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To clear or not to clear: Unpacking soy farmers' decision-making on deforestation in Brazil's Cerrado

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Agriculture-driven deforestation has come to the top of the environmental policy agenda as one of the main sustainability issues of current food systems. A major case is soy production in Brazil, the largest grower and exporter of what has become the world's crop of choice for animal feed protein. Soy expansion has contributed to the continuous erasure of the Brazilian Cerrado, a highly biodiverse savanna with significant underground carbon storage that plays vital hydrological functions but remains mostly unprotected. Much of the remaining Cerrado vegetation is located within private farms and can be cleared legally; therefore, understanding soy farmers' attitudes regarding deforestation is paramount. Hence, this study explores and analyzes Brazilian soy farmers' perspectives, attitudes, and behavior concerning land-use change. We draw from the literature and semi-structured interviews with 24 soy farmers in Tocantins State, part of an agricultural frontier region called Matopiba. Our findings show how soy-farmer behavior follows primarily an economic rationale unconcerned with environmental sustainability. Farmers have moved to the frontier attracted primarily by cheap land prices and mainly occupied degraded pastures. Still, they have cleared vegetation directly for planting soy and show little restraint. Although chiefly interested in increasing yields, Brazil's soy farmers feel entitled to open new areas whenever they have the economic means and motivation. They may also engage in pre-emptive deforestation for fear of more stringent forthcoming regulations. Such attitudes offer a cautionary note to strategies that hope to conserve the Cerrado through voluntary behavioral change, such as adopting "best practices" or focusing on improving production in already-open areas. We argue that greater regulatory stringency and enforcement are much more promising pathways in the context of excessive permissiveness to deforestation in the Cerrado and actors oriented by profit and by what they are allowed to do. Well-enforced public policies that legally restrict their deforestation rights and protect the remaining areas of Cerrado would offer a royal road, but supply-chain actors, too, may

need to become stricter about requesting conversion-free soy. We conclude that, without such actions, soy farmers' attitudes promise a continuation of business as usual toward the Cerrado's end.

KEYWORDS

land-use change, agriculture, commodity trade, sustainability, food systems

Introduction

Addressing natural ecosystem loss has become fundamental for food system sustainability. Food security is broadly dependent on environmental conservation due to vital ecosystem services, yet agriculture is the primary driver of land-use change and ecosystem loss (Curtis et al., 2018; De Sy et al., 2019; Pendrill et al., 2022). While some of that is for small-scale farming, most agriculture-driven deforestation is due to key export crops such as soy and oil palm, which are responsible for 38–48% of emissions embodied in production (Pendrill et al., 2019). This situation creates a key role for consumer countries and commodity traders in solving deforestation, and indeed many certification initiatives, zero-deforestation commitments, and more recently mandatory due diligence policies have aimed at eliminating ecosystem conversion embedded in those supply chains (Zu Ermgassen et al., 2020; Schilling-Vacaflor and Lenschow, 2021). Still, such demand-side measures ultimately depend on the behavior of producers and farmers' decisions to clear vegetation to expand production further or not.

Brazil's Cerrado—the country's second largest biome after the Amazon and the world's most biodiverse savanna (Myers et al., 2000; Strassburg et al., 2017)—offers a striking case. This ecosystem originally spanned over 2,036,448 Km² (IBGE, 2004), yet nearly half of it has already been lost, primarily to soy farming and cattle ranching (Rausch et al., 2019). Between 2008 and 2021, deforestation¹ in the Cerrado was 21% higher than in the Brazilian Amazon (INPE, 2022). Furthermore, soy-driven deforestation in this region was almost double the rate of the Brazilian Amazon between 2001 and 2016 (Song et al., 2021). Some authors have highlighted the aggregate economic benefits of soy expansion in Brazil despite increases in inequality (see Martinelli et al., 2017). Still, some have accused it of promoting

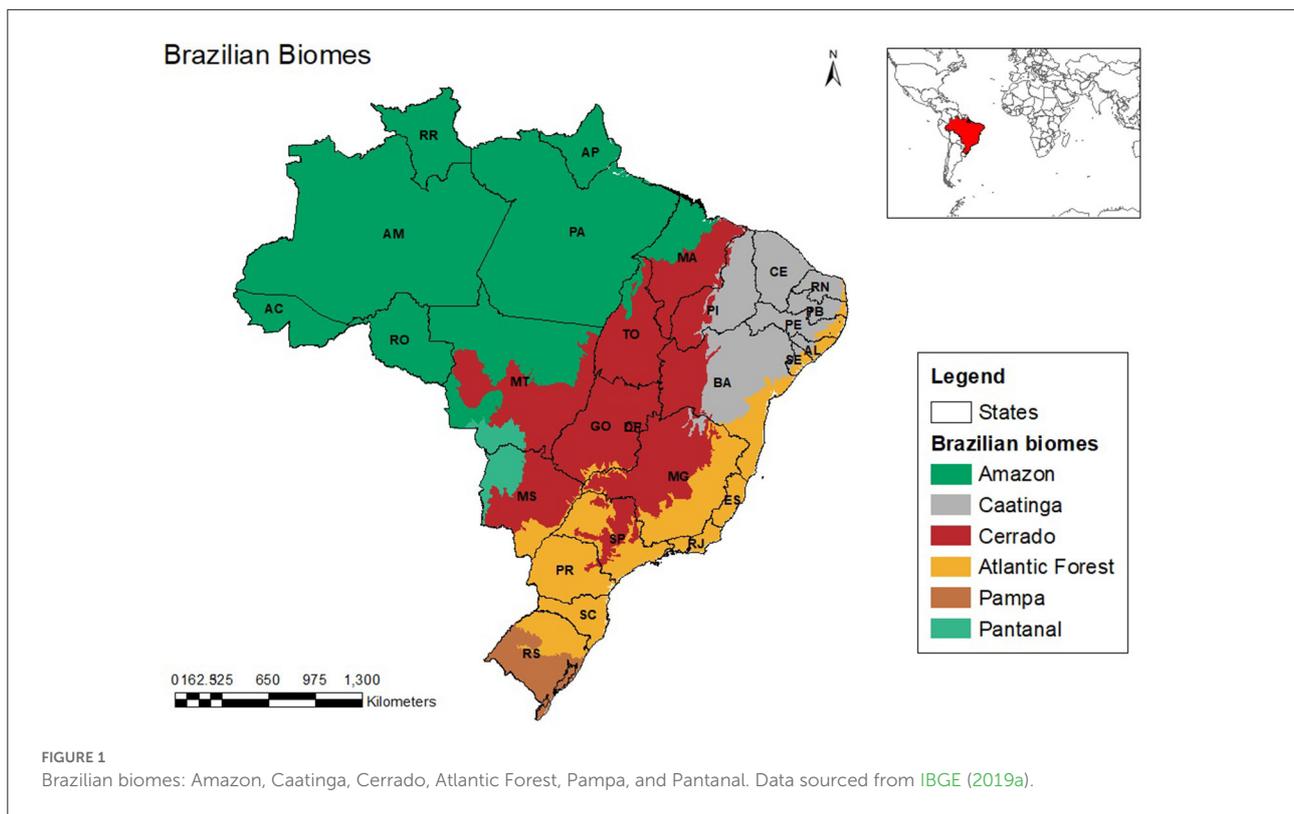
“maldevelopment” (Russo Lopes et al., 2021), and a significant number of scholars have addressed the problems of Cerrado deforestation and its impacts on climate change, biodiversity, and the hydrological cycle (Spera et al., 2016; Coe et al., 2017; Noojipady et al., 2017; Strassburg et al., 2017; Flach et al., 2021).

Soy production has rapidly expanded worldwide because of its various uses: animal feed, human food, and biofuel (WWF, 2014; Trase, 2018a). Feed is by far the primary use of soybeans, as they are a nutrient-rich and affordable source of protein suitable for livestock, mainly poultry and pork (WWF, 2014; Trase, 2018a). Direct human consumption represents only 6% of soybean use, the majority of which is processed food additives (WWF, 2014; Fraanje and Garnett, 2020). More recently, soy has found increased use as a biodiesel feedstock in Brazil, as the country has a sizable (10%) blending mandate met primarily using soy oil, a co-product of the soybean meal used for feed (Bastos Lima, 2021).

The Cerrado has long been the Amazon's poor cousin, leading some authors to refer to it as a “martyr” or a “sacrifice zone” for agricultural expansion (Oliveira and Hecht, 2016; Sauer and Cabral, 2022). Conservation Units cover only 8% of the Cerrado ecosystem, in contrast to 28% of the Brazilian Amazon (Ministério do Meio Ambiente, 2022).² Much of what remains of the Cerrado now exists within private farms, including many soy-grower properties, where deforestation can happen legally (Soares-Filho et al., 2014). Although illegal deforestation is common in the Cerrado, a study analyzing satellite images and land cover data between 2003 and 2015 showed that most of the land conversion for soy occurred within legal area limits (Rausch et al., 2019). Meanwhile, voluntary zero-deforestation commitments from soy traders have been elusive (Zu Ermgassen et al., 2020), and mandatory due diligence regulations so far either disregard savanna ecosystems such as the Cerrado (see European Commission, 2021) or limit themselves to combating illegal deforestation, as in the UK law (see DEFRA, 2021). Therefore, soy farmers are central to tackling Cerrado deforestation in Brazil because they are key agents. Soares-Filho et al. (2014) have suggested that as much as 40 million hectares (Mha) could still be cleared legally across Brazil, and much of that is in the Cerrado.

¹ There is discussion as to whether Cerrado clearing counts as deforestation. The concept of “forest” is often classified in terms of the percentage of canopy cover (FAO, 2015), excluding areas such as savannas. Yet many scholars and civil society organizations have asked for a more comprehensive understanding of deforestation, which would include land ecosystems of high conservation value and areas of lower tree height but crucial (underground) carbon storage, among other ecosystem services (ProForest, 2008; Garrett et al., 2019). Here, we align ourselves with those broader calls for due recognition of ecosystems such as the Cerrado. “Deforestation” and “conversion” are thus used interchangeably in this article.

² These values exclude indigenous territories. To see all protected areas within Cerrado, including indigenous territories, check the reference: Centro de Sensoriamento Remoto da Universidade de Minas Gerais (2020).



Building on previous research about farmers' perceptions on land-use change conducted in the Cerrado (Jepson et al., 2010; Rasmussen et al., 2017; Guerrero et al., 2021), this study explores farmers' perspectives in more depth by examining migration patterns, engagement with institutions, land tenure, and land clearing decision-making. It focuses on the motivations, concerns, and drivers of soy farmers in the Brazilian state of Tocantins, the largest one in what has become known as the Cerrado's Matopiba frontier (see Bastos Lima and Kmoch, 2021). This region, named after the initials of the states of Maranhão, Tocantins, Piauí, and Bahia, is where most remaining areas of Cerrado vegetation are found (see Figure 1). In exploring farmers' decision-making, we have sought to learn more about the limitations and possibilities for targeted engagement or interventions that consider these stakeholders' mindsets and attitudes.

The challenge of stemming deforestation in the Cerrado

The Brazilian Cerrado and its vulnerability

Deforestation in Brazil is commonly associated with the Brazilian Amazon, noticeable by the number of articles assessing forest loss in that ecosystem (see Laurance et al., 2000; Fearnside, 2005, 2017; Nepstad et al., 2014; Hummel, 2016; Frey et al.,

2018; Carvalho et al., 2019). However, much of the country's deforestation has happened elsewhere, notably in the Cerrado, its second-largest biome and a global biodiversity hotspot (Myers et al., 2000; Strassburg et al., 2017; see Figure 1). Compared to other Brazilian ecosystems, such as the Amazon or the Atlantic Rainforest, the Cerrado is recognized by Brazil's Ministry of Environment as the country's most damaged by human activity (ICMBio, 2022).

The first Brazilian Forest Code, a law to regulate agricultural land use with respect to environmental protection, was adopted in 1934 (Brazil, 1934) and revised in 1965 to establish Permanent Preservation Areas (e.g., hillsides and river margins to prevent erosion) and Legal Reserve mandates (a percentage that landowners ought to keep as native vegetation in their farms) (Brazil, 1965). The specifics of those rules have changed over time. Currently, the 2012 Forest Code mandates that private landowners preserve at least 80% of their properties in the Brazilian Amazon as native forest, as opposed to 20–35% in the Cerrado (Brazil, 2012). That, however, leaves out a substantive amount of Cerrado vegetation that can be cleared legally, compromising ecosystem functions and being particularly detrimental to larger fauna (e.g., giant armadillo, giant anteater, puma) that struggle in fragmented patches within separate farms (see Rocha et al., 2018; Green et al., 2019).

A key piece of Brazil's current Forest Code is the Rural Environmental Registry (*Cadastro Ambiental Rural*—CAR). The CAR is a spatially explicit mechanism to link landowners to

information on their properties (Ministerio do Meio Ambiente, 2022). Farmers are obliged to register the geographical coordinates of their lands as well as to identify the Permanent Preservation Areas and Legal Reserves of their farms (Brazil, 2012). They must indicate if they have a greater or lesser percentage of native vegetation than legally required. If farmers have less, they are supposed to reforest to fulfill the requirement. Issues arise, however, when landowners with a higher percentage of native vegetation than required decide to subvert the CAR registration by declaring a lower rate and then clear that surplus without the necessary license (Rajão et al., 2012). A mechanism that could reduce this subversion is the Environmental Reserve Quotas (*Cota de Reserva Ambiental*—CRA), whereby landowners with surplus areas can receive a certificate and sell it to those with Legal Reserve deficits in their farms (Soares-Filho et al., 2016). Still, overall, much of the Cerrado remains exposed to being deforested legally (especially in the Matopiba frontier), and the CAR has so far failed to stem illegal deforestation (Azevedo et al., 2017; Santos et al., 2022).

Concerned actors have tried to sway farmers from vegetation clearing in the Cerrado through awareness-raising, certification, voluntary trader commitments, and other demand-side measures, yet none of these approaches have been successful. The Cerrado Manifesto, released in 2017 and signed by over 60 civil society organizations, was a call for immediate action to protect the Cerrado. It was hoped that companies that buy soy or beef from this region and their investors would act more meaningfully to halt the ecosystems' disappearance (Cerrado Manifesto, 2017). Subsequently, 23 consumer-goods companies signed a Statement of Support (SoS) for the Cerrado Manifesto, recognizing the need to protect the biome to help mitigate climate change and secure agriculture resilience (FAIRR, 2017).

The SoS signatories eventually joined the Cerrado conservation debate with a multi-stakeholder initiative (the Cerrado Working Group) composed of traders and environmental NGOs. The discussion initially had a broad scope, but over time it became focused on creating a so-called Cerrado Conservation Mechanism, which aimed at paying soy farmers to forgo their right to clear legal reserve surpluses (see ABIOVE, 2022). However, the idea stumbled upon many problems, such as who would pay for it, for how long such payments could be sustained, and the risks of perversely legitimizing a sense of “right to clear” among soy farmers (Bastos Lima and Persson, 2020; Garrett et al., 2022). Some authors have identified significant risks of further legitimizing a sense of appropriateness of clearing unless farmers were paid not to do so, which could become particularly problematic if payments were eventually discontinued (Bastos Lima and Persson, 2020; see also Ling and Xu, 2021).

Such efforts were initially inspired by the Amazon Soy Moratorium, whereby commodity traders have agreed not to source from areas cleared after a 2008 cut-off date, which has

successfully reduced direct soy deforestation (Heilmayr et al., 2020). Yet the Cerrado is left out, and some have argued that it may have even experienced further, displaced deforestation through land-use leakage from the Amazon (see Bastos Lima et al., 2019; Souza et al., 2020). Calls for expanding such a moratorium to the Cerrado, even with a later cut-off date, have gone unheeded despite the significant conservation benefits it would have (Soterroni et al., 2019).

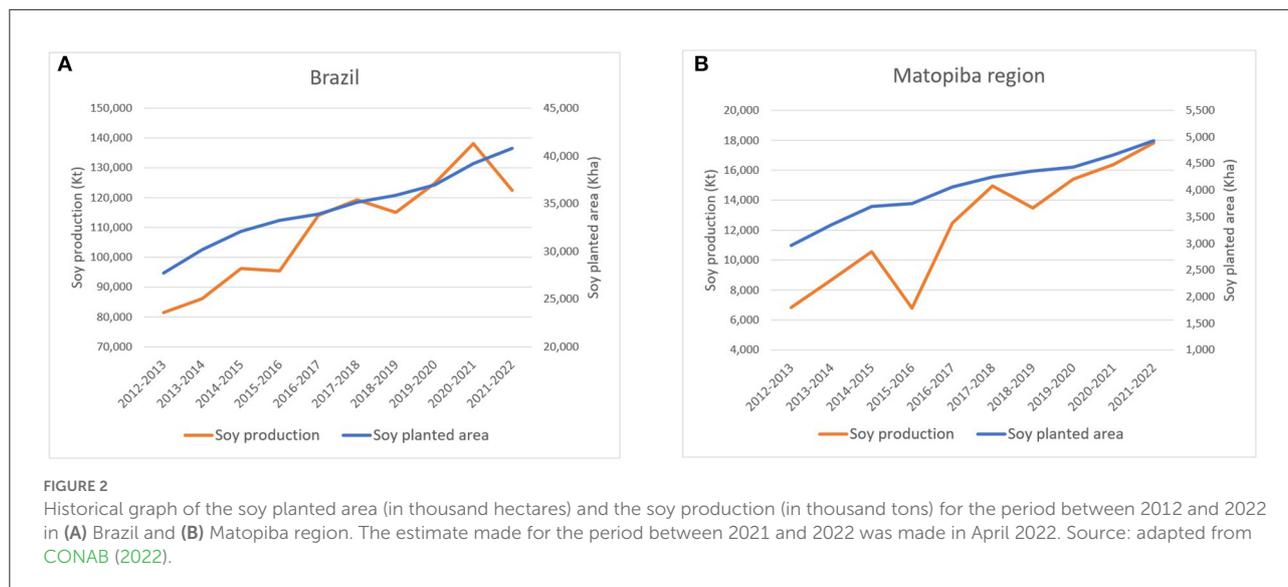
Other initiatives, too, remain so far restricted to the Amazon biome. One fledgling case is Selo Verde (“Green Stamp”)³, a partnership between the Federal University of Minas Gerais and the state government of Pará. It creates a publicly available data platform with traceability information on land-use change and farms' compliance with the Forest Code to expose gaps and assist decision-making (Selo Verde, 2021). The initiative has so far focused on livestock. Still, it has potential to be extended to other chains and Brazilian states if policymakers and supply-chain actors decide to act on the Cerrado (Rajão, 2021).

The soy supply chain and the key role of farmers

Under the current circumstances, soy cropland alone is expected to expand 318% between 2015 and 2050 in the Cerrado's Matopiba frontier (Soterroni et al., 2019). This will add to increased ecosystem conversion pressures from seasonal crops, which expanded by ~48% between 2006 and 2017 in the Cerrado (IBGE, 2019b). Studies suggest that such loss of vegetation cover has already affected rainfall and compromises agriculture itself, which is primarily rain-fed (Flach et al., 2021; Leite-Filho et al., 2021; Marengo et al., 2022). Moreover, Hofmann et al. (2021) showed that Cerrado temperatures increased over the last 60 years, while humidity decreased by ~15% between 1961 and 2019. Some of these local environmental changes, such as lower rainfall, have already been perceived by local farmers (Russo Lopes et al., 2021).

Soy cultivation alongside cattle ranching, which often paves the way for its expansion, has been chiefly responsible for Cerrado deforestation (Gibbs et al., 2010; Fearnside, 2017; Piotrowski, 2019; Rausch et al., 2019; Song et al., 2021). Between 2003 and 2014, 16–32% of Cerrado vegetation was directly replaced by soy, and an additional share followed a pattern of conversion into pastures that later became soy cropland (Rausch et al., 2019). Figure 2 shows the soy production volume growth in Brazil and the Matopiba region in the past 10 years and its expanding cropland area. These annual fluctuations show how overall national production has decreased due to harvest losses

³ For more information on Selo Verde, access: <https://www.semas.pa.gov.br/seloverde/>.



and reduced yields in Brazil's South (CONAB, 2022), while in Matopiba it continues to grow alongside area expansion.

The soy supply chain processes go through four main phases: production, storage and processing, trade, and consumption (Garrett et al., 2013; Brack et al., 2016). Figure 3 illustrates this sequence and the stakeholders in each phase. Although the representation shows the main stakeholders, the exact configuration of the soy supply chain may vary (Garrett et al., 2013; Hinkes and Peter, 2020).

The fact that most Brazilian soy is traded internationally could suggest that traders and concerned consumers have the upper hand in determining practices (Heron et al., 2018). However, one marked feature of Brazil's soy sector is the significant political, economic, and decision-making power of soy farmers, who tend to be well-capitalized and politically influential (Hopewell, 2014; Søndergaard, 2020). Some studies have therefore focused on investigating these farmers' perspectives on conservation (e.g., Diniz et al., 2015; Trevisan et al., 2016; Latawiec et al., 2017; Rasmussen et al., 2017; Cortner et al., 2019). Rasmussen et al. (2017), for instance, examined whether the CAR has influenced farmers' behaviors toward deforestation in the Cerrado. They surveyed 1,177 smallholders and demonstrated that most landowners with more native vegetation than legally required did not intend to alter their deforestation behavior after CAR registration. However, the authors indicated that the intention was due to a lack of sufficient economic resources to clear the land rather than a desire to conserve. Thus, easier access to (unconditional) credit would risk facilitating further deforestation. Pfaff (1999) and Hargrave and Kis-Katos (2013) also found a positive correlation between access to credit and deforestation.

Guerrero et al. (2021) interviews with stakeholders from the Brazilian soy supply chain revealed that almost all other

actors considered farmers' mindset a barrier to a deforestation-free agenda. Furthermore, farmers' lack of engagement in conservation policies and a lack of incentives to engage influence the capacity to implement zero-deforestation policies (see Guerrero et al., 2021). Participation of producers in Guerrero et al.'s (2021) research was minimal, however, with only one association representing the view of a group of farmers who complained about the lack of NGOs support and market incentives to reduce deforestation. Research on Brazil's soy farmers' views remains limited and is a crucial gap, especially considering their decision-making role regarding clearing the remnants of Cerrado vegetation and their influence over other stakeholders' initiatives against deforestation.

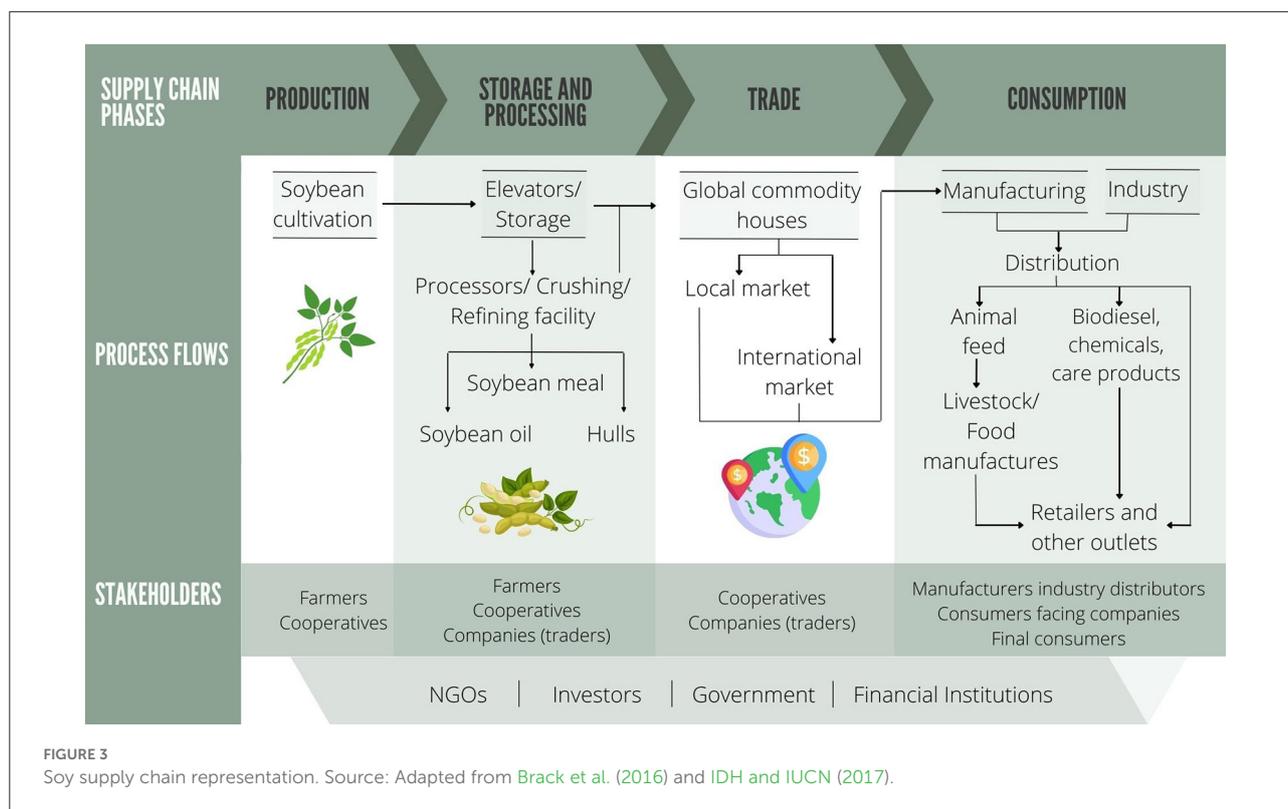
Table 1 lists relevant studies conducted in Brazil on farmers' perceptions of land-use change and their main findings. This list is not exhaustive but provides an overview of what is available in the literature.

Methods

Study site

This study employs a combination of qualitative methods and quantitative data. To select the study area, we analyzed an indicator called "soy deforestation,"⁴ developed by Trase. Trase is a transparency initiative that uses public data to track environmental and social risks linked to commodity production, trade, and consumption (Trase, 2020). Its soy deforestation

⁴ See more information on the soy deforestation indicator at Trase website: http://resources.trase.earth/documents/data_methods/Indicators_Brazil_June%202020.pdf.



indicator calculates how much deforested land becomes soy cropland within 5 years in different municipalities.

Based on Trase's sub-national indicators, we selected the state of Tocantins within the Cerrado biome as our study area. Tocantins State sits at the interface between the Cerrado and the Amazon, with much of its land being part of the former but at the edge of the latter. It suffered the second-highest rate of soy deforestation among all Brazilian states according to the latest Trase data (Trase, 2018b). Mato Grosso State has the largest area of deforested land due to soy, but it is also much larger than Tocantins. Therefore, in relative terms, Tocantins experiences Brazil's highest rate of direct soy deforestation; that is, without considering soy's role in indirect land-use change by pushing cattle ranching further into the frontier.

Figure 4 shows the Tocantins municipalities within the Cerrado with their respective soy deforestation between 2003 and 2018. It also shows the number of farms belonging to the study participants. Some of the farmers interviewed cultivated soy in multiple farms across several municipalities, resulting in a coverage of 38 farms⁵ in 15 Cerrado municipalities: Porto Nacional, Aparecida do Rio Negro, Paraíso do Tocantins,

⁵ This is an estimate based on the participants' responses. In some cases, the participants mentioned the municipalities where they cultivate soy, but did not specify the exact number of farms in each municipality. For these cases, we are considering one farm per municipality.

Divinópolis, Marianópolis, Caseara, Araguacema, Lagoa da Confusão, Santa Rita do Tocantins, Monte do Carmo, Fátima, Campos Lindos, Figueirópolis, Lagoa do Tocantins, and Palmeirante. The average size of the cultivated soy area per participant is ~1,839 ha.

Data collection and analysis

Our empirical data collection began in Tocantins's state capital, Palmas. Due to COVID-19 international travel restrictions, we hired two Brazilian residents who are native speakers of Brazilian Portuguese and could travel to Tocantins State as research assistants. One of the research assistants was a female social scientist pursuing a master's degree in sustainability sciences. The other research assistant was a male agronomist with a background in crop monitoring. Despite the research assistants' previous experience with farmers, a training session was provided before the data collection commenced.

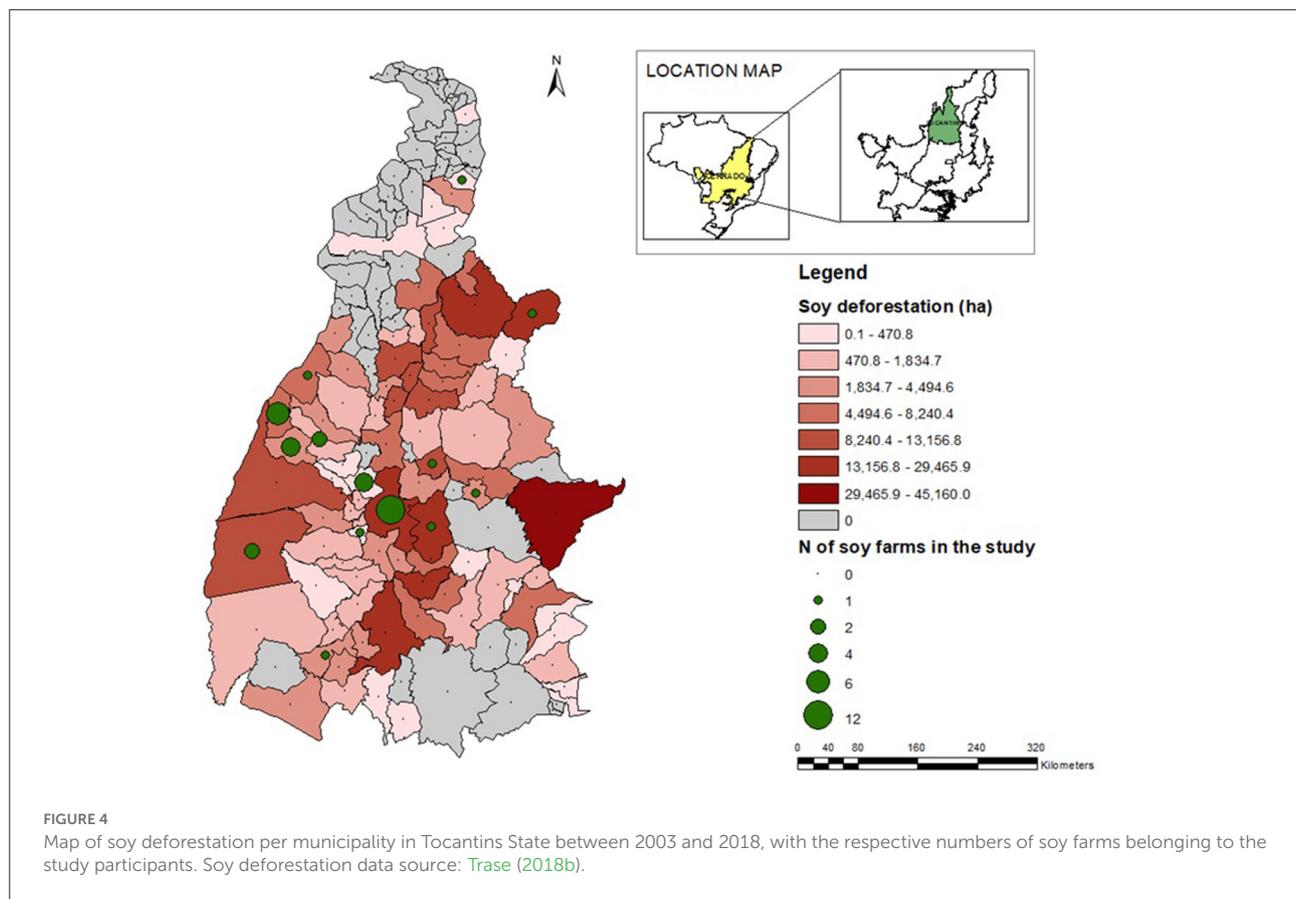
These assistants both had personal contacts with soy farmers elsewhere in Brazil and utilized them to conduct a snowball sampling procedure (see Noy, 2008). They asked each farmer for whom they had contact details to suggest other farmers who met the selection criteria. These were then contacted and asked to suggest another farmer, and so on. The research assistants used messaging apps to contact potential interviewees and

TABLE 1 List of studies exploring Brazilian farmers' perceptions on land-use change.

| Publications | Ecosystems | Stakeholders | Objectives | Main findings |
|-------------------------------------|------------------|--|--|---|
| Guerrero et al. (2021) | Cerrado | Soy supply chain actors | Identify similarities and differences in the factors perceived to promote or inhibit a reduction of deforestation from soy production. | Obstacles to commitments to reduce deforestation are: different perceived financial risks, differences in the levels of influence and power, and farmers' perceived "right" to deforest. |
| Pacheco et al. (2021) | Brazilian Amazon | Farmers | Explore farmers' interests in regularizing their land. | Farmers with medium and large properties tend to compensate for their previous illegal deforestation in other areas, while the ones with small properties tend to do that within their own land. |
| Pereira et al. (2020) | Brazilian Amazon | Cattle supply chain actors | Characterize cattle supply chain stakeholders and their responses to zero-deforestation cattle agreements. | Loopholes weaken zero-deforestation cattle agreements and permit non-compliance. |
| Campos Tisovec-Dufner et al. (2019) | Atlantic Forest | Cattle ranchers and eucalyptus growers | Explore how ecological contexts influence conservation behavior | People living in more forested ecological contexts have more intention of conserving. |
| Cortner et al. (2019) | Brazilian Amazon | Cattle ranchers | Explore factors guiding farmers' adoption of integrated crop-livestock systems (ICLS). | Structural barriers impeded greater adoption of ICLS, and quality of life and traditions drove farmers' decisions. |
| Latawiec et al. (2017) | Brazilian Amazon | Cattle ranchers | Explore factors leading or inhibiting land management improvement. | Farmers adopting improved pasture management had lower levels of forest cover, and lack of labor and finance were the main constraints to adoption. |
| Rasmussen et al. (2017) | Cerrado | Smallholders producing maize, bean or cassava, and cattle ranchers | Explore factors associated with deforestation behavior and Brazil's Rural Environmental Registry (CAR) relation with deforestation intentions. | Factors associated with the intention to deforest are: native vegetation on property, agricultural loans, age and experience. |
| Rausch and Gibbs (2016) | Brazilian Amazon | Soy farmers | Explore implications of properties' arrangements and soy governance for deforestation. | Soy properties' arrangements are complex and hard to trace, allowing soy associated with deforestation to enter the supply chain. |
| Trevisan et al. (2016) | Atlantic Forest | Dairy farmers | Assess farmers' perceptions of the pre-2012 Forest Code. | Although many farmers understand the pre-2012 Forest Code, they disagree with it and are not willing to comply in the future. Payments for Ecosystem Conservation could be an alternative for them. |
| Gardner et al. (2013) | Brazilian Amazon | Farmers | Present the Sustainable Amazon Network (RAS), a multidisciplinary research aiming to access social and ecological aspects of land-use. | Related aspect explored in this research network: persistence of environmentally degrading land use. |
| Jepson et al. (2010) | Cerrado | Farmers | Explore how farmers engage with institutions and organizations, influencing their land-use decisions. | Farmers engaged in land-leasing and production contracts and worked through cooperatives and firms to access resources, which influenced land-use decisions and regional patterns of land-cover change. |

visited soy farms to recruit participants for the study. Many Tocantins soy farmers either live or have family and other social contacts in Palmas. Direct contact proved the most effective

method to identify participants, as spontaneous visits are not uncommon in Brazil, particularly in the countryside. The refusal rate was very low (around 4%). Soy farmers who refused to



participate showed distrust in people outside their network, and antagonistically associated the research with NGOs. The interviews were conducted in Portuguese, in December 2021, during planting time for soy and thus a period when farmers were most likely to be at the farm.

The research assistants conducted semi-structured interviews with 24 farmers producing soy across 15 Tocantins municipalities. A large sample of soy farmers is difficult to obtain in Brazil. Long distances to access farms make it difficult to reach many farmers in a single day, which increases the time and costs of the research. Nevertheless, this sample size aligns with most studies using qualitative interviews; for example, it is the same sample size used by [Maye et al. \(2017\)](#) and larger than the one used by [Oreszczyn and Carr \(2008\)](#).

The semi-structured interview framework contained open-ended questions designed to elicit factors that influence soy farmers' land-use decision-making, particularly with respect to cropland expansion. Knowledge elicitation tries to contemplate the key attributes of a domain; however, conscious and unconscious decision-making phases in a person's mind may represent a limitation to this process ([Bharwani, 2006](#)). The interview framework contained a series of questions about farmers' role in soy production,

perceptions on expanding their soy production, and factors influencing their land-use decisions. A laddering technique was used in the questions to stimulate the participants' critical thinking ([Reynolds and Gutman, 1988](#)) and to reflect on the reasons behind their responses, trying to elicit previously unconscious aspects of their decision-making. Each response to a question was followed by other probing questions, such as "what do you mean by...", "why is this important", "what influences...". [Table 2](#) shows the open-ended questions asked during the interviews. A pilot test with three people was conducted using the initial interview question framework, and modifications were made to ensure clarity before the data collection commenced.

Participants were invited to choose a location of their preference to participate in the interview. Approximately 92% were conducted on farms while 8% were in Palmas, where some farmers live. The interviews lasted from half an hour to 2 h, depending on the participants' availability and the length of their answers. One research assistant conducted all the interviews, while the other took notes and/or audio recordings. Most participants chose not to have their interviews recorded. Therefore, the second research assistant took detailed notes based on the participants' responses. Three participants

TABLE 2 Open-ended questions asked during the semi-structured interviews.

Interview questions

1. How long have you been farming?
2. Tell me about the commodities you produce and your involvement in soy production.
3. In case the demand for soy continues to increase, what would you do to meet this demand?
- 3a. Would you consider expanding your production? If yes, how?
4. What are some factors you take into account when deciding whether to expand cropland or not?
- 4a. What do you mean by [said factor], do you have an example?
- 4b. Why is [said factor] important? What happens if [said factor] is subject to change?
- 4c. What other factors influence the sourcing of [said factor]? External/internal?

TABLE 3 Sociodemographic profile of the 24 farmers interviewed.

| Sociodemographic aspects | Number |
|--------------------------------|--------|
| Interviews | 24 |
| Male | 20 |
| Female | 4 |
| Age range | 21–77 |
| Landowners | 14 |
| Tenants | 6 |
| Employees | 4 |
| Total farms in Tocantins | 38 |
| Total cultivated soy area (ha) | 44,140 |

agreed to recordings and the audio was transcribed using the software NVivo9.

Table 3 shows the sociodemographic profile of the participants. Most of the participants (50%) were part of the second or third generation in their families working in agriculture, with a much smaller number (16.6%) being the first farmers in the family. Our sample was composed of soy farmers who either own land, lease land or are an employee of the farmers and help them to make decisions over their soy production. Half of the employees (two of the four) were managers or administrators of the farm, and the other half were agricultural technicians. All farmers cultivated soybeans as their priority, usually adopting a double-cropping system with maize when not in the season for soybean production.

The interview data were transcribed into English, and direct quotations from the farmers are used in the results section to support findings in the participants' own words. In line with ethical clearance for the research and promises to interviewees, anonymity is preserved by not identifying the individual farmers. The anonymity also served to decrease farmers' discomfort to talk about sensitive topics and to

encourage them to provide reliable answers. Moreover, the interview was conducted in a relaxed friendly manner to put people at ease. Sensitive words such as “deforestation” were avoided by the interviewers, replaced by similar terms, for example, “clearing new areas” and “expanding to areas with native vegetation.”

The interview data were examined through content analysis, first identifying important aspects in the participants' answers, contextualizing them, creating categories and compiling the findings (Bengtsson, 2016). The use of this method provides credible and replicable inferences from the data (Downe-Wamboldt, 1992). Thematic coding was also performed using the software NVivo9 (NVivo, RRID:SCR_014802), helping to easily identify coded text in each node. The thematic coding focused on identifying the reasons farmers chose to migrate to the Tocantins frontier and their decisions on soy production.

Results

A deforestation economy in Tocantins

Soy-farmer migration to Tocantins

Most of the interviewees were originally from the state of Rio Grande do Sul, in the south of Brazil. Others came from the states of Paraná, Goiás, Minas Gerais, São Paulo or Mato Grosso. Some migrated first to Mato Grosso and later moved to Tocantins. Among the participants, the earliest farmer in Tocantins moved in 2012, while the most recent arrival was in 2020. Even though all farmers were relatively new to this state, some had more than 50 years of experience in agriculture. This migration process required farmers to adapt to new conditions as the climate, soil, and altitude differed from their home state: “Here [in Tocantins] everything is new. What we knew there [in the other state] we needed to forget and learn it over again here.”

Table 4 presents the reasons soy farmers offered for deciding to relocate to Tocantins. Land prices were the most common reason for migrating: “Land prices in Tocantins are very low.” However, other features of the land were also a drawback: “The price was good, the altitude was higher, and the soil was more clayey. The guy sold me [cleared land] for the price of land with vegetation.” Comparison to the price of land with vegetation came from the fact that land with vegetation cover is cheaper than cleared land, because clearing requires a high investment in machinery, labor, agricultural inputs, and time.

Another common goal of farmers who came to Tocantins State was to have larger cultivated areas. Farmers could buy more land in Tocantins than in their original state and at more affordable prices, therefore they found it worth migrating to have more land. Farmers also considered environmental aspects such as climate and soil conditions. Tocantins' environmental conditions were mentioned as a pull factor either because they were deemed good for soy production or as a personal

TABLE 4 Reasons why soy farmers migrated to Tocantins State in descending order of the frequency with which each reason was mentioned.

| Reasons for moving to Tocantins | Details |
|---------------------------------|---|
| Land prices | The prices were very low compared to the land price “back home” in Rio Grande do Sul or in other more consolidated agricultural states such as Mato Grosso. |
| Expansion | Some farmers had land in other states, but it was smaller, and the price was too high to expand there, so they decided to obtain more land for a cheaper price in Tocantins. |
| Climate | The climate conditions in Tocantins were good for soy cultivation. Some farmers had preferences for a warmer climate, such as that of Tocantins. |
| Production | Tocantins land promised better production than the land in other states. |
| Neighbors’ influence | Neighbors who moved to Tocantins said that production was going well, and so decided to move. |
| Profits | Tocantins offered opportunity to lease parts of land to other soy producers to increase their profits. |
| Soil | Farmers claim the soil in Tocantins holds nutrients longer than in other states. |
| Various personal reasons | The death of a patriarch who cultivated soy in Tocantins led his son to migrate and lead the business. A manager received a job offer in Tocantins. Drought resulted in large debts for a farmer, who then chose to sell his land to pay what he owed and bought cheaper land in Tocantins. |

preference for a warmer climate. Some farmers argued that they obtain higher soy yields in Tocantins than elsewhere.

Neighbors’ examples also influenced farmers’ decisions to migrate. For some participants, their neighbors had migrated to Tocantins and it had worked well for them, so they decided to follow. Although neighbors were mentioned most often, farmers also mentioned migration of family members as influencing their decisions.

Business opportunities appeared in soy cultivation and also from land dealings. A participant mentioned that he migrated to Tocantins to make money by buying the land for a low price, preparing the soil for agriculture, and selling it for a higher price. Also from a profit-seeking perspective, some farmers chose to cultivate soy on a small part of their property and rent the remaining land to other farmers.

Finally, some participants mentioned personal reasons to migrate. One example was the death of a family member who

owned land in Tocantins, and the farmer decided to migrate and take over the business as he already had experience with agriculture. Another example was a severe drought that a farmer went through, losing all his crops in his home state. The farmer needed to sell his land to pay his debts and then bought cheaper land in Tocantins.

Land tenure

Most participants either were landowners ($n = 14$) or rented land ($n = 6$) to produce soy. In both cases, the farmers managed the farm by themselves or with family members or business partners. A small group ($n = 4$) was hired by the farmers (either landowners or tenants) to work on the land as managers, helping on daily tasks and in decision making about soy production. Therefore, the people making production decisions, including whether to expand cultivation or not, have been the farmers themselves, either tenants or landowners, rather than third-party managers.

There was no consensus on the cost-benefit of renting land. Some farmers claimed that it was only worth expanding cropland if the person was the landowner and argued that paying rent would compromise their profit. A wary farmer argued that “farmers producing in rented lands do not know their finances, the costs.” Nonetheless, others considered expanding production even on rented land because, from their point of view, it pays off. A few farmers spoke confidently about this subject while others were content to follow advice from other people or institutions, for example: “They [an agriculture association] say that it is not worthwhile to open new areas in rented land; it is only worthwhile if it is your own land.”

Land clearing

Land clearing in Tocantins takes place both legally and illegally. While respondents were willing to discuss land tenure and legal clearing, the vast majority were uncomfortable discussing illegal deforestation. Some said illegal deforestation in Tocantins hardly occurs, due to control by the public authorities and its consequences. Others, however, mentioned that lack of enforcement (e.g., of licensing requirements or imposition of fines for violations) enables illegal deforestation in the state. One farmer was dismissive of the strictness of such rules and “sticks” in place against illegal clearing:

“The fines are not a risk; it is easier to start your production [without the necessary environmental licenses] and pay the fines later. If you need to do any [environmental] compensation, you plant around ten trees, and [the] problem [is] solved.”

The analysis shows that legal deforestation is seen by soy farmers as their legal rights, and it proved to be a more

comfortable topic for them. Typically, they were unequivocal about being entitled to clear the land. One farmer was particularly blunt, while also revealing that waiting for land price increases is part of the business: “*My land is there, standing still, gaining value. Getting dirty [i.e., growing natural vegetation] is the least; [we] throw it with the big chain, take the trees down, and keep going.*”⁶

Some farmers pointed out that even if they did not wish to plant on a cleared area immediately, they sometimes pursued legal clearing preemptively to ensure they could use that land for agriculture in the future. They expressed concern about maintaining native vegetation on their properties, wary that changes in the environmental or land-use legislation could eventually prohibit them from clearing such areas in the future. As one farmer vented with frustration at such control measures: “*You buy it [the land], fence the area, abandon it, the grass comes back, and when you get back to clear it again, they will not give you the license.*”

For most participants, the land they bought or rented in Tocantins was cleared before they arrived. They encountered it as degraded pasture before planting soy, and this pasture to soy change was noted as positive for the soil: “*It got to the point that the livestock farms were getting tired and only spending soil nutrients without replacing them, and there was no way back to correct the soil except with agriculture.*” Degraded pastures required that farmers invest time and money to clear remnants of vegetation and improve deteriorated soils by adding agricultural inputs. This process often required hiring manual laborers to remove rocks in the fields, and was a stress factor for some farmers who generally prefer to keep the farm work within the family.

Despite its costs, land-use change for planting soy is perceived as a worthwhile investment for most: “*the more time a land is used for agriculture, the more valuable it gets.*” However, tenants, who grow soy on rented land, may be more detached from such longer-term considerations and also from implications related to clearing. Tenants said that the land clearing process, including the application for the necessary environmental licenses, is typically handled by the landowners beforehand. Therefore, tenants feel that the responsibility for, and consequences of, clearing native vegetation rests with the landowners, not with them: “*He [the landowner] clears the vegetation; we correct the soil to plant.*”

The economics of farming

Although farmers commonly grow one or more commodities besides soy, soy represents the largest part of

6 The “big chain” (*correntão*) is a thick metal chain usually tied to two powerful tractors that are then used to clear the vegetation in an area by knocking it down after the larger (and economically valuable) trees have been removed.

most farmers’ income. A few mentioned maize, which typically is intercropped with soy in Brazil, as being equally valuable. Other common crops complementing incomes are sorghum, beans, and millet, besides livestock.

Tocantins farmers sell their grains to a range of traders, allegedly seeking whoever will “pay better” (see also [Zu Ermgassen et al., 2022](#)). Some of the commodity traders mentioned by the farmers in order of importance were: ALZ, Bunge, Agrex, Granol, Fazenda Agro, ADM, Agrextz, Frizia, CHS, Fiagril, Silo do Simiao, Matosul, and Priori. For the year 2018 in Brazil, [Trase \(2022\)](#) found that Bunge was the commodity trader with the highest exposure to deforestation (10,935 ha), followed by ALZ (7,393 ha). This deforestation exposure indicator shows how much deforestation may be embedded in the soy that companies are sourcing.

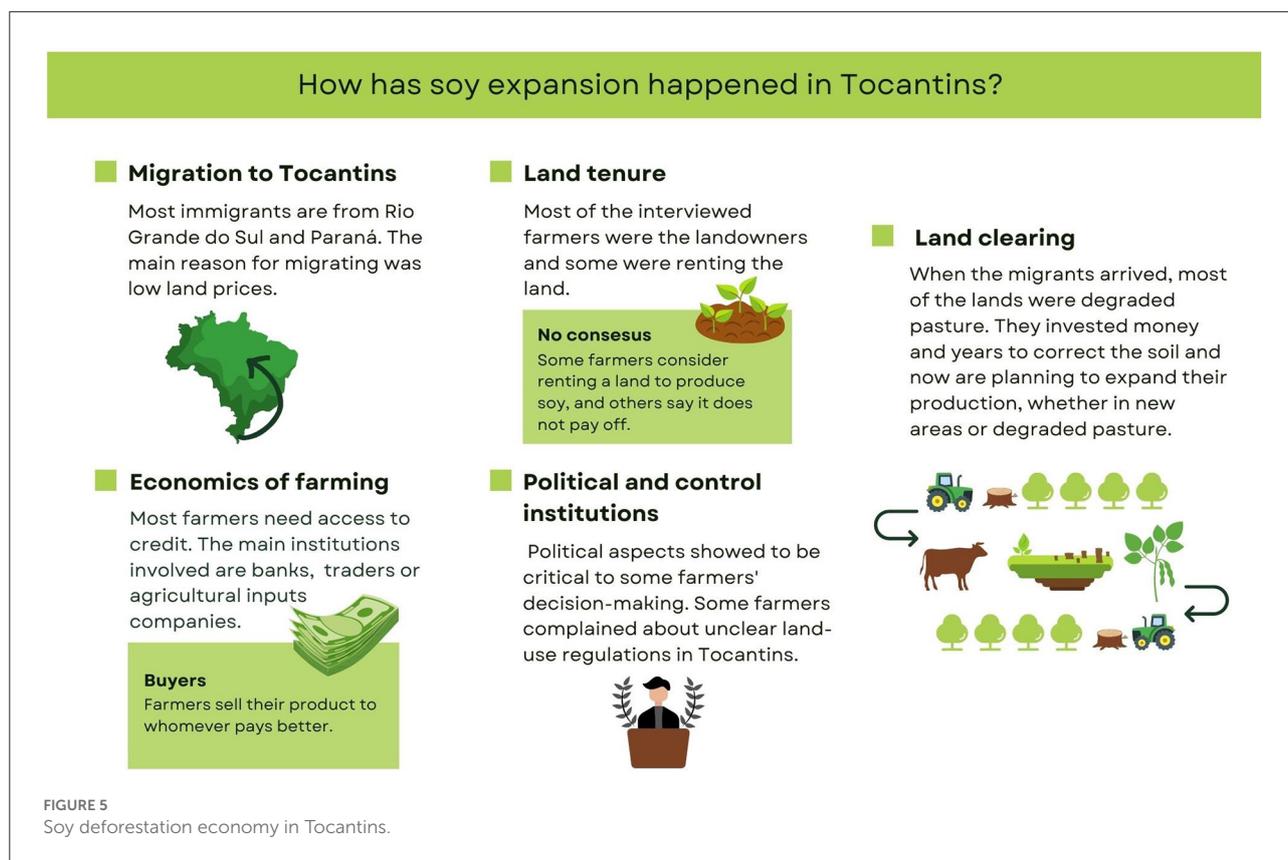
Farmers were also asked about how they finance their soy cropping. Most farmers obtain credit from banks, commodity traders, or agricultural input companies. Only a small minority ($n = 2$) had sufficient resources not to need access to loans. In a frontier region such as Tocantins, financial institutions lending money to farmers or investing in companies in the soy supply chain are directly or indirectly exposed to sourcing soy directly associated with recent deforestation. The financier institution with the highest soy deforestation exposure in Brazil in 2018 was the Japan Agricultural Cooperatives Group, with a deforestation exposure of 2,468 ha ([Trase, 2022](#)).

The most common cost concern for farmers was the recent increase in agricultural input prices, notably fertilizers. They saw such price hikes as an obstacle to continuing planting. Yet, the price of soy has also been increasing. When asked about the increases in the price of soy, a farmer reasoned that “*the soy value has increased, but the costs also have increased. So it is almost the same thing.*” Some farmers claimed that their decision to continue cultivating soy in the following year would ultimately depend on agricultural input prices.

Political and control institutions

A final consideration in what we have referred to as soy’s deforestation economy in Tocantins is the public institutions responsible for identifying and reporting any illegal clearing—and their broader political context. It is common for soy farmers in Tocantins to resent or criticize the works of those entities. For example, one farmer complained about contradictory instructions from different agencies. He reported applying for an environmental license and being given permission to clear a specific part of his land. However, when he cleared the land, another agency said that was illegal and issued him with a fine. Some farmers argued that the land-use regulations on what is permitted or not is unclear. They rely on the agencies for direction but often do not find their guidance satisfactory.

More broadly, some farmers mentioned political aspects influencing their soy production. Although these farmers were



a minority, they spent much of the interview time talking about this subject and how it stresses them and influences their decisions. These participants showed an aversion to public institutions in general and said they avoid contact with them even to obtain environmental licenses. While political affiliation was not asked in the interviews, soy farmers have been among the most vocal supporters of the Bolsonaro administration and its agribusiness-friendly land-use policies in Brazil (see Hochstetler, 2021). As Brazil's 2022 presidential elections drew nearer, with Bolsonaro seeking reelection against the left-leaning former president Lula, one farmer stated that he would sell all his lands and machinery and leave the country depending on the election outcome.

Figure 5 summarizes Tocantins's deforestation economy based on the interview findings. Although not every aspect of that dynamic is covered in this analysis, the results still offer a coherent picture and can help identify some of the key features from the perspective of soy farmers.

Soy farmers' decision-making about cropland expansion

Farmers were asked what they would do if soy demand increased, and why. Although most ($n = 14$) said they would

promptly expand their cropland area in response, nearly half ($n = 10$) considered not expanding. That is telling because it offers insights into what restrains farmers from pursuing area expansion even in the presence of market demand for soy.

A large group of farmers used the term "good opportunity" when asked what they would do if the demand for soy continued to increase. This term seems to be a relevant factor influencing their decisions. A participant stated, "I believe that I would expand my soy cultivation area. Farmers are silly, right? We cannot see any [opportunity], and we automatically want to take it." A good opportunity in their perception is related to low land prices, good soil conditions, and proximity to roads and commodity traders. The quality of the land also influences their decision on whether to expand. One farmer believes that a smaller plot of good-quality land is better than having more land of poorer quality: "It is no use having quantity but not quality."

Farmers mentioned productivity issues as well as various economic or personal aspects as reasons not to expand their production area, but none demonstrated that environmental care or concerns would influence their decisions. A farmer who expressed appreciation for the environment said that he would conserve vegetation only if it was on an area unsuitable for cultivation (very steep or at risk of

erosion), otherwise he would prioritize agriculture. Those who would choose not to expand would be restrained mostly by financial constraints. As two different farmers summarized, “*If I have the money, it is worth expanding*” (landowner) and “*If I had a piece of land, I would clear it*” (tenant).

Farmers also mentioned social aspects connected with their reasons to expand. These were all related to family members, especially their children. One farmer would only expand if his children would also choose to do so, depending on their ambitions. Others said they would not expand soy cultivation production because they could still improve yields in the area they already have. Only one farmer mentioned he had already achieved maximum productivity and would therefore expand to new areas. Either way, soy farmers in Brazil frequently employ a neo-Malthusian justification for growing their business: “*We are the ones who feed the world, and the population is growing*” (see also De Schutter, 2017). Some of the farmers felt that such a benign societal role justified their choice to expand cropland area—clearing vegetation if necessary and within their financial means. Table 5 summarizes the main reasons Tocantins’ soy farmers provided for their choices to expand cultivation.

Discussion

Soy farmers in context: Who is responsible for deforestation in Tocantins?

In trying to understand agriculture’s deforestation economy in Tocantins, it is helpful to assess soy farmers’ positions, attitudes, and perspectives. That will also be valuable when considering approaches to address the Cerrado’s fast-paced disappearance.

First, it is important to locate soy farmers within a broader context of land-clearing dynamics and indirect land-use change through the expansion of cattle ranching. Most soy farmers confirmed that the land had already been cleared when they migrated to Tocantins State—yet a few said they cleared it directly for planting soy (which, as seen, may have happened within the law in Brazil). These results qualitatively corroborate those of Rudorff et al. (2015), which suggest that most agricultural expansion in Tocantins between 2000 and 2014 occurred over pasturelands. Song et al. (2021) also show that from 2000 to 2019, soy expansion across Brazil occurred mostly on degraded pastures. In this context, our results indicate that although soy farmers defend their “right to deforest,” they claim no responsibility for deforestation that occurred before their arrival. That is despite the fact that, as soy farmers advance, they purchase farms from cattle ranchers, who then use the

TABLE 5 Reasons why soy farmers in Tocantins’ Cerrado would, or would not expand their soy production if the demand for soy continues to increase.

| | Explanation |
|---|---|
| Reasons to expand* | |
| Business opportunity | Most farmers would expand to new areas if they found a good opportunity to do so; i.e., land located near a road and traders, with an attractive price and good soil quality. |
| Income diversification | They would expand their cultivated area to have more space to grow other crops or to farm livestock, not to depend exclusively on profits from soy. |
| Personal reasons | Some participants would choose to expand their area to secure a better future for their children. |
| Reasons not to expand | |
| Limited financial resources | Most farmers were deterred by high fertilizer prices, which they said were almost making soy cultivation financially unviable in Brazil (Cerrado soil requires high investments in fertilizers to be suitable for soy). |
| Possibility of optimizing existing production | Some farmers said they would choose to invest in technology, employees’ training, change of providers, soil quality improvements or sustainable practices to increase production without area expansion. |
| Personal reasons | Personal reasons, such as sons’ willingness to expand the business or the death of family members, guided the decisions of some farmers. |
| Hired labor requirements | Some soy farmers alleged they would refrain from expanding due to the need for hiring labor to clear or prepare the new areas for cultivation. |

*The reasons are organized in descending order of frequency that each reason was mentioned.

capital to continue deforesting further into the frontier (see Arima et al., 2011). This suggests that soy farmers will likely resist any assigned blame or accountability calls for their role in indirect land-use change.

Second, although the lands that soy farmers currently cultivate may have been previously deforested for livestock farming, they still contain significant remnants of Cerrado vegetation that could legally be cleared for expanding soy production—and most farmers are keen to do so if the demand for soy continues to grow. That is worrisome because global soy demand has steadily increased over the past 60 years (Ritchie and Roser, 2021) without signs of abating. Similar to our findings, Rausch and Gibbs (2016) found that 44% of 43 soy farmers surveyed in the neighboring state of Mato Grosso between 2013 and 2014 intended to expand their production area. However, in the Amazonian part of Mato Grosso State, less than 2% of the properties producing soy could be cleared

legally when the survey was conducted (Gibbs et al., 2015). In Tocantins, in contrast, up to 20% of the properties with vegetation over 25 ha of Legal Reserve in 2015 could be legally cleared (Rausch et al., 2019). These numbers suggest that although soy farmers in different parts of Brazil might share a similar wish to expand cultivation to new areas, current regulations make the Cerrado far more susceptible to legal deforestation.

It is in this context that soy farmers emphasize their entitlement to clearing further land as their legal prerogative and almost obligation. They think they are forsaking their rights and bearing an opportunity cost if they do not deforest. In a sense, permissive regulation becomes a tacit incentive. Even when soy farmers do not intend to use the land immediately, they still wish to secure their possibility of using it in the future—something they have increasingly become wary of under growing environmentalist pressure and a shifting policy landscape. Following the logic of securing such a “right to deforest,” our results corroborate other studies showing that the threat of upcoming stricter deforestation-free sourcing policies may increase deforestation in the short run (see Guerrero et al., 2021; Garrett et al., 2022). Some farmers mentioned that they already refrain deliberately from conserving native vegetation in their lands due to the fear that they may not be able to clear it later if more stringent regulations are introduced.

That sense of entitlement in reality exceeds the law itself, as research shows that many soy farmers clear native vegetation also illegally (see Rajão et al., 2020). Our results indeed demonstrate that farmers do not see fines necessarily as a risk. Some would rather do what they want to do and pay the fine later. The farmers in our study generally resented such external control over their land-use decisions, which they often regard as haphazard and sometimes undue. They see themselves as providing an insufficiently recognized public social good by “feeding the world.” The longstanding observation that food insecurity, globally or within Brazil itself, is not due to food shortage but insufficient access to it (see Sen, 1982; Yasmeen, 2022) does not come into the reasoning. Soy farmers often agree that increased production does not always require opening new areas—a point often made also by Brazilian institutions (Embrapa, 2018)—yet they do not forgo their right to clear land. When they refrain from doing it, it is because of socio-economic considerations such as hiring external labor, soy prices, and or agricultural input costs.

Soy farmers show little intrinsic motivation not to deforest. If economic incentives and policies allow them to convert native vegetation into new agricultural areas, they will do so. They assess it essentially as a business opportunity, responding to market signals within what is a lax policy setting. As such, the responsibility—and accountability—for losing the Cerrado biodiversity hotspot does not only rest with the farmers; it needs to be analyzed within the broader picture of the public policies in place and of the multiple stakeholders within the soy supply

chain. If the farmers show little to no inclination to change their behavior in the current setting, then the setting may need to change.

The case for greater stringency and enforcement to reduce Cerrado deforestation

A core insight from our qualitative work is that soy farmers essentially follow an economic rationale in their decision-making, unencumbered by environmental sustainability concerns. Moreover, they have developed a sense of entitlement to deforest due to the Cerrado’s lax protection policies. We argue, therefore, that much of the current advocacy effort—focused on having soy farmers voluntarily adopt “best practices” or expand production without deforestation—is misplaced. Our findings vindicate the warning of Soares-Filho and Rajão (2018) that such an approach is ineffectual and instead stricter rules and law enforcement are needed.

We have shown that persuasive policy instruments in the form of campaigns or awareness-raising are unlikely to suddenly foster a conservation ethic or environmental consciousness among soy farmers. Younger generations may be more sensitive to such matters, and one factor we identified as influential on farmers’ decisions was their children’s opinion. However, time is a critical factor as Cerrado deforestation has been a fast affair, and local environmental change is already being felt (see Flach et al., 2021; Russo Lopes et al., 2021). Campaigns to optimize production without area expansion (see Bicudo da Silva et al., 2020) may want to focus on such younger generations for greater effectiveness, but that alone as a solution would be elusive. The recent past shows that despite crop yield improvements (see Koch et al., 2019), between 2002 and 2014 horizontal expansion was responsible for 85% of the soy production growth in Brazil (Cassman and Grassini, 2020). Santos et al. (2021) suggest that it is possible to double soybean yields through improved agricultural management in the Cerrado, yet others have shown that higher returns in Brazilian agriculture have historically led to area expansion and deforestation—the so-called Jevons paradox (Ceddia et al., 2013). Soy farmers’ low threshold for clearing new vegetation for profit only reaffirms the limits of voluntary action.

Likewise, the notion of paying off soy farmers to refrain from clearing seems unwise, for it would reinforce an already-strong sense of entitlement to deforest. That is besides other problems that previous studies already identified, such as the inequity of rewarding wealthier farmers who have deforested but not others more in need and who have helped conserve the Cerrado, or having to sustain payments that would need to match the opportunity costs of not growing soy (see Bastos Lima and Persson, 2020; Garrett et al., 2022). Environmental NGOs as well

as supply-chain actors may therefore be more effective moving away from trying to sway soy farmers through incentives. A more promising pathway may be working to reduce the current permissiveness that allows soy farmers to feel entitled to deforest the Cerrado and eventually hold it to ransom.

Given that soy farmers are conditioned—even moved—by what they can legally do, and considering that much soy expansion in the Matopiba frontier has exploited the insecure land tenure of local communities (Russo Lopes et al., 2021), improving Brazil's land policies is of paramount importance. We concur with Resende et al. (2021) that the Cerrado urgently needs more conservation areas, either in the form of public reserves or socially-oriented initiatives that could also help traditional communities secure their land rights and livelihoods (see also Bastos Lima and Kmoch, 2021). These alternatives may be less risky than trying to renegotiate Brazil's Forest Code (and its Legal Reserve requirements for private farms) under a Congress that remains dominated by large agribusiness interests—and which could eventually use the opportunity to relax the rules further (see Kroger, 2017; Søndergaard, 2020; Bastos Lima, 2021). Still, the Executive may improve enforcement through better monitoring and a mechanism to ensure that (1) fines are priced correctly—meaning that it should not be worth paying the fine in order to increase profits with the newly cleared area; (2) farmers will pay the fines; (3) punishment options other than fines are available for those who constantly keep paying the fine and not changing the behavior.

Meanwhile, supply-chain actors need not wait for a change of tack in Brazil. They can already engage in initiatives to select against wrongdoers and favor suppliers who grow soy without deforestation. There has been a call for commodity traders to adopt a Cerrado Soy Moratorium similar to the one for the Amazon (see Soterroni et al., 2019), but it remains an elusive ambition. Mandatory due diligence legislation in importing regions is forcing companies to act (Schilling-Vacaflor and Lenschow, 2021); however, some (e.g., the UK one) remain attached to curbing only illegal deforestation, which is insufficient (see Reis et al., 2021). The European initiative, in turn, helpfully sets a cut-off date for any deforestation (legal or illegal), but it still leaves most of the Cerrado ecosystem uncovered (see European Commission, 2021). Greater stringency is also required from such policies, not only the Brazilian ones. Moreover, our findings on anticipatory clearing suggest that implementation speed is critical to reducing the risk of pre-emptive deforestation due to such conservation-oriented policies.

Finally, there is the question of leakage to other markets, such as China, which consumes the bulk of Brazilian soy. That requires further attention—and eventually engagement with Chinese actors. Still, already-concerned supply-chain actors can draw lessons from traceability systems such as Selo Verde in the state of Pará and implement deforestation-free clearance systems

that multinational traders and financiers may request regardless of who will consume the soy. If anything, our results strengthen the case for greater stringency and due enforcement, without which there is little hope for the Cerrado.

Conclusion

This study has assessed soy farmers' perspectives on land use and clearing in Tocantins State, an agricultural frontier in Brazil's Cerrado. It shows they have mostly migrated from Rio Grande do Sul State, highly motivated by the economic opportunities presented by cheaper land prices and Tocantins' agricultural potential. Many reported moving to already degraded pastures (confirming environmentalists' concerns about indirect land-use change as cattle ranching expands into native vegetation areas), though some mentioned having cleared the land directly for soy and intending to continue doing so in the future.

Our conclusions are three-fold. First, soy farmers in Brazil show little to no self-restraint when it comes to converting native Cerrado vegetation into agriculture despite the growing scientific recognition of its environmental importance. They are inclined to continue clearing whenever it pays off and follow what is essentially an economic rationale. As such, conservation strategies based on voluntary land sparing are likely to be short-lived and elusive. Educational initiatives to promote deforestation-free “best practices” or a conservation ethic are unlikely to be effective in the short term. Environmentally oriented efforts run against a deeply entrenched mindset of a near-sacrosanct “right to deforest” and a certain righteousness in doing it for the sake of “feeding the world” among Brazil's soy farmers. A change of ethic may take generations. Any attempt to compensate such farmers for conservation, therefore, would dangerously have to sustain a price competition with the profitability of growing soy. Our findings suggest that such approaches may be alluring for landholders from a business point of view but hold little promise as a strategy to conserve the Cerrado.

Second, improved enforcement is of paramount importance, as illegal deforestation also continues to take place and soy farmers show disregard for the eventual costs of breaking the law. In this sense, supply-chain actors may have a critical role to play—even those that are limited to screening out illegal deforestation. There can be synergies between public and private sector players in ensuring that illegal deforestation is reduced to zero in the Cerrado, among others through traceability mechanisms along the lines of Selo Verde in Pará State, which may be mimicked in Cerrado states and elsewhere.

Third, too much of the Cerrado can still be cleared without either legal or market-access penalties. Soy farmers have benefited from the right to do so, and our research

makes it evident that they are not inclined to voluntarily change that behavior. Therefore, conserving what remains of that ecosystem depends also on creating stricter regulations. Changes would require quick implementation, as soy farmers are inclined to pre-empt regulatory restrictions through anticipatory clearing. Traders and importing markets may wish to impose cut-off dates for what constitutes acceptable deforestation as has been done in the Amazon Soy Moratorium or in the European mandatory due diligence legislation being conceived, though both so far leaving the Cerrado as a sacrifice zone.

Public policy changes may help rectify the current situation through the creation of more Conservation Units, a higher percentage of required Legal Reserves within private farms, or greater recognition of traditional community land rights and support for convivial forms of Cerrado conservation, all of which would constitute additional *legal* restrictions to conversion. Further research is needed to understand the socio-economic and environmental outcomes of those potential interventions. What is clear is that, as things stand, the Cerrado's continued existence—and with it the vital ecosystem services on which society depends—relies far too much on the individual good will and voluntary action of actors that do not recognize its value.

Understanding that soy farmers' decisions on cropland expansion follow an essentially economic rationale suggests this could also be more fertile ground for policy action, should more stringent land-use regulations not be forthcoming for political reasons. However, we advise caution with incentives, such as payments for conservation, as other research has shown their dangers. Instead, we argue that other, more environmentally concerned actors in the soy sector (and beyond) could look to restricting the market incentives for unrestrained soy expansion, for instance by encouraging more sustainable supply chains driven by international consumer demand. Responsibility for Cerrado deforestation should not be placed exclusively on soy farmers' shoulders but on the whole agri-food system that relies on it; therefore, accountability may also be pursued for other actors to create an economic incentive structure more conducive to conservation.

Data availability statement

The original contributions presented in this study are included in the article. Further queries can be directed to the corresponding author.

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Ethics statement

The studies involving human participants were reviewed and approved by Griffith University Human Research Ethics Committee (GUHREC). The participants provided their written informed consent to participate in this study.

Author contributions

RA and MB contributed to the conception and design of the article. Data collection was planned and managed by RA with the supervision of HR, MB, and GB. RA wrote the first draft of the manuscript. All authors contributed to manuscript revision, read and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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