Two Decades of Round Table on Responsible Soy, Near-Zero Physical Segregation

Rethinking Soy Chain-of-Custody Governance in the Shadow of EU Deforestation Regulation

Daniela Barreto Gonçalves

Independent project • 30 credits
Swedish University of Agricultural Sciences, SLU
Faculty of Forest Sciences
Southern Swedish Forest Research Centre
Erasmus Mundus Joint Masters programme in Sustainable Forest and Nature Management
Alnarp, Sweden 2026

Two Decades of Round Table on Responsible Soy, Near-Zero Physical Segregation

Rethinking Soy Chain-of-Custody Governance in the Shadow of European Union Deforestation Regulation

Duas Décadas de Certificação da Mesa Redonda da Soja Responsável, Segregação Física Quase Nula

Repensando a governança da cadeia de custódia da soja no Brasil na sombra do regulamento de desflorestação da União Europeia

Daniela Barreto Gonçalves

Supervisors:	Luis Andrés Guillén Alm, Swedish University of Agricultural Sciences, Southern Swedish Forest Research Centre.
	Sofie Nielsen, Lead Specialist, Forests, World Wildlife Fund Denmark
Examiner:	Vilis Brukas, Swedish University of Agricultural Sciences, Southern Swedish Forest Research Centre

Credits:	30 credits
Level:	Advanced level, A2E
Course title:	Master's Thesis in Forestry Science
Course code:	EX1034
Programme/education:	Erasmus Mundus Joint Masters programme in Sustainable Forest and Nature Management
Course coordinating dept:	Department of Southern Swedish Forest Research Centre
Place of publication:	Alnarp, Sweden
Year of publication:	2026
Cover picture:	Cerrado biome at Chapada dos Guimarães, Mato Grosso, Brazil, Abril 2026. Photo by the author
Copyright:	All featured images are used with permission from the copyright owner.
Keywords:	RTRS certification; physical segregation; EU Deforestation Regulation (EUDR); soy supply chains; chain-of-custody governance; Brazil

Swedish University of Agricultural Sciences
Faculty of Forest Sciences
Department of Southern Swedish Forest Research Centre

Acknowledgements

To my supervisor, Luis, who said yes to being my supervisor within the first hour, and who gave me endless feedback while trying to organize my scatterbrain into something readable.
To my supervisor, Sofie, whose input shaped the direction of this thesis and who offered so much support along the way.
To André Freitas and Cid Sanches, both of whom acted as gatekeepers for this thesis in their own way. André was always kind and available, and Cid was generous with the advice that helped draft this thesis idea.
To all those who cannot be named due to the anonymity of this work, but who agreed to be interviewed and generously shared their time, knowledge, and perspectives with me. This thesis would not have been possible without you.
To everyone at the WWF Brazil office, who welcomed me during my time in Brasília.
To Julia Williams, who introduced me to this topic two years ago and reawakened a teenagerhood environmental rebellion on the deforestation crise that had gotten lost along the way.
To my friends, the ones who went through this process alongside me and the ones I made in Brazil, thank you for being such a huge part of my support team.
To my family, who may not have followed every detail of what I was researching, but supported me during the journey.
And to my grandfather, who crossed over during the writing of this thesis, and to whom I owe much of my values. Not an academic, but a teacher with a huge impact on our small village, someone who gave his time, his work, and his knowledge to his community. Exactly what I hope to do with this.

Abstract

Despite two decades of Round Table on Responsible Soy, the volume of physically segregated, deforestation-free soy traded out of Brazil remains negligible; most certified soy instead moves through a credit-based system that separates the certificate from the physical grain. This gap is sharpened by the EU Deforestation Regulation (EUDR), which from December 2026 will require all soy placed on the EU market to be legally produced and traceable to deforestation-free land, and by a growing number of companies aligning their deforestation- and conversion-free sourcing commitments with frameworks such as the Accountability Framework initiative (AFi). This thesis examines why physically segregated RTRS-certified soy has failed to scale, asking how stakeholders perceive the feasibility, legitimacy, fairness and power of segregated deforestation- and conversion-free (DCF) supply chains (RQ1), and what has specifically limited their scaling (RQ2).

Drawing on 24 semi-structured interviews with producers in Mato Grosso, traders, cooperatives, NGOs, and downstream buyers over Brazil and Europe, together with a review of academic and grey literature, the thesis finds that segregation is technically feasible where a single actor controls the chain, but is blocked more broadly by fragmented ownership and inconsistent buyer demand, Segregation further raises questions of legitimacy, fairness and power: cut-off dates grow stricter building on the Brazilian law legality, unevenly distributed costs and benefits, and a power standoff in which no single actor can resolve the deadlock alone.

RTRS-certified segregation has failed to scale because three barriers compound one another. First, too much certification moves through the credit system, which decouples the certificate from the physical grain: several interviewees noted that this lets buyers claim they are supporting change on the ground without certification having a big impact on altering production practices, and that credits are simply cheaper to buy than physically segregated soy. Second, certified production is too limited and scattered to fill shared storage capacity. Third, demand for segregated soy is weak and indirect, driven by buyers' sustainability departments rather than consumers, and rarely reaches the upstream actors who would need to act on it. The RTRS-DCF Controlled Mix pilot offers a partial response to the second barrier, but leaves the third untouched.

Keywords: *RTRS certification; physical segregation; EU Deforestation Regulation (EUDR); soy supply chains; chain-of-custody governance; Brazil*

Contents

List of tables

List of figures

Abbreviations

Abbreviation	Description
ABIOVE	Associação Brasileira das Indústrias de Óleos Vegetais (Brazilian Vegetable Oil Industry Association)
AFi	Accountability Framework Initiative
ASM	Amazonian Soy Moratorium
CAR	Cadastro Ambiental Rural (Rural Environmental Registry)
CoC	Chain of Custody
CSPO	Certified Sustainable Palm Oil
DCF	Deforestation and Conversion- Free
EU	European Union
EUDR	European Union Deforestation Regulation
FLAG	Forest, Land, and Agriculture
FEFAC	European Feed Manufacturers' Federation
ISEAL	International Social and Environmental Accreditation and Labelling
GHG	Greenhouse Gases
RTRS	Round Table on Responsible Soy
RSPO	Roundtable on Sustainable Palm Oil
SBTi	Science Based Target Initiative
MATOPIBA	Agricultural frontier region spanning parts of **Ma**ranhão, **To**cantins, **Pi**auí and **Ba**hia
NGO	Non-Governmental Organisation
NSMDS	Non-State Market-Driven
PES	Payment for Ecosystem Services
TEGRAM	Terminal de Grãos do Maranhão (Maranhão Grain Terminal)
VSS	Voluntary Sustainability Standards
WWF	World Wildlife Fund
ZDC	Zero Deforestation Commitment

Cerrado nem dado, nem herdado

— Soy producer, Mato Grosso, fieldwork interview, 2026

["The Cerrado, neither given, nor inherited."]

1. Introduction

1.1 Agricultural Expansion and Global Land-Use Change

Global deforestation and the conversion of natural ecosystems are driven by a range of activities, including timber extraction, mining, infrastructure development, urban expansion and fire. However, agricultural expansion remains one of the most significant drivers of deforestation, forest degradation and conversion of natural landscapes linked to global commodity markets, such as soy, beef and palm oil, contributing significantly to biodiversity loss and greenhouse gas emissions (Cammelli et al., 2026; Gollnow et al., 2022; Pacheco et al., 2021). The increasing integration of agricultural production into international trade has strengthened the connection between global consumption patterns and land-use change in producer countries. It is estimated that between 20% and 39% of carbon emissions linked to deforestation between 2000 and 2014 were associated with international trade in agricultural commodities (Pacheco et al., 2021). In terms of the land itself, 24% of deforestation between 2000 and 2012 was caused by illegal conversion for the production for export markets (Rau, 2019).

Deforestation tends to occur in areas where the opportunity for agricultural conversion is highest. These areas are typically characterised by favourable climatic and topographic conditions, as well as accessibility to markets through transport infrastructure (Pacheco et al., 2021). In addition to these direct drivers, a range of indirect factors also influence land-use change dynamics, including demographic trends, technological developments, economic incentives and environmental conditions (Pacheco et al., 2021).

Brazil plays a central role in this global dynamics. The country holds the second-largest forest area in the world, yet recorded the highest average annual net forest loss worldwide between 2015 and 2025, at approximately 2.9 million hectares per year (FAO, 2025). Within South America, several regions have emerged as key agricultural frontiers, defined as areas of recent, rapid agricultural expansion into previously uncultivated land, shaped by the dynamics described above, where commodity expansion intersects with ecosystems of high ecological value.

1.2 Global Soybean Expansion and Brazil's Role in Production

Soybean *(Glycine max L.)* has become one of the most important agricultural commodities in the global food system, serving as a key source of vegetable oil and

livestock feed (Aragão et al., 2024; Peng et al., 2026). Since the 1960s, global demand for soybeans has grown rapidly alongside increasing consumption of meat and processed foods (Peng et al., 2026). The global harvested area of soybeans increased from approximately 23.8 million hectares in 1961 to 143.8 million hectares in 2024 (FAO, 2026).Today, soybeans occupy more than 10% of the world's arable land, making them the fourth largest crop globally after maize, wheat and rice. Rising global population and increasing demand for animal protein are expected to further increase soybean demand in the coming decades, placing additional pressure on land resources (FAO, 2026; Min & Wimer, 2024).

South America has become the epicentre of this expansion, currently accounting for producing more than half of global soybean that is consumed, particularly from Europe and China (Min & Wimer, 2024). Within the region, Brazil plays a particularly important role as the world's largest soybean producer and exporter, with a share of global soybean trade projected to increase from 51.6% to 60.6% between the 2021/22 and 2032/33 marketing years, making Brazil the leader in soy production and exports (Valdes et al., 2023).

Given its scale of forest loss and dominant role in soy production, Brazil is a key setting for examining the governance of soy-driven deforestation. This trajectory has drawn the attention of a range of actors, governments, companies and civil society, seeking to curb deforestation and conversion driven by soy's economic expansion.

1.3 Governance Responses to Deforestation and Conversion

While state-led policies and regulations remain central, market-based initiatives, including private sustainability standards and certification schemes, have played a growing role complementing public regulation and influencing land-use outcomes through market access (Pacheco et al., 2021). Figure 1 traces the key milestones in this evolving governance landscape.

In Brazil, land use is regulated by the Brazilian Forest Code (Lei nº 12.651/2012), which requires rural landholders to maintain a proportion of native vegetation as Legal Reserve. This proportion varies by biome and location: landholders in the Legal Amazon must protect 80% of native vegetation on forested land, 35% on Cerrado-classified land within the Legal Amazon boundary, and 20% on land elsewhere in the country, including Cerrado areas outside the Legal Amazon (Lei Nº 12.651, 2012, Art. 12; Lahsen et al., 2016). The law also created the Rural Environmental Registry (Cadastro Ambiental Rural, CAR), a mandatory national electronic registry through which landholders declare their property

boundaries and Legal Reserve area for monitoring and enforcement purposes (Lei Nº 12.651, 2012, Art. 29).

Alongside public regulation, a range of private governance initiatives have emerged to address deforestation and conversion associated with soybean production in Brazil. The most prominent mechanisms include the Amazon Soy Moratorium and corporate zero-deforestation commitments (ZDCs) (Brandão et al., 2025), and certification schemes such as the Round Table on Responsible Soy (RTRS) and ProTerra (Angnes et al., 2025). However, the effectiveness of these commitments depends on their implementation and enforcement, as voluntary pledges do not necessarily translate into reduced deforestation on the ground (Gollnow et al., 2022).

Most recently, and aiming explicitly to minimise the EU's contribution to global deforestation and reduce its contribution to greenhouse gas emissions and biodiversity loss (Regulation (EU) 2023/1115, 2023, Art. 1), the EU Deforestation Regulation (EUDR), adopted in 2023 and applicable from December 2026 following implementation delays, introduces mandatory requirements for deforestation-free supply chains (Leal et al., 2026; Regulation (EU) 2023/1115, 2023). Soy is among the commodities covered by the regulation, alongside cattle, cocoa, coffee, palm oil, rubber and wood, with operators required to demonstrate compliance through geolocation and due diligence (Regulation (EU) 2023/1115, 2023). As a legally binding instrument, the EUDR marks a significant shift from the collaborative governance arrangements described above toward unilateral regulatory action.

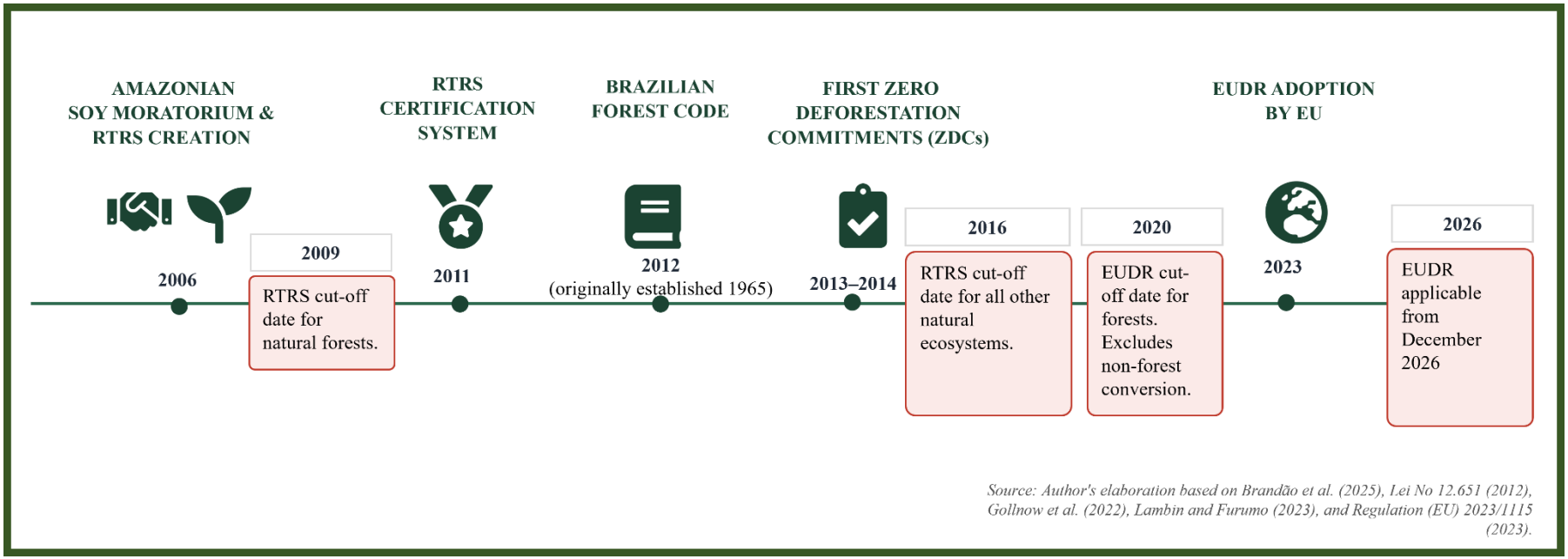

Figure 1. Key policy and governance milestones shaping soy governance in Brazil

1.4 Certification and the Challenge of Physical Traceability

In order to reduce the negative impacts of soy production, several initiatives have been created, the best known of which is the Round Table on Responsible Soy (RTRS), a multi-stakeholder certification scheme for soy production, processing and trade (Chen et al., 2024; Garrett et al., 2016; RTRS, n.d.-a).

Certified soy can be traded through several chain-of-custody models, Identity Preserved, Segregated, Mass Balance and Credit-based (Table 1), which differ in the extent to which they physically link certified production to final products (Bosselmann et al., 2025; RTRS, n.d.-a; Staricco, 2021).

Despite nearly two decades since RTRS's founding, and fifteen years from the Chain of Custody Standard launch, the overwhelming majority of RTRS-certified soy continues to be traded through the credit system rather than through physically traceable supply chains. In 2024, approximately 85% of RTRS-certified soy globally was traded as credits, with the remaining ~15% traded through physical Mass Balance; Segregated volumes specifically are estimated at 0,1% (RTRS, personal communication, April 9, 2026).

This gap between certification's stated aims and its limited transformation of physical commodity flows has become increasingly relevant as companies face growing demands for transparency and deforestation-free sourcing, and as regulatory initiatives such as the EUDR place greater emphasis on physical traceability. This tension motivates the research gap addressed in this thesis.

1.5 Research Gap and Objectives

Despite this certification scheme and growing corporate commitments to responsible sourcing, the volume of RTRS-certified soy traded through Mass Balance and physically segregated soy remains negligible. While certification schemes have contributed to the expansion of certified production and sustainability claims, uptake has concentrated overwhelmingly in credit-based systems. This raises fundamental questions about the extent to which RTRS, as a round table, and can drive flows of soy under stricter chain-of-custody models — segregation and Mass Balance — in a way that meets corporate sourcing commitments and sends a market signal against deforestation and conversion. Only under segregation is uncertified soy actually excluded from the supply chain; under Mass Balance, certified and uncertified soy can still be mixed, with only the volumes tracked administratively.

This question is now echoed, and sharpened, by the EUDR. The regulation sets a mandatory floor for legality and traceability, but it does not require the broader sustainability standards, covering labour rights, community relations and good agricultural practices, that RTRS certification encompasses and are third party audited. Whether EUDR will stimulate demand for certified segregated supply chains, or instead consolidate minimum compliance as the new ceiling for sustainability ambition, remains an open and consequential question.

This thesis therefore examines why physically segregated RTRS-certified soy has failed to scale despite fifteen years of certification standards.

To address this objective, the thesis is guided by the following research questions:

RQ1: How do different stakeholders perceive the feasibility, legitimacy, fairness and power within physically segregated Deforestation-and-Conversion-Free (DCF) soy supply chains?

RQ2: What factors have limited the scaling of physically segregated RTRS-certified soy supply chains?

A combination of qualitative interviews with 24 stakeholders in Brazil across the soy value chain and a review of academic and grey literature was carried out to analyse the barriers to physical segregation through the lenses of feasibility, legitimacy, fairness and power.

1.6 Academic and Practical Relevance

This study contributes to ongoing academic debates concerning the effectiveness of market-based governance mechanisms in addressing deforestation and ecosystem conversion (Garrett et al., 2016; Raasch et al., 2026). By examining the limited uptake of physically segregated soy supply chains, it provides insights into the relationship between certification systems, supply-chain governance and emerging regulatory approaches to sustainability.

The study also has practical relevance for actors involved in the implementation of deforestation- and conversion-free supply chains. As governments, companies, certification bodies and civil society organisations seek to strengthen traceability and sustainability performance within agricultural commodity markets, understanding the opportunities and limitations associated with physically segregated sourcing becomes increasingly important. The findings will therefore

inform both private governance initiatives and public policy efforts aimed at reducing the environmental impacts of global soy supply chains.

This study departs from prior work in several respects. Existing fieldwork-based research on RTRS in Brazil, such as Raasch et al. (2026), has examined certification adoption and its effects on production practices at the level of individual farms or producer groups in Mato Grosso. This study instead traces the chain of custody as a whole, from producers to traders to consumers, focusing specifically on segregation, the physical and documentary separation of certified from non-certified soy, rather than on certification or adoption more broadly. It also examines RTRS in the period leading up to EUDR enforcement, as the regulation's core obligations approach their December 2026 application date. This is, in addition, the first analysis of the RTRS-DCF Controlled Mix pilot, a new RTRS chain-of-custody model piloted in response to the same low uptake this thesis investigates. The four lenses of Feasibility, Legitimacy, Fairness, and Power are treated as connected rather than separate, showing how a problem in one tends to create problems in the others. Finally, the study treats Brazilian law, RTRS standards, and the EUDR not as a single governance instrument but as three systems interacting but misaligned.

2. Background

2.1 The Soy Supply Chain

Once harvested, soybeans are rarely sold as a single identifiable batch. Most are crushed, splitting into soy meal and soy oil, with the remainder as hulls, and from that point onward the material moves through the chain as a processed input rather than a traceable raw commodity (Figure 2). This is a key reason soy is invisible to the end consumer: unlike commodities carrying a direct ingredient label, soy enters final products already transformed, with no marker connecting it back to its origin (Hinkes & Peter, 2020). As a result, it's hard to know where a given volume of soy came from or how it was produced. Trade relationships are rarely linear, supply paths cross multiple intermediaries, and batches are routinely merged or split as they move through the chain, so a single shipment may contain soy from several different origins by the time it reaches a buyer (Hinkes & Peter, 2020).

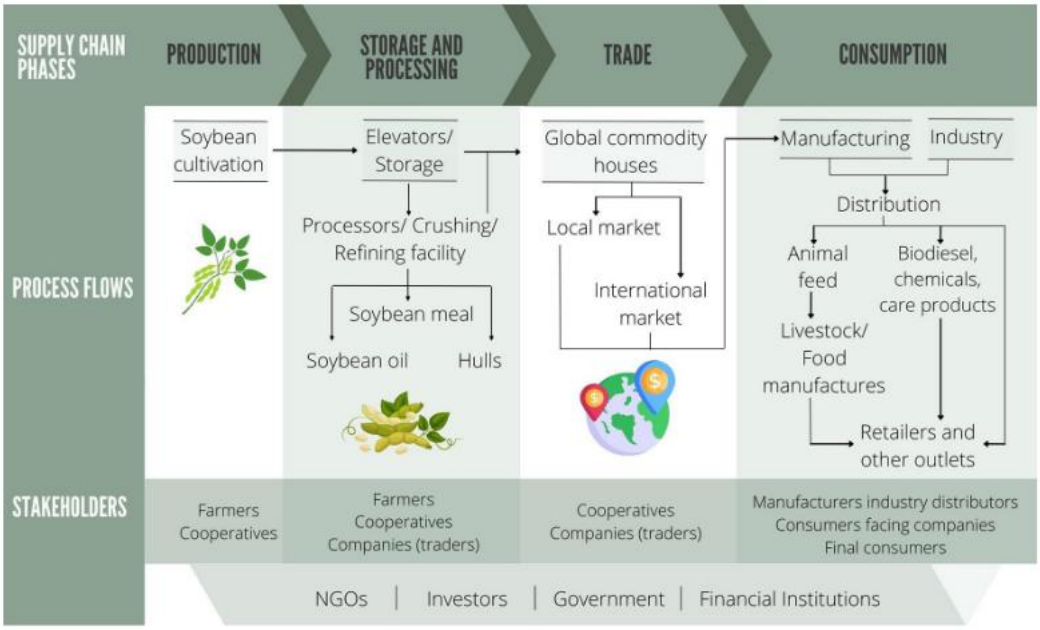

Figure 2. Soy supply-chain representation. Retrieved from Aragão et al. (2022)

Commodity supply chains such as soy's are commonly described as having an hourglass shape (Figure 3): production and consumption are both fragmented across large numbers of actors, while the middle of the chain narrows around a small number of traders and shippers handling disproportionate volumes (Fripp et al., 2023). In the case of soy, this structure runs from harvest at farm level through storage, which may take the form of on-farm storage, cooperative infrastructure, local trader facilities, or collection silos, before moving to crushing and refining facilities, and then into trading and shipping (Figure 2). The largest global soy

traders are Archer Daniels Midland (ADM), Amaggi, Bunge, Cargill, COFCO and Louis Dreyfus Company (LDC), controlling 42.5% of Brazilian soy export volumes in 2022, illustrating how few firms sit at this point of convergence (Hinkes & Peter, 2020; Trase, 2025).

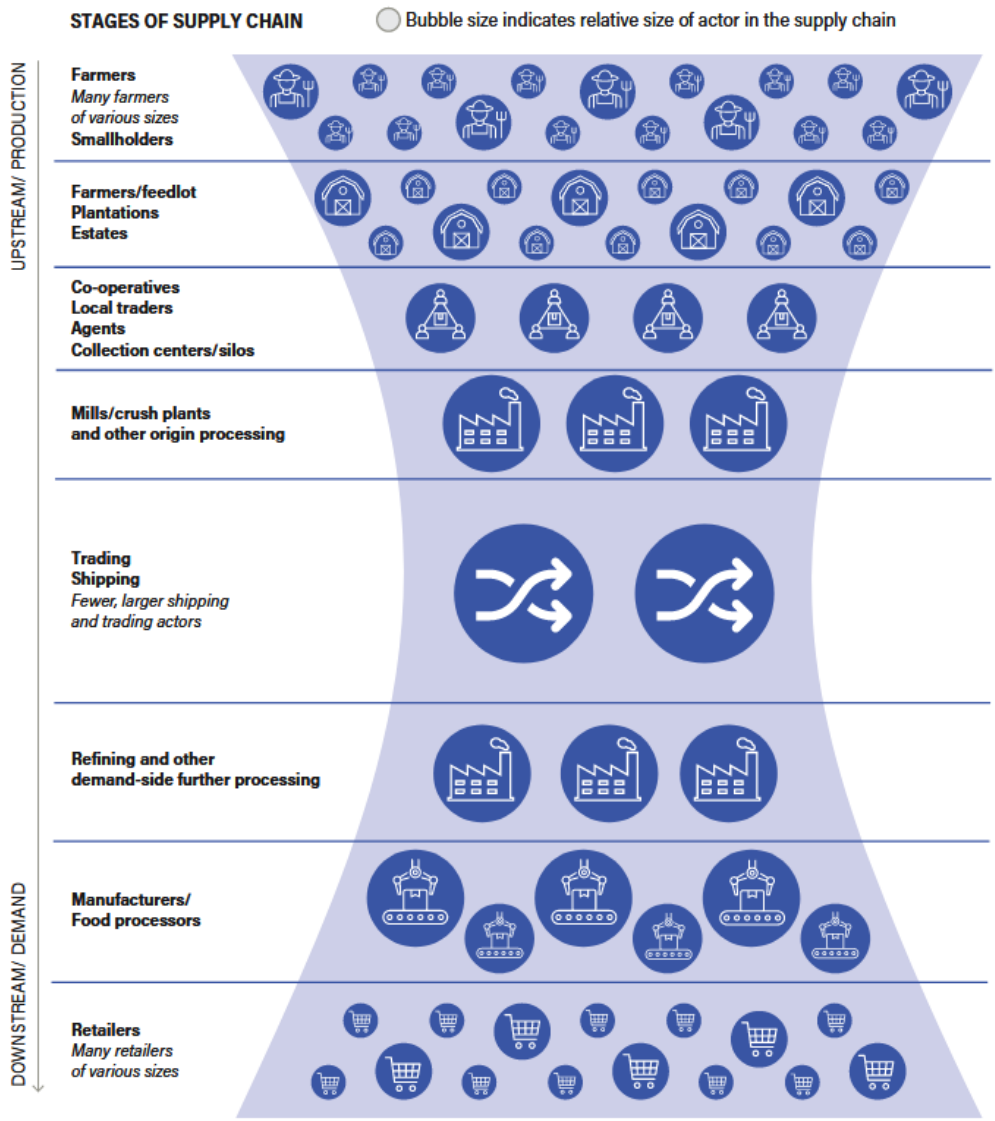

Figure 3. Stages of supply chain, retrieved from Fripp et al. (2023).

Cooperatives play a particularly important role in Brazil's South, concentrated in Paraná, Rio Grande do Sul, and Santa Catarina, where they have historically served as an alternative to direct trader relationships, supplying members with inputs, credit, technical assistance, and agricultural supplies (Reis et al., 2023). This structure contrasts with Brazil's agricultural frontiers, such as Mato Grosso and MATOPIBA, where farmers typically negotiate directly with large traders and

commit greater shares of their harvest to pre-harvest financing contracts (Reis et al., 2023).

2.2 Certification and Market-based Governance

Cashore (2002) describes Non-State Market-Driven (NSMD) governance systems, as private, market-based governance arrangements, where authority derives not from state regulation but from market incentives and supply-chain relationships. These arrangements reflect a broader reconfiguration of governance, in which private companies, non-governmental organisations (NGOs), industry associations and multi-stakeholder initiatives have taken on governance functions traditionally associated with states, a shift closely linked to wider trends of privatisation and deregulation (Min & Wimer, 2024). Compliance is driven by purchasing decisions along the supply chain, market access, and "moral suasion" (Cashore, 2002).

Within this context, Voluntary Sustainability Standards (VSS) emerged as an important mechanism for addressing sustainability challenges in global supply chains. Lamolle et al., (2019) define VSS as non-governmental, voluntary and typically third-party-assessed standards relating to environmental, social, ethical and food safety issues that are adopted by companies to demonstrate the sustainability performance of their organisations or products. VSS gained prominence in situations where governments and market actors were perceived as either unwilling or unable to adequately address the sustainability agenda and its implementation through public regulation alone (Lamolle et al., 2019).

Certification schemes are the main instrument through which NSMD governance and VSS operate in practice, giving private actors a way to govern sustainability outcomes within global commodity chains. Examples include the Round Table on Responsible Soy (RTRS) and the Roundtable on Sustainable Palm Oil (RSPO) (Min & Wimer, 2024). These initiatives establish requirements related to environmental protection, labour conditions, community relations and responsible production practices, thereby creating market-based incentives for more sustainable forms of production (Min & Wimer, 2024).

Alongside certification, growing pressure from civil society organisations and downstream buyers has led many companies to adopt Zero-Deforestation Commitments (ZDCs): corporate pledges to exclude commodities associated with recent forest conversion from their supply chains (Lambin et al., 2018; Garrett et al., 2019). Certification systems frequently serve as the implementation mechanism for these pledges, allowing companies to evidence compliance and manage

sustainability risk without independently verifying every supplier. (Lamolle et al., 2019; Rau, 2019).

This risk-management function can be broken down further. According to Komives and Jackson (2014), as cited by (Lamolle et al., 2019), companies primarily use VSS for three purposes: ensuring long-term supply by addressing environmental, social and economic risks; facilitating relationships between suppliers and buyers through commonly recognised standards; and exercising influence over production practices by transmitting sustainability requirements throughout the supply chain. As a result, certification has become a central component of sustainable sourcing strategies adopted by multinational companies across a range of commodity sectors (Lamolle et al., 2019).

Despite their growing importance, certification schemes and other forms of private governance have also been subject to criticism. Scholars have highlighted concerns regarding their democratic legitimacy, fragmented nature and limited ability to address broader structural drivers of unsustainable land-use change (Min & Wimer, 2024). Because certification schemes are voluntary and developed by private actors rather than elected institutions, questions have been raised regarding accountability, representation and power imbalances in standard-setting processes (Min & Wimer, 2024), concerns that recur throughout the certification scheme examined in this thesis.

2.3 Traceability and Chain-of-Custody Models

Traceability has become increasingly important within global supply chains as companies, regulators and other stakeholders seek greater transparency regarding the environmental and social characteristics of products (Ellebrecht, 2019; Norton et al., 2014). While sustainability standards and assurance procedures establish requirements at the production stage, traceability is necessary to ensure that sustainability information is maintained throughout the supply chain (Hinkes & Peter, 2020).

Although definitions vary across sectors, traceability is generally understood as the ability to link a product to information about its origin, movement and transformation throughout the supply chain (Fripp et al., 2023). Muirhead & Porte (2019) add that this depends on a “system”, showing that traceability is not just a characteristic of the product itself, but a process through which information is generated, recorded and transmitted across successive stages of the supply chain.

Traceability is closely related to, but distinct from, transparency, which refers to the disclosure and sharing of information among stakeholders, a distinction that is often blurred in practice (Fripp et al., 2023).

Traceability systems help to enforce environmental regulations and let the civil society hold supply chain actors accountable, while also giving companies a way to monitor their own sustainability commitments (Fripp et al., 2023). Within agricultural supply chains, traceability has traditionally been associated with food safety and quality assurance, but growing sustainability concerns and regulatory requirements have expanded its role beyond product safety toward responsible sourcing and legal compliance (Fripp et al., 2023; Hinkes & Peter, 2020). Reflecting this evolution, Muirhead & Porter (2019) argue that traceability systems can be understood as emerging forms of global governance, connecting broad policy objectives with the physical mechanisms required to monitor and address environmental impacts across increasingly complex global supply chains. This governance function is particularly relevant for commodities like soy, where traceability systems must reconnect production landscapes with downstream sourcing decisions.

As companies face increasing expectations to demonstrate progress against existing deforestation- and conversion-free commitments, traceability systems have become increasingly important for monitoring sourcing practices, assessing compliance and supporting corporate reporting. Accordingly, the Accountability Framework Initiative (AFi), a multi-stakeholder coalition of NGOs and companies that sets consensus-based guidance for ethical supply chains, states that the origins of materials in supply chains are expected to be known or controlled to a sufficient extent to ascertain that production and processing units comply with company commitments, while emphasising that supply chain mapping and traceability play important roles in assessing and managing compliance (AFi, 2020). At the same time, corporate climate strategies have increased the importance of physical traceability. The GHG Protocol Land Sector and Removals Standard (hereafter LSR Standard) establishes that the ability to accurately account for land-sector emissions, removals and other metrics depends on the level of traceability that companies can establish to lands within their value chains, recommending that companies establish the most specific level of physical traceability feasible given their position in the value chain, in order to improve the accuracy and credibility of greenhouse gas accounting and support climate change mitigation (LSR Standard, 2026).

One of the principal mechanisms through which traceability is implemented in certified commodity supply chains is through chain-of-custody (CoC) systems.

(Fripp et al., 2023). Chain-of-custody systems differ in the degree to which they preserve the link between certified production and final products. Consequently, they provide different levels of traceability, transparency and assurance, enabling different types of sustainability claims to be made by companies (Hinkes & Peter, 2020). The selection of a CoC model is influenced by factors such as supply chain complexity, operational feasibility and the level of assurance required by buyers (Ellebrecht, 2019).

Four principal CoC models are commonly recognised in agricultural supply chains: Identity Preserved, Segregation, Mass Balance and Book-and-Claim (Ellebrecht, 2019; ISEAL Alliance, 2025); (Table 1). Identity Preserved represents the highest level of traceability, ensuring that certified material from a specific production unit remains physically separated from all other sources throughout the supply chain. This model allows highly specific claims regarding both the origin and production characteristics of a product.

The Segregation model also requires certified material to remain physically separated from non-certified material throughout the supply chain. However, certified volumes from different certified sources may be mixed. As a result, segregation provides assurance that the product originates entirely from certified sources, although not necessarily from a specific producer (Ellebrecht, 2019; ISEAL Alliance, 2025).

Mass Balance encompasses a range of approaches that allow certified and non-certified material to be physically mixed, provided that the volumes entering and leaving the system are administratively balanced. Under this model, sustainability claims are linked to accounting systems rather than to the physical composition of individual products (Hinkes & Peter, 2020). ISEAL Alliance (2025) stresses that certified material may still be present in Mass Balance products, but the model provides no guarantee of this. This distinguishes it from the physical relationship maintained under Segregation and Identity Preserved. verifies that input and output volume are administratively balanced, not that certified material is physically present in the product sold.

More recently, ISEAL has named a stricter variant of this model, Controlled Mass Balance, in which every input entering the mix — certified or not — must first meet a minimum compliance requirement, rather than only certified material being tracked (ISEAL Alliance, 2025).

At the opposite end of the spectrum, the Book-and-Claim model (Credits) completely decouples sustainability attributes from physical commodity flows. Certified and non-certified products move freely through the supply chain, while

sustainability certificates or credits are traded independently through dedicated platforms. Purchasers of credits support certified production but do not receive physically certified material (Ellebrecht, 2019; ISEAL Alliance, 2025).

These models involve important trade-offs between traceability, operational complexity and cost. Physical models such as Identity Preserved and Segregation provide stronger assurances regarding product origin and production conditions but require dedicated storage, handling and logistics systems. In contrast, Mass Balance and Book-and-Claim offer greater flexibility and scalability within complex global commodity supply chains, albeit with weaker links between sustainability claims and physical product flows (Bosselmann et al., 2025; Hinkes & Peter, 2020).

Table 1. Chain-of-custody models and their traceability characteristics. Adapted from LSR Standard (2026).

Model	Physical separation from non-certified material	Mixing of certified sources	Basis of sustainability claim
Identity Preserved	Yes, fully separated	No, kept separate by production unit	Physical product, traceable to a specific production unit
Segregation	Yes, fully separated	Yes, different certified sources may mix	Physical product, traceable to certified sources (not a specific producer)
Mass Balance	No, certified and non-certified material physically mixed	Yes	Administrative/accounting balance of volumes in vs. out
Book-and-Claim / Credits or Certificates	No, no physical link at all	Not applicable, certificates traded independently	Certificates/credits traded on dedicated platforms

2.4 European Union Deforestation Regulation (EUDR)

The European Union Deforestation Regulation (EUDR), Regulation (EU) 2023/1115, was adopted with the objective of minimising the European Union's contribution to global deforestation and forest degradation, and reducing the Union's contribution to greenhouse gas emissions and global biodiversity loss. The Regulation establishes rules governing the placing, making available on the Union market, and export from the Union of products containing, fed with, or produced using cattle, cocoa, coffee, oil palm, rubber, soy and wood. To be placed on the EU market or exported, relevant products must be deforestation-free, produced in accordance with the relevant legislation of the country of production, and covered by a due diligence statement (Regulation (EU) 2023/1115, 2023).

The Regulation defines a cut-off date of 31 December 2020, meaning that commodities and products associated with deforestation or forest degradation occurring after this date are not compliant with the Regulation. According to the Regulation (EU) 2023/1115, (2023), this date was selected to align with international commitments such as the Sustainable Development Goals and the New York Declaration on Forests, while also preventing an anticipated acceleration of deforestation during the period between the proposal and entry into force of the Regulation.

A central feature of the EUDR is its requirement for geolocation-based traceability. Operators must trace relevant commodities back to the plot of land where they were produced, and submit a due diligence statement with geolocation information is a prerequisite for placing products on the EU market, exporting them, or transacting within the EU market. Downstream operators and traders do not submit due diligence statements themselves. Instead, they maintain traceability by collecting information about their direct suppliers and customers, and making this information available to competent authorities upon request (Regulation (EU) 2023/1115, 2023).

The EUDR's environmental scope is determined by its definition of forest, which has generated debate regarding the treatment of non-forest ecosystems such as savannas and grasslands. According to Article 2(4), a forest is defined as land spanning more than 0.5 hectares with trees higher than five metres and a canopy cover exceeding 10%, or trees capable of reaching these thresholds in situ (Regulation (EU) 2023/1115, 2023).While this definition captures many forest ecosystems, it has generated concerns regarding ecosystems that do not meet these criteria. Brandão et al., (2025) argue that the EUDR reflects a continuing forest bias in international environmental governance, one that has historically favoured humid

tropical forests such as the Amazon over savanna ecosystems such as the Cerrado, because it does not currently include “other wooded land” within its scope.

This is particularly consequential in practice, since much of the biome's native vegetation does not meet the Regulation's forest definition, meaning its conversion may fall outside the scope of the Regulation (Brandão et al., 2025). Recognising this limitation, Article 34 of the Regulation foresees future assessments of possible scope extensions. The Commission was required to assess the inclusion of “other wooded land” and, subsequently, other natural ecosystems such as grasslands, peatlands and wetlands, accompanied where appropriate by legislative proposals (Regulation (EU) 2023/1115, 2023). The 30 June 2024 and 30 June 2025 deadlines set by Article 34 for these assessments passed without a resulting legislative proposal, leaving uncertainty regarding the future treatment of non-forest ecosystems.

Importantly, while the EUDR establishes detailed traceability requirements, it does not prescribe a specific chain-of-custody model, nor does it adopt the certification-industry taxonomy of Identity Preserved, Segregation, Mass Balance and Book-and-Claim. Nevertheless, Commission guidance is explicit that Mass Balance (in its original, conventional definition, i.e. the physical mixing of certified and non-certified material within an administratively balanced accounting system) is not permitted, since it does not guarantee that the products placed on the EU market are themselves deforestation-free (European Commission, 2026). Compliant material must instead remain segregated from non-compliant or unknown-origin material at every step of the supply chain, and any product mixed with such material becomes wholly non-compliant. Consequently, compliance may be achieved through different traceability arrangements, provided that non-compliant material is excluded from EUDR-compliant supply chains at all times.

2.5 Round Table on Responsible Soy

The World Wildlife Fund (WWF) initiated a multi-stakeholder dialogue in the early 2000s that ultimately led to the creation of the Round Table on Responsible Soy (RTRS) in 2006 (Garrett et al., 2016). RTRS was designed as a platform bringing together actors from across the soy value chain, including producers, traders, processors, retailers, financial institutions and civil society organisations, to develop and promote shared principles for responsible soy production, processing and trade (Bosselmann et al., 2025; Chen et al., 2024).

Compared with unilateral corporate sourcing policies, multi-stakeholder roundtables are often considered to provide higher levels of participation,

transparency and accountability by enabling different stakeholder groups to participate in deliberations regarding sustainability standards and good practices within a commodity sector. At the same time, NSMD governance theory holds that the involvement of industry actors in standard-setting creates a structural trade-off between requirement stringency and firm support, since standards set too strictly risk losing the very producers they depend on for market uptake (Cashore et al., 2022).

The RTRS certification scheme is based on two principal standards: the RTRS Standard for Responsible Soy Production (currently Version 4.0) and the RTRS Chain of Custody Standard (currently Version 3.1) (RTRS, n.d.-b). Producers seeking certification must demonstrate compliance with five principles including legal compliance, responsible labour conditions, responsible community relationships, environmental responsibility and good agricultural practices. Requirements relating to social responsibility include the prohibition of child labour, forced labour, discrimination and harassment, as well as provisions on freedom of association, collective bargaining and grievance mechanisms. The standard also promotes good agricultural practices through integrated crop management and restrictions on the use of hazardous agrochemicals. Under its environmental responsibility requirements, RTRS prohibits the conversion of native forests after May 2009, with a 2016 cut-off date applying to the conversion of other natural ecosystems. RTRS also includes biodiversity conservation measures aimed at protecting threatened species, supporting the conservation and restoration of native vegetation and preventing the introduction of invasive species (Boev & van Dam, n.d.; Bosselmann et al., 2025; RTRS, 2021). Producers who meet these requirements receive one RTRS credit for each tonne of certified soy produced (Chen et al., 2024). RTRS certifies compliance through independent audits and publicly discloses information regarding certified operators across the supply chain.

The RTRS CoC Standard governs how RTRS-certified soy is handled, traded and tracked throughout the supply chain. Chain-of-custody certification is mandatory for all organisations wishing to receive, process or trade RTRS-certified soy (Bosselmann et al., 2025; RTRS, 2021). Certified organisations may include handlers, such as farmer or cooperative warehouses; processors, such as soybean crushers; transformers, such as feed and food manufacturers; and outsourced service providers responsible for storage or transport activities (RTRS, 2021).

The RTRS CoC Standard consists of two core traceability models: Model A (Mass Balance Chain of Custody) and Model B (Segregation Chain of Custody). In addition, the standard includes four optional models: Multi-site Chain of Custody (Model I), Non-GMO Chain of Custody (Model II), Country Material Balance Chain of Custody (Model III) and EUDR-aligned Chain of Custody (Model IV) (Figure 4).

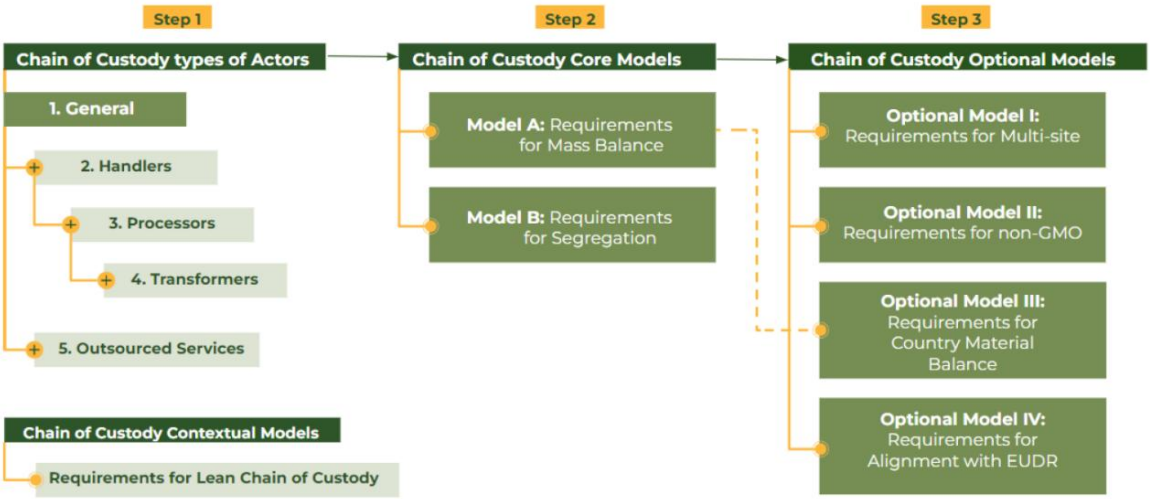

Figure 4. Overview of the standard structure. Retrieved from RTRS Chain of Custody Standard, Version 3.1(RTRS, 2025)

Of these, Optional Model IV – Alignment with EUDR Chain of Custody, can be applied by certified organisations on top of either core traceability model. Under Model IV, certified entities must collect plot-level geolocation data, implement a due diligence system covering information collection, risk assessment and risk mitigation, and retain records for at least five years. Any deforestation or forest degradation on a given plot after 31 December 2020 disqualifies the associated soy from being placed on the EU market under this module (RTRS, 2025). Model IV, however, only applies to soy that is already RTRS-certified. RTRS has since begun piloting a further mechanism aimed at increasing the physical uptake of certified soy by drawing on soy beyond its own certified base, discussed in section 2.6.

Raasch et al. (2026) note that RTRS certification requirements are stricter than national legal requirements in several areas, for instance, the standard's zero-deforestation criterion is stricter than what national law requires, a divergence that led the Brazilian Association of Soy Producers (APROSOJA) and Brazilian Vegetable Oil Industry Association (ABIOVE) to abandon RTRS altogether, though ABIOVE and RTRS signed a memorandum of understanding in November 2024 to renew cooperation on certification promotion (RTRS, 2024). Consequently, RTRS should not be understood solely as a mechanism for achieving

deforestation- and conversion-free sourcing, but rather as a broader sustainability framework addressing multiple dimensions of responsible soy production.

The growing number of voluntary sustainability standards in agricultural supply chains has raised questions regarding their credibility, effectiveness and comparability. More than 300 voluntary sustainability standards are currently in operation globally, differing considerably in their governance arrangements, assurance systems, transparency requirements and substantive criteria (Marx et al., 2024). Consequently, a variety of benchmarking and recognition initiatives have emerged to assess the robustness and credibility of certification systems. Examples include the ISEAL Alliance, which promotes good practices in standard setting, assurance and impact evaluation, and the European Feed Manufacturers' Federation (FEFAC) Soy Sourcing Guidelines, which benchmark soy standards against minimum requirements for responsible sourcing (Bosselmann et al., 2025). Independent benchmark assessments consistently rank RTRS among the most comprehensive soy sustainability standards. Kusumaningtyas & van Gelder, n.d. identified RTRS as one of the standards containing the largest number of provisions related to forest, wetland and biodiversity protection combined with relatively high levels of assurance. Similarly, the Farm Sustainability Assessment (FSA) developed by the Sustainable Agriculture Initiative (SAI) Platform awarded the RTRS Production Standard its highest level of equivalence, granting it Gold Level recognition and making it the only benchmarked standard specifically designed for soy production (RTRS, 2023; SAI Platform, 2025).

Beyond these benchmark assessments, RTRS has also overgrown ProTerra, previously the leading soy certification by market share, a shift linked to RTRS's greater flexibility in chain-of-custody options and its allowance of genetically modified soy (Hinkes & Peter, 2020).

Notably, most benchmarking exercises and comparative assessments focus primarily on the RTRS Production Standard, while considerably less attention has been devoted to evaluating the RTRS CoC Standard and its effectiveness in facilitating the market uptake of physically traceable soy supply chains.

Despite these strengths, questions remain regarding the effectiveness of certification systems in generating sustainability outcomes at scale. Garrett et al. (2016) argue that the impact of RTRS remains constrained by relatively low levels of adoption and by the tendency of voluntary standards to expand where implementation costs are lower rather than where environmental benefits may be greatest. Similarly, Raasch et al. (2026) note that, despite ongoing efforts to promote the uptake of certified soy, certified production continues to represent a

niche segment of the global market. This limited adoption becomes evident when comparing certified volumes with total soy production. According to the United States Department of Agriculture, global soybean production reached 427.89 million tonnes in the 2024/2025 market year, whereas RTRS-certified production amounted to approximately 10 million tonnes in 2025 (Santos 2026; USDA FAS, n.d.). Consequently, RTRS-certified soy represented only around 2% of global soybean production, illustrating the continued gap between the recognition of the standard and its uptake within global soy markets.

2.6 RTRS-DCF Controlled Mix: An Optional Pilot Model

2.6.1 Model Design and Mechanism

In response to the limited uptake of physically traceable RTRS CoC (see section 1.3), RTRS has piloted an additional optional CoC model, distinct from the four optional models described above (RTRS, pers. comm, 2026a). This near-total reliance on credits means the bulk of RTRS's certified volume does not meet the physical traceability requirements of the EUDR or provide the physical material needed for corporate climate and biodiversity commitments."

The pilot, referred to as Optional Model V (DCF Additionality), introduces a new “RTRS-DCF Controlled Mix” category. Unlike the existing Mass Balance (Model A) and Segregation (Model B) models, this pilot permits RTRS-certified material to be mixed, under audited control, with soy that is not RTRS-certified but is independently verified as deforestation- and conversion-free (vDCF). Verification follows Minimum Monitoring Criteria for DCF commodities originating in Brazil, agreed between The Nature Conservancy (TNC) Brasil, Imaflora, World Resources Institute (WRI) Brasil and WWF, and aligned with the definitions and guidance of the AFi (RTRS, pers. comm, 2026a). Verified DCF status requires the absence of conversion after December 2020, consistent with the EUDR cut-off date.

RTRS's own label for this claim, "RTRS Controlled Mass Balance," corresponds to the Controlled Mass Balance model described in Section 2.3, where all pooled inputs, not just certified ones, must meet a minimum compliance bar before being mixed.

The model targets the first aggregation point as the critical control node for preventing the mixing of compliant and non-compliant soy. At this stage, non-RTRS-certified producers whose land shows post-2020 conversion are excluded from entering the controlled mix, while RTRS-certified producers and

independently verified DCF producers are permitted to supply the same pooled volume. According to RTRS, the intended outcomes of this model are to increase the physical flow of RTRS-produced soy to meet market demand, generate a "spillover" effect extending verified DCF sourcing beyond RTRS-certified producers, and reduce incentives for large-scale conversion. (RTRS, pers. comm, 2026a).

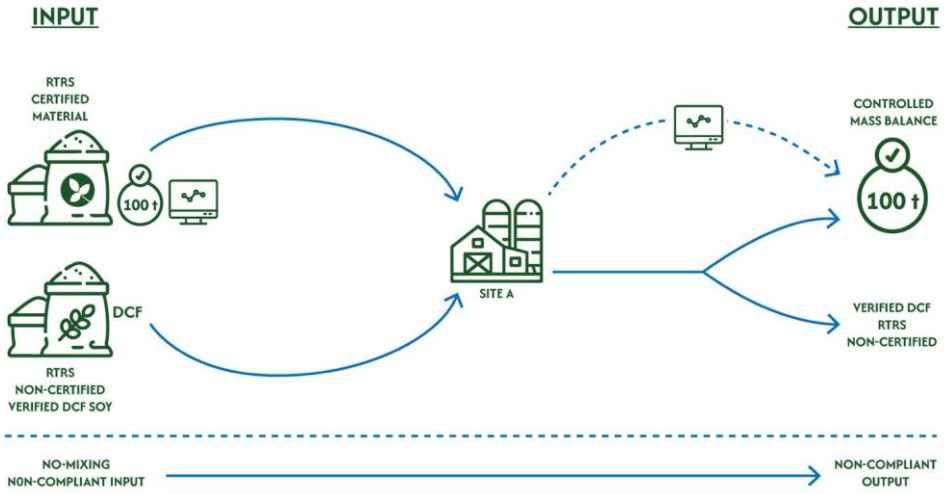

Figure 5. RTRS-DCF Controlled Mix Model: Input–output flow in the chain of custody. Retrieved from RTRS, pers. comm., (2026a).

As shown in Figure 5, the model does not physically separate certified from non-certified material, RTRS-certified soy and independently verified DCF soy are pooled together at the aggregation point ("Site A"). What is tracked instead is volume: the amount of RTRS-certified input sets a cap on how much of the pooled output can carry the "RTRS Controlled Mass Balance" claim, while the remainder is sold under a separate "Verified DCF, RTRS Non-Certified" claim. Both claims attach to physically identical material; what differs is the commercial label, and the premium that comes with it. Volumes that meet neither verification standard are excluded from the pool entirely, following a separate non-compliant pathway. In this sense, the Controlled Mix is not a new traceability mechanism but a new accounting rule layered on RTRS's existing mass balance logic, giving verified

DCF soy outside the RTRS system access to a commercially differentiated claim through RTRS's system.

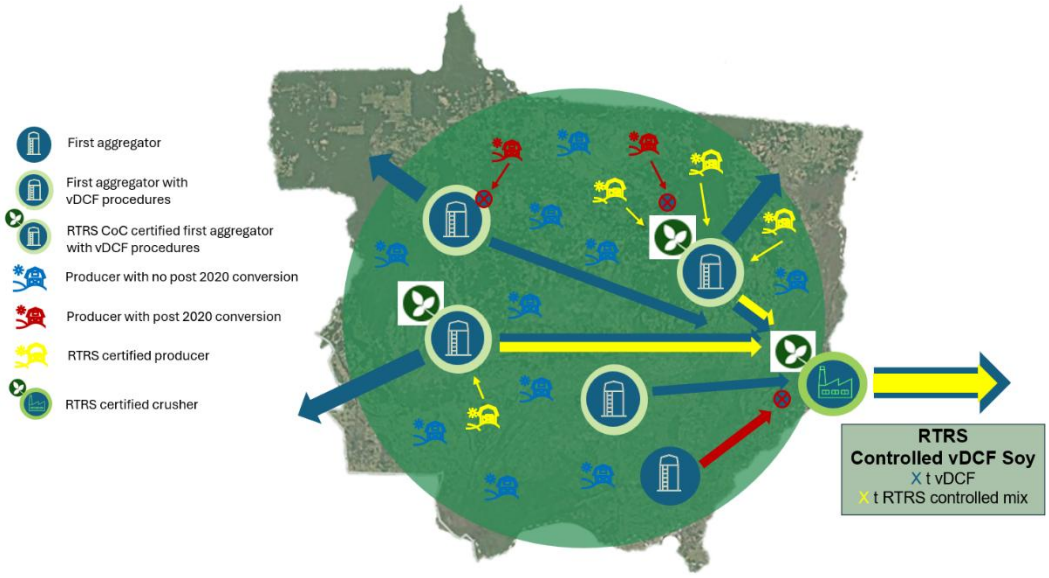

Figure 6. RTRS-DCF Controlled Mix: supply chain flow and actor mapping in Brazil. Retrieved from RTRS, pers. comm., (2026a).

Figure 6 situates this control logic within the wider sourcing landscape. Aggregators are differentiated by verification status: ordinary first aggregators, first aggregators that have adopted vDCF procedures, and first aggregators with full RTRS Chain-of-Custody certification and vDCF procedures. Producers supplying them are differentiated by conversion history: RTRS-certified producers and independently verified DCF producers with no post-2020 conversion are permitted into the controlled pool, while producers with post-2020 conversion are excluded at the point of aggregation. Compliant volumes then converge on RTRS-certified crushers, which issue the final RTRS Controlled vDCF Soy output. The figure shows that the model does not depend on a single certified actor controlling the whole chain, multiple aggregators at different verification levels can feed the same controlled pool, provided the exclusion rule at first aggregation is applied consistently.

2.6.2 Geographic Distribution of RTRS-Certified Infrastructure

RTRS-certified chain-of-custody infrastructure in Brazil is concentrated across four main export corridors: Madeira River, Itaqui/Maranhão, the BR-163 route, and Vitória/Tubarão, as illustrated in Figure 7. The first three form part of the “Arco

Norte", the northern logistics network that routes soy to ports in the North and Northeast rather than the traditional southern ports of Santos and Paranaguá. Within this group, Madeira River and BR-163 rely on river barge transport (via the Madeira and Tapajós rivers, respectively) to reach export terminals, while Itaqui/MA is reached overland by truck or rail to the deep-water port of São Luís. Vitória/Tubarão, by contrast, is not part of Arco Norte: it is the established southeastern rail corridor connecting inland production to the port of Vitória

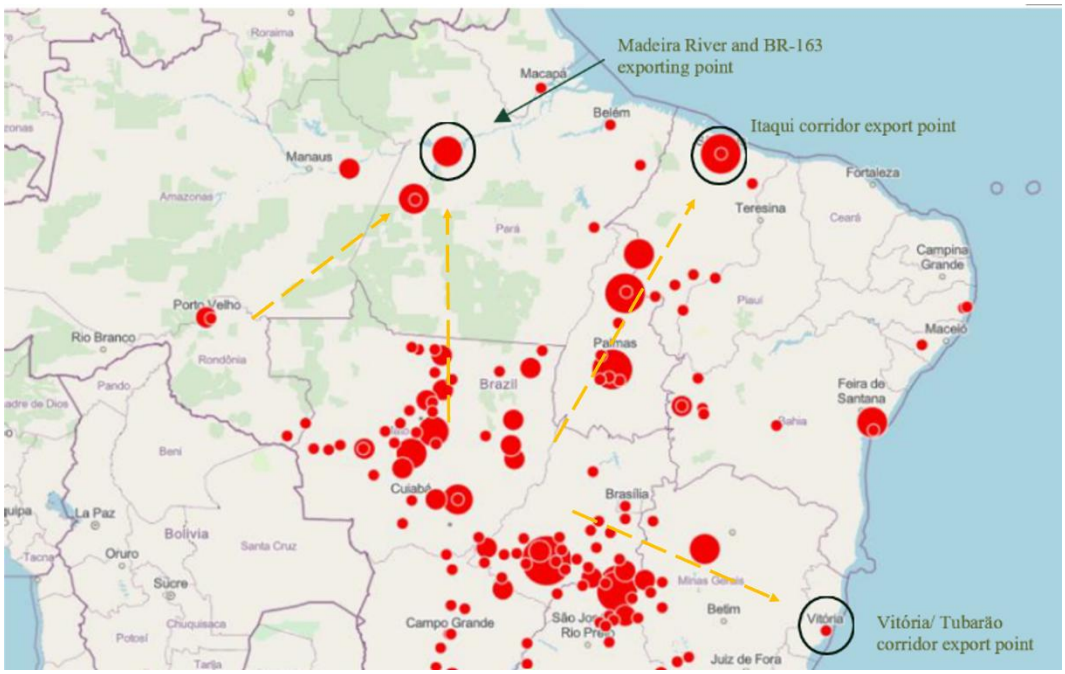

Figure 7. RTRS chain-of-custody certified infrastructure - "North Arc" – Brazil. Retrieved from RTRS, pers. comm., 2026b and modified by the author.

These corridors vary considerably in the scale and composition of their certified infrastructure (RTRS, pers. comm, 2026b), as shown in Table 2. This corridor-level view of storage, processing and port infrastructure is relevant because the capacity to physically segregate or pool certified soy, central to the Chain of Custody models discussed above depends on where that infrastructure is actually located.

Table 2. RTRS chain-of-custody certified infrastructure by export corridor (2025) (RTRS, 2026b).

Corridor	Storage silos	Processing plants	Ports	Transshipment points	Certified volume (t)	Total corridor volume[1] (Mt)	Certified share of total (%)
Madeira River	13	2	5	2	2,160,758	11,2	19,3
Itaqui/MA	59	4	13	4	2,895,643	13,5	21.4
BR-163 route	54	2	10	11	2,120,808	15	14.1
Vitória/ Tubarão	22	5	2	9	1,068,309	3	35.6

[1] Total corridor volumes (crop 2023/2024) include non-certified soy, including volumes non-compliant with DCF and EUDR requirements.

Beyond these four corridors, RTRS reports an additional 105 certified industrial units in the southern states and São Paulo, served by the ports of Santos, Paranaguá, and Rio Grande, along with newly certified capacity at the ports of Suape (Pernambuco) and Aratu (Bahia) (RTRS, pers. comm, 2026b). This indicates that certified chain-of-custody infrastructure, while concentrated in the four corridors analysed here, is not limited to them.

2.7 Analytical Perspectives

The complexity of governing DCF soy supply chains extends beyond technical considerations and involves questions of authority, equity and influence. To capture these dimensions, this research employs four analytical lenses: feasibility, legitimacy, fairness and power.

Orsmond & Cohn (2015) describe feasibility studies around the central question of whether a proposed intervention "can work". Similarly, (Bause et al., 2014) explain that such assessments aim to identify opportunities and risks associated with planned interventions and commonly consider technical, economic, legal, operational dimensions and scheduling dimensions. Within the specific context of voluntary environmental policy adoption in soy supply chains, Brandão et al. (2025) similarly employ feasibility as an analytical lens, identifying public opinion, policy and political context, company power, financial costs, and leadership as the

key factors shaping whether a stringent zero-deforestation agreement is adopted. Drawing on these understandings, this research employs feasibility as an analytical lens, rather than conducting a dedicated feasibility study, to examine stakeholder perceptions regarding the opportunities, constraints and conditions associated with scaling physically segregated RTRS-certified soy.

Bernstein (2011) defines political legitimacy "as the acceptance and justification of shared rule by a community". Legitimacy concerns situations in which an authority claims a right to govern and affected actors hold the belief that such a claim is justified and appropriate. According to Bernstein (2011), legitimacy matters because it increases the likelihood that rules and decisions will be accepted and followed, particularly in governance arrangements where coercive power is limited or absent. In this research, legitimacy is employed as an analytical lens to examine how stakeholders perceive and justify different governance arrangements, rules and authority claims addressing deforestation and conversion in soy supply chains.

McDermott et al. (2012) note that justice, fairness and equity all imply "fair treatment or due reward". They further argue that equity is principally concerned with relationships between people and their relative circumstances. McDermott et al. (2012) argue that equity comprises distributive, procedural and contextual dimensions. Distributive equity concerns the allocation of costs and benefits among stakeholders, while procedural equity refers to fairness in decision-making processes, including recognition, inclusion and participation, and contextual equity concerns the pre-existing political, economic and social conditions that shape different actors' capacity to participate in and benefit from a given system in the first place. Drawing on these understandings, fairness, the third lens applied in this research, captures how stakeholders perceive the distribution of costs, benefits, responsibilities, decision-making opportunities and capacity to participate in deforestation and conversion-free soy governance across the supply chain.

Morrison et al. (2019) define power as the capacity of different actors to influence the goals, processes and outcomes of governance, a capacity that is typically distributed unevenly across actors. The authors argue that power is inherent in all governance arrangements and shapes rule-setting, decision making processes and governance frameworks implementation. Dallas et al. (2019) refine this concept further within global value chain governance specifically, distinguishing power by its transmission mechanism, direct or diffuse, and by the arena in which it operates, dyadic or collective, yielding four types: bargaining, demonstrative, institutional and constitutive power. The final lens, power, draws on Dallas et al.'s typology to examine how different actors shape the design,

implementation and direction of governance approaches addressing deforestation and conversion in soy supply chains.

3. Methods

3.1 Research Strategy and Design

This study adopts a qualitative research strategy. This approach is appropriate given the exploratory nature of the research, which seeks to capture stakeholder perspectives, experiences and reasoning on the legitimacy, feasibility, fairness and power of physically segregated soy supply chains and RTRS certification. This reflects the inductive and interpretivist orientation of qualitative research, in which theoretical insights emerge from the data and the aim is to understand how participants interpret their social world (Clark et al., 2021, p. 350). Within this strategy, the study takes the form of a case study, and the primary research method is the semi-structured interview (Clark et al., 2021, p. 59)

3.2 Case Study

This thesis takes the Cerrado biome (Figure 8), as the ecological anchor for fieldwork, while tracing the governance of physically segregated soy along the supply chain to actors located beyond the region, reflecting the chain's international structure. Within the wider Cerrado, MATOPIBA, the agricultural frontier spanning Maranhão, Tocantins, Piauí, and Bahia, is the sub-region most associated with recent and projected deforestation (Aragão et al., 2022). Furthermore, another motivation for the chosen area has raised from the nature of the Cerrado as an ecosystem, a mosaic of forest, other wooded land and grassland, representing approximately 26%, 56% and 18% of its area respectively (Deutsche Umwelthilfe et al., 2023). Unlike the Amazon, whose closed-canopy forest is captured almost entirely under the FAO's forest definition, most of the Cerrado's native savanna vegetation falls outside that definition and is therefore left uncovered by the EUDR scope (Pinho et al., 2025), a loophole particularly concerning given the biome's ongoing deforestation rates, explored further below.

The Cerrado has relied primarily on certification schemes such as RTRS, without a comparable sector-wide agreement (Brandão et al., 2025). This makes it a strategic setting for examining the limits of certification-based governance specifically, where market mechanisms operate without the complementary sector-wide coordination seen in the Amazon.

The Cerrado biome is a vast neotropical savanna covering more than 2 million square kilometres of central Brazil, an area equivalent to the combined territory of England, France, Germany, Italy and Spain, and the second-largest biome in Latin America after the Amazon (Lahsen et al., 2016). Spanning 13 Brazilian states and

roughly 23% of the national territory (Ministério do Meio Ambiente e Mudança do Clima, 2024), the Cerrado's gentle topography, favourable climate and comparatively low land prices have made it highly suitable for mechanised agriculture

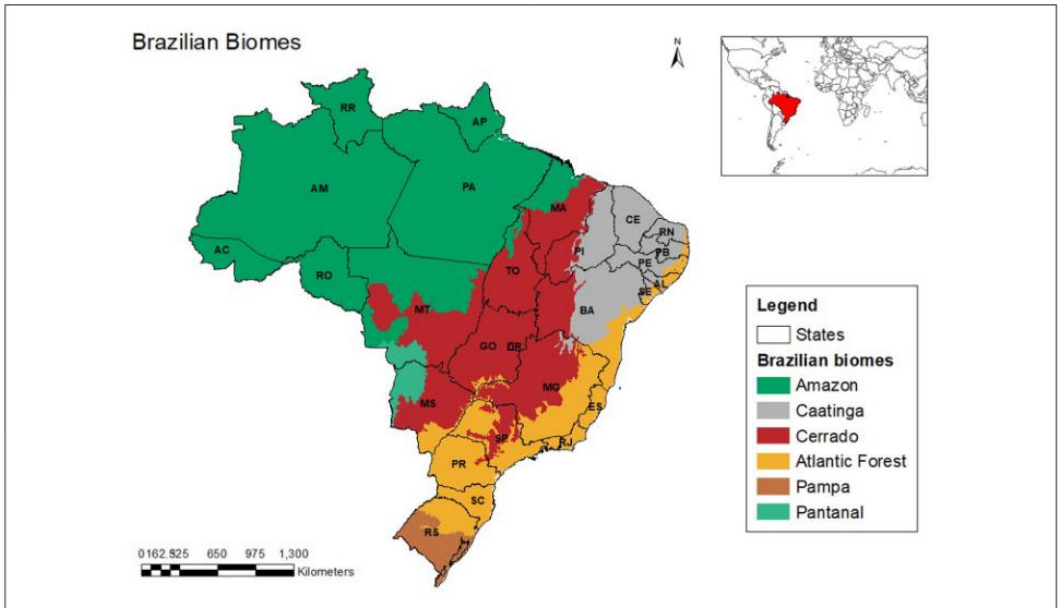

Figure 8. Brazilian biomes and states. Retrieved from Aragão et al. (2022).

The Cerrado's acid, nutrient-poor soils had long been considered unproductive, “Cerrado, nem dado, nem herdado” [“the Cerrado, neither given, nor inherited”], as one producer interviewed in Mato Grosso described it. It was only through sustained public investment in agricultural research, chiefly via EMBRAPA (Brazil's national agricultural research corporation), and the technological correction of soil fertility that the region was transformed into one of the most dynamic agricultural frontiers (Araujo et al., 2026; Lahsen et al., 2016). This transformation was accompanied, from the 1970s, by a migration flow of farmers already familiar with soy cultivation in Brazil's Southern Region, later described in the literature as the “southerners' march”(Russo Lopes et al., 2021). Farmers relocated from a South where land had become consolidated and expensive toward the Center-West and North, drawn above all by cheap land prices (Aragão et al., 2022). Mato Grosso today exemplifies the outcome of that transformation: it is recognised as one of the most productive soy-growing regions in the world, with productivity reaching 4.03 t/ha in the 2024/25 harvest (Araujo et al., 2026). The state's soy sector is now dominated by a small number of multinational trading companies, as noted in 2.1, which control much of the region's crushing, storage, and port infrastructure (Hinkes & Peter, 2020; Trase, 2025). China remains by far the largest destination for this production, purchasing approximately 73% of

Brazil's total soybean exports as of 2024 (USDA Foreign Agricultural Service, 2024).

Landholding in the Cerrado's soy sector is highly concentrated: while properties between 10 and 250 hectares make up 64% of all soy-producing properties, they account for only 17% of the soy area. By contrast, properties larger than 2,500 hectares represent just 3.1% of properties yet also occupy 17% of the soy area, and properties above 1,000 hectares, only 10.5% of the total, are responsible for 52% of the Biome's soy production (Serasa Experian S.A, 2025). This concentration of land ownership is intensifying rather than easing over time (Lahsen et al., 2016).

By 2015, approximately 41% of the Cerrado's native vegetation had already been converted, primarily for pasture and agricultural production (INPE, 2015, as cited in Rausch et al., 2019), more recent evidence indicates that land conversion remains ongoing: as shown in Figure 9, MapBiomas indicate that around 44 million hectares of native vegetation were lost between 1987 and 2024 (MapBiomas Project, 2025). Soybean cultivation has been a major driver of this transformation; Figure 10 shows its expansion from 1.2 million hectares in 1985 to nearly 20 million hectares in 2024, representing more than a sixteen-fold increase over the period (MapBiomas Project, 2025), and has accelerated particularly in the MATOPIBA region (Araujo et al., 2026).

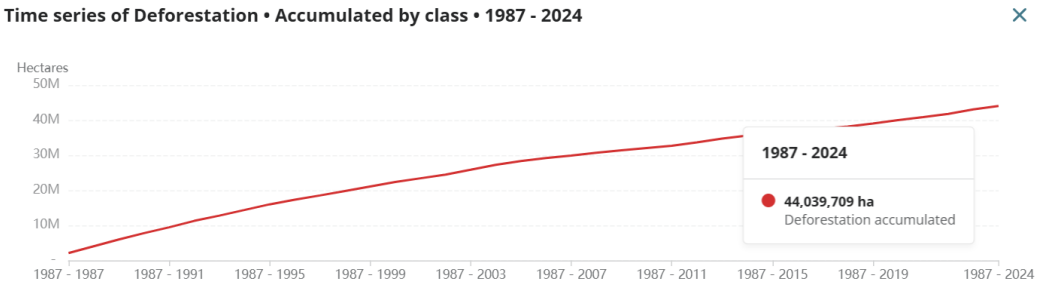

Figure 9. Accumulated Deforestation in Cerrado between 1987-2024. Source: (MapBiomas Project, 2025).

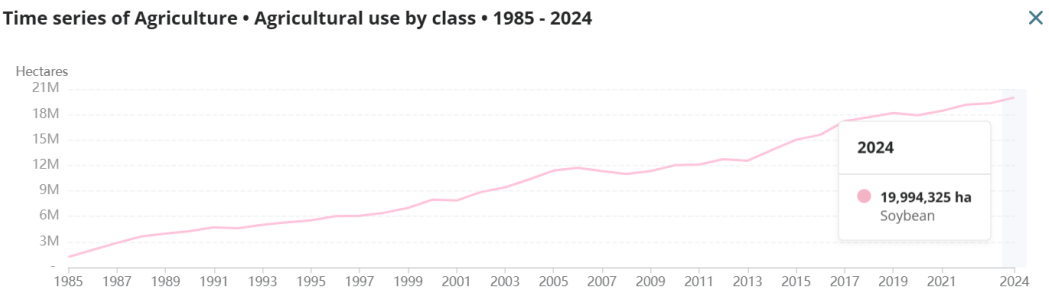

Figure 10. Land use for soy cultivation between 1985-2024. Source: (MapBiomas Project, 2025).

This biome ranks among the most biodiverse savanna ecosystems in the world and is classified as a global biodiversity hotspot (Rodrigues et al., 2022). At least 901 species are currently at risk of extinction, including 266 fauna and 635 flora species (Lahsen et al., 2016), with habitat loss from agricultural expansion among the main drivers. These pressures are compounded by low legal protection: only around 9% of the Cerrado is designated as protected area, compared to approximately 29% of the Amazon (*Painel Unidade de Conservação Brasileiras*, n.d.), below the 17% national conservation target Brazil has committed to under the Convention on Biological Diversity's Aichi Target 11. (Lahsen et al., 2016).

The Cerrado's importance also extends to the ecosystem services it provides, critical to regional climate and freshwater regulation, feeding 8 of Brazil's 12 hydrographic regions and supplying water to hydroelectric plants that generate roughly 80% of the country's electricity (Lahsen et al., 2016). The biome is also home to diverse traditional and local communities, including Indigenous peoples, quilombolas, geraizeiros, sertanejos and vazanteiros, who have historically depended on its natural resources for their livelihoods (Lahsen et al., 2016). Agricultural expansion has produced uneven development outcomes, improving some socioeconomic indicators while displacing communities and restricting access to natural resources (Brandão et al., 2025; Pacheco et al., 2021). The Cerrado therefore represents not only an environmental frontier but a socio-ecological system in which agricultural expansion raises questions of equity, inclusion and the distribution of benefits and costs.

3.3 Data Collection

3.3.1 Semi-Structured Interviews

Interviews were conducted with key soybean value chain stakeholders, including producers, cooperatives, certification groups, traders, consumers, industry

associations, non-governmental organisations, international organisations, consultancies, and think tanks.

A total of 24 interviews were conducted (Table 3).

Table 3. Interview participants by stakeholder category and location.

Stakeholder Category	**Position/ Role**	**Working/ Organisation Location**	**Date**
Certified Producer	CEO	Mato Grosso, Brazil	24/03/2026
Certified Producer	Farm finance manager	Mato Grosso, Brazil	27/03/2026
Cooperative	Sustainability Coordinator	Tocantins/Paraná, Brazil	30/03/2026
Producer Association	Agribusiness manager	Bahia, Brazil	17/04/2026
Certification Group	Certification Manager	Mato Grosso, Brazil	24/03/2026
Certification Group	CEO	Goiás, Brazil	1/04/2026
Certification Group / Foundation	Superintendent	Maranhão, Brazil	17/03/2026
Trader	Sustainability Manager	São Paulo, Brazil	21/04/2026
Trader	Vice President Ag Commodities Sustainability	São Paulo, Brazil	9/03/2026
Trader	Head of Sustainability	Mato Grosso, Brazil	15/04/2026
Grain export terminal	Manager	Maranhão, Brazil	26/05/2026
Downstream industry (Consumer)	Senior Manager Sustainability Lead	São Paulo, Brazil	16/04/2026
Downstream industry (Consumer)	Sustainability Consultant	Denmark	21/04/2026

Stakeholder Category	Position/ Role	Working/ Organisation Location	Date
Industry Association	Sustainability Manager	Brazil	4/03/2026
Non-governmental Organisation	Conservation Specialist	Brazil	13/03/2026
Non-governmental Organisation	Soy Projects Coordinator	Brazil	20/03/2026
Non-governmental Organisation	NGO's Brazil representative	Brazil	29/05/2026
Non-governmental Organisation	Projects and Services Coordinator (Soy-specific)	Brazil	29/05/2026
Multi-stakeholder Platform (NGO)	Senior Policy Advisor	Netherlands	16/04/2026
International Technical Cooperation Organisation	Technical advisor	Germany/Brazil	24/04/2026
International Technical Cooperation Organisation	Trade and Traceability Expert	Europe	27/04/2026
Think Tank	Senior Consultant	Denmark	13/05/2026
Consultancy	Partner and former Co-founder of Soy Alliance	Brazil	8/04/2026
Consultancy / NGO	Technical Director and Associate	United Kingdom	23/04/2026

Semi-structured interviews were selected as the primary data collection method because they provide a balance between consistency and flexibility (Clark et al., 2021). A common interview structure was developed around the research

objectives, the analytical lenses adopted in the study, and insights gained from preliminary discussions with institutional contacts at RTRS, WWF Brazil, and WWF Denmark. From this structure, three interview guides were developed for the broad stakeholder categories of producers, traders, and NGOs, with questions adapted during the interview to reflect each participant's specific role in the soy value chain, allowing flexibility to explore emerging topics in greater depth. The interview guides are provided in Appendices 1, 2, and 3

These same institutional contacts also acted as gatekeepers, facilitating introductions to relevant stakeholders and effectively seeding the snowball sample, while also informing the research's initial thematic focus. From this seed, further participants were recruited through snowball sampling, whereby interviewees referred other individuals with relevant experience. This was complemented by criterion-based purposive sampling (Clark et al., 2021, p.381-385), which relied on targeted LinkedIn searches for soy specialists within relevant organisations, as well as authors of reports on soy sustainability and deforestation governance. Where interviewees provided contacts, these individuals were approached directly. Combining these two approaches helped offset the risk of network homogeneity inherent in snowball sampling alone, and ensured representation from different segments of the value chain.

Fieldwork was conducted in Brazil between March and May 2026. The core of the in-person fieldwork took place in Mato Grosso, including farm visits in the Sorriso municipality, which allowed direct observation of production and certification conditions on the ground (Figure 11). While based in Brazil, further interviews were conducted with stakeholders in Brasília and São Paulo, most held virtually to accommodate participant availability, with a small number conducted in person when scheduling and travel coincided. Additional interviews were conducted remotely with stakeholders based in Europe, including Denmark, Germany, the Netherlands, and the United Kingdom, reflecting the international structure of the soy supply chain traced in this study. In total, interviews averaged 50 minutes in duration.

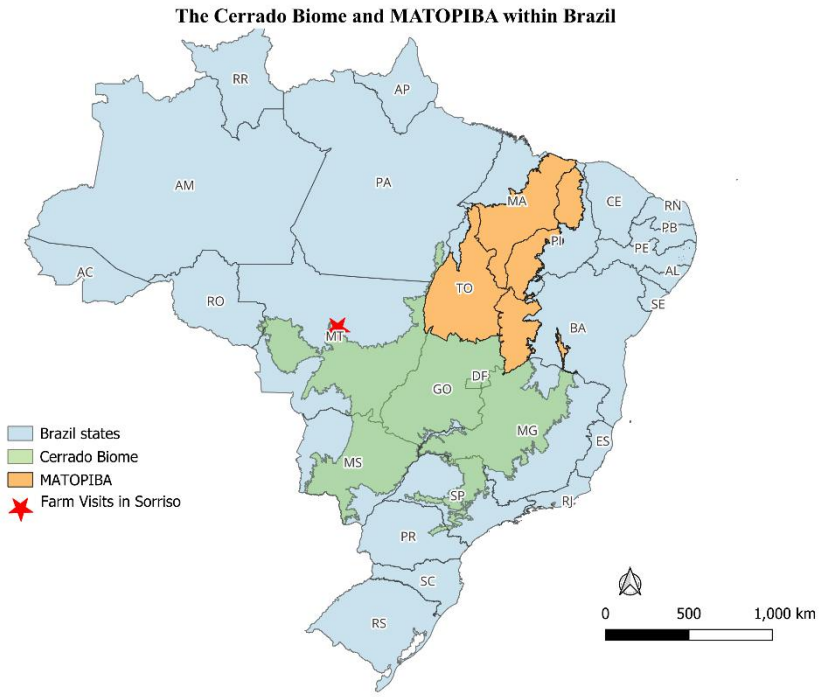

Figure 11. The Cerrado biome and MATOPIBA sub-region within Brazil, with fieldwork site (Sorriso, MT) indicated. Biome boundaries: IBGE (2025); state boundaries: geodata-br-states, GitHub (accessed 2026).

Fieldwork also included participation in the closing event of the WWF Brazil's Scaling Up Sustainable Soy project in Brasília, implemented in partnership in the Ministry of Foreign Affairs of Denmark; attendance at the Round Table on Responsible Soy Meeting Point in São Paulo; and participation in a two-day seminar organised by the Norway's International Climate and Forest Initiative, at the Norwegian Embassy in Brasilia. These events provided access to key stakeholders and facilitated additional interview contacts.

When participants authorised the use of AI-assisted tools, interviews were audio-recorded and transcribed using Fireflies.ai. When not authorised, handwritten notes were taken during the interview. All interviews were conducted in the participant's preferred language (Portuguese, English or a combination of both) to ensure natural expression of views.

To protect participant confidentiality, interviews were anonymised in the analysis (Clark et al., 2021, p.124-125). Each interviewee is identified by a categorical label reflecting their role or organisational affiliation in relation to the soy sector.

3.4 Data Analysis

A qualitative thematic analysis was conducted, combining inductive and deductive coding. This reflects the iterative relationship between theory and data that is common in qualitative research (Clark et al., 2021, p. 20). Coding was initially guided by a provisional list of codes derived from the literature and preliminary discussions with institutional partners described in Data Collection. However, as analysis progressed, this list was substantially revised as new codes emerged directly from participants' narratives, ensuring the analysis remained grounded in the data rather than confined to predetermined categories (Clark et al., 2021, p. 534-535). Coding was conducted manually in Microsoft Excel, with the AI tool Claude (Anthropic) used to support the organisation and consolidation of the resulting codes as their number grew. Related quotes and ideas were grouped into thirteen codes across four higher-order thematic clusters — structural barriers to physical segregation, governance failures, market dynamics, and governance futures and alternatives (Table 4) — which provided the structure for the Results chapter. Each code was subsequently mapped against four analytical lenses — feasibility, legitimacy, fairness, and power — each grounded in a distinct body of literature (2.7 Analytical Perspectives), in a parallel column identifying which lens or lenses it related to. In the Discussion chapter, these lenses were applied explicitly to interpret findings across the four clusters, allowing findings to be brought together where they speak to the same underlying theoretical dimension. Figure 12 summarises this workflow, from data collection through coding to the analytical lenses applied in the Discussion chapter.

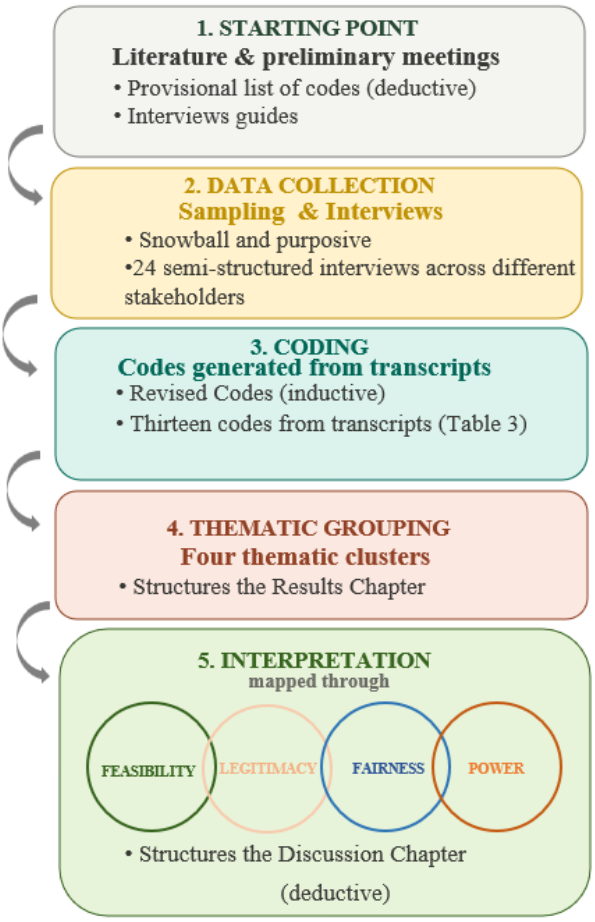

Figure 12. Data collection and analysis workflow.

Table 4. Final Coding Framework.

Thematic cluster	Code	Code Description
Structural Barriers to Physical Segregation	Code 1	Commodity system built against segregation
	Code 2	Traceability breakdown
Governance Failures	Code 3	Weak and incoherent demandfor certified and segregated soy
	Code 6	Structural governance failure
	Code 7	Contested legitimacy of external governance
	Code 8	Market governance as insufficient substitute for public policy
	Code 10	Price-driven commercial behaviour overrides sustainability commitments
Market Dynamics	Code 3	Weak and incoherent demand for certified and segregated soy
	Code 4a	Credits crowding out physical flows
	Code 4b	Established industry preference for Mass Balance over physical segregation
	Code 5	Weak economic incentives for certification
Governance Futures and Alternatives	Code 9	Certification as a local development tool
	Code 11	Territorial heterogeneity of certification feasibility and meaning
	Code 12	Transitional governance mechanisms
	Code 13	Alternative DCF governance models

*Code 3 contributes to both the Governance Failures and Market Dynamics clusters because participants described weak demand as both a market phenomenon

and a governance challenge. Similarly, Codes 9 and 11 are grouped under Governance Futures and Alternatives for their forward-looking character, but the interview material supporting them is discussed in the Results chapter alongside the themes it arose together with in participants' accounts, Code 9 within Market Dynamics, Code 11 within Governance Failures, rather than repeated separately.

3.5 Use of AI tools

Generative AI tools supported this research at several stages: Fireflies.ai for interview transcription where authorised (Data Collection). Claude (Anthropic) supported the organisation and consolidation of qualitative codes as their number grew during coding, for example by grouping related codes and flagging overlapping label; all coding decisions and interpretation remained the author's own (Data Analysis). Claude was also used to support academic writing throughout the thesis, including refining sentence structure, clarity and phrasing in text drafted by the author

3.6 Ethical Research Conduct

Participation in the study was voluntary. Data processing and protection were conducted in accordance with the General Data Protection Regulation (GDPR). Names and identifying details of interview participants have been anonymised in the research results.

3.7 Study limitations

Interview data reached saturation at the level of the study's core thematic clusters. no new overarching themes emerged in later interviews. However, how these themes manifested varied both geographically and across stakeholder groups, and the study cannot claim to have exhaustively captured this variation across Brazil's soy-producing regions.

The sample did not include non-certified producers; all producer perspectives came from certified operations, so the study cannot speak to how non-certified producers view these same barriers and governance mechanisms.

The interviews also did not probe why producers convert land in the first place. This study's questions were oriented toward RTRS and chain-of-custody governance specifically, not toward farmers' broader motivations for land conversion, which may include general agricultural expansion unrelated to soy demand. Understanding whether increased demand or price for certified soy could compete with these other incentives to convert land remains an open question for future research.

European-based stakeholders were included in the sample, but none were port operators on the European import side. As a result, how segregated soy is handled physically upon entry into the EU is not part of this study.

The RTRS-DCF Controlled Mix pilot discussed in this thesis was not yet formalised at the time of fieldwork, as introduced in Section 2.6, so the analysis of that model draws on interviewees' responses to it as a hypothetical, alongside RTRS's own published description of the pilot as it now stands.

Premium and cost figures discussed throughout this thesis (e.g. for segregated EUDR-compliant and RTRS-certified soy) are drawn from individual stakeholder estimates rather than independently verified market data, reflecting the fact that a formal market for physically segregated soy does not yet exist at scale.

4. Results

The results are organised around four thematic clusters: Market Dynamics, Structural Barriers to Physical Segregation, Governance Failures, and Governance Futures and Alternatives with a focus on the emerging RTRS-DCF Controlled Mix model. Each section draws on convergent and divergent perspectives across stakeholder groups to examine the barriers limiting the flow of physically segregated soy to European markets.

4.1 Market Dynamics

Interviews consistently identified weak downstream demand as a major constraint on the expansion of certified and physically segregated soy supply chains. Unlike commodities such as cocoa or coffee, soy is rarely consumed directly and instead functions as an ingredient in the production of meat, dairy, eggs and processed foods. As the international technical cooperation representative explained, *"soy has constraints because it is an ingredient (...) coffee and cocoa are 100% certified and soy, chicken meat, pork meat, no one is worried about that."* This indirect consumer pattern leaves consumers unable to distinguish certified or segregated soy from conventional products, limiting their capacity to drive demand for differentiated sustainability attributes.

Although consumer demand remains limited, demand for certified and segregated soy has emerged primarily through corporate sustainability commitments. One downstream industry representative explained that requests for sustainable soy are often initiated within the companies rather than by customers purchasing final products: *"If we look at our customers and who [creates] the demand for segregation and sustainable soy, it comes from the sustainability departments…They are the ones internally pushing for sustainable soy because they need it in their reports. They need CO_2 reduction and they have a target around deforestation- and conversion-free soy."* The same interviewee further explained that, despite these commitments, companies remain cautious in their procurement decisions because of uncertainty surrounding the implementation of EUDR. While many companies have adopted Zero-Deforestation Commitments some are postponing decisions regarding sourcing models until regulatory requirements become clearer. The stakeholder explained *"We are sort of anticipating the outcome of the EUDR before we can make any decisions regarding what should the sustainability attributes be on the soy."*

The same respondent argued that this limited consumer recognition makes it difficult for companies to transfer the additional costs associated with certified or

segregated soy to final consumers, particularly for an EUDR scenario after December 2026, *"When a company goes and sells the milk, I'm not sure they're going to increase the price on the milk, because now it's EUDR. The consumer in the end doesn't know what EUDR means. They don't even know what deforestation and credits [are]… and certification doesn't ring a bell to the consumer."* Similarly, an international technical cooperation representative emphasized that certification systems ultimately depend on market demand rather than support from civil society or academic actors, stating *that "there's no beautiful certification for NGOs and academia, there's a market"*. The respondent also said certification works better for products with a clear label consumers see when they buy them. Soy-based products don't have that kind of label, so consumers don't know the sustainability story behind them.

4.1.1 Fragmented Sustainability Demand

A recurring theme across interviews was the heterogeneity of sustainability demand across geographical markets. Stakeholders distinguished between large-volume markets where sustainability requirements remain limited and more demanding markets that request differentiated products with specific sustainability attributes. Several respondents identified China as the largest example of a market primarily driven by price considerations, where sustainability requirements play a limited role in purchasing decisions. However, interviewees also described that sustainability-oriented markets do not generate a single, coherent demand signal. Rather than requesting a common sustainability standard, buyers often seek different combinations of attributes, including deforestation-free sourcing, carbon accounting, labour standards, human rights safeguards, certification, and traceability requirements.

As one trader representative explained: *"When we look at our value chain and the markets where we operate, we have very different demands. We have markets with zero demand for sustainability; they only want price, and that is the largest share of the market, mainly the Chinese market. At the same time, we have a very demanding market that wants differentiated products. But when they ask for differentiated products, they also have different demands. One client wants carbon calculations, another wants only zero deforestation at low cost, another wants zero deforestation combined with labour issues at low cost, while another wants the complete package."* A downstream industry representative attributed part of this fragmentation to misalignment between the sustainability frameworks buyers reference, noting that SBTi, AFi, EUDR and FEFAC each apply different ambition levels and criteria for what counts as "sustainable soy": *"there's a difference in the ambition on what is the sustainability criteria of the soy. And they are not as of*

right now aligned towards their objectives." He ranked EUDR as the narrowest in scope, covering only deforestation, with FEFAC alone incorporating social criteria such as labour conditions.

This fragmentation is not only external, between markets with different demands, but also internal, as the next paragraph shows.

Despite these commitments, interviewees suggested that they are not always translated into procurement decisions within trading companies. Several stakeholders described a disconnect between sustainability departments, which define corporate sustainability objectives and monitor regulatory developments, and commercial teams responsible for sourcing soy and maintaining relationships with producers. As one NGO representative explained, *"We have a sustainability team... and we have the commercial team... And we don't see a connection."* Respondents argued that commercial teams primarily respond to procurement objectives and commercial performance indicators and are therefore unlikely to prioritise certification unless sustainability requirements are explicitly incorporated into purchasing decisions. As one certification group manager stated, *"If the trader doesn't have demand for certification, it will buy the soy from the producer without the certificate…"* Corporate sustainability commitments therefore do not automatically translate into procurement practices but depend on how effectively they are embedded within commercial decision-making.

Interviewees also pointed to producers' strong bargaining position: with multiple export markets to choose from, soy sellers aren't as dependent on sustainability-driven buyers. As a NGO commodity expert explained, *"The bargaining power of soy producers is much higher [than it is of palm oil producers]."* The respondent attributed this difference to the relatively limited market penetration of RTRS.

This fragmented demand has encouraged larger market actors to develop company-specific sustainability schemes tailored to specific commercial and customer requirements, rather than relying exclusively on RTRS certification. As one industry representative explained, *"When a company[trader] has their own certification scheme, the certification is going to be cheaper and easier to perform than RTRS."* In contrast, the industry association representative also viewed that smaller companies without established certification or due diligence systems could instead adopt the RTRS EUDR module as a practical mechanism for demonstrating EUDR compliance, mirroring cost burden asymmetry among producers, where fixed certification costs fall hardest on smaller farms

One European consultant argued that some market actors have limited incentives to actively promote physically segregated supply chains: *"Most of the shippers really don't want to provide it. They don't want to offer segregated soy because it's a pain. They've also been pushing back against the EUDR and, if they supply it, then they're effectively saying it's possible."* The respondent also pointed to companies' interest in preserving the commercial value of proprietary sustainability services: *"They want to be able to charge for any extra work they're kind of doing."* Beyond this, the respondent was sceptical of the severity of the cost narratives shippers themselves use to justify resisting segregation: *"there's a lot of people being spooked by traders to say the world will end, pigs will die if we go segregated. And I don't think that's entirely true."* The interviewee anticipated that such extra costs would decline once EUDR comes into force, as competition among traders intensified and segregated supply chains became more established, arguing that current cost estimates say more about negotiating tactics than actual costs, predicting that prices would fall once EUDR made compliance mandatory across the market: *"the law will require it, [Trader A] will supply it, and they'll say it's $15 a ton. As soon as they do, [Trader B] will say I can do it for $10, and then [Trader C] will say I can do it for $9."*

These commercial dynamics also reflect the historical evolution of sustainability demand. As one European consultant explained, *"We didn't ask for segregated soy until relatively recently… Nobody asked for segregated. They asked for sustainable soy."* A downstream feed industry representative offered a related account, tracing current sourcing practices back to a 2019 agreement to source according to FEFAC guidelines: *"the agreement has been made using a different... ambition level back then where the knowledge maybe wasn't [there]... we are more educated now on the topic than we were seven years ago."* This historical evolution helps explain why credit- and Mass Balance-based approaches became the dominant governance models long before physically segregated supply chains emerged as a market expectation.

4.1.2 Credits

Interviewees consistently identified credits as the most accessible mechanism for supporting sustainable soy production. Compared with Mass Balance or physically segregated supply chains, credits were described as both less costly and easier to implement because they do not require changes to sourcing practices, logistics systems or trade flows. As one trader representative noted, credits remain attractive because they can be purchased independently from physical supply chains and do not generate additional logistical costs: *"Today credits are much easier for companies and are much cheaper, because they don't have any cost, not the same*

mass balance would bring. When the farmer produces [soy], credits are put it there on the platform. And they are sold". This preference was echoed by certification groups, who reported similar reasoning among producers.

This same decoupling from physical flows, however, means that once a producer sells credits through the RTRS Web platform, the physical soy itself can still enter conventional supply chains. As one certification group representative explained, *"I sell the paper [credit], they sell the physical [soy] for whoever they want."* Stakeholders differed in their assessment of this separation between sustainability investments and physical commodity flows. Several respondents viewed it positively, arguing that it allows European buyers to support certified production even when the physical soy is exported to markets with limited sustainability demand. Others argued that this same feature weakens incentives to develop physically segregated supply chains. As one trader representative observed, *"I think the fact that there are so many credits available, it ends up refraining the physical market."* An NGO representative further questioned whether credits create meaningful market signals for deforestation-free production, arguing that they can become *"an instrument of buying clear conscience,"* providing reassurance to buyers without guaranteeing that the physical soy originates from certified farms.

Beyond their market function, RTRS credit revenues, collected by the producers, were also described as supporting local development: one certification group respondent noted that certification revenues had funded a local *"health centre".*

4.1.3 Mass Balance

Several interviewees described Mass Balance as a pragmatic middle ground, letting companies support sustainable production without the logistical costs of physical segregation. As one trader representative explained: *"To be sustainable, it has to be cost-efficient. I cannot dramatically increase logistics costs when the objective is to promote sustainable agriculture. A well-managed mass balance system, with annual audits and controls, is a more appropriate approach. Even if it is not exactly the same product, you are only commercialising the volumes that were produced in that specific area."* This cost-efficiency rationale reflects a broader tension between segregation and the operational logic of the Brazilian trading system, examined further in Structural Barriers below.

At the same time, other stakeholders expressed strong criticism of Mass Balance systems. Several interviewees questioned the integrity of sustainability claims that are not linked to physically segregated products, with one international technical cooperation representative describing Mass Balance as *"an absolute lie,"* since the product ultimately consumed may originate from a recent deforested area,

described in similarly stark terms elsewhere as *"accounting fiction"* or *"make-up."* Overall, interviewees did not reach a common view on Mass Balance.

4.1.4 Physical Segregation

Several stakeholders converged on physical segregation as the sourcing model provides the highest level of traceability and assurance. One NGO stakeholder emphasized that the primary value of segregation lies in its ability to guarantee compliance with specific sustainability requirements established by buyers*: "Physical segregation is important to guarantee, for whoever is buying, for whoever is generating the demand, that the product meets the conditions that it imposed, that it asked for. Mass Balance doesn't deliver that guarantee."* Beyond verification, this assurance also had a relational effect: one European consultant noted that asking suppliers directly about soy's origin *"gives credibility in commercial relations with suppliers because you're asking about soy [where it comes from]... it forces them [traders] to change and accelerate their own policies."*

At the same time, respondents consistently highlighted the economic challenges associated with segregated supply chains, arguing that the costs associated with segregation are often difficult to recover through market premiums, reducing incentives for both traders and producers to adopt physically segregated sourcing models. The scale of this cost, in terms of capital investment and premium levels, is examined in the Structural Barriers section below.

Despite these cost barriers, interviewees pointed to non-GMO segregation as an existing, functioning example of physical segregation within the Brazilian soy system. One European downstream buyer representative estimated that approximately 10% of the company's sourced soy is non-GMO and fully segregated, while the remaining 90% is genetically modified soy purchased through credit systems. Stakeholders linked the viability of this smaller segregated segment to a period of clear and stable demand: a trader representative recalled that *"when, about 15 years ago, Europe wanted GMO-free, it paid a premium and bought easily."* Interviewees contrasted this with current DCF and RTRS-related demand, described as fragmented across multiple, inconsistent buyer requirements (see 4.1.1, Fragmented Market Demand).

Segregation was also described as a deterrent: making it costly enough that companies simply avoid letting soy linked to recent deforestation into their supply chain in the first place. As one NGO representative put it, *"physical segregation*

provides a situation where segregation becomes so complex and onerous that a company prefers not to let non-compliant soy enters their chain."

Not all stakeholders viewed full segregation as the goal. Several interviewees argued that governance objectives could be achieved without universal physical segregation. One European NGO stakeholder stated: *"I give less value to the importance of a fully segregated certified trade chain."* Alternative governance models exploring this possibility are addressed in section 4.4, Governance Futures and Alternatives.

4.2 Structural Barriers to Physical Segregation

Interviewees described the Brazilian soy export system as built for scale, speed and bulk logistics, a structure fundamentally at odds with physical segregation, whether the goal is EUDR compliance or RTRS certification. Soy is traded as a homogenous commodity, as one certification group representative put it, certified soy *"does not change flavour, colour or size…what matters is on the paper"***.** Because the system treats all soy as physically identical, with narrow exceptions, for instance, non-GMO varieties (addressed in 4.1 above), any attempt to segregate soy requires rebuilding the logic of the entire chain from farm to port onto a system whose architecture was not designed to carry it.

At farm level, segregation is structurally prevented before soy leaves the property. Most farmers have no on-farm storage, so soy moves directly from harvester to truck to trader or cooperative warehouse. This challenge is compounded in frontier regions where infrastructure investment has not yet caught up with production expansion. In MATOPIBA, for instance, as one NGO representative described, *"West Bahia soy can travel over 800 kilometres before reaching the first aggregation point",* a distance that multiple interviewees described as impossible to justify without a significantly higher premium to keep the certified or EUDR-compliant soy separated from conventional soy. Brazil's continental scale compounds this challenge, the further production occurs from the coast, the more transboarding points soy must pass through before reaching export terminals, multiplying both mixing risk and logistics cost.

Figure 13. Soybean and corn storage silos, Sorriso, Mato Grosso, Brazil - a first aggregation point: (a) storage silos and warehouse; (b) grain aggregation facility, complete with weighbridge. Photograph courtesy of Júlia F. Viotto, 2026.

4.2.1 Cost and Premium Uncertainty

The capital investment required to build dedicated segregated infrastructure is itself a structural barrier, - Figure 13 shows storage silos and warehouse at a first aggregation point in Sorriso, Mato Grosso. One certification group manager estimated that a trader constructing segregated receiving facilities would need *"many years of premium payments just to cover the construction,"* with costs running to "many millions" of reais, an assessment echoed by a European NGO commodities expert, who likewise described the "cost of segregation will be huge."

Stakeholders also expressed uncertainty regarding the premium required to sustain segregated supply chains at scale. One European NGO commodities expert estimated a premium of between 15 and 30 euros per tonne for segregated EUDR-compliant soy, extending this to over €100 per tonne for RTRS-certified full physical segregation, equivalent to roughly a quarter or more above the prevailing commodity price of approximately €409 per tonne in May 2026 (World Bank, 2026).

Some stakeholders also questioned whether these costs could be sustained over the long term, given broader concerns about food affordability and market competitiveness. As a result, interviewees expressed differing expectations about whether future sustainability requirements would ultimately favour full physical segregation.

4.2.2 Infrastructure and Logistics

The infrastructure deficit extends beyond storage, as one industry expert with direct port operations experience noted, the barriers encompass *"railway*

infrastructure, road infrastructure, waterway infrastructure" none of which were designed with segregated flows in mind, making the problem "not quick or easy to solve". Even where port infrastructure is being expanded, as in the case of the TEGRAM terminal in Maranhão, one port operations executive noted that *"the problem is not the TEGRAM, the problem is getting there"* pointing to the upstream logistics corridor as the binding constraint.

Alongside the lack of infrastructure, the ubiquity of contract farming models was identified as an important barrier for RTRS CoC certification to scale. In Cerrado, most of the farmers close pre-harvest financing contracts with cooperatives and traders for which they commit volumes before the crop is even planted in exchange of financing for inputs such as seeds, fertilizers, and pesticides. Signing a pre-harvest contract means producers cannot redirect Book and Claim certified volumes to segregated chains even if they wanted to, because the soy that would be harvested is already sold. Moving away from contract-farming is not simple, as one producer noted "forward selling is always best" as it allows producers to manage risks of e.g. market volatility.

Even where the physical infrastructure existed, interviewees argued that segregation remains incompatible with the commercial organization of the Brazilian soy trade. The trader business model requires commercial flexibility: the ability to swap cargo positions between vessels, optimize logistics corridors, and reallocate shipments across routes in real time. As an international technical cooperation representative noted, *"segregation eliminates precisely this flexibility"*, removing a core source of competitive advantage that traders depend on to minimise costs and maximise margins. As one industry representative added, *"You bring a new regulation... you destabilise the rules of the game."*

This commercial flexibility is enabled by a multi-step logistics network in which soy passes through multiple aggregation and transshipment points before export. One trader representative interviewee described a specific northern Mato Grosso route, from farm to storage facilities in *Lucas do Rio Verde*, to Miritituba transbording point on the Tapajós river, then barge to Santarém or Barcarena, then ocean vessel. Each step represents an opportunity for conventional and compliant soy to mix. Interviewees consistently identified the first aggregation stage as the most critical bottleneck, where volumes from multiple farms converge in local silos before entering the further logistics network. As one trader representative explained, *"it is in the smaller silos",* a finding corroborated by a certification group manager.

The challenge is further reinforced at port level, where multiple traders routinely share silos, berths and loading equipment through joint venture arrangements. As a Brazilian consultant (former port concession executive) described, cargo sharing between traders is routine commercial practice: *"if there is space in the vessel, you ask a friend to fill that space. I send your volume, I complete my vessel, and I return the load in one week."*. Port operations also depend on assembling sufficient volumes within tight loading windows. As one NGO representative noted *"a moored vessel cost around 60 mil reais per day, if that volume of segregated soy is not available to load, the companies will have to pay that value until fill that volume"*, meaning delays while waiting for segregated volumes quickly become economically prohibitive. Similarly, a certification group manager hypothetically explained that filling a single vessel of RTRS-certified soy would require coordinating certified production across dozens of fragmented producers: "I will have to gather all my certified producers."

Maintaining physical segregation requires continuity across most stages of the supply chain. As one downstream industry representative explained, achieving segregation would require *"separate trucks carrying this to a silo that has been cleaned and emptied. a separated flow through the harbour and on a different separate ship",* each step adding cost, placing segregated flows in an *"entirely different price class"* compared to conventional sourcing. Similarly, one certification group manager summarised, "there is no point segregating here if when it arrives at the port there is no separation".

Full vertical integration was the one case where physical segregation appeared operationally feasible. One major trader described operating a fully segregated logistics corridor from producing farms through its own transborder facility to its own port terminal. This corridor was described as originating from a specific market requirement rather than from RTRS or DCF-related demand. According to a trader representative, the [CompanyX] buyer, a different case from the non-GMO example discussed above, accepts only non-GMO soy, which requires dedicated testing and segregation to prevent mixing with genetically modified material: *"Because there [country in Europe] only accepts non-GMO. And non-GMO needs to be tested. And to do the test it has to be segregated, tested, and it really cannot be mixed with GMO."* When asked whether the same corridor could operate at full capacity for segregated certified soy, the response was unambiguous; *"I could operate 100% segregated from my port…but there is no demand"*. The conditions enabling this, full ownership and control of every logistics node from farm to vessel, were met only by actors with complete vertical integration.

4.3 Governance Failures

4.3.1 Traceability

Traceability across the Brazilian soy supply chain was consistently described as fragmented, limiting chain-wide origin verification even where individual monitoring systems exist. Rather than operating through a common platform, major traders have developed proprietary traceability systems. As one cooperative manager explained, *"[Trade A] wants us to use their traceability tool, which is [X], [Trader B] wants us to use [Y]Tools, and then [Trader C] wants us to use another tool."* Although an industry association representative noted that major traders "can now know where the soy comes from and it is also verified by third parties," interviewees stressed that this capability depends largely on direct purchasing relationships and cannot be guaranteed across the entire supply base.

Cooperatives were also reluctant to share producer data, worried that traders could use it to buy directly and cut them out. As one cooperative manager put it, *"If I pass the information from my producer, the CAR [Rural Environmental Registry], the location, who guarantees that in a short time I don't have someone knocking on his door, buying directly from him?"* Traders said they were investing in relationships with cooperatives to get around this. But other interviewees said farm-level information still depends on what intermediaries agree to share.

Even where information is exchanged, interviewees questioned whether existing systems can provide plot-level verification. According to downstream industry representative (former sustainability manager in a trader organisation), purchase receipts are linked to farm-level volumes rather than individual CAR registrations, making it impossible to confirm whether soy originated from a compliant plot or from land converted after the regulatory cut-off date. The same respondent illustrated how this gap could be exploited in practice: a producer with a restricted CAR (flagged for irregularities such as deforestation beyond the Brazilian legal limit), could sell the compliant share (under a legal CAR) of their harvest to one trader, while selling the remainder, sourced from that same property but with the restricted CAR, to a second trader, telling both that the volume was fully compliant. As the respondent put it, *"I have my [farm] and I'll negotiate half my volume with [Trader A], the other half with [Trader B]. So I can sell to [Trader A] what came from that farm with that problematic CAR, I can sell to [Trader B] 100% of what isn't restricted, and I'll tell both that everything was fine."* Together, this account illustrates how traceability in Brazil's soy chains can remain dependent on fragmented platforms, commercial relationships and incomplete farm-level data, limiting the ability of governance systems to reliably verify deforestation-free claims.

4.3.2 Domestic governance failures

Governance failure begins at the Brazilian state level. Despite an established and clear Brazilian Forest Code, stakeholders identified two distinct enforcement failures: i) a resource and technical problem, where the state lacks adequate capacity to monitor and detect all violations, and ii) a political economy and institutional credibility problem, where even detected violations result in fines that producers can avoid paying or that are economically negligible relative to expansion profits. A downstream buyer stated plainly: *"The big problem in Brazil today is illegal deforestation."* First, state enforcement capacity remains insufficient to monitor Brazil's scale of production, leaving illegal deforestation largely undetected. Second, even where violations are detected, penalties carry limited institutional consequence: as one stakeholder observed, *"It's no use... if the fine is not paid."*

An international technical cooperation representative stated: *"We are still discussing what is legal and illegal in Brazil. We don't have clarity on what can have authorisation of deforestation and what does not have."* A producer association representative echoed this regarding MapBiomas: *"This platform [MapBiomas], it cannot separate legal deforestation from illegal deforestation."* Participants explained that state-level authorisation databases for legal land clearing remain fragmented across federal and state authorities, limiting access to documentation demonstrating that land conversion was legally authorised.

Additionally, state-level variation complicates this picture. For instance, Goiás state operates a regularisation pathway where producers who engaged in illegal suppression of vegetation without environmental licence can retroactively regularise their "environmental debt" (*passivo ambiental*) through compensation mechanisms. A certification group representative from Goiás explained the process: *"If I engaged in illegal deforestation suppression without environmental licence before [December 27, 2021], I have the possibility to regularise my debt. After that date I pay a fine and depending on the area I have to do compensation. The person makes an environmental declaration of the property, the superintendent analyses it and draws up an environmental commitment term. In that many years they need to fulfil the commitment, whether buying area in a park, planting, or compensating in some way. And they can do it. By doing this, they can work, buy product, get financial credit, do their commercialisation without getting blocked.",* (see Figure 14). However, the interviewee adds *"if, for instances, [Trader D] was going to buy that grain and they have interest in that batch to sell to European Union, they won't buy from that producer"*, a situation explored further in the next section 4.3.3.

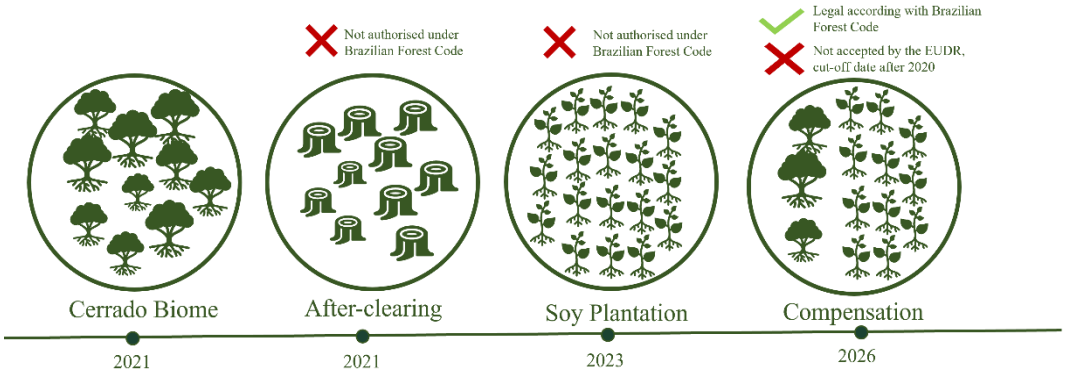

Figure 14. Goiás example: Even after clearing without authorization from the government, legality can be met with compensation.

Beyond state regularisation pathways, historical shifts in legal requirements have created a further governance conflict. Producers who cleared land under government colonisation incentives, for instance, in Mato Grosso decades ago were told they could open 80 percent and leave 20 percent of native vegetation. Today, the Brazilian Forest Code for the Cerrado-Amazonia intersection requires 35 percent legal reserve. A certification group representative, from Mato Grosso region, noted the logical impossibility this creates: *"You're not going to tell a producer to restore an area to make it beautiful. This sounds unviable and will never be done."*

4.3.3 The failure between International vs Domestic Law

Another major governance failure emerges from a direct conflict between what is legally permitted in Brazil and what international market access requires. A certification group representative stated the problem plainly: *"Brazilian legislation allows it and there [in the European Union] it doesn't... It's a bit complicated."* Producers who comply with Brazilian law by clearing within domestically permitted percentages find themselves outside EUDR's December 2020 cut-off date.

Stakeholders converged on the observation that EUDR functions as trade redirection rather than environmental governance. An international technical expert stated: "EUDR only comes to restructure the supply chain without impact… it is helping the Europeans to have a clean conscience without creating impact." A downstream buyer reinforced this assessment: *"EUDR solves the problem of the European Union [reducing greenhouse gas emissions], not the Brazil problem [deforestation]."* An industry expert made this explicit: *"EUDR will have very little*

transformation impact on the main production region in Brazil. Ninety percent of soy in these frontier regions goes to China which has no sustainability requirements."

The regulation was also perceived as drafted without adequate understanding of Brazilian production realities. One soy executive expert recalled: *"When EUDR was being discussed in 2021, there were several meetings with the Danish and Belgium embassies where we showed them that Brazil lacks infrastructure for that type of segregation. The law was going to raise with a huge gap."*

Producers questioned the fairness and legitimacy of external governance by comparing European market requirements with the regulatory obligations they already face under Brazilian law. One producer asked, *"What are the regulations in Europe? How much do you need to protect of native vegetation?"* while contesting that *"Their plantations extend till river banks."* Another producer summarised the comparative regulatory landscape by stating that *"The Forest Code is the most rigorous on the planet."* These perceptions reflect the view that Brazilian producers face stricter domestic environmental requirements than European producers while also being subject to additional external conditions for market access.

Beyond these comparisons, several stakeholders pointed to EUDR's potential to favour European protein crop production over soy imports. As one stakeholder argued*, "The easiest way to resolve the problem of EUDR is not to buy soy, buying corn here in Europe. It ends up being a protectionism measure."* Not all stakeholders saw this as a criticism, however. A Brazilian downstream buyer representative framed it instead as acceptance: *"I think it's a market instrument. We just can't be naive that it's something for the environment, because it isn't. I think there are a lot of protectionist interests behind it, protecting the European market, and that's fine, rules of the game, capitalist market."* The same respondent also pointed to the regulation's two postponements, but again read them as part of the same normal process rather than a flaw: *"I understand this is being remedied, and these postponements... were exactly about how to make this operational. They started to realise, wait, maybe it's not that easy."*

Others thought EUDR would eventually stop being a disadvantage, once it became the standard every buyer required. As one European consultant put it: *"EUDR could level the playing field… there'll be a competition and it'll just become normal, a new normal."*

4.3.4 Limitations of Voluntary and Market-Based Governance

Interviewees identified market-based and voluntary governance mechanisms as insufficient for six main reasons, the first two concerning market-based governance broadly, and the remaining four concerning specific limitations of RTRS certification: i) market mechanisms cannot function effectively without complementary government enforcement, ii) the global nature of soy markets requires multilateral cooperation that single-market regulation cannot provide, iii) certification tends to reward producers who had already stopped deforesting before seeking it, while its eligibility rules exclude some interested producers and leave others eligible but uninterested; iv) certification's perceived value lies in administrative and legal support rather than the price premium meant to reward compliance, v) farm-level rather than operation-level certification allows harmful practices to continue alongside certified production, and vi) reluctance to engage with RTRS extends to active avoidance of the topic itself.

First, several stakeholders argued that certification, corporate commitments, and buyer requirements alone cannot effectively reduce deforestation without stronger government intervention. As one consultancy specialist explained, *"I need governments to join in. So I need the UK government to legislate EUDR to be, you know, carried forward. And I need to also think, how do farmers that are not interested in supplying Europe going to be convinced not to deforest? Well, that's the Brazilian government, the Argentinian government, Landscape Initiatives and others."*

Second, an international technical cooperation representative argued that *"We need multilateralism… that is precisely what we are losing today,"* highlighting the need for coordinated action among both producing and consuming countries. Stakeholders also pointed to the limitations of private collective action, referring to the Amazon Soy Moratorium, an agreement between major traders to exclude soy linked to deforestation in the Amazon, which faced legal challenges on antitrust grounds (Hanbury, 2025). As the same representative concluded, *"It seems much more important [to strengthen] compliance with Brazilian law and [promote] the adoption of sustainability protocols by Chinese buyers."*

Third, several stakeholders argued that RTRS-certified farms tend to be highly consolidated operations that had already ceased deforestation activities before entering certification schemes. As one NGO representative explained, *"The farms that get certified are very few, very special, very advanced. So it's very easy for them not to deforest, because they're already consolidated, they've already made the economic decision to open an area a long time ago."* This perception raises questions about the additionality of certification, suggesting that RTRS may reward

producers who were already compliant rather than encouraging changes in land-use practices. Stakeholders also highlighted limitations associated with the scheme's eligibility criteria. One NGO representative noted that some producers interested in certification are excluded by the 2016 cut-off date despite meeting other certification requirements, while producers in Western Bahia who remain eligible often *"don't see benefits on certification."*

Fourth, interview data suggest that RTRS certification functions primarily as an administrative and legal compliance tool, providing legal compliance, farm management support and organisational development, rather than as a mechanism that actively drives behavioural change or offers a premium: certification groups support producers with documentation, record-keeping and administrative processes required by both certification standards and national legislation. However, both certified producers and certification groups acknowledged that certified soy is treated as a commercially differentiated product, despite being physically identical to conventional soy, as noted above. As one certification group manager explained, *"They already do everything, it is [RTRS] only a control… we only organize documentation."* This suggests that certification often formalises and verifies existing practices rather than inducing substantial changes in production systems. Consistent with this, respondents repeatedly downplayed the importance of certification premiums. One certification group representative stated that *"Today, our producers, when you ask them about benefits, I think 100% no one is going to talk about the value of the premium."*

Looking ahead to a scenario of EUDR-compliant or fully segregated soy, stakeholders questioned whether a future premium would reach producers at all. One European NGO commodities expert asked, *"who is gaining from that? Maybe the logistics companies, but not the farmer and actually also not nature."* This finding extends the concern that market governance mechanisms do not guarantee that the value associated with compliance reaches the producers whose behaviour they are intended to reward, even in a future scenario where compliance requirements are stricter.

Fifth, interviewees also identified important limitations in the design of the RTRS certification system, particularly its certification of individual farms rather than entire agricultural operations or economic groups. An NGO representative illustrated this concern by describing producers who own multiple farms but certify only one property: *"Imagine there are several producers who have four, five, six farms. Then he has one certified farm and the others are not. And then he can be selling the certified soy from here and at the same time deciding to open a new farm, a new area."* According to the same interviewee, this allows producers to

benefit from sustainability markets while continuing environmentally harmful practices elsewhere within their operations: *"So, in other words, you're still giving money to this guy who is going to do deforestation, you're filling his pockets."*

Sixth, this limited engagement was also expressed indirectly, through avoidance of the topic rather than direct confrontation. Non-certified producers were described as reluctant to engage with external sustainability agendas, particularly RTRS. As an international technical cooperation representative observed, *"no one wants to talk about that [RTRS] anymore."* According to the same respondent, event organisers seeking to bring together producers, traders and other stakeholders deliberately avoided naming RTRS or EUDR when convening meetings, instead describing them as *"sustainable soy meetings"* without reference to either framework in the invitation. Despite this omission, the respondent noted that these topics inevitably resurfaced during discussions, describing the pattern as *"eating by the edges."*

4.3.5 Uneven Territorial Outcomes

Interviewees described governance mechanisms and their benefits as unevenly distributed across producing regions. Several stakeholders highlighted the role of RTRS credits in reaching producers who lack the logistics and export infrastructure to access physical supply chains or EUDR-compliant markets directly. However, stakeholders also identified tensions with the RTRS certification framework itself in this respect: as one international cooperation expert argued, *"RTRS is exclusionary,"* explaining that the certification framework does not support farmers in more recent agricultural frontiers who converted land after 2016.

Territorial heterogeneity in certification feasibility was not limited to eligibility under RTRS's cut-off date. One cooperative manager in Paraná described a distinct barrier facing small producers in the South, where properties are typically far smaller than in frontier regions: *"properties here in our region are small, 300, 400 hectares. It's different when you take Mato Grosso, which has 2,000-hectare properties. So there, the producer manages to add value. So this small producer here in the region finds it harder to cover the cost."* According to the same respondent, certification-related costs, including certification fees, dedicated infrastructure, and additional staff, are largely fixed regardless of property size, meaning they fall disproportionately harder on smaller producers. Notably, the respondent described producers in this region as environmentally well-positioned for certification, since consolidated land use with little recent conversion is common in the South, and already familiar with cooperative structures similar to RTRS's requirements. Despite this, the same fixed costs that pose little burden for

a 2,000-hectare Mato Grosso property can render certification economically unviable for a 300-400 hectare property in Paraná, even where that producer meets every environmental and organisational requirement.

This unevenness extends beyond certification eligibility and cost structure to the broader economic benefits of soy expansion. One certification group representative described soy's arrival in previously poor territories as having "brought wealth, tax generation, job creation," while also contrasting two neighbouring municipalities in Maranhão: *"Balsas has it justified, it has a hospital, schools, universities, a bakery, a supermarket. Tasso Fragoso remains in poverty, why? The money circulates where the soy areas are, not in the city."* According to this account, the benefits of soy expansion are spatially concentrated in the production areas themselves, rather than distributed more broadly across the surrounding region.

4.4 Governance Futures and Alternatives: The RTRS-DCF Controlled Mix and Beyond

As introduced in section 2.5, RTRS has since piloted this approach as Optional Model V, the RTRS-DCF Controlled Mix. At the time of fieldwork, however, the model had not yet been formalised under that name, it remained a newborn initiative within the sector, and was explored with interviewees as a hypothetical chain-of-custody arrangement, in which a first aggregator would receive only RTRS-certified soy and independently verified deforestation-free soy. One industry association representative assessed the model favourably compared to full-chain segregation, arguing that verification concentrated at a single aggregation point reduces mixing risk, ensures that all volume entering the system meets consistent criteria, and allows Mass Balance to be applied safely from that point onward. According to the same respondent, this generates *"information security"* and a more efficient way for companies to control both the origin of the product and how it is mixed against agreed criteria. A European consultant described the same idea as *"a sort of EUDR mass balance control"* coming from RTRS, in which a minimum of EUDR compliance could be mixed with RTRS certification *"to comply with the EUDR but add some value to it,"* drawing a comparison to how FSC and PEFC adapted once timber regulations were introduced.

Building on the volume constraint of RTRS-certified soy, one NGO representative put it: *"you don't even have enough number of certified farms to fill a silo, to fill a ship... let's say we have 10 certified farms. These 10 farms will fill 10% of the silo... fill the other 90% with non-certified soya, but that is at least deforestation-free."* This would substantially lower the cost of segregation while still allowing the buyer to *"emit the signal that he doesn't accept deforestation,"* even where the bulk of the volume was not formally RTRS-certified.

A cooperative representative, when presented with the same hypothetical model, responded that the cooperative had already been considering a similar approach: *"it's more or less what we've been thinking, doing two segregations,"* referring separately to soy from land free of post-2020 conversion and RTRS-certified soy. The respondent identified volume as the central obstacle in practice: despite a nationally record harvest, the cooperative's own harvest that year was, in their words, *"a frustrated one,"* leaving insufficient certified volume to justify dedicated segregation. As a possible solution, the respondent suggested an external third-party processor could receive segregated volumes directly from producers, avoiding the need for the cooperative itself to manage dedicated storage. However, the respondent was clear that this would only be viable with a materially better price, arguing that no cooperative or company would separate out certified volumes for a small group of certified producers while directing the majority through standard channels without a stronger financial incentive to do so.

Stakeholders further emphasised that ensuring compliance at the first silo represents the most effective intervention point for preventing the mixing of compliant and non-compliant soy, reinforcing the first-aggregation-point logic underpinning the Controlled Mix model itself. Some respondents extended this logic further, describing a possible "mass balance 2.0" combined with credit systems as an additional hybrid option worth exploring.

Beyond the RTRS-DCF Controlled Mix model itself, interviewees raised a range of further proposals for the future of soy governance, which, while outside this thesis's primary focus, are worth noting. Several stakeholders argued that RTRS should move beyond a binary certified/non-certified structure toward a tiered system, rewarding incremental sustainability performance rather than requiring a single, all-or-nothing standard: one NGO commodities expert proposed a payment structure layering a baseline EUDR premium with additional payments for DCF compliance, RTRS certification, and regenerative agriculture practices. Related to this, a European expert argued for closer integration between existing governance instruments rather than treating them as separate tracks: *"Why not bundle those values? That's the next step."* Others proposed RTRS should certify at the level of the economic group rather than the individual property, addressing the farm-level certification gap discussed above in 4.3.4. Other proposals included stronger international cooperation mechanisms (e.g., Mercosur-EU trade dialogue), direct producer-buyer relationships bypassing intermediaries, regional/territorial-scale compliance, financial regulation as a behavioural lever (e.g., Central Bank agricultural credit restrictions), and landscape-level investment beyond supply-chain interventions alone.

5. Discussion

Sections 5.1 through 5.4 address feasibility, legitimacy, fairness and power in turn, together answering RQ1. RQ2's narrower question, why RTRS-certified segregation specifically has failed to scale, is addressed across all four lenses and resolved directly in Section 5.5.

5.1 Feasibility

Across stakeholder groups, segregation was usually described as achievable for a single actor, but much harder to keep up once the full scale of the Brazilian soy system is taken into account. Part of the reason lies in soy itself: as a physically homogeneous commodity, there is no observable difference between grain produced on deforestation-free land and grain produced on land converted before or after relevant cut-off dates, meaning segregation depends entirely on procedural and documentary control rather than any inherent property of the product. This is a different challenge from whether Brazilian logistics can physically sustain a segregated supply chain at all, on that front, the system is not incapable: non-GMO soy is segregated for buyers in Europe, and one downstream buyer reported that roughly 10% of its sourced volumes remain non-GMO and fully segregated, a pattern also seen across the rest of the EU market, where non-GM segregated soybean has made up 8% of imports in major buying countries across Europe (Tillie & Rodríguez-Cerezo, 2015). This precedent suggests that the barrier facing physically segregated soy may not be a fixed technical ceiling on Brazilian logistics. The volumes needed to supply EUDR- or RTRS-compliant soy at scale, however, are far larger than those required for the smaller, already-established non-GMO segment, a difference examined further below.

Independent evidence supports a related pattern: feasibility is not uniform across Brazil, and where it exists, it appears to track ownership rather than location. A 2026 case study by Proforest and RMR Consulting examined a major soy trader's operations along the Santarém corridor and found segregation to be logistically feasible, not because the trader owns the export terminal, but because the "processing facility and port of export can be fully controlled by the trader", and "the trading company operates its own fleet" from the inland waterway leg to the port (Proforest & RMR Consulting, 2026). This is a narrower form of control than full vertical integration, since it extends over processing, export, and transport rather than the farms themselves, but it produces a similar effect. Segregation holds wherever the trader can govern the chain without depending on shared, multi-actor infrastructure. This finding closely parallels this study's own vertical-integration case. A trader operating its own terminal along a different export corridor reported

the same capacity to operate fully segregated from its own facility. Reis et al. (2023) find the same pattern more broadly across Brazilian soy corridors. One trader controlling a corridor makes trade relationships there stickier, more stable, and less likely to change from year to year. They were not looking at segregation specifically, but it is the same mechanism, concentrated control producing stability. By contrast, the Proforest report found the Santos corridor, organised around shared, multi-trader rail and port infrastructure, currently unfeasible for segregation. The port terminal cannot separate soy by trader, and coordination among the traders using it is limited: don't trust each other's control systems, even though the regulation itself permits mixing as long as the whole volume stays compliant (Proforest & RMR Consulting, 2026).

Beyond who controls each loading and unloading point in the chain, the distance separating farms from ports is considerable. Souza et al. (2023) estimate an average of 700 km between the farm and the nearest railway or waterway terminal, which contributes to the country's reliance on road transport for 49% of its soy exports. This distance is even more pronounced at the frontier: this study's own findings show that in MATOPIBA, the distance from farm to first aggregation point can reach 800 km. The longer and more multimodal the route to port, the more transshipment points certified or EUDR-compliant soy must pass through, and the more actors must coordinate to maintain documentation and avoid mixing with non-compliant volumes.

A related set of barriers operates at the farm level itself. As this study's fieldwork found, the absence of on-farm storage means most farmers have no opportunity to hold, sort, or verify soy before selling it. This is compounded by the ubiquity of pre-harvest financing contracts, which commit volumes to a buyer months before harvest, meaning certified soy cannot be redirected into segregated chains later, since by the time it exists, it has already been sold. Reis et al. 2023 were not studying segregation, but they document the same underlying logic across Brazilian soy corridors more broadly: credit and barter arrangements made in advance of harvest lock farmers into their buyers, reducing the room they have to redirect volumes once conditions change. On top of this structural constraint, traceability to the farm is often undermined by the intermediaries soy passes through. Proforest identifies this as the main obstacle in Rio Grande do Sul, where smallholders selling through cooperatives make it hard to trace soy back to its origin (Proforest & RMR Consulting, 2026). This study's interviews suggest a further reason for why the gap persists: cooperatives are often reluctant to share producer data, since doing so risks losing that producer to a trader willing to buy direct. Traceability gaps in the South are therefore not just about missing documentation, but about cooperatives actively protecting their role as intermediaries.

The clearest proximate explanation for why few actors attempt segregation, even where structurally possible, is the absence of demand, as the vertically integrated trader's own account makes plain. Yet this raises a further question: if segregation already works for non-GMO soy, why hasn't it worked for deforestation-free soy? One difference lies in verifiability. Non-GMO status can be tested directly, a lab sample proves it on the spot. EUDR or RTRS- compliance status cannot. It depends entirely on paperwork and records tracing the soy back to a specific plot of land, since the grain itself shows no physical sign of where it came from. This makes EUDR and RTRS-compliant soy segregation much harder to verify than non-GMO segregation, regardless of how strong buyer demand is. The second difference is that non-GMO demand was also clear and consistent: buyer representatives recalled that European demand for non-GMO soy, roughly fifteen years ago, was met with a reliable premium and straightforward uptake. EUDR and RTRS-related demand, by contrast, arrives as a fragmented set of buyer-specific requirements, as shown in Section 4.1 (Market Dynamics), some want carbon accounting, others only deforestation-free status, others a full package. This mirrors the findings from Garrett et al. 2019): because companies define their own commitment goals and implementation mechanisms individually, ZDC content varies widely across firms, with no convergence on a shared standard.

This section's evidence points to two reinforcing barriers rather than one. There is a coordination problem, built into how ownership is spread across shared infrastructure: But even where that coordination problem could be solved, demand itself remains too fragmented to justify the investment. The vertically integrated case discussed above resolves only one of the problems: ownership of the full chain means the benefit of segregation stays with one actor rather than spreading to competitors. It does not resolve the second. This reframes the barrier examined throughout this section: not a fixed technical ceiling on Brazilian logistics, but a coordination problem layered on a demand problem.

5.2 Legitimacy

Where Feasibility examined segregation as a practice, the interview data pushed the legitimacy lens in a different direction. Stakeholders rarely spoke about the legitimacy of segregation itself. Instead, they consistently spoke about the legitimacy of the governance systems that call for it, RTRS and the EUDR, and how these compare against the legitimacy of Brazilian law's own framework. This section follows that shift, treating legitimacy as a property of the governance systems that define compliant soy rather than of segregation as a technique.

Bernstein (2011) defines legitimacy as whether an authority's claim to govern is accepted by those it affects as justified, distinct from whether its rules are actually followed. This distinction is useful across all three governance systems discussed here, Brazil's own law, RTRS certification, and the EU's regulation, even though each draws its authority from a different source. In each case, stakeholders rarely questioned the instrument's basic right to exist. What they questioned was something more specific, whether the rules it produced were credible, workable, and actually able to stop deforestation.

One part of the mismatch starts with Brazilian law itself. The Forest Code only requires producers to conserve a set share of their land, not all of it, so the rest can be cleared legally. RTRS and the EUDR each draw a stricter line of their own. RTRS applies a cutoff of 2016, the EUDR a cutoff of 2020. Figure 15 shows how these systems relate to each other. Brazilian law acts as the legal floor, and RTRS and the EUDR build a stricter, independent layer on top of it, while still requiring compliance with Brazilian law underneath. Because of this layering, land cleared entirely legally under the Forest Code, within Legal Reserve limits, can still disqualify a producer from RTRS certification or from EUDR compliant markets, simply because the clearing happened after one of these later cutoffs. Legal, in other words, does not mean RTRS or EUDR compliant. Three institutions define acceptable land use in three different ways.

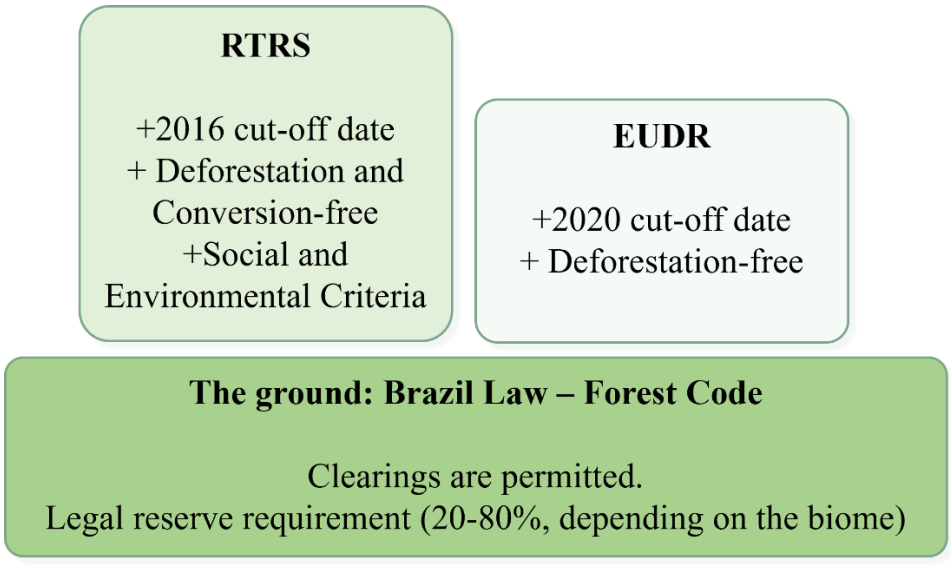

Figure 15. Brazilian law works as the legal ground. RTRS and EUDR are built on top of it, but with stricter requirements — A shared base with two independent, stricter layers.

This mismatch is strengthened with cases such as. Goiás state, where producers regularise past unlicensed clearing through a compensation process (see Figure 14, Section 4.3.5). The same thing happens at the national level too. Reis et al. (2021) show that Brazil's legal framework itself was, at the time of their study, being revised to retroactively legalise land that had been cleared illegally. In their words, "what was illegal may become legal shortly." A state compensation process can make a producer legal again. But this only settles the question inside Brazilian law. EU-facing buyers may still reject that producer if the clearing happened after the 2020 cutoff.

This legal permissiveness is compounded by a separate weakness: as illustrated in the same section of the Results, the tools available for verification have their own limits. Monitoring platforms such as MapBiomas track land-use change over time and flag spatial indications of irregularity (e.g., absence of a matching authorisation, or overlap with protected or embargoed land), but these indications do not amount to a legal ruling of illegality (MapBiomas, 2026). Even where authorities do have the power to act on these indications, enforcement has often proven ineffective: embargoes on illegally deforested land in Mato Grosso are routinely ignored, with over 80% of embargoed areas remaining in agricultural use afterward (Roquette et al., 2026). Rajão et al. (2020) estimate that as much as 22% of Brazilian soy exported to the EU between 2009 and 2017 may have come from land cleared in violation of the Forest Code, soy that CAR-based monitoring failed to catch.

Another weakness shows up at the property level: Brazil's Rural Environmental Registry (CAR) relies on self-declared boundaries, and recent research confirms this produces widespread unreliable and contested data, 16% of registered land in the Legal Amazon carries competing claims, inflating declared legal reserve by up to 9.7 million hectares (Furumo et al., 2024). This thesis's own interviews point to a related vulnerability: a producer with one restricted CAR could still sell soy from that land under a separate, unrestricted CAR (Section 4.3.1, Traceability). This is a distinct failure from the enforcement gap above: it is not that violations go undetected or unpunished, but that the underlying record producers are checked against cannot itself be trusted. Legal compliance, in other words, is unreliable not only in practice but at the level of the data meant to establish it.

RTRS and EUDR try to avoid these weaknesses by applying their own independent checks rather than relying on legal status alone. This is consistent with Reis et al. (2021) argument that legality alone is an insufficient basis for protecting forests, given that Brazil's own legislation authorises substantial vegetation loss and carbon emissions despite the global climate crisis, by their estimate, the Forest Code

leaves open around 101 Mha for potential legal deforestation, equivalent to over 12 billion tons of CO_2. The RTRS and EUDR cut-off date, introduced earlier, are the clearest expression of this: a mechanism the Forest Code does not provide, aimed specifically at addressing climate impact rather than legal status.

RTRS presents a different kind of legitimacy problem. Cashore (2002) shows that certification schemes like RTRS have no state authority to force compliance. Their legitimacy depends entirely on whether the people and companies they're trying to govern decide to grant that legitimacy. In practice, this plays out through two things: whether RTRS's process is seen as credible, and whether its results are effective. The stakeholders interviewed for this thesis largely accepted RTRS's process, describing it as multi-stakeholder and independently audited. However, two other studies add nuance to that picture. Schilling-Vacaflor et al. (2021) found RTRS audits in Western Bahia raise question about whether producers actually respected local communities' land and water rights. Raasch et al. (2026) go back further, to when the standard was first written in 2008, and show that peasant movements and NGOs who objected to the criteria had limited involvement in shaping the final criteria. Taken together, these two points raise a question about what the acceptance in this study's interviews actually reflects. It may say more about who was in the room, back when RTRS was founded and again in this study's own sample, than about whether people genuinely trust the standard. This acceptance of RTRS as a credible process is also not the same as willingness to engage with it as discussed in Section 4.3.4 (Limitations of Voluntary and Market-Based Governance), reluctance was common, particularly among frontier producers, in part because RTRS's requirements exceed what Brazilian law itself demands. Stakeholders can regard RTRS as legitimately run while still avoiding a standard that asks more of them than the law requires.

What stakeholders in this research questioned was whether RTRS certification changes much in practice. First, certified farms tend to be large, already-consolidated operations that had stopped deforesting years before seeking certification. Secondly, it certifies individual properties rather than whole farms , so a producer can certify one property while continuing to clear land on others. Thirdly, the premium meant to reward better practice is small enough that producers barely notice it, valuing the paperwork and legal cover more than any environmental gain. This is consistent with RTRS's comparatively small premium, estimated at around 0.5% of the soy price (Solidaridad, 2020), substantially lower than premiums reported for other voluntary sustainability standards: a systematic review found certified producers under standards like Fairtrade, Organic, and Rainforest Alliance typically receive 20–30% higher prices, raising household incomes by 16–22% on average (Meemken, 2020). Finally, the 2016 cut-off date

excludes some willing producers outright, while others who qualify say it isn't worth the effort. Taken together, these four points suggest that what people accept when they accept RTRS may have more to do with its multi-stakeholder, audited process than with any visible change in practice on the ground.

The EUDR raises a related legitimacy question, though smaller and more specific one. Some stakeholders read the regulation not as forest protection but as trade management, redirecting Europe's exposure to deforestation rather than reducing it, or as a form of protectionism favouring European producers over Brazilian exporters, a reading some accepted simply as part of how trade works between unequal partners (Results, International vs Domestic Law). Academic policy analysis of the EUDR's drafting process suggests this framing is not simply mistaken: (Berning & Sotirov, 2024) find that business actors' interest in market protectionism was a genuine, documented part of the coalition that built the EUDR, alongside its environmental and climate objectives. However, not every stakeholder saw this as illegitimate; some expected these tensions to fade once compliance became universal rather than a competitive advantage held by early movers. The regulation's own delays also raise questions about its legitimacy, read by some as evidence the EU had not fully worked out how the rule would be enforced before legislating.

None of the three systems change the economics of land conversion itself. They sort soy into compliant and non-compliant after clearing has already happened, not before. So a rule can be fully accepted, and still not stop the thing it exists to stop. That leaves a further question. Even where a rule is accepted, is it actually fair?

5.3 Fairness

The clearest distributive concern raised by stakeholders is that segregation, in demanding proof of compliance with RTRS and EUDR cut-off dates, asks Brazilian producers to document something European producers never have to prove in the first place. Brazilian producers are legally required to conserve a fixed share of their land as Legal Reserve, ranging from 20% in the Cerrado to 80% in the Amazon, while EU producers face no equivalent binding, per-property conservation requirement. Producers pointed to this directly, contrasting Brazil's Forest Code, which they saw as among the strictest in the world, with European farming practices that in their view extend right up to riverbanks with no comparable restriction. This asymmetry is sharpened further by the shifting reserve requirements already discussed above: producers who cleared land under earlier state incentives now face conservation obligations the state itself did not originally impose. The EU's 2024 Nature Restoration Law does set restoration targets, but these apply at the level of

member states rather than individual farms, and key agricultural provisions, such as rewetting drained peatland, remain voluntary for farmers, a materially lighter obligation than Brazil's mandatory, per-property Legal Reserve (Regulation (EU) 2024/1991, 2024) Some stakeholders see this asymmetry as fair, simply how market competition works. Others see it as a real injustice. Brazil conserves land Europe was never required to conserve, while facing market conditions Europe does not face in reverse. What determines acceptance isn't the size of the burden, but how stakeholders read it, as ordinary competition, or as unfair treatment.

A second distributive concern is whether the premium associated with physically segregated, compliant soy actually reaches the producers who segregate. This is a different premium from the one RTRS certification currently pays under credits: as shown in Section 4.2 (Structural Barriers to Physical Segregation), segregated volumes are expected to command a substantially higher premium, one interviewee's estimate placed this at 15 to 30 euros per tonne for EUDR-compliant segregated soy, and over 100 euros per tonne for full RTRS segregation, precisely because segregation is costlier to deliver. Reaching that premium first requires the capacity to invest in segregation. Producers need farm-level storage and handling to keep certified soy separate before it reaches the shared aggregation points discussed in Section 5.1 (Feasibility). This capacity to invest is not evenly distributed. Larger, better-capitalized farms are more likely to own silos and access credit independent of traders, while smaller producers more often lack storage and depend on trader-supplied credit and inputs, a dependence that limits rather than builds their capacity to invest (Reis et al., 2023). Even for producers who can invest, whether the premium payment itself reaches them is another matter, a concern stakeholders raised directly in Results (4.1.4). This reflects a broader pattern in global value chain governance. Power and control tend to concentrate with the actors who coordinate the chain, those able to monitor, direct, and set terms for others, rather than with the producers who generate the underlying value (Gereffi et al., 2005). In the soy chain, traders and logistics operators occupy this coordinating position.

A further distributive question moves beyond these two concerns to ask who within Brazil would actually benefit from a shift toward certified, physically segregated soy. Soy expansion has already produced benefits that are concentrated in specific places rather than spread evenly, as the Maranhão example in Results (4.3.5) shows. This matches a broader pattern documented across the wider MATOPIBA region: Russo Lopes et al. (2021) found that soy-linked municipalities saw regional GDP grow by 542% between 2000 and 2013, but that gains concentrated in soy hub towns while conditions in surrounding areas “changed relatively little.”

Left on its current trajectory, segregation risks repeating this hub-concentration dynamic: the regions and producers already positioned to invest capture more of the benefit, while smaller producers, priced out by certification costs that don't scale down with property size (discussed further under Power), fall further behind regardless of how well they meet the environmental requirements. So even setting aside who captures the premium, there's a deeper question here: the gains from soy, and likely from any shift toward certified physical flows, are already unevenly shared among the producers and regions in the chain.

McDermott et al.'s (2012) second dimension, procedural equity, asks not who bears the costs of a rule, but who had a genuine say in shaping the rules segregation now has to satisfy. On this measure, Brazilian stakeholders describe a limited role in EUDR's design, a gap between what industry warned the EU about and what was ultimately legislated, as shown in Results (4.3.3). This pattern of formal input without real influence is not unique to EUDR's design. Russo Lopes et al. (2021) find a similar dynamic in Cerrado multi-stakeholder soy governance forums, describing most such processes as forms of "tokenism", participation that is procedurally present but fails to translate into substantive influence over outcomes. One CSO (civil society) representative they interviewed put it bluntly: they had "never been invited" to speak on their own terms in these forums.

Costs, benefits, and decision-making power are all unevenly distributed here, between Brazil and Europe, among actors in the chain, and among Brazilian regions themselves. Whether smaller producers and peripheral regions have any real voice in any of this remains an open question. That's where Power picks up next.

5.4 Power

This section addresses the last of the lenses: who stakeholders themselves see as holding the power to make segregation happen, block it, or set the terms under which it occurs. It applies Dallas et al.'s (2019) typology of power, introduced in Section 2.7, to clarify what kind of power each actor holds, rather than treating power as a single undifferentiated capacity.

The European Union's position illustrates this directly: it does not need Brazil's consent to set deforestation-free requirements, because it controls something Brazilian exporters want, access to a market that pays premium prices. In Dallas et al. (2019) terms, this is institutional power, the capacity to set the rules of market participation unilaterally, without needing to bargain with any individual exporter. Bradford (2012, 2020) identifies the underlying resource that makes this possible as market power: because EU market access is large, valuable, and difficult to

substitute, the EU does not need to negotiate to obtain compliance, a dynamic she terms *de facto* Brussels Effect. Some scholars describe this pattern as part of a broader coloniality of mandating behavioural change, in which colonial legacies continue to shape how power and decision-making are distributed in global governance, deepening inequalities as decisions affecting producers are made external to their local context (Collins et al., 2021; Kuhl et al., 2025, as cited in (Afriyie-Kraft et al., 2026).

Brazil has leverage of its own. Where EU market access creates pressure to comply, the availability of large, undemanding alternative markets limits how far that pressure can reach. This thesis's interview data reach the same conclusion as Min & Wimer, 2024: weak governance of the Chinese soy market means Brazilian producers facing stricter demands elsewhere can simply reroute unsustainably produced soy toward China instead, diluting the effectiveness of both EU and non-state governance efforts. In Dallas et al. (2019) terms, this is bargaining power, direct and dyadic, contingent on an exit option remaining available, unlike the EU's diffuse, rule-setting institutional power.

This same dynamics shapes producers' bargaining power more broadly. As shown in Results (4.1.1), RTRS's roughly 2% share of global soy production sits far below RSPO's approximately 20% of palm oil, and this gap holds up against the secondary literature too. Garrett et al. (2016) put RTRS adoption at only 0.41% of global harvested soy area in 2014, against 14% for RSPO in oil palm, dated figures, but consistent with both the interview finding and the more recent estimate (Garrett et al., 2019). Where a large share of a commodity's global trade already requires certification, as with palm oil, producers have less room to simply sell elsewhere. Soy producers, as discussed above, still have China as an exit option, and Raasch et al. (2026) document the same pattern more broadly. Producers face no meaningful incentive to invest in certification when their principal export market imposes no comparable sustainability requirements. Power in this system is therefore relational, not one-sided. The EU's leverage over Brazilian exporters depends on how much they need EU market access specifically, and for soy, that dependence remains limited.

RTRS, as a roundtable, occupies a different position altogether: unlike the EU or Brazil-as-exporter, it cannot force either side to do anything, and it holds none of Dallas et al., four types of power in any meaningful sense, it cannot bargain, demonstrate, set binding rules, or shape what counts as legitimate practice beyond its own limited base of certified users. As discussed in Section 5.2 (Legitimacy), its authority rests entirely on being seen as credible, since it has no coercive power of its own. But credibility of this kind does not translate into power if neither buyers

nor producers are compelled to use the standard: RTRS's relevance depends entirely on whether commercial actors choose to demand it, a choice it cannot compel. This is not a new phenomenon: ABIOVE and Aprosoja's earlier withdrawal from RTRS (see Section 2.5) reflects more than one pressure, Schleifer (2017) traces it to reputational damage from anti-GMO NGO campaigns against RTRS, compounding the stricter zero-deforestation criteria noted by Raasch et al. (2026). So RTRS's authority is not fixed, it depends on circumstances. Actors withdrew when the standard's terms or reputation stopped serving their interests, and came back in 2024 once things changed again. Even so, this renewed cooperation has not been mirrored across all of RTRS's original base: one NGO representative described larger NGOs as having deprioritised RTRS in favour of EUDR compliance work instead. So RTRS's power is not something it can count on long term. It has to keep convincing people, on both the industry and NGO sides, that using the standard is worth it. It cannot assume that authority will just stay in place.

Power also shows up here in a different way, through property scale. Scale determines who can absorb RTRS certification's largely fixed costs, as shown in Results (4.3.5). Producers most burdened by this cost structure are not poorly positioned environmentally, and are often already familiar with cooperative governance similar to RTRS's own model. Their exclusion follows from scale alone. This suggests certification's design implicitly favours already-large, already-consolidated operations regardless of environmental merit, reinforcing existing power asymmetries between large frontier producers and smaller, longer-established ones, rather than levelling them.

Power in this system also operates through control of information, not just market access or cost. Results showed that cooperatives were often reluctant to share producer-level data with traders, fearing this would let traders bypass them and buy directly from farmers. This is not a technical traceability gap but a deliberate withholding of information by an actor protecting its own commercial position. Fripp et al. (2023) document the same dynamic across the wider Brazilian soy sector, where cooperatives and intermediaries were similarly unwilling to share supplier data for the same reason. Their account also shows how this kind of power asymmetry can be resolved: the Soft Commodities Forum, formed by major competing traders, addressed the impasse not through any single actor's initiative but through a collective, third-party-audited protocol letting intermediaries share data without losing their commercial position. This suggests fragmented traceability in the Brazilian soy chain reflects unresolved power dynamics between traders and the intermediaries controlling farm-level data, dynamics that, as the Soft Commodities Forum shows, tend to require collective arrangements no single actor can produce alone.

Together, these findings show power scattered across several actors, none of them dominant. The EU has real power but limited leverage: it can pressure Brazil only through its own market, and that pressure matters less while an undemanding alternative market, mainly China, remains available. Should China ever adopt comparable requirements, this exit option would disappear, and pressure to address deforestation at the production level, rather than simply redirect compliant and non-compliant volumes to different buyers, would be far stronger than EUDR can achieve alone. RTRS, meanwhile, has neither kind of power: it depends on producers and consumers choosing to use it. Fixed certification costs add a further twist, quietly excluding smaller producers regardless of merit, while unresolved data-sharing power dynamics keep traceability fragmented even where the technology to fix it exists. No single actor examined in this thesis holds enough power to break this deadlock alone, and as long as an undemanding alternative market remains available, the EU's rules will keep redirecting trade rather than reducing deforestation at its source.

5.5 Why RTRS-Certified Segregation Has Failed to Scale: Three Compounding Barriers

Why has physically segregated RTRS-certified soy specifically failed to scale, when the barriers examined above apply, in principle, to any DCF segregation effort? The answer lies in three barriers that compound rather than operate independently.

Start from RTRS's credit system, which breaks the link between certificate and physical soy entirely, letting a producer sell the credit while selling the grain to anyone (Results, Market Dynamics). This alone would only mean credits compete with physical flows. It compounds with a second problem: as interviews revealed, RTRS-certified farms are often too few and too scattered to fill a shared silo on their own, so even certified producers may find no practical way to segregate.

These two barriers may be reinforced by a third, one that is specific to soy rather than a generic feature of certification. Soy is physically transformed early in the chain, crushed into meal and oil and metabolized further through livestock into meat, dairy and eggs, so it reaches the consumer with no marker connecting it back to its origin (Hinkes & Peter, 2020). Palm oil, by contrast, passes through fewer steps and typically retains its identity on the ingredient list of the final product. RTRS's certified share of global soy production remains roughly a tenth the size of RSPO's share of palm oil (2% vs 20%, Results, Power), and this same gap appears in each standard's certified volume. 51% of Certified Sustainable Palm Oil (CSPO)

produced globally in 2024 was sold through physical supply chain models against 16.9% as credits, compared with the credit-dominated pattern this thesis documents for RTRS-certified soy (RSPO, 2026). This does not establish that soy's lack of consumer visibility caused the difference, but the two commodities' different paths to the shelf offer one plausible reason. Demand for segregated soy, where it exists at all, therefore rarely originates from consumers, but instead from sustainability departments inside buyer companies pursuing their own reporting targets, a form of demand that registers as a compliance requirement rather than a financial signal reaching downstream. Whether a comparable dynamic shapes palm oil demand is beyond what this study can establish; the more direct explanation for the segregation gap is likely the visibility difference noted above, unlike soy, palm oil typically retains a traceable identity on the ingredient list, which may sustain consumer-facing demand in a way soy's invisibility cannot. This suggests one reason the credit system may persist unchallenged from below: whatever demand for segregation exists downstream buyers may struggle to travel past the upstream layer. This does not establish that certified producers are unaware of RTRS-segregation as an option, but it suggests one reason why the incentive to pursue it may not reach them in a form compelling enough to act on, leaving the credit system's modest, low-effort return as the more visible alternative.

Together, these three problems compound each other: weak downstream demand removes the pressure to fix the credit system, the credit system removes the incentive to segregate, and scarce certified volume removes the means to do so even where the incentive exists. RTRS's own response to this diagnosis, the Controlled Mix pilot discussed in Section 2.5, is examined next.

5.5.1 A closer look at RTRS-DCF Controlled Mix pilot

The Controlled Mix pilot is a real response to the volume problem that has kept certified segregation from scaling. Pooling certified and verified-DCF soy at the first aggregator solves the too-few-RTRS-farms problem this thesis identified as the most immediate barrier to RTRS-certified segregation. Part of how it does this is through the cut-off date itself: verified DCF material only needs to be DCF since 2020, four years later than RTRS's own 2016 standard, which expands the pool to include land that would never qualify for RTRS certification on its own.

But this only works if the soy actually reaches that aggregator. This study found that most producers lock in their buyer through pre-harvest financing contracts before the crop is even planted, which fixes the certification status of that volume months ahead of harvest. Controlled Mix therefore depends on an upstream condition it does not itself address: unless pre-harvest contracts are written to

designate volumes for the Controlled Mix stream from the outset, there may be nothing left to pool by the time soy reaches the aggregator.

Compounding this, whether pooling at the first aggregator is even possible depends on RTRS-certified storage capacity actually being present at that point in the chain. RTRS's own corridor-level data show this certified capacity is unevenly distributed: as of 2025, certified silo counts ranged from 13 along the Madeira River corridor to 59 along Itaqui/Maranhão (Background, Geographic Distribution of RTRS-Certified Infrastructure). Where certified storage capacity is limited, Controlled Mix's aggregation-point model has less room to operate, regardless of how much certified or verified-DCF volume exists upstream. This unevenness mirrors, in miniature, the hub-concentration pattern identified under Fairness, though addressing that distributive problem was not Controlled Mix's aim.

Controlled Mix leaves the demand barrier largely untouched. As a supply-side pooling mechanism, it takes downstream demand as given: if that demand remains weak and disconnected from producers in the way Market Dynamics describes, pooling supply more efficiently at the aggregator does not by itself pull more of it through the chain.

It does not resolve RTRS's deeper legitimacy or authority problems, since certification still documents rather than changes behaviour, and RTRS still cannot compel anyone to participate. Those, however, were never problems DCF-Controlled Mix was designed to fix. Its more targeted contribution may in fact lie elsewhere, in catching Cerrado-type non-forest conversion that EUDR regulation misses: because verified DCF status covers conversion of native vegetation broadly, not only forest as EUDR narrowly defines it, Controlled Mix can flag Cerrado clearing that would pass EUDR due diligence undetected.

5.6 Implications to future studies

Further topics that could be explored include the following, focused mainly on the RTRS-DCF Controlled Mix model, as the more demanding, forward-looking direction for RTRS-certified soy governance.

First, this thesis spoke with producers and traders already involved in certification, not those outside the RTRS system, so future studies could examine whether non-certified producers would be willing to join a Controlled Mix-style pooling model, given its lower entry bar.

Second, this thesis could not measure real demand for RTRS-DCF Controlled Mix soy directly; a study surveying European buyers could establish how much

they would actually buy, and whether interest is limited mainly to more ambitious companies going beyond EUDR's baseline legal requirements.

Third, this thesis identified rerouting to undemanding markets, particularly China, as a way to sidestep stricter EU-facing requirements. Future studies could examine the social and environmental impacts of this rerouting, and whether it reduces deforestation overall or simply reallocates it, along with its costs, toward the regions and producers least able to avoid supplying the non-compliant side.

6. Conclusion

These findings are anchored in the Cerrado specifically, not Brazil's soy sector in general. The Cerrado's weaker legal protections, a 20% Legal Reserve requirement against the Amazon's 80%, and its exclusion from the EUDR's narrow forest definition make it a harder case for governance to reach than the Amazon. The barriers this thesis identifies are not incidental to that context. They are sharpened by it.

Feasibility is mainly a coordination problem, rather than a technical one: segregation works more easily for a single actor, but ownership across the chain is fragmented and demand is inconsistent. Legitimacy is complicated by three systems, Brazilian law, RTRS and the EUDR, each defining acceptable land use differently, so soy can be legal under one and non-compliant with another; none of the three's authority was seriously questioned, but none of them stop deforestation before it happens, only sort soy afterward. Fairness is uneven: Brazilian producers document obligations European producers don't face, premiums associated with segregation are not guaranteed to reach the producers bearing segregation's cost, and the benefits of soy expansion concentrate in a few hub municipalities. Power is fragmented too: the EU can set requirements, but China's undemanding market gives exporters a way around them, and RTRS has less leverage, since its influence depends entirely on actors choosing the certification scheme. RTRS is in no position to push anyone from credits toward the harder, costlier step of physical segregation.

Taken together, the four applied lenses converge on an answer to why RTRS-certified segregation specifically has failed to scale. Three barriers compound one another: RTRS's credit system separates the certificate from the physical grain, certified production is too scattered to fill a shared silo, and weak, indirect demand for segregated soy rarely reaches the producers who would need to act on it. None appears to be decisive alone, but together they remove the incentive to segregate, the volume to make it worthwhile, and the pressure that might otherwise resolve either. The RTRS-DCF Controlled Mix pilot responds to the second of these barriers, but leaves the third untouched and does not address RTRS's underlying legitimacy or authority limits.

Two of these findings sit closer to confirming and extending existing research: the limits of market-based governance generally (Garrett et al., 2016; Raasch et al., 2026), and the shift in focus from farm-level certification effects to whole-chain segregation outcomes (Section 1.6). The three-barrier interaction and the

Controlled Mix analysis above are this thesis's own contribution, not previously examined in the literature on RTRS.

These four lenses aren't separate problems, they feed into each other, with findings from one helping explain gaps in another. With EUDR's core obligations starting December 2026, the open question is not only whether it pulls RTRS-certified physical volumes toward real scale, but whether physical segregation remains the right chain of custody model for progress at all, or whether EUDR just becomes another baseline companies comply with on its own terms, leaving the physical segregation problem this thesis identifies just as unresolved.

7. Recommendations

1. For companies, NGOs and consumers

Many buyers already have a formal reason to want DCF soy. Over 260 companies have set Forest, Land and Agriculture (FLAG) targets under the SBTi. These targets require no-deforestation and no-conversion sourcing with a 2020 cut-off (Science Based Targets initiative, 2026). RTRS's Controlled Mix pilot plans to use this same requirement and cut-off for verified DCF material (Section 5.5.1, RTRS-DCF Controlled Mix pilot).

EUDR compliance doesn't meet this commitment, since EUDR's forest-only definition excludes Cerrado conversion (Section 2.4, EUDR). So a company can be fully EUDR-compliant and still fall short of its own FLAG target. Controlled Mix uses controlled mass balance. It could close this gap without buyers needing to fund full segregation.

What's missing is demand. This thesis's findings suggest buyer sustainability departments rarely act without pressure from their own consumers (Section 4.1.1, Fragmented Sustainability Demand). NGO campaigns have previously shown this kind of pressure can shift both consumer purchasing decisions and corporate sourcing commitments. Closing this gap is a collective action problem. It is one for NGOs, buyers and consumers to solve together, not something EUDR or RTRS can solve alone.

This collective action solves demand for the market it reaches, but that market has a limit. NGO and consumer pressure works on buyers who need FLAG-aligned market access. But producers with a buyer in China face no equivalent pressure at all (Section 5.4, Power). What could change this is a shift on China's side, from voluntary buyer preferences to government-backed sourcing requirements. This would be a de jure Brussels Effect (the process where foreign governments formally adopt European Union-style laws and regulations into their own national legal systems) Bradford (2012, 2020).

2. For philanthropists

This thesis did not investigate why producers convert land in the first place (Section 3.7, Study Limitations). The literature is clearer on what actually stops it. Conservation only competes with clearing when it offers a comparable economic return (Wunder, 2007). Garrett et al. (2022) compare payments for ecosystem services (PES) directly against market exclusion mechanisms, of which RTRS and

EUDR are both examples, for Cerrado soy specifically. They find that combining the two works better than either alone, with exclusion applied broadly and PES targeted at the most vulnerable producers.

This thesis's findings raise a further point. Exclusion only works if a producer actually needs RTRS or EUDR market access. Brazil's domestic market and China's export market both buy soy with no certification requirement at all, so a producer who can sell there loses nothing by staying excluded. PES is one of the few tools that could still reach these producers directly, regardless of what market they can access.

3. For state and national governments, closing the documentation gap in frontier regions

Fieldwork suggests producers rarely organise toward certification on their own. Entry usually depends on a certification group or cooperative already present in the region. In MATOPIBA, though, the deeper obstacle may not be price or timing at all. RTRS certification requires legal documentation of land status before anything else. Land tenure across much of the region is informal or contested (Russo Lopes et al., 2021). This means RTRS may be structurally unable to certify a producer there, even before the cost or cutoff-date exclusions raised elsewhere come into play (Section 4.4,, Governance Futures and Alternatives). In practice, many producers in this frontier region do not apply for RTRS certification at all. Land cleared after RTRS's cutoff date would exclude them regardless of documentation status. The two barriers compound. Cutoff timing rules some producers out before they start, and land tenure rules out many of the rest.

One MATOPIBA state already has a working answer to this documentation problem. Maranhão's SIFMA Selo Verde platform is a state government system built with WWF Brazil. It cross-references land registry (CAR) data with satellite monitoring and tax records. It produces an automated, publicly accessible report for each property. This report flags the exact problems that block RTRS entry. These include unresolved land disputes, overlapping registrations, conflicts with Indigenous or quilombola territory, environmental embargoes, and forced-labour flags (Freitas, 2024). Participation is mandatory for producers above 1,000 hectares. The system was extending its coverage to indirect suppliers as of the presentation date (Freitas, 2024). SIFMA does not certify sustainability compliance itself. But it does the work that has to happen first. It establishes clean, verified legal status before any certification body can even begin.

The gap here is coverage, not concept. SIFMA-style platforms already operate in Pará, Minas Gerais, Maranhão, Tocantins, Acre and Espírito Santo. Of MATOPIBA's four states, only Maranhão and Tocantins have one. Bahia and Piauí do not, and these are the two states where the problem is worst. Bahia alone accounts for 63.3% of all recent deforestation within MATOPIBA, and Piauí a further 10.1% (Freitas, 2024). Extending this model to Bahia specifically would target the documentation failure exactly where it is doing the most damage.

4. For RTRS

As noted above (Section 4.4, Governance Futures and Alternatives), several interviewees proposed RTRS should certify at the level of the economic group rather than the individual property. This thesis's findings point to two related design problems that support that proposal. Certification costs are largely fixed regardless of property size. This means costs fall hardest on smaller producers, even when those producers are otherwise well positioned environmentally (Section 4.2.1, Cost and Premium Uncertainty). Separately, RTRS certifies individual properties rather than whole farms. This lets a producer certify one property while continuing to clear land on others they own (Section 4.3.4, Fragmented Sustainability Demand).

Both problems point toward the same fix. RTRS already offers a group or multi-site certification option. But it remains a secondary route within a system still built around per-farm assessment and per-farm fees. Making group certification the primary entry point would lower this fixed-cost barrier. Pricing would need to reflect the economics of a group, not a single farm. Certifying the whole operation, rather than farm by farm, would also close a loophole. This thesis's interviews describe certified and uncertified land sitting side by side under common ownership.

References

AFi. (2020). *Operational Guidance on Supply Chain Management*. Accountability Framework initiative. https://accountability-framework.org/fileadmin/uploads/afi/Documents/Operational_Guidance/OG_Supply_Chain_Management-2020-5.pdf

Afriyie-Kraft, L., Zabel, A., & Breu, T. (2026). Dealing with the cost of EUDR compliance data and potential monetisation: Opportunities and risks. *Forest Policy and Economics*, *184*, 103709. https://doi.org/10.1016/j.forpol.2026.103709

Angnes, G., Denny, D. M. T., Grenz, J., Libório Romanelli, T., & Cherubin, M. R. (2025). Voluntary sustainability standards and soil health: Insights from a case study in soybean production in Brazilian Savannah. *Experimental Agriculture*, *61*, e13. https://doi.org/10.1017/S0014479725000110

Aragão, R., Bastos Lima, M. G., Burns, G. L., & Ross, H. (2022). To clear or not to clear: Unpacking soy farmers' decision-making on deforestation in Brazil's Cerrado. *Frontiers in Sustainable Food Systems*, *6*, 942207. https://doi.org/10.3389/fsufs.2022.942207

Aragão, R., Burns, G. L., Lima, M. G. B., Ross, H., & Biggs, D. (2024). 'Greenlash' and reactionary stakeholders in environmental governance: An analysis of soy farmers against zero deforestation in Brazil. *Forest Policy and Economics*, *166*, 103267. https://doi.org/10.1016/j.forpol.2024.103267

Araujo, G. R., Da Silva, F. L., Adegas, F. S., Velini, E. D., & La Cruz, R. A. (2026). Brazil as a Global Leader in Soybean Production: Historical Trends, Current Status, and Future Perspectives. *International Journal of Plant Production*, *20*(2), 56. https://doi.org/10.1007/s42106-026-00434-x

Bause, K., Radimersky, A., Iwanicki, M., & Albers, A. (2014). Feasibility Studies in the Product Development Process. *Procedia CIRP*, *21*, 473–478. https://doi.org/10.1016/j.procir.2014.03.128

Berning, L., & Sotirov, M. (2024). The coalitional politics of the European Union Regulation on deforestation-free products. *Forest Policy and Economics*, *158*, 103102. https://doi.org/10.1016/j.forpol.2023.103102

Bernstein, S. (2011). Legitimacy in intergovernmental and non-state global governance. *Review of International Political Economy*, *18*(1), 17–51. https://doi.org/10.1080/09692290903173087

Bicalho, T., & Courthaudon, L. (2026). *Forest, Land and Agriculture (FLAG) science-based target-setting guidance* (Version 1.2). Science Based Targets initiative. https://files.sciencebasedtargets.org/production/files/SBTiFLAGGuidance.pdf

Boev, P., & van Dam, J. (n.d.). *EUDR Compliant Plus: A Summary*.

Bosselmann, A. S., Frandsen, O., & Andrade de Sá, S. (2025). *Status of Danish imports of sustainable and deforestation- and conversion-free soy*. Department of Food and Resource Economics, University of Copenhagen. IFRO Documentation No. 2025/01¨

Brandão, J., Cardoso, F. C., & Garrett, R. (2025). Why has the Brazilian Cerrado been left behind by voluntary environmental policies? *Global Environmental Change*, *92*, 103005. https://doi.org/10.1016/j.gloenvcha.2025.103005

Bradford, A. (2012). The Brussels Effect. Northwestern University Law Review, 107(1), 1–68.

Bradford, A. (2020). The Brussels Effect: How the European Union Rules the World. Oxford University Press.

Cammelli, F., Gibbs, H. K., Gollnow, F., Levy, S. A., Stigler, M., & Garrett, R. D. (2026). Deforestation-focused policies do not reduce degradation in the Brazilian Amazon. *Proceedings of the National Academy of Sciences*, *123*(18), e2507793123. https://doi.org/10.1073/pnas.2507793123

Cashore, B. (2002). Legitimacy and the Privatization of Environmental Governance: How Non–State Market–Driven (NSMD) Governance Systems Gain Rule–Making Authority. *Governance*, *15*(4), 503–529. https://doi.org/10.1111/1468-0491.00199

Cashore, B. (2022). Non-State Market-Driven Tools. In M. Howlett, *The Routledge Handbook of Policy Tools* (1st ed., pp. 356–370). Routledge. https://doi.org/10.4324/9781003163954-34

Chen, Y., Fiankor, D. D., & Tan, F. (2024). Assessing the effect of the Round Table on Responsible Soy certification on soybean exports. *The World Economy*, *47*(7), 2970–2994. https://doi.org/10.1111/twec.13564

Clark, T., Foster, L., Sloan, L., & Bryman, A. (2021). *Bryman's Social Research Methods* (6th ed.). Oxford University Press.

Corbera, E., & Schroeder, H. (2011). Governing and implementing REDD+. *Environmental Science & Policy*, *14*(2), 89–99. https://doi.org/10.1016/j.envsci.2010.11.002

Dallas, M., Ponte, S., & Sturgeon, T. J. (2019). *A Typology of Power in Global Value Chains*.

Ellebrecht, A. (2019). Chain of Custody and Transparency in Global Supply Chains. In M. Schmidt, D. Giovannucci, D. Palekhov, & B. Hansmann (Eds.), *Sustainable Global Value Chains* (Vol. 2, pp. 227–237). Springer International Publishing. https://doi.org/10.1007/978-3-319-14877-9_13

European Commission. (2026). *Questions and answers on the implementation of the EU Deforestation Regulation* (Version 5). https://environment.ec.europa.eu/document/download/744919a7-8650-4850-89ad-a597268cd69e_en?filename=FAQ-UPDATE-5th-Iteration%20FINAL.pdf

FAO. (2025). *Global Forest Resources Assessment 2025*. FAO. https://doi.org/10.4060/cd6709en

FAO. (2026). *FAOSTAT*. https://www.fao.org/faostat/en/#data/QCL/visualize

Freitas, A. (2024). *Plataformas públicas de rastreabilidade e transparência: Iniciativas estaduais, SIFMA Selo Verde MA* [Presentation]. WWF Brasil.

Fripp, E., Gorman, J., Schneider, T., Smith, S., Paul, J., Neeff, T., Marietti, F., Van Wie McGrory, L., & Zosel-Harper, A. (2023). Traceability and Transparency in Supply Chains for Agricultural and Forest Commodities. *World Resources Institute*. https://doi.org/10.46830/wrirpt.22.00156

Furumo, P. R., Yu, J., Hogan, J. A., Tavares De Carvalho, L. M., Brito, B., & Lambin, E. F. (2024). Land conflicts from overlapping claims in Brazil's rural environmental registry. *Proceedings of the National Academy of Sciences*, *121*(33), e2407357121. https://doi.org/10.1073/pnas.2407357121

Garrett, R. D., Carlson, K. M., Rueda, X., & Noojipady, P. (2016). Assessing the potential additionality of certification by the Round table on Responsible Soybeans and the Roundtable on Sustainable Palm Oil. *Environmental Research Letters*, *11*(4), 045003. https://doi.org/10.1088/1748-9326/11/4/045003

Garrett, R. D., Levy, S., Carlson, K. M., Gardner, T. A., Godar, J., Clapp, J., Dauvergne, P., Heilmayr, R., Le Polain De Waroux, Y., Ayre, B., Barr, R., Døvre, B., Gibbs, H. K., Hall, S., Lake, S., Milder, J. C., Rausch, L. L., Rivero, R., Rueda, X., … Villoria, N. (2019). Criteria for effective zero-deforestation commitments. *Global Environmental Change*, *54*, 135–147. https://doi.org/10.1016/j.gloenvcha.2018.11.003

Garrett, R. D., Grabs, J., Cammelli, F., Gollnow, F., & Levy, S. A. (2022). Should payments for environmental services be used to implement zero-deforestation supply chain policies? The case of soy in the Brazilian Cerrado. *World Development*, *152*, 105814. https://doi.org/10.1016/j.worlddev.2022.105814

Gereffi, G., Humphrey, J., & Sturgeon, T. (2005). The governance of global value chains. *Review of International Political Economy*, *12*(1), 78–104. https://doi.org/10.1080/09692290500049805

Gollnow, F., Cammelli, F., Carlson, K. M., & Garrett, R. D. (2022). Gaps in adoption and implementation limit the current and potential effectiveness of zero-deforestation supply chain policies for soy. *Environmental Research Letters*, *17*(11), 114003. https://doi.org/10.1088/1748-9326/ac97f6

Hinkes, C., & Peter, G. (2020). Traceability matters A conceptual framework for deforestation-free supply chains applied to soy certification. *Sustainability Accounting, Management and Policy Journal*, *11*(7), 1159–1187. https://doi.org/10.1108/SAMPJ-04-2019-0145

ISEAL Alliance. (2025). *Title: Chain of custody models and definitions: A reference document for sustainability system stakeholders* (V2.0; Version 2.0). ISEAL Alliance.

Instituto Brasileiro de Geografia e Estatística (IBGE). (2025). *Biomas e sistema costeiro-marinho do Brasil: 1:250.000* [Shapefile]. IBGE. http://geoftp.ibge.gov.br/informacoes_ambientais/estudos_ambientais/biomas/vetores/

Kusumaningtyas, R., & van Gelder, J. W. (n.d.). *Setting the bar for deforestation-free soy in Europe*.

Lahsen, M., Bustamante, M. M. C., & Dalla-Nora, E. L. (2016). Undervaluing and Overexploiting the Brazilian Cerrado at Our Peril. *Environment: Science and Policy for Sustainable Development*, *58*(6), 4–15. https://doi.org/10.1080/00139157.2016.1229537

Lambin, E. F., Gibbs, H. K., Heilmayr, R., Carlson, K. M., Fleck, L. C., Garrett, R. D., Le Polain De Waroux, Y., McDermott, C. L., McLaughlin, D.,

Newton, P., Nolte, C., Pacheco, P., Rausch, L. L., Streck, C., Thorlakson, T., & Walker, N. F. (2018). The role of supply-chain initiatives in reducing deforestation. *Nature Climate Change*, *8*(2), 109–116. https://doi.org/10.1038/s41558-017-0061-1

Lamolle, M., Leicht, S. C. de, & Taimasova, R. (2019). Future Role of Voluntary Sustainability Standards: Towards Generation 3.0? In A. Russillo (Ed.), *Sustainable Global Value Chains* (Vol. 2). Springer International Publishing. https://doi.org/10.1007/978-3-319-14877-9

Land Sector and Removals Standard (Version 1.1). (2026). World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD). https://ghgprotocol.org/sites/default/files/2026-06/Land-Sector-and-Removals-Standard-v1.1.pdf

Leal, A., Trevizan, A. F., Martins, M. M. V., & Fonseca, C. (2026). *EUDR and Deforestation in Brazil: Are Producers Anticipating the European Deforestation-Free Regulation?*

Lei Nº 12.651, Pub. L. No. 12.651/2012, 12.651 Diário Oficial da União (2012). https://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651compilado.htm

Macedo, G. (2021). *geodata-br-states* [Data set]. GitHub. https://github.com/giuliano-macedo/geodata-br-states

MapBiomas Project. (2025). *MapBiomas* [Dataset]. https://plataforma.brasil.mapbiomas.org/deforestation/deforestation_annual_accumulated?tl[id]=36&tl[themeKey]=deforestation&tl[subthemeKey]=deforestation_annual_accumulated&tl[pixelValues][]=1&tl[year][]=1987&tl[year][]=2024&tl[legendKey]=deforestation_annual_accumulated&t[regionKey]=brazil&t[ids][]=1-4-3&t[divisionCategoryId]=4

Marx, A., Depoorter, C., Fernandez de Cordoba, S., Verma, R., Araoz, M., Auld, G., Bemelmans, J., Bennett, E. A., Boonaert, E., Brandi, C., Dietz, T., Fouilleux, E., Grabs, J., Gulbrandsen, L. H., Harrison, J., Heilmayr, R., Hernandez, A., Hoekman, B., Lambert, S. R., … van der Ven, H. (2024). Global governance through voluntary sustainability standards: Developments, trends and challenges. *Global Policy*, *15*(4), 708–728. https://doi.org/10.1111/1758-5899.13401

McDermott, M., Mahanty, S., & Schreckenberg, K. (2012). Examining equity: A multidimensional framework for assessing equity in payments for ecosystem services. *Environmental Science & Policy*, *33*, 416–427. https://doi.org/10.1016/j.envsci.2012.10.006

Meemken, E.-M. (2020). Do smallholder farmers benefit from sustainability standards? A systematic review and meta-analysis. *Global Food Security*, *26*, 100373. https://doi.org/10.1016/j.gfs.2020.100373

Min, Z., & Wimer, F. R. (2024). Transnational Governance of Soybean Land Use in South America: A Polycentric Approach. *Transnational Environmental Law*, *14*(1), 145–170. https://doi.org/10.1017/S2047102524000268

Ministério do Meio Ambiente e Mudança do Clima. (2024, September 5). *Cerrado*. Governo Federal Do Brasil. https://www.gov.br/mma/pt-br/assuntos/biodiversidade-e-biomas/biomas-e-ecossistemas/biomas/cerrado

Morrison, T. H., Adger, W. N., Brown, K., Lemos, M. C., Huitema, D., Phelps, J., Evans, L., Cohen, P., Song, A. M., Turner, R., Quinn, T., & Hughes, T. P. (2019). The black box of power in polycentric environmental governance. *Global Environmental Change*, *57*, 101934. https://doi.org/10.1016/j.gloenvcha.2019.101934

Muirhead, J., & Porter, T. (2019). Traceability in global governance. *Global Networks*, *19*(3), 423–443. https://doi.org/10.1111/glob.12237

Norton, T., Julia Beier, & Lauren Shields. (2014). *A Guide to Traceability: A Practical Approach to Advance Sustainability in Global Supply Chains*. UN Global Compact / BSR. https://www.bsr.org/reports/BSR_UNGC_Guide_to_Traceability.pdf

Orsmond, G. I., & Cohn, E. S. (2015). The Distinctive Features of a Feasibility Study: Objectives and Guiding Questions. *OTJR: Occupational Therapy Journal of Research*, *35*(3), 169–177. https://doi.org/10.1177/1539449215578649

Pacheco, P., Kemeny Mo, Nigel Dudley, Ari Shapiro, Naikoa Aguilar-Amuchastegui, P.Y Ling, Courtney Anderson, & Alezander Marx. (2021). *Deforestation fronts: Drivers and responses in a changing world*. WWF. https://www.wwf.ch/sites/default/files/doc-2021-01/Deforestation fronts - drivers and responses in a changing world - full report.pdf

Painel Unidade de Conservação Brasileiras. (n.d.). CNUC – Cadastro Nacional de Unidades de Conservação. Retrieved 4 June 2026, from https://app.powerbi.com/view?r=eyJrIjoiMGNmMGY3NGMtNWZlOC00ZmRmLWExZWItNTNiNDhkZDg0MmY4IiwidCI6IjM5NTdhMzY3LTZkMzgtNGMxZi1hNGJhLTMzZThmM2M1NTBlNyJ9&pageName=ReportSectione0a112a2a9e0cf52a827

Paulo Santos. (2026). *Certified soy production reaches record high worldwide – RTRS* [RTRS]. https://responsiblesoy.org/certified-soy-production-reaches-record-high-worldwide?lang=en

Peng, D., Zhang, H., Zhang, Y., Yu, L., Chen, M., Chen, J. M., You, L., Li, P., Liu, J., Zhang, X., Arvor, D., Kuchler, P., Huang, J., Zhang, H., Hao, P., Huang, J., Shi, Z., Wang, F., Song, K., … Zhang, B. (2026). Global soybean trade dynamics: Drivers, impacts, and sustainability. *The Innovation*, *7*(2), 101124. https://doi.org/10.1016/j.xinn.2025.101124

Pinho, P., Zerbini, O., S Garcia, A., De Castro Silva, I., A Silvestrini, R., Conciani, D., Rodrigues, A. D. A., Garrido, B., Alencar, A., Ribeiro, F. D. F., & Moutinho, P. (2025). Protecting the Brazilian Cerrado: Conservation strategies and the EUDR's emphasis. *Environmental Research Letters*, *20*(4), 041004. https://doi.org/10.1088/1748-9326/adc28f

Proforest & RMR Consulting. (2026). *Logistics-driven GHG impacts in EUDR-compliant soy supply chains: A case study in Brazil*. Proforest.

Raasch, W. G., Bezerra, J. E., & Herod, A. (2026). Evaluating the adoption of the Round Table on Responsible Soy in Mato Grosso, Brazil. *The Journal of Peasant Studies*, 1–25. https://doi.org/10.1080/03066150.2025.2586090

Rajão, R., Soares-Filho, B., Nunes, F., Börner, J., Machado, L., Assis, D., Oliveira, A., Pinto, L., Ribeiro, V., Rausch, L., Gibbs, H., & Figueira, D. (2020). The rotten apples of Brazil's agribusiness. *Science*, *369*(6501), 246–248. https://doi.org/10.1126/science.aba6646

Rau, F. (2019). Potential for Joint Public and Private Initiatives to Eliminate Deforestation from Global Supply Chains. In M. Schmidt, D. Giovannucci, D. Palekhov, & B. Hansmann (Eds.), *Sustainable Global Value Chains* (Vol. 2, pp. 673–688). Springer International Publishing. https://doi.org/10.1007/978-3-319-14877-9_36

Rausch, L. L., Gibbs, H. K., Schelly, I., Brandão, A., Morton, D. C., Filho, A. C., Strassburg, B., Walker, N., Noojipady, P., Barreto, P., & Meyer, D. (2019). Soy expansion in Brazil's Cerrado. *Conservation Letters*, *12*(6), e12671. https://doi.org/10.1111/conl.12671

Regulation (EU) 2023/1115, Pub. L. No. 2023/1115, L 150 Official Journal of the European Union (2023). http://data.europa.eu/eli/reg/2023/1115/oj.

Regulation (EU) 2024/1991 of the European Parliament and of the Council of 24 June 2024 on Nature Restoration and Amending Regulation (EU) 2022/869 (Text with EEA Relevance) (2024). http://data.europa.eu/eli/reg/2024/1991/oj

Reis, T. N. P. D., De Faria, V. G., Russo Lopes, G., Sparovek, G., West, C., Rajão, R., Napolitano Ferreira, M., Elvira, M. M. S., & Do Valle, R. S. T. (2021). Trading deforestation—Why the legality of forest-risk commodities is insufficient. *Environmental Research Letters*, *16*(12), 124025. https://doi.org/10.1088/1748-9326/ac358d

Reis, T. N. P. D., Ribeiro, V., Garrett, R. D., Kuemmerle, T., Rufin, P., Guidotti, V., Amaral, P. C., & Meyfroidt, P. (2023). Explaining the stickiness of supply chain relations in the Brazilian soybean trade. *Global Environmental Change*, *78*, 102633. https://doi.org/10.1016/j.gloenvcha.2022.102633

Rodrigues, A. A., Macedo, M. N., Silvério, D. V., Maracahipes, L., Coe, M. T., Brando, P. M., Shimbo, J. Z., Rajão, R., Soares-Filho, B., & Bustamante, M. M. C. (2022). Cerrado deforestation threatens regional climate and water availability for agriculture and ecosystems. *Global Change Biology*, *28*(22), 6807–6822. https://doi.org/10.1111/gcb.16386

Roquette, J. G., Jordani, A. V., Luíza Ávila Peterlini de Souza, A., & Angelo Correa-Gonzaga, C. (2026). When administrative sanctions fail: Land embargoes have not been enough to curb illegal deforestation in Mato Grosso, Brazil. *Forests, Trees and Livelihoods*, *35*(2), 126–136. https://doi.org/10.1080/14728028.2025.2591607

RTRS. (n.d.-a). *About RTRS – RTRS*. RTRS. Retrieved 5 June 2026, from https://responsiblesoy.org/about-rtrs?lang=en

RTRS. (n.d.-b). *Certifications – RTRS*. RTRS – Round Table on Responsible Soy. Retrieved 25 July 2026, from https://responsiblesoy.org/certificacion?lang=en

RTRS. (2021). *RTRS Standard for Responsible Soy Production* ((Version 4.0)). https://responsiblesoy.org/wp-content/uploads/2023/03/RTRS-Standard-for-Responsible-Soy-Production-V4.0.pdf

RTRS. (2023). *RTRS Standard awarded the maximum equivalence level against SAI Platform's FSA, helping to increase industry sustainability – RTRS*. https://responsiblesoy.org/rtrs-standard-awarded-the-maximum-equivalence-level-against-sai-platforms-fsa?lang=en

RTRS. (2025). *RTRS Chain of Custody Standard* (Version 3.1). Round Table on Responsible Soy. https://responsiblesoy.org/wp-content/uploads/2026/03/RTRS-Chain-of-Custody-Standard-V3.1-updated.pdf

Russo Lopes, G., Bastos Lima, M. G., & Reis, T. N. P. D. (2021). Maldevelopment revisited: Inclusiveness and social impacts of soy expansion over Brazil's Cerrado in Matopiba. *World Development*, *139*, 105316. https://doi.org/10.1016/j.worlddev.2020.105316

SAI Platform. (2025). *FSA Benchmarking Results* [Dataset].

Schilling-Vacaflor, A., Lenschow, A., Challies, E., Cotta, B., & Newig, J. (2021). Contextualizing certification and auditing: Soy certification and access of local communities to land and water in Brazil. *World Development*, *140*, 105281. https://doi.org/10.1016/j.worlddev.2020.105281

Schleifer, P. (2017). Private regulation and global economic change: The drivers of sustainable agriculture in Brazil. *Governance*, *30*(4), 687–703. https://doi.org/10.1111/gove.12267

Serasa Experian S.A. (2025). *Serasa Experian S.A. - Agribusiness. Dinâmica da expansão da soja no bioma Cerrado de 2020/21 a 2023/24 – Florianópolis, Santa Catarina, Brasil, 2024: Serasa Experian S.A. - Agribusiness. Dinâmica da expansão da soja no bioma Cerrado de 2020/21 a 2023/24 – Florianópolis, Santa Catarina, Brasil, 2024*. Serasa S.a.

Staricco, J. I. (2021). The Round Table on Responsible Soy's Landnahme: Converting sustainable practices into tradable intangibles to protect the environment. *Journal of Cultural Economy*, *14*(5), 564–579. https://doi.org/10.1080/17530350.2020.1846591

Trase. (2025). *Company profiles: Brazil soy exports.* Trase.Earth. https://trase.earth/explore/companies

USDA FAS. (n.d.). *Soybeans | USDA Foreign Agricultural Service*. Retrieved 12 June 2026, from https://www.fas.usda.gov/data/production/2222000

Valdes, C., Gillespie, J., Dohlman, E. N., & United StatesDepartment of AgricultureEconomic Research Service. (2023). *Soybean production, marketing costs, and export competitiveness in Brazil and the United States*. Economic Research Service, U.S. Department of Agriculture. https://doi.org/10.32747/2023.8142532.ers

World Bank. (2026). *Commodity markets: Pink sheet, June 2026* [Data set]. https://thedocs.worldbank.org/en/doc/74e8be41ceb20fa0da750cda2f6b9e4e-0050012026/related/CMO-Pink-Sheet-June-2026.pdf

Wunder, S. (2007). The efficiency of payments for environmental services in tropical conservation. *Conservation Biology*, *21*(1), 48–58. https://doi.org/10.1111/j.1523-1739.2006.00559.x

Personal communications

RTRS. (2026). Personal communication, April 9. Round Table on Responsible Soy Regional Meeting Point Brazil presentation.

RTRS. (2026a), pers. comm., RTRS vDCF Pilot shared via email.

RTRS. (2026b), personal communication, Institucional - Corredores de Exportação do Brasil, shared via email.

Appendix 1 – NGOs Interview Guide

Desire Change - Increased physical flow of segregated RTRS soy to the EU
Unit of analysis - Individual perception – NGOs
Sections and interview questions
Section 0 – Role and Positioning – Who are you? ***(Perfil e contexto da organização)***
Q1. Can you describe your role and your organization's engagement in soy governance or certification? Pode descrever o seu papel e o envolvimento da sua organização na governança da soja?
Q2. How would you describe your organization's position regarding RTRS? Como descreveria a posição da sua organização em relação à RTRS?
Section 1 – Understanding of Certification and Segregation - What certification means for you? ***(Certificação e Segregação Física)***
Q3. In your view, what does RTRS certification currently achieve, and what does it fail to achieve? Na sua opinião, o que a certificação RTRS consegue alcançar hoje? E onde ela falha?
Q4. How do you see the role of physical segregation compared to credits or Mass Balance? Como você vê o papel da segregação física em comparação com créditos ou Mass Balance?
Q5. Do you see physically segregated RTRS soy as strategically important for the future? Na sua opinião, soja RTRS é estrategicamente importante para o futuro?
Section 2 – Deforestation-Free Governance and EUDR ***(Livre de Desmatamento e Conversão e EUDR)***
Q6. How do producers in your experience perceive European regulations such as the EUDR? Como é que os produtores encaram as regulamentações europeias, como a EUDR?
Q7. Do you observe resistance when sustainability requirements go beyond Brazilian lay?

Você enxerga resistência quando os requerimentos vão para além da Lei Brasileira?
Section 3 - Current Volumes and Constrains – How does it work in practice? ***(Volumes atuais e barreiras)***
Q8. Why do you think volumes of physically segregated RTRS soy remain limited? Por que você acredita que os volumes de soja RTRS fisicamente segregada ainda são limitados?
Section 4 – Incentives and Market Dynamics – Why isn't it scaling? ? ***(Incentivos e Dinâmica de Mercado)***
Q9. Who benefits most from segregated RTRS flows? Who bears the main cost? Quem mais se beneficia dos fluxos de soja RTRS fisicamente segregada? Quem arca com os principais custos da segregação?
Q10. Do you think current DCF models are perceived as fair by producers? Na sua opinião, modelos DCF atuais são enxergados como justos pelos produtores?
Section 5 – Decision making and Influence – Who influences that? ***(Poder e Influência)***
Q11. How much influence EU buyers realistically have over land-use decisions at farm level? Qual é o grau de influência dos compradores europeus nas decisões de?
Q12. What role do traders play in shaping whether segregation scales? Qual é o papel dos traders em influenciar o aumento da segregação?
Q13. If all EU buyers required fully segregated DCF soy tomorrow, what would realistically happen? Se todos os compradores europeus pedissem soja DCF segregada amanhã, o que aconteceria?
Section 6 – Looking ahead – What could change? ***(Olhando para o Futuro)***
Q14. What would need to change structurally for segregation to scale? O que necessita mudar estruturalmente para aumentar a segregação?

Introduce DCF chain of custody model as an hypothetic model ***Explicaçáo de um modelo de cadeia de custódia DCF hipotético.***
Q15. Could stricter DCF chain-of-custody models influence future segregated flows? Modelos emergentes de cadeia de custódia DCF poderiam influenciar os fluxos futuros de soja segregada? De que forma?
Q16. What concerns or risks would companies have regarding stricter chain-of-custody requirements? Que riscos ou desafios você vê relacionados a exigências mais rigorosas de cadeia de custódia?

Appendix 2 – Producers Interview Guide

Desire Change - Increased physical flow of segregated RTRS soy to the EU
Unit of analysis - Individual perception – Producers
Sections and interview questions
Section 0 – Role and Positioning – Who are you? ***(Perfil e contexto da propriedade)***
Q1. Could you describe your property? • Location • Size (approximate) • Type of production (conventional, certified, integrated soy, etc.) Poderia descrever sua propriedade? • Localização • Tamanho (aproximado) • Tipo de produção (soja convencional, certificada, integrada etc.)
Q2. How does the marketing/sale of your soy normally work? Do you use forward contracts or barter (inputs in exchange for production)? • Who do you sell to? (trader, cooperative, crusher) • Do you sell forward or spot? • What weighs most in the sale decision? Como funciona normalmente a comercialização da sua soja? Você utiliza contratos antecipados ou barter (insumos em troca da produção)? • Para quem vende? (trader, cooperativa, esmagadora) • Vende antecipado ou spot? • O que pesa mais na decisão de venda?
Q3. Do you have your own storage? If so, does that influence your ability to choose the timing of the sale? Você possui armazenagem própria? Se sim, isso influencia a sua capacidade de escolher o momento da venda?
Q4. Do you hold any certification (RTRS, ProTerra, 3S, others)? Why? If yes: • What motivated you to join?

- Is it worth it economically?

Section 1 – Understanding of Certification and Segregation – What certification means for you? ***(Certificação e Segregação Física)***

Q5. What does it mean, in practice, for you to produce certified soy?

O que significa, na prática, para você produzir soja certificada?

Q7. Have you ever sold physically segregated soy?

If yes:

- How did it work?
- Was it more complex?
- Was there a premium?

If no, what would prevent that sale?

Você já vendeu soja fisicamente segregada?

Se sim:

- Como funcionou?
- Foi mais complexo?
- Houve prêmio?

Se não, o que impediria essa venda.

Q8. In your opinion, why are volumes of physically segregated certified soy still low?

(Infrastructure? Lack of premium? Logistics? Lack of stable demand?)

Na sua opinião, por que os volumes de soja certificada fisicamente segregada ainda são baixos?

(Infraestrutura? Falta de premium? Logística? Falta de demanda estável?)

Section 2 – Deforestation-Free Governance and EUDR ***(Livre de Desmatamento e Conversão e EUDR)***

Q9. How do you understand the concept of "deforestation and conversion-free" (DCF) soy?

Como você entende o conceito de soja "livre de desmatamento e conversão" (DCF)?

Q10. In your view, what is the difference between complying with Brazilian law and meeting European requirements such as the EUDR?

Na sua visão, qual é a diferença entre cumprir a legislação brasileira e atender exigências europeias como a EUDR?

Q11. How are these new international requirements being discussed among producers in your region?

Como essas novas exigências internacionais têm sido discutidas entre produtores da sua região?

Q12. Do you notice resistance when requirements go beyond Brazilian legislation? Why?

Você percebe resistência quando exigências vão além da legislação brasileira? Por quê?

Section 3 – Incentives and Market Dynamics – Why isn't it scaling? ***(Incentivos e Dinâmica de Mercado)***

Q14. Is there sufficient premium to compensate for the costs of certification or segregation?

Existe prêmio suficiente para compensar os custos da certificação ou segregação?

Q15. Who do you think benefits most from certified soy?

Quem você acha que mais se beneficia da soja certificada?

Q16. And who bears the main costs?

E quem arca com os principais custos?

Q17. What costs or risks do you associate with adopting stricter DCF models?

Quais custos ou riscos você associa à adoção de modelos DCF mais rigorosos?

Section 3.1 – Fragmentation and Territoriality ***(Fragmentação e Territorialidade)***

Q18. Do certification requirements apply to the whole farm, or only to part of the production?

As exigências de certificação se aplicam à fazenda inteira ou apenas a parte da produção?

Q19. Do requirements from certain markets influence decisions about land expansion or use?

Exigências de determinados mercados influenciam decisões sobre expansão ou uso da terra?

Section 4 – Decision-making and Influence – Who influences that? *(Poder e Influência)*

Q20. In practice, do European buyers influence land-use decisions on your property?

Na prática, compradores europeus influenciam decisões de uso da terra na sua propriedade?

Q21. Does the role of trading companies make physical segregation easier or harder? Does the commercial team you negotiate with treat certification as a priority or as something secondary?

O papel das tradings facilita ou dificulta a segregação física? A equipe comercial que negocia com você trata certificação como prioridade ou como algo secundário?

Q22. How much time is there typically between closing a contract and delivering the grain? Does this timeframe make it harder to align physical certification?

Quanto tempo normalmente há entre fechar contrato e entregar grão? Este prazo dificulta alinhar certificação física?

Q23. If tomorrow all European buyers required fully segregated DCF soy, what would happen?

Se amanhã todos os compradores europeus exigissem soja totalmente segregada DCF, o que aconteceria?

Section 5 – Looking Ahead – What could change? *(Olhando para o Futuro)*

Q24. What would need to change for physically segregated soy to increase?

O que precisaria mudar para que a soja fisicamente segregada aumentasse?

Introduce DCF chain of custody model as a hypothetical model
Explicação de um modelo de cadeia de custódia DCF hipotético.

Q25. Could stricter DCF chain-of-custody models work? Under what conditions?

Modelos mais rigorosos de cadeia de custódia DCF poderiam funcionar? Em que condições?

Q26. Thinking longer term… has climate change influenced your production or commercial decisions?

Pensando mais no longo prazo… mudanças climáticas têm influenciado suas decisões produtivas ou comerciais?

Q27. What risks do you see in stricter requirements?

Quais riscos você vê em exigências mais rigorosas?

Appendix 3 -Traders Interview Guide

Desire Change - Increased physical flow of segregated RTRS soy to the EU
Unit of analysis - Individual perception – Traders
Sections and interview questions
Section 0 – Role and Positioning – Who are you? ***(Papel e Posicionamento)***
Q1. Can you describe your role and your company's involvement in soy sourcing/trading? Pode descrever o seu papel e o envolvimento da sua empresa na comercialização e originação de soja?
Q2. What share of the soy your company trades is physically segregated RTRS? Que proporção da soja comercializada pela sua empresa é RTRS fisicamente segregada?
Q3. What procurement or sourcing arrangements do you typically use when purchasing soy? (e.g., spot market, forward contracts, long-term agreements, pre-financing/barter?) Que tipos de arranjos de compra de soja a sua empresa utiliza? (por exemplo: mercado spot, contratos a termo, contratos de longo prazo, pré-financiamento/barter?)
Section 1 – Understanding of Certification and Segregation – What certification means for you? ***(Compreensão sobre Certificação e Segregação)***
Q4. What does RTRS certification mean in your operations? O que a certificação RTRS representa nas operações da sua empresa?
Q5. In your experience, when do companies prefer segregation over credits or Mass Balance, and why? Na sua experiência, em que situações as empresas optam por segregação física em vez de créditos ou Mass Balance? Por quê?
Q6. How do you define “deforestation and conversion-free” (DCF)? Como você define soja “livre de desmatamento e conversão” (DCF)?

Section 2 – Deforestation-Free Governance and EUDR *(Livre de Desmatamento e Conversão e EUDR)*
Q7. How are these new international requirements being discussed in your company? Como essas novas exigências internacionais têm sido discutidas na sua organisação?
Q8. Do you notice resistance when requirements go beyond Brazilian legislation? Why? Você percebe resistência quando exigências vão além da legislação brasileira? Por quê?
Section 3 – Incentives and Market Dynamics – Why isn't it scaling? ***(Incentivos e Dinâmica de Mercado)***
Q9. Who benefits most from segregated RTRS flows? Quem mais se beneficia dos fluxos de soja RTRS fisicamente segregada?
Q10. Who bears the main cost? Quem arca com os principais custos da segregação?
Q11. What would need to change to increase volume? O que precisaria mudar para que os volumes de soja segregada aumentassem?
Section 4 – Decision-making and Influence – Who influences that? ***(Poder e Influência)***
Q12. Who ultimately decides whether segregated volumes increase? Quem, em última instância, decide se os volumes de soja segregada aumentam?
Q13. How much influence do EU buyers have? Qual é o grau de influência dos compradores europeus nessas decisões?
Q14. How does financing affect producer decisions? Como o financiamento ou a oferta de crédito influencia as decisões dos produtores em relação à segregação?

Section 5 – Looking Ahead – What could change? ***(Olhando para o Futuro)***

Q15. Do you see potential for significant growth in segregated volumes in the coming years?

Você enxerga potencial para um crescimento significativo dos volumes de soja RTRS fisicamente segregada nos próximos anos?

Introduce DCF chain of custody model as a hypothetical mode
Explicação de um modelo de cadeia de custódia DCF hipotético l

Q16. Could DCF chain-of-custody models influence future segregated flows? In what way?

Modelos emergentes de cadeia de custódia DCF poderiam influenciar os fluxos futuros de soja segregada? De que forma?

Q17. What concerns or risks would companies have regarding stricter chain-of-custody requirements?

Que riscos ou desafios você vê relacionados a exigências mais rigorosas de cadeia de custódia?

Popular science summary

Why doesn't "deforestation-and- conversion free" soy from Brazil actually stay separate on its way to Europe?

Soy grown in Brazil ends up in animal feed, cooking oil, and thousands of other products across Europe. For over fifteen years, a certification scheme initiated by the Roundtable on Responsible Soy (RTRS) has tried to guarantee that some of this soy comes from land that wasn't deforested or converted. But there's a catch almost no one outside the industry knows about: even when soy is certified as deforestation-and-conversion-free, it almost never travels through the supply chain as a physically separate, identifiable batch. Instead, companies buy a "credit", a kind of a “paper” certificate, while the actual grain gets mixed with soy from anywhere, including land that was deforested illegally, or legally cleared under Brazilian law but still falling short of the stricter standards RTRS or the new EU rules set for “deforestation-free”. The paperwork says one thing; the truck, the train or the vessel carry a mix of everything.

This thesis asks why. Based on 24 interviews with Brazilian farmers from Brazil’s soy farming heartland, grain traders, cooperatives, environmental groups, industry associations and European buyers. It finds that physically keeping certified soy separate is possible when a single company controls enough of the chain, from farm to port. Most of the time, that's not how Brazilian soy moves: it passes through many different hands, storage facilities, and transport routes, all mixed together for efficiency.

Three problems reinforce each other and keep real separation from becoming the norm. First, the credit system itself removes the pressure to segregate soy physically, since buyers can claim credit for sustainability without ever handling separated grain. Second, farms that are certified are too few and scattered to fill a shared storage silo on their own. Third, the demand driving all of this comes mostly from corporate sustainability targets rather than consumers, so it rarely reaches the level of individual farmers in a way that changes their decisions.

This matters because of a new EU law, the EU Deforestation Regulation, which from December 2026 will require companies to prove their soy is deforestation-free, not just claim it through credits. Furthermore, companies setting deforestation-and-conversion-free targets need to know exactly where the soy they are sourcing comes from. The EUDR won't accept the workaround that's kept certification comfortable for twenty years. Whether it can succeed depends on solving exactly

the problem this thesis uncovers. The paper trail and the physical grain finally have to match.

Publishing and archiving

Approved students' theses at SLU can be published online. As a student you own the copyright to your work and in such cases, you need to approve the publication. In connection with your approval of publication, SLU will process your personal data (name) to make the work searchable on the internet. You can revoke your consent at any time by contacting the library.

Even if you choose not to publish the work or if you revoke your approval, the thesis will be archived digitally according to archive legislation.

You will find links to SLU's publication agreement and SLU's processing of personal data and your rights on this page:

- https://libanswers.slu.se/en/faq/228318

☒ YES, I, Daniela Barreto Gonçalves, have read and agree to the agreement for publication and the personal data processing that takes place in connection with this

☐ NO, I/we do not give my/our permission to publish the full text of this work. However, the work will be uploaded for archiving and the metadata and summary will be visible and searchable.