an inclusive development process. However, democracy allows for voices to be heard and inclusive interventions to be developed. It is important to note that political will alone is not enough, and strategies can lead to either inclusion or exclusion depending on their design. Therefore, political will aligned with the development of capabilities and inclusion-oriented actions are crucial. Additionally, political capability within PNPB was essential for legitimacy, involving the identification and engagement of different stakeholders and institutions, neutralizing oppositions, and building consensus among diverse actors with different and conflicting interests.

Regulatory capability played a crucial role in creating a market for smallholders' products and benefits for large biodiesel-producing

companies, ensuring policy stability over time. But although stability was important, adaptable capability was also essential, highlighting the need for the development of an institutional and regulatory framework that is robust yet flexible. Such a framework can support the growth of renewable energy sources, their accessibility through society, and incentives for inclusion.

The capacity for coordination with other existing policies was also fundamental. This highlights the importance of leveraging existing capabilities to support the development of others. However, the ability to coordinate in highly fragmented states with weakened bureaucracies is a challenging task. Even with this challenge, through coordinated efforts to connect PNPB with other policies, the Brazilian State was able to equip smallholders with a set of capabilities for production and created an environment that was conducive to their productive inclusion in the biodiesel value chain.

The development of PNPB and of the necessary capabilities to build the biodiesel production chain in Brazil with the inclusion of smallholders was highly influenced by pragmatism and commitment to reality. Given the complexities involved, there was significant efficiency in developing the biodiesel production chain as inclusively as possible. At the time of policy creation, smallholder agro-industries did not have the necessary capabilities to lead the production chain. Policymakers needed to balance creativity with pragmatism and, based on the context, defined the possible format for the productive inclusion of smallholders. This format was the sale contract of raw materials between them and large industries. Those large industries were already equipped with the necessary capabilities to ensure energy efficiency and provision of biodiesel to the market.

The importance of capabilities manifests itself at different times and with varying intensities. As capabilities are built up sufficiently to overcome one barrier, another one arises. Given this context, advancing the development of capabilities in the energy transition process without leaving the goal of inclusion behind is crucial. The experience of PNPB showed that to guarantee commitment to productive inclusion in the long run, different sets of capabilities should have been developed. Instead, the inclusion model designed in the program's creation has been perpetuated. This has led to limited inclusion results. Therefore, the adaptive governance approach seems particularly interesting, as it allows for learning from past experiences and adapting strategies to deal with new challenges and opportunities.

Approaches that engage stakeholders and consider local needs and characteristics are crucial for successful actions aimed at productive inclusion. Strategies must balance environmental and socio-economic impacts, rather than solely focusing on technical-environmental goals. Productive arrangements that consider local culture, appropriate technologies, access to credit, certifications, and required skills can determine whether inclusion is achieved or the result is exclusion. Adaptive governance can guide identifying key factors for productive inclusion in specific cases, and the development of capabilities can pave the path to an inclusive energy transition.

Chapter 5

Conclusions and Recommendations

5.1. Conclusions

This doctoral dissertation discusses the productive inclusion of smallholders in the biodiesel value chain, drawing on Brazil's National Policy for Biodiesel Production and Use (PNPB). Smallholder farmers are key players in agricultural value chains, particularly in the Global South. Yet, bioeconomy policy planning in these countries often overlooks them, leaving their perspectives underutilized (Lima, 2022). This oversight can result in power imbalances and increased vulnerabilities. In the energy transition debate, the topic also isn't a priority. The focus lies on technical and technological developments that replace fossil fuels with renewable sources to ensure energy provision and efficiency. It also emphasizes short-term solutions for immediate efficiency. Within the context of Brazil's PNPB, the emphasis was on meeting biodiesel mandates.

By exploring PNPB design and implementation (Chapter 2), analyzing the development of an innovative biobased value chain (Chapter 3), and reflecting on the topic of state capabilities (Chapter 4), this thesis provides an identification and understanding of the challenges and opportunities for the development of inclusive biobased value chains. This chapter recaps the main conclusions that address the central question: *How can governance contribute to smallholder inclusion in biobased value chains in Brazil?* "It also outlines this study's limitations and offers recommendations for future research.

5.2. Governance for smallholder productive inclusion in biobased value chains

The overarching theme of this doctoral dissertation is the concept of productive inclusion. Debates on possible types of inclusion consider

feasible and desirable characteristics for the concept, as organized in the literature review in Chapter 1. A novel contribution of this thesis is proposing a definition of productive inclusion to support policy and action formulation addressing this challenge. Thus, the proposed definition of productive inclusion in this thesis is the promotion of stable and decent jobs and income generation, with economic risks equitably distributed among stakeholders. We argue that productive inclusion should be understood as a process and a long-term development goal, particularly for Global South countries.

Addressing the historical-structural challenges in most Global South countries requires implementing integrated and multidimensional policies due to poverty and inequality's multifaceted nature (da Silva Medina, Scolari, & DelGrossi, 2021). Facing historical-structural problems is a lever to enable productive inclusion. This involves providing access not only to elements such as technical assistance, skills development, microcredit, and technology. It is also critical that an integrated approach addresses the challenges of access to land, water, electricity, education, and other essential resources related to well-being and dignity. Implementing policies that address these diverse dimensions creates enabling conditions for vulnerable groups, such as smallholder farmers, to be included. This also enables them to engage in more complex activities, and ultimately improve their living conditions. As highlighted in Chapter 2, fragmented policies focusing on only one inclusion dimension will fall short.

In this context, the role of the State is fundamental. As discussed in Chapter 4, the state's role as a key participant in advancing socioeconomic and sustainable development is an ongoing subject of scholarly discourse (Dosi & Tranchero, 2021). In the Global South, the State's role as a policy formulator and primary driver of sustainable and

inclusive development is paramount (Gomide, 2016). In the interviews conducted in the scope of this thesis, four stakeholders highlighted that including smallholders in value chains involves many risks. To deal with those risks, incentives, and subsidies are necessary, and only the State is capable of bearing that. Furthermore, the support and guidance of the State are also relevant in the development of new biobased value chains, as even more risks might be involved. As concluded in Chapter 3, without this support from the State, markets and entrepreneurs/investors may be unable or uninterested in providing the conditions necessary to develop alternative crops, combined or not with smallholders' productive inclusion (Millard, 2017).

However, the State alone lacks the necessary capabilities to reach the goals of productive inclusion efficiently. The private sector is a strategic partner to create synergies and maximize the impact of development initiatives. Private companies, as key components of the private sector, significantly contribute to economic growth, innovation, job creation, and the provision of goods and services. Hence, a partnership between the State and the private sector is a win-win relationship, as the State can be supported in reaching its inclusive goals, while the private sector benefits from a more stable and predictable business environment. Additionally, the private sector can also benefit from incentives and subsidies for the development of strategic sectors.

This win-win relationship between the State and the private sector is illustrated in Chapter 2. In the context of PNPB, the Brazilian State created the Social Biofuel Seal (SBS) to connect private companies and smallholder farmers in the biodiesel value chain. While the State could count on private biodiesel mills to include smallholder farmers as feedstock providers, those mills received tax exemptions and market benefits guaranteed by the State. Even if smallholder inclusion outcomes

faced limitations, we consider this a successful model. Some aspects could be improved, such as the provision of transformative technical assistance.

While the State's efforts are crucial, Brazilian private companies also have a significant opportunity to proactively embrace inclusive development, moving beyond merely reacting to state initiatives. The growing focus on environmental, social, and governance (ESG) dimensions provides an opportunity for private companies to engage in responsible governance. This means that by integrating ESG elements into their operations, investments, and supply chains, companies can contribute to environmental sustainability, improved social conditions, and the promotion of more transparent and ethical governance practices.

In addition to the private sector partnership, it is also important that the State collaborate with society. Policies and economic incentives are not sufficient without the participation of society, mainly of target groups. Target groups can highlight the problems they face and the necessities they have. Policies in the Global South are mostly marked by approaches in which more powerful actors set the agenda. The contribution of society is either co-opted or occurs at a later stage during the implementation process. Participation can take different forms, such as in forums designed to be collaborative spaces, or through social movements, associations, and unions. The paramount consideration is that early identification of target groups' real needs and problems depends on their participation, regardless of the form it takes. Likewise, collaboration with society is necessary to avoid power imbalances.

As explained in Chapter 2, PNPB in Brazil fostered participation from target groups right from its design phase. Smallholders' organizations were critical of contract farming with large private companies and fought this model of productive inclusion proposed by policymakers. After negotiations, smallholders agreed upon contract farming with private

companies under the condition that contracts must be approved by a representative collective organization to safeguard against smallholder vulnerability. This illustrates the importance of participation to avoid power imbalances.

Accordingly, hearing the voices of society through participatory processes helps prevent exclusion and the deepening of inequalities. As concluded in Chapter 4, the transition to an inclusive bioeconomy should not be a one-size-fits-all intervention that countries follow by meeting established criteria. This transition should be an effort that involves identifying the wicked local problems based on stakeholder engagement, searching for solutions together, and building the necessary capabilities to reach productive inclusion goals. For instance, the collaboration between different stakeholders and the possibility for society to take an active role in designing and decision-making processes is only possible in democratic contexts.

Regarding the collaborations among stakeholders, Chapters 2 and 3 emphasize the importance of multistakeholder governance models. We explain that the tripartite governance model, involving the State, entrepreneurs/investors, and smallholders, is important for the support and development of research, financing, technology, and stable regulation to enable productive inclusion. It is important to note that multistakeholder governance models do not eliminate the particular interests of each stakeholder. Particular interests might be conflicting among different groups. In this sense, a central role of governance is to ensure that expressions of diverse interests do not conflict with public policies' goals or put stakeholders in unfavorable conditions. Thus, responsible governance has mechanisms to prevent the realization of interests that may be disadvantageous to individuals or groups. The State should be responsible for consensus building that leads to the

achievement of policy goals and avoids unfavorable outcomes for stakeholders.

In addition to multistakeholder governance, this doctoral dissertation also highlights the importance of adaptive governance. This type of governance, mentioned in Chapter 4, involves creating an institutional environment that allows experimentation, learning, and continuous adaptation of policies and regulations to deal with new challenges and opportunities. This approach emphasizes the importance of collaboration between the State, civil society, and the private sector, as well as the need for an evidence-based approach to decision-making (Andrews et al., 2017). Adaptive governance also recognizes the importance of diversity and decentralization, allowing policies and regulations to be adapted to local and regional conditions. Responsible governance is also key in this case. The flexibility to adapt should not lead to power imbalances or unfavorable outcomes for stakeholders.

The Brazilian experience with the SBS in including smallholders in the biodiesel value chain highlighted the importance of an institutional and regulatory framework that is robust yet flexible. A robust regulatory system provides the stability and predictability necessary for economic agents, promoting trust and a safe institutional context. On the other hand, flexibility is essential to allow adaptation to changes and to enable adjustments based on learnings through time. Thus, a balance between the solidity of the rules and the ability to adjust is crucial for the efficiency of productive inclusion goals. Adaptive governance, in this sense, is a suitable governance model for developing the necessary capabilities to promote productive inclusion.

Complementing the discussion on governance and the development of state capabilities in Chapter 4, we present mission-oriented policies (Mazzucato, 2018) as an effective strategy for the State

to set ambitious goals and direct investments and efforts to achieve them. This type of policy requires the active participation of various stakeholders and, aligned with the concept of adaptive governance, mission-oriented policies should be informed by evidence. This helps ensure that resources are allocated effectively and policies are directed for maximum impact.

Reflecting on the general question of this thesis about "*How can governance contribute to smallholder inclusion in biobased value chains in Brazil?*", overall the core of the answer lies in three main dimensions: a model based on mission-oriented visions, combined with adaptive governance, and stakeholder participation. The mission-oriented vision of productive inclusion is necessary as a starting point, setting a clear direction toward the goal of including smallholders in biobased value chains. Adaptive governance gains ground for the productive inclusion mission to be implemented, ensuring the effective achievement of productive inclusion goals over time. In this regard, state capabilities, such as rules, incentives, and coordination with already existing policies, are necessary. Stakeholder participation enables the identification of challenges and needs, and prevents power imbalances. By incorporating those three dimensions, this model of governance may also be characterized as responsible. Even if our research is based on the case of Brazil, this governance model allows different countries to develop inclusive biobased value chains, also having as target groups different stakeholders.

5.3. Appropriate balance between immediate needs and long-term goals to promote inclusion

The experience of the SBS in Brazil discussed in Chapter 2 evidenced that achieving an appropriate balance between immediate and

long-term goals is of paramount importance for productive inclusion. By appropriate we mean a balance that does not hinder the goal of productive inclusion. The Brazilian experience reveals the intricate dynamics between meeting immediate market demands for biodiesel and fostering smallholder productive inclusion. While the actions prioritized immediate goals, the rhetoric of the policy emphasized long-term goals, translated into concerns about regional development and smallholder inclusion. In this sense, we conclude that an appropriate balance ensures that immediate needs do not compromise the long-term goal of productive inclusion. Adaptive governance could facilitate achieving this balance over time.

As mentioned at the beginning of this chapter, the productive inclusion of vulnerable groups should be recognized as a process rather than a singular outcome because it is a complex and multifaceted challenge that in general takes time. Often, there is a tendency to prioritize immediate and technical goals, such as efficiency and technological advancements, potentially overshadowing the broader developmental goals. Since some decisions addressing immediate market requirements may not heavily prioritize inclusion, it is imperative to maintain a holistic perspective. In the medium to long term, policymakers must develop enabling conditions that facilitate productive inclusion. This nuanced approach acknowledges the need to address immediate demands while still creating the foundations for productive inclusion to be achieved.

Components that support achieving the appropriate balance between immediate needs and long-term goals are participatory policy design and implementation. By incorporating the voices and perspectives of diverse stakeholders, including the vulnerable ones, policymakers might gain insights related to the challenges and needs to be addressed. Participatory approaches in policymaking foster a deeper understanding

of the intricacies of inclusion and enable the identification of solutions. Through a participatory policy design and implementation, a comprehensive and context-relevant strategy emerges, aligning more closely with the genuine needs of policies' target groups. This not only enhances the effectiveness of policies but also contributes to the cultivation of a sense of identity, belonging, and empowerment among stakeholders.

In the pursuit of creating enabling conditions for the productive inclusion of smallholders in the long run, in Chapter 3 we identified a series of critical topics to be considered. Contracts appeared as a relevant topic, mainly because interviewees perceived them as a risk, mainly long-term contracts. Adapting contracts and certification schemes to smallholder realities is crucial if contract farming is to effectively include smallholder farmers in biobased value chains. This might involve recognizing and adjusting contracts and certifications to the heterogeneous and context-specific nature of smallholder practices.

Accordingly, a possible solution involves incorporating an adaptation period within contracts, giving smallholders a period to adjust to the stipulated rules and standards, so they can feel more confident that they will be capable of meeting the commitments acquired. During this period, providing transformative technical assistance is imperative. Assistance from skilled professionals can guide smallholders through the intricacies of compliance, and also empower them with the knowledge and skills needed to meet the contract-related requirements. Tailoring these standards to smallholders' specific needs requires collaboration among contract and certification bodies, policymakers, and smallholder unions. Additionally, community-based smallholders' organizations can empower, incentivize, and enable them to navigate and benefit from contract farming and certification schemes.

5.4. Funding and incentives

Developing inclusive biobased value chains that prioritize smallholder farmers requires capital-intensive financing. The State, with limited resources, does not have the capability to finance it alone. Encouraging partnerships between private companies and smallholder agriculture is essential for the inclusive development of biobased value chains. However, as concluded in Chapter 3, the risks involved and the high up-front capital needed in general discourage private investors. Recognizing that such collaborations may not always align with the immediate interests of private enterprises, the State plays a pivotal role in offering incentives. Drawing from successful models like the SBS in Brazil, the provision of tax exemptions and market benefits incentivized private companies to engage with and support smallholder farmers to be included in the biodiesel value chain.

International collaboration also plays a pivotal role in mobilizing resources. Partnerships between international organizations such as universities, companies, and development banks facilitate the exchange of financial resources, but also knowledge and technology. Collaborative initiatives often involve joint research projects, capacity-building programs, and knowledge-sharing platforms. These partnerships also foster cross-cultural understanding, creating a conducive environment for inclusive development and innovative solutions.

As highlighted in Chapter 3, blended finance is a potent tool for fostering the development of inclusive biobased value chains. Blended finance is the combination of public, private, and multilateral organizations' funding, and is useful in mitigating risks. By enabling the pooling of resources from organizations such as development banks, impact investors, and private companies, blended finance enhances the

financial sustainability and economic viability of biobased value chains. Furthermore, blended finance can stimulate additional investment by assuming first-loss risk, providing technical assistance, and bolstering investor awareness. This mechanism not only encourages the adoption of inclusive and sustainable practices within biobased value chains but also contributes to the realization of the United Nations Sustainable Development Goals (SDGs) (Basile & Dutra, 2019).

In the sphere of funding initiatives, the importance of patient capital cannot be overstated. Patient capital is characterized by a willingness to endure uncertainties and wait for longer-term investment gains. Initiatives involving smallholder inclusion often face inherent risks and a longer period for financial returns. By providing financial support that takes into account the unique challenges and opportunities faced by smallholder farmers in different contexts, patient capital can contribute to the development of inclusive biobased value chains.

5.5. Stakeholder main responsibilities

The discussions conducted in this thesis led to the conclusion that responsible governance for smallholder inclusion in biobased value chains in Brazil relies on a mission-oriented approach to productive inclusion combined with adaptive governance and stakeholder participation. Even if various stakeholders might be involved, it is possible to highlight at least five fundamental ones: the State, the private sector, the smallholders, the researchers, and the civil society. Each of those stakeholders plays specific roles and has specific responsibilities in the development of an inclusive biobased value chain. In the table below, we organized their set of main responsibilities:

Table 5.1: Set of responsibilities by stakeholder

Stakeholder	Responsibility
State	• Develop public policies aimed at productive inclusion; • Establish regulations and incentives to promote productive inclusion and create a safe institutional environment for stakeholders; • Provide enabling conditions for smallholders' productive inclusion, such as technical assistance and microcredit; • Ensure coherence and coordination among policies of different dimensions, so that they complement each other; • Facilitate partnerships and collaborations among different stakeholders, such as private companies, smallholder farmers, and also international organizations; • Act as a consensus-builder to avoid unfavorable outcomes for stakeholders and power imbalances.
Private sector	• Contribute to the financing of inclusive biobased value chains; • Design or be involved in contract farming initiatives benefiting smallholders; • Provide technical assistance services and support skills development for smallholder farmers; • Participate or promote forums and initiatives that aim for smallholders' productive inclusion; • Play a more proactive role in initiatives related to the ESG dimensions; • Engage the broader society to support products and initiatives derived from smallholder inclusion in biobased value chains.

Smallholders	• Engage in/create spaces of participation to share needs, challenges, and opinions; • Integrate into cooperatives and/or associations and unions; • Adopt sustainable and innovative practices to increase productivity and product quality; • Actively participate in training and technical assistance programs to enhance skills and knowledge; • Adhere to contracts, regulations, and established standards; • Monitor and report on policy outcomes, aiming to ensure transparency and social responsibility.
Researchers	• Produce evidence to support the development of policies aimed at smallholder productive inclusion in biobased value chains; • Provide space to hear local communities and value their knowledge and experiences; • Propose innovative solutions to overcome specific challenges faced by smallholder farmers to be included in different value chains; • Assess the socioeconomic impacts of policies through time; • Communicate research findings in accessible language.
Civil society	• Participate or promote forums and initiatives that aim for smallholders' productive inclusion/sustainable development; • Monitor and report on practices regarding productive inclusion, aiming to ensure transparency and social responsibility; • Support initiatives that seek to strengthen the productive capacity and productive inclusion of smallholders, such as buying products or services that certify this practice.

5.6. Limitations

The present study acknowledges three limitations that should be recognized. First and foremost, the research is focused on the context of Brazil. Even though some conclusions might be applied to other countries, the smallholder realities, and local and institutional contexts discussed are particular to Brazil.

Second, the methodological approach chosen for this research involved purposive sampling, opting against large-scale interviews. While large-scale interviews seek statistical representativeness on a broad scale, purposive sampling focuses on the deliberate selection of specific participants, providing a deeper and qualitative understanding of the study. In contrast to large-scale interviews, purposive sampling may limit the generalizability of the results to a broader population.

Third, the unprecedented challenges posed by the global COVID-19 pandemic significantly impacted the research process of this doctoral dissertation. The fieldwork was abruptly interrupted due to the pandemic. The restrictions imposed by the pandemic required adaptations, which allowed the continuity of the research. However, the context hindered the completion of planned interviews with smallholder farmers, as conducting them online was not feasible.

5.7. Recommendations for future research

Looking ahead, there are promising opportunities for future research that can build upon this doctoral dissertation. Notably, the findings highlight that productive inclusion is not prioritized within energy transition policies. This underscores the pressing need for the development of targeted policy instruments that facilitate productive

inclusion. Future research should explore challenges and opportunities worldwide for the development of inclusive biobased value chains, generating evidence and contributing to a broader understanding of policy impact and stakeholder roles. Comparing approaches across countries offers a compelling way to illuminate diverse strategies and contexts. The challenges for productive inclusion should be a research agenda in countries of the Global South.

Moreover, a valuable direction for future research involves conducting large-scale interviews with stakeholders, mainly smallholder farmers. This approach could validate and extend the insights gained from the purposive sampling performed in the scope of this thesis. By upscaling the scope of interviews, researchers can refine the understanding of smallholders' perceptions and needs regarding productive inclusion in biobased value chains, ultimately enhancing evidence availability on the topic.

Finally, the social aspects of new and innovative biobased value chains deserve heightened attention in future research. While current literature tends to emphasize economic viability and technological aspects, a more holistic understanding necessitates investigations into the social dimensions of these value chains. This involves exploring the impacts and interactions of such chains on local communities, social structures, and cultural dynamics, thereby providing a more nuanced understanding of their broader societal implications.

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Curriculum Vitae

Gabriela Solidario de Souza Benatti was born in Mogi Mirim, a small city in the countryside of the state of São Paulo, in Brazil. After completing her Bachelor's in International Relations, Gabriela decided she wanted to explore the corporate sector. After two years of working in a company, her curious and restless mind was claiming for research. Therefore, Gabriela decided to apply for a master's degree program.

Gabriela pursued a master's degree in Economic Development at the Universidade Estadual de Campinas (Unicamp). Her master's degree was instrumental in opening the doors for the understanding of the intricate relationship between state capabilities, public policies, and sustainable development. She continued her studies in Economic Development at Unicamp as a PhD student.

While in her first year of the doctoral program, Gabriela connected with the Dutch-Brazilian collaboration through the Unicamp-Be Basic partnership, being included in the project that gave rise to this thesis: Inclusive Biobased Value Chains. From the beginning of the project, exciting opportunities crossed her path. The approval for the Dual Degree program with TU Delft injected even more enthusiasm into her life. Gabriela made the most of the year she spent conducting her research in the lovely and *gezellig* city of Delft. For the first time living outside Brazil, her curious mind wanted to enjoy every moment. Beyond the academic experience, the Dual Degree provided personal development and positive transformation.

Committed to her life mission of driving sustainable development through research and policy analysis, Gabriela returned to Brazil in 2023 to dedicate herself to a new job, in addition to completing her dissertation. As a researcher at the Instituto Veredas in Brazil, she gained hands-on experience in translating complex knowledge into actionable policy recommendations to inform policymakers and investors. Bridging the gap between policy and evidence, Gabriela has the feeling of contributing to sustainable development in Brazil.

Recomeçar

O conteúdo deste e-book é a tese de doutorado de Gabriela Solidario de Souza Benatti, que foca na inclusão de agricultores familiares na cadeia produtiva do biodiesel no Brasil. A autora analisa a Política Nacional de Produção e Uso do Biodiesel (PNPB), destacando tanto os desafios quanto as potencialidades do instrumento de inclusão do programa, o Selo Biocombustível Social (SBS). Além disso, também são analisados os desafios e as potencialidades para a inclusão produtiva da agricultura familiar em uma cadeia promissora: a da macaúba. A pesquisa enfatiza a importância de políticas públicas que equilibrem demandas imediatas do mercado com objetivos de desenvolvimento sustentável e inclusão produtiva no longo prazo. Fundamentada em uma sólida base empírica, obtida por meio de entrevistas qualitativas com atores-chave e análise documental aprofundada, a pesquisa propõe um modelo integrado de governança adaptativa, orientada por missões e aberta à participação multissetorial. A autora argumenta que, sem a participação ativa e equitativa da agricultura familiar, políticas públicas correm o risco de reproduzir desigualdades históricas e limitar o acesso aos benefícios socioeconômicos gerados pelas cadeias produtivas.

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