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Contents

Executive Summary

This report analyzes private initiatives aimed at decreasing deforestation of the Amazon biome, focusing on measures taken by the soy and the beef private sectors to decouple supply chains from Amazon deforestation. Moreover, we highlight important existing challenges and present a series of recommendations for how remaining issues can be confronted through sustainable solutions from an environmental and social perspective.

Environmental issues are becoming central in defining the conditions for Brazilian agri-food's global market access. With strong public attention towards surging Amazon deforestation in recent years, this issue has become central in molding the dominant international narratives and perceptions of Brazilian agriculture.

Lacking public commitment to respond to this challenge over recent years has left the private sector in a situation in which it has been forced to act to avoid environmental reputational risks. The *Soy Moratorium* and the *Beef Moratorium* signed in the late 2000´s were initial steps on the way to decouple soy cultivation and export-oriented beef production from Amazon biome deforestation.

Challenges nonetheless remain for the decoupling of beef and soy from Amazon deforestation. On the producer level, zero-deforestation commitments have been met with resistance, and non-compliant soy supply chains have grown slightly in the Amazon biome. The *Beef Moratorium* has been somewhat less effective, and measures to identify and exclude non-compliant producers have confronted challenges of cattle "laundering" and "leakage" which complicates traceability.

However, different **monitoring and traceability** instruments exist which could help slaughterhouses in their efforts to ensure zero-deforestation supply chains. **Public registries** play a central role, and if non-disclosure of important production data can be guaranteed, combining data from existing registries could significantly diminish the risk of non-compliant beef products entering compliant supply chains.

Other important measures which can support efforts to curtail Amazon biome deforestation are **sustainable intensification** whereby proper pasture management and integrated systems can provide significant yield increases per hectare; **payments for environmental services** whereby producers are financially compensated for preserving areas which they otherwise would be legally entitled to deforest; **inclusion and technical assistance** to smallholders and other producers without the resources and knowhow to produce sustainably without depending on periodical deforestation; and **landscapes approaches** which provide a new and more inclusive governance instrument to certifying territorial entities as sustainable sourcing areas.

Finally, private initiative is essentially limited without strong **public engagement** in implementing existing legislation through **command-and-control** mechanisms. As by far **the largest share of Amazon deforestation occurs illegally**, private actors have come to undertake essentially public responsibilities to avoid rejection of Brazilian products within international markets and divestment from the agricultural sector. However, as long as Amazon deforestation continues, it will be impossible to completely dissociate this process from Brazilian agriculture within the eyes of the **global public**. Adherence to the **Forest Code** as the dominant legal framework governing land use in Brazil, as well as strong and effective public monitoring and exercise of authority in guaranteeing the preservation of this biome, is therefore imperative.

Hence, although we recognize the positive contribution made by private initiatives, **we strongly highlight the need for legal compliance as a *sine qua non* condition for effective action to conserve the Amazon**. Strict, swift, and effective implementation of existing legislation is therefore indispensable to shield Brazilian agri-food exports against environmental risks and their effects within global supply chains.

Motivations

Accelerating climate change and biodiversity loss has led to increased global attention towards the drivers of tropical deforestation. Agricultural and livestock production has become central to these discussions which often revolve around solutions to effectively halt the conversion of native vegetation. As a large agricultural producer with most of the Amazon biome within its national territory, the Brazilian agricultural and livestock sector will inevitably have to become part of such efforts.

Important experiences from past initiatives taken within the soy and beef supply chains demonstrate the effectiveness of the combination of public and private engagement in large-scale conservation efforts. Increasing recent deforestation rates, and the surging reputational risks to which Brazilian agri-food exporters become subjected nonetheless demonstrate that further action is needed to protect the Amazon biome and hereby also avoid the indirect export of deforestation through food products.

As the task of confronting the climate crisis becomes increasingly urgent, and as signs appear that the global market access of Brazilian agricultural products could be seriously jeopardized by increasing deforestation, it becomes imperative that academia, public policymakers, and civil society engage with this issue. Indeed, an important space does exist for public debate in which a wide range of agricultural, environmental, and other stakeholders can seek consensus regarding future pathways for effective action.

With this policy paper, elaborated in cooperation between **Insper Agro Global** and the **Brazilian Center for International Relations (CEBRI)**, we seek to contribute to debates about how to ensure the decoupling of soy and beef production from illegal Amazon biome deforestation. Existing experiences and ongoing initiatives demonstrate that reconciling increased agricultural output with Amazon conservation is not only technically possible, but also more economically profitable than business as usual. We also draw upon insights from debates on agriculture and sustainability organized by Insper Agro Global during 2020, and which will continue in 2021. We hereby hope to contribute to a qualified public discussion on a contemporary issue of vital global importance.

Glossary

ABC Plan: *Plano de Agricultura de Baixo Carbono* (Low Carbon Agriculture Plan) is a public policy to support Low Carbon Agriculture that encompasses six elements with goals for mitigating GHG emissions: recovery of degraded pastures; crop-livestock-forest integration and agri-forestry systems, no-tillage, biological nitrogen fixation; forest planting; and animal waste treatment.

AMAZON biome: represents more than half of the remaining tropical forests in the world. It comprises the largest biodiversity in a tropical forest on the planet, in addition to the largest hydrographic basin in the world. The largest share of this biome is situated within the Brazilian territory, corresponding to 4,196,943 km², which comprises 60% of the Amazon, followed by Peru with 13%, and with smaller fragments in Colombia, Venezuela, Ecuador, Bolivia, Guyana, Suriname and French Guiana. It occupies 49.3% of the Brazilian territory and covers three regions in the North, Northeast, and Center-West of the country.[1]

Legal AMAZON: refers to an area of 5,217,423 km², which corresponds to 61% of the Brazilian territory. Apart from comprising the entire Brazilian Amazon biome, it still contains 20% of the Cerrado biome and part of the Mato Grosso Pantanal. It encompasses all the states of Acre, Amapá, Amazonas, Mato Grosso, Pará, Rondônia, Roraima and Tocantins and part of the State of Maranhão (municipalities located west of the 44th meridian). The concept of Legal Amazon was instituted by the Brazilian government as a way of planning and promoting the social and economic development of the states in the Amazon region, which historically share the same economic, political, and social challenges. Its current form was defined by the 1988 Constitution.[2]

APP: *Área de Preservação Permanente* (Permanent Preservation Area) is a protected area, covered or not by native vegetation, with the environmental function of preserving water resources, the landscape, geological stability and biodiversity, facilitating the gene flow of fauna and flora, protecting the soil and ensuring well-being of human populations.

CAR: *Cadastro Ambiental Rural* (Rural Environmental Registry) is a national electronic public register, mandatory for all rural properties, with the purpose of integrating the environmental information of rural properties related to the APPs, legal reserves, areas of restrict use, forest remnants, and other forms of native vegetation, and of consolidated areas, comprising a database for control, monitoring, environmental and economic planning, and combating deforestation. It is the first step in the process of ensuring a property's environmental regularity and includes: data from the owner; data on proof of ownership and/or possession documents and georeferenced information on the property's perimeter with information on different types of land use.[3]

1. O Eco (2014a)
2. O Eco (2014b); IBGE (2019)
3. Sicar (2021)

CLFi: Crop-Livestock-Forest integration (*Integração Lavoura-Pecuária Floresta*) is a production strategy that integrates different productive, agricultural, livestock and forestry systems within the same area. It can be done in intercropped cultivation, in succession, or in rotation, so that there is mutual benefit for all activities. This form of integrated system seeks to optimize land use, raising productivity levels, diversifying production, and generating quality products. This reduces the pressure for inclusion of new areas for agricultural and livestock production.[4]

Double cropping: is a form of land use intensification, by planting two different crops in the same field during a single year without irrigation. In Brazil, the first harvest (typically soy) combined with a second (corn or cotton) significantly increases the total production of the cultivated areas and stops horizontal land expansion.

GTA: *Guia de Trânsito Animal* (Livestock Transit Guide) is an official document which is mandatory for both interstate and intrastate transit of animals regardless of the purpose. The GTA allows the livestock sanitary services to monitor the movement of animals, thus avoiding the introduction of diseases that could put the population at risk or cause losses to producers.

PRA: *Programa de Regularização Ambiental* (Environmental Conformity Program) consists of a set of actions to be developed in rural properties with the objective of adapting and promoting environmental regularization in accordance with the provisions of the Forest Code. It must be followed by rural properties with environmental liabilities related to the irregular suppression of remnants of native vegetation, which occurred until July 22, 2008 through recovery, restoration, regeneration or compensation.[5]

RL: *Reserva Legal* (Legal Reserves) is an area located inside a rural property or possession, with the function of ensuring the sustainable economic use of the natural resources of the rural property, assisting the conservation and rehabilitation of ecological processes and promoting the conservation of biodiversity, as well as shelter and the protection of wild fauna and native flora. Its minimum size in percentage relative to the property area is dependent on its location. In simple terms, this amounts to 80% in the Amazon biome; 35% in the northern Cerrados, and 20% in other areas.

Sisbov: *Serviço Brasileiro de Rastreabilidade da Cadeia Produtiva de Bovinos e Bubalinos* (Brazilian Service for Traceability of the Bovine and Bubaline Production Chains) is a system for tracing the movements of individual bovine animals. In general membership is voluntary, although mandatory for export to countries that require traceability, as is the case in Europe.

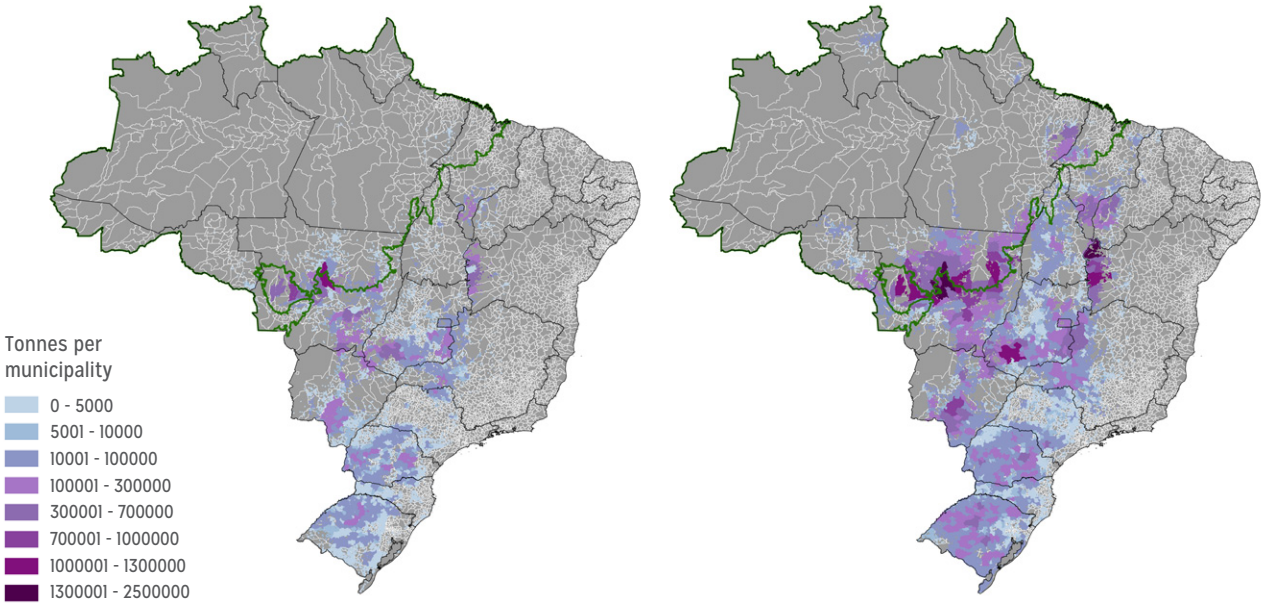
4. Rede ILPF (2020)
5. Ibid.

Illustrative Maps

Brazilian biomes

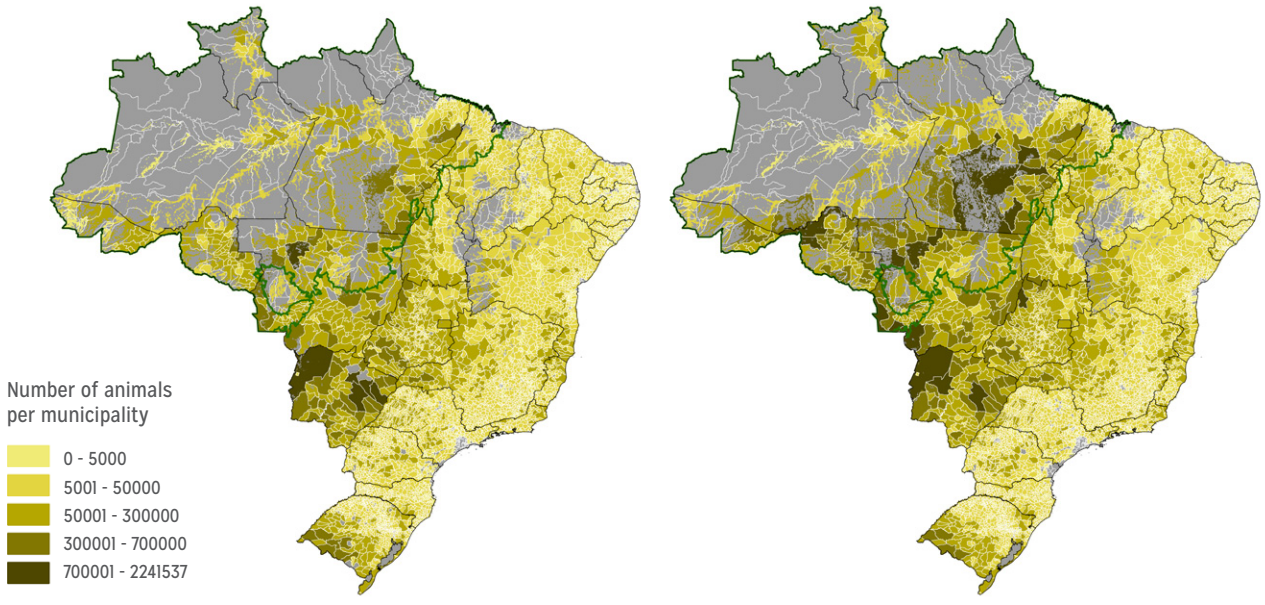
Amazon biome vs
Legal Amazon and the
Brazilian Federal States

Soybean production in Brazilian municipalities (2000 and 2019)



Source: Agrotools' elaboration based on soybean production volumes represented by the respective areas dedicated to soybean production from Mapbiomas (2020) and Municipal Agricultural Survey / PAM (IBGE, 2020a).

Livestock production in Brazilian municipalities (2000 and 2019)



Source: Agrotools' elaboration based on the number of cattle represented by areas dedicated to grazing from Lapig (2020) and Municipal Livestock Survey / PPM (IBGE, 2020b).

Notes: (i) the agricultural and pasture areas were approximated and highlighted using the AT Agrum spatial representation grid. (ii) AT Agrum, is a cartographic base produced by Agrotools that allows to connect and present large volumes of data at the sub-municipal level.

Introduction

As fires in the Brazilian Amazon Rainforest drew international headlines in 2019, environmental issues, with climate change concerns at their core, reached an unprecedented level of strategic significance which inevitably would define the future agenda for Brazilian agriculture. The official Brazilian responses to the burnings did not only spark a diplomatic crisis between the country and a range of European governments[6], but also led to reactions from private actors which expressed concern about increasing deforestation[7]. Sustainability-related concerns are not new to Brazilian agribusiness, which during recent years has responded to such challenges through different technical improvements and governance initiatives. Yet, the scale of the repercussions produced by the fires, and the global context of accelerating climate change, has produced a hitherto unseen degree of pressure directed towards actors thought to be either directly or indirectly associated with deforestation.

An important reason for the global outcry in response to the Amazon deforestation is that the debate about this problem has become increasingly salient. From previously mainly being a strong concern within certain areas of public policy making, and parts of civil society and NGO community, this issue has now also become central to private sector actors, and in some cases even gained the character of a national security challenge[8]. Within Brazil, increasingly strong calls from civil society and certain business sectors[9] for public action in relation to the effective implementation of the Brazilian Forest Code and land tenure regulation are evidences of the dimension that the debate has reached. As reports from the Intergovernmental Panel for Climate Change (IPCC)[10] point to a significant acceleration of climate change in recent years, the issue is increasingly significant within international

6. Watts (2019)

7. The Economist (2019); Scott (2019) Lopes (2019)

8. Walt (2019) Chade (2020)

9. Along July and August 2020, representatives of the Brazilian Business Council for Sustainable Development [Conselho Empresarial Brasileiro para o Desenvolvimento Sustentável (Cebds)] took part in meetings with the Brazilian Vice President, the President of the Chamber of Deputies and with the President of the Supreme Court, besides the province governors of the Legal Amazon. The council comprises 72 organizations, of which 62 are large companies, five are investment funds and five are sector associations. Together they comprise more than 40% of the Brazilian GDP (CEBDS, 2020).

10. IPCC (2018)

politics, but also amongst global investors[11]. Signals emanating from large institutional investors thus point to a serious risk of divestment[12]. Moreover, concrete cases of boycotts and withdrawal of capital have already materialized[13].

Grain traders and slaughterhouses operating in Brazil have faced substantial pressure regarding their links to deforestation. This fact has pushed them to define deadlines for mapping their entire supply chains to ensure zero-deforestation compliance. Although agricultural expansion in Brazil mainly occurs far from the fringes of the Amazon, and despite successful efforts to partly decouple certain agricultural and livestock production activities from deforestation of this biome[14], expansion of agricultural and livestock production has still been linked with Amazon deforestation[15]. This mainly regards a small number of rural properties and municipalities, which nonetheless account for a large share of total deforestation of the Amazon[16]. Therefore, the sector has become vulnerable to the negative repercussions of this development in different degrees. This has resulted in a situation in which assuming a proactive stance in relation to environmental issues has become imperative to agents throughout agricultural supply chains. This is especially urgent for actors within sub-sectors with a particular relevance regarding land-use change dynamics, such as soy and beef.

Between 2005 and 2018, a **combination of public legislative activism and private initiatives** such as Soy and Beef Moratoriums, sustainable production practices, and rapid productivity increases helped curb Amazon biome deforestation[17]. However, during 2019, a spike has raised serious international concerns. A deliberate weakening of command-and-control mechanisms on behalf of the Federal Government appears closely related to sudden increases on illegal deforestation observed in 2019[18]. While international concerns about Amazon deforestation historically have been met through dialogue and domestic efforts to modernize monitoring and law-enforcement capabilities[19], in the current Brazilian context of weak enforcement and absence of substantial public engagement[20], private actors will have to assume the initiative in order to confront urgent problems, while also seeking a more structured engagement in order to provide sustainable long-term solutions[21]. This objective becomes even more urgent, as some financial institutions have adopted socio-environmental criteria in the concession of credits to rural producers, and as broader decisions about sourcing and investment in Brazil come to hinge on these issues.

The soy and beef sectors stand in a particularly central position in terms of influencing land-use dynamics. The **Soy Moratorium of 2006**, and subsequently the **Beef Moratorium of 2009**, along with a series of initiatives on the company, pan-sectorial, or multi-stakeholder levels have had a significant effect in halting deforestation. Yet, a range of loopholes still exist, which means that despite efforts on behalf of important actors within the soy and beef chains to decouple production from Amazon deforestation, this goal has not been entirely accomplished[22]. More specifically, this is largely related to problems of "leakage"

11. CAN (2019)
12. Phillips (2020); Stuenkel (2020)
13. Andreoni (2019)
14. Gibbs et al. (2016)
15. Gibbs et al. (2015); Júnior & Lima (2018)
16. Rajão et al. (2020); Trase (2020a)
17. Nepstad (2014); Stabile et al. (2020)
18. Borges (2019); Shalders (2019)
19. Rajão & Georgiadou (2014)
20. Azevedo-Ramos et al. (2020, p.2)
21. Economist (2020); Coalizão (2016); Muggah & Abdenur (2019)
22. Rausch & Gibbs (2016); Lima et al. (2019); Rajão (2020)

and "laundering" of soy and beef[23], which concerns the distribution of these products either through parallel unregulated supply chains aiming at the domestic market, or through the sales of agricultural commodities produced irregularly through leakage into formally regulated supply chains[24]. Besides the influence of soybean cultivation and livestock activities, the heterogeneous character of the dynamics of land-use change in the Amazon biome further complicates this picture. In short, deforestation occurs mainly because of the following processes:

- Large-scale land speculation through the invasion of public lands to obtain land titles[25];
- Deforestation on private lands, whether legal or illegal, to develop economic activities such as soybean and livestock[26];
- Small land clearances and slash-and-burn practices on behalf of settlers and smallholders without sufficient means to cultivate lands for a longer period of time[27] [28];

Responses to the challenge of halting Amazon deforestation will thereby need to comprise of a series of diverse measures on behalf of both public and private actors, comprising of calibrated interventions[29], compensation mechanisms[30], and improved control systems[31]. Moreover, it will also be necessary to address the critique of private standards by rural producers dissatisfied that their level of compliance in relation to zero-deforestation requirements exceeds legal requirements.

In the current study, we seek to contribute to the efforts of defining effective and sustainable interventions to halt illegal deforestation by gathering assessments from academic, industry, public sector and civil society specialists, and providing a structured synthesis of their proposals. For this purpose, we draw on interviews with selected experts, combined with insights obtained from discussions during a series of online debates arranged by the Center for Global Agribusiness, as well as secondary sources. This has yielded a range of different perspectives on the complexities and often very practical impediments to the effectiveness of sector-wide initiatives that in principle should serve to decouple soy and livestock production from illegal deforestation. Moreover, we recognized different potential paths to address the multifaceted challenges of defining and implementing effective conservation measures at the sectoral level. The conclusions and policy recommendations presented in this paper thereby directly reflect both the specific suggestions and the general lines of reasoning which became evident during our interviews and discussions.

23. While "leakage" refers to the process whereby produce from illegally deforested lands are sold through unregulated supply chains, "laundering" happens when these commodities enter otherwise regulated/compliant supply chains.

24. Gibbs et al. (2016); Thaler (2017)

25. Azevedo-Ramos et al. (2020); Fearnside (2020)

26. Maisonnave (2018); Azevedo et al. (2017)

27. Mapa (2020a); Zycherman (2016)

28. Some indigenous and local communities' use of fire is considered as a sustainable land-management practice, as for example, small-scale rotational forest farming, to drive and trap game and to set firebreaks and limits the potential for catastrophic fires (Mistry, 2019).

29. Seymor & Harris (2019)

30. Soterroni, et al. (2019)

31. Silva, Barioni & Moran, (2020)

In this study, **we focus on the problem of deforestation in the Brazilian Amazon biome, namely on how interventions with a point of departure in the soy and beef sectors can work to halt this development in an effective way**. To this end, we address a range of questions, such as:

- How have the Soy Moratorium (2006) and the Beef Moratorium (2009) affected deforestation in the Brazilian Amazon biome, and what can be done to strengthen them?
- Which measures can be taken on the industry level to avoid "laundering" and "leakage" of soy and beef?
- Which tools and methods can traders and slaughterhouses apply in order to avoid products associated with illegal deforestation within their supply chains?
- What are the obstacles to the implementation of available measures to curb deforestation which traders and slaughterhouses might encounter on the producer level?
- How to enhance instruments of monitoring and traceability in order to ensure deforestation-free supply chains within the soy and beef sectors?
- How can payments for environmental services serve to avoid deforestation in the Amazon?
- How can sustainable intensification help decouple soy and beef production from deforestation of the Amazon?
- What is the effectiveness of private initiative in combating deforestation in the absence of public initiative and commitment?

This paper proceeds in the following manner. We initially present our methodological approach and considerations about the type of knowledge yielded by the interviews. Hereafter, **we analyze the experiences and challenges that private actors within the soy chain used to face to decouple soy expansion from Amazon biome deforestation in an effective way**. We then direct our analytical focus towards the beef sector, **seeking to assess how existing experiences with curbing illegal deforestation as well as novel initiatives on the sectoral level can lead to effective results**. Finally, we analyze our findings based on the conversations and debates and seek to provide a structured synthesis of potentially fruitful pathways to guarantee decoupling of production from illegal deforestation in the Amazon biome.

Methodological considerations

In the current study, we analyze private sector engagement in combating deforestation with a particular focus on soy and beef production. We have chosen these commodity sectors as they, depending on the regulatory interventions made, are associated with a significant potential (soy) and effective impact (beef) on deforestation in the Amazon biome. This is mainly due to the scale of the land use changes induced by soy and beef production in Brazil, meaning that successful efforts to decouple these economic activities from relying on the incorporation of native vegetation in the Amazon are imperative to conserving this biome. We concentrate on the Amazon due to its unique significance in terms of biodiversity, carbon sequestration potential, preservation of indigenous livelihoods, and importance for regional precipitation patterns. This has also meant that this biome has attained a particularly sensitive status in the eyes of the global public and within environmental debates. The strong repercussions which increasing deforestation of this biome implies are therefore more likely to lead to economic consequences for business sectors associated with this. By analyzing private sector initiative to decouple production from Amazon deforestation, we thereby treat one of the most important factors in defining the international image of the Brazilian agricultural sector. The relative success or failure of these efforts is likely to affect the conditions for the sector's global market access for many years to come.

It is also important to note that the Brazilian agri-environmental agenda in the Amazon consists of both public and private initiatives. The former refer to the enforcement of a legal environment that guarantees adequate inspection, liability, and punishment through command-and-control measures, land tenure regularization mechanisms, allocation of undesignated public forests, and strict implementation of the Forest Code. The second regard private sector efforts to coordinate agricultural supply chains according to certain sustainability-related concerns. The focal point of this paper is private coordination, although a certain degree of interconnectedness of public and private regulatory frameworks means that it has become necessary to treat aspects of the former.

In the current study, we rely on a triangulation strategy of different data sources, encompassing interviews, organization of debate sessions, quantitative data, news items, public policy papers, and secondary research papers and reports. Data triangulation helps to observe important processes and trends through different types of empirical evidence[32], and thereby adds to the reliability of our findings. This analytical method can also help to assess the role of specific actors in decision-making processes, as different types and diversified samples of data material provide a variety of perspectives on the interactions examined[33]. As part of the research process, we conducted a series of interviews with sectoral representatives in order to gather information about experiences and perspectives on decoupling efforts within soy and beef chains. In this particular, we conducted semi-structured interviews to guarantee a certain degree of freedom to the interviewees when answering on issues that they found to be particularly relevant. At Insper Agro Global we also organized a cycle of debates in which specialists from civil society, the private sector, and academia discussed different topics related to sustainability and Brazilian agriculture. These online events served the dual purpose of informing the public debate on an increasingly salient and important issue. It also contributed with valuable perspectives about the opportunities and challenges treated in this paper, which indirectly also informed our conclusions and policy recommendations. Finally, we have obtained important information and references from what we believe to be the state of the art regarding academic literature on the problem of Amazon deforestation, and from a range

32. Yin (2009, p.116)

33. Nemina & Zelicovich (2017, p.438)

of recent NGO studies, discussion papers, and corporate sustainability reports. We have also obtained quantitative data from Brazilian and international databases that support our argument by illustrating important trends within our field of analysis.

Deforestation and land use in the Amazon biome: soy and livestock production

Approximately 17% of the vegetation in the Amazon biome has already been deforested (INPE, 2020). Climatological projections indicate that the Amazon Rainforest is headed for a "tipping point" – between 20 and 25% - at which further deforestation could catalyze an autonomous process of degeneration, by which changing rainfall patterns will lead to the drying out of part of this biome (Lovejoy & Nobre, 2019). In this regard, we can divide Amazon deforestation into three different categories:

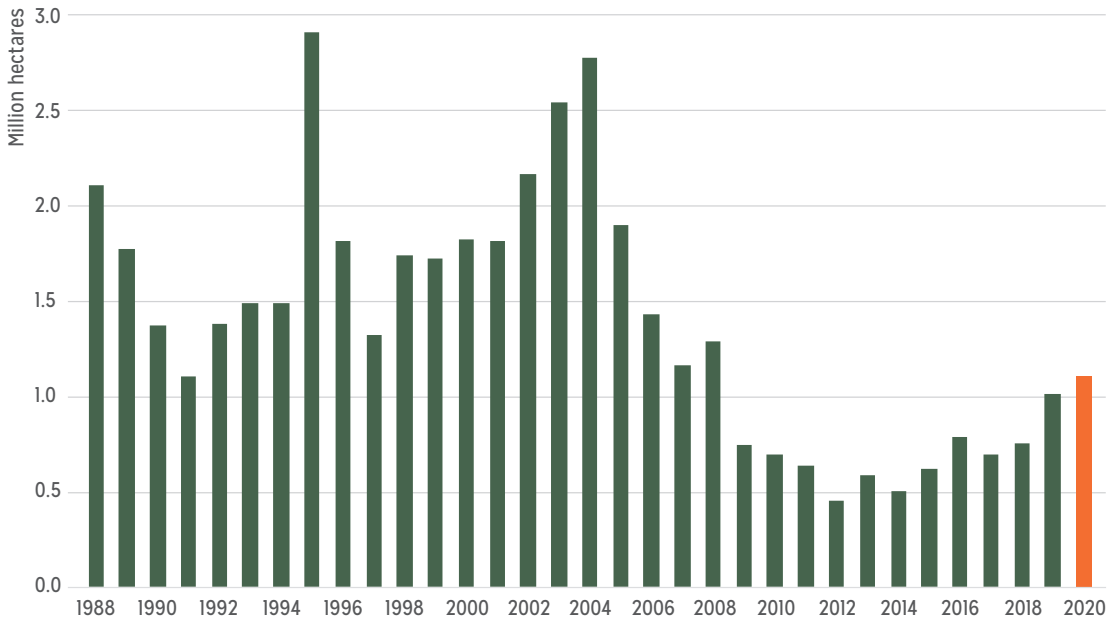
1. Legal deforestation, when licenses have been emitted permitting this activity;

2. Illegal deforestation, when native vegetation conversion violates existing laws, and;

3. Irregular deforestation, when clearings happen in accordance with the law, but without official permission.

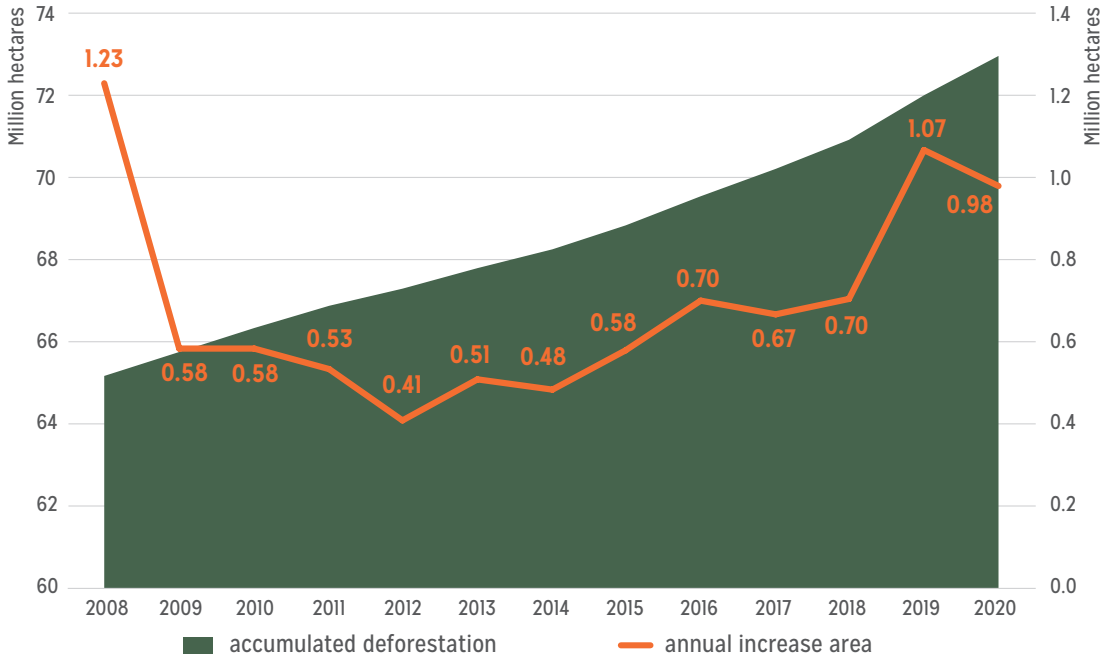
After reaching record highs in 1990s and early 2000s, deforestation in the Amazon underwent successive declines from 2005. Yet, deforestation rates have been rising again in recent years. In 2020, they reached a new peak since the 2000s (Figure 1). Thus, while a trend of flattening of the curve for accumulated deforestation could be detected in the early 2010s, a certain degree of steepening becomes evident in the last years of this decade, as annual deforestation rates were close to 1 million hectares annually in 2019 and 2020, as can be seen on Figure 2.

Figure 1 - Deforestation rate in the Legal Amazon since 1988 (in million hectares)



Source: INPE (2020). Note: data from 2020 is temporary and based on INPE projections. Definitive data will be released by INPE by mid-2021. For the full methodology see Câmara, Valeriano and Soares (2006).

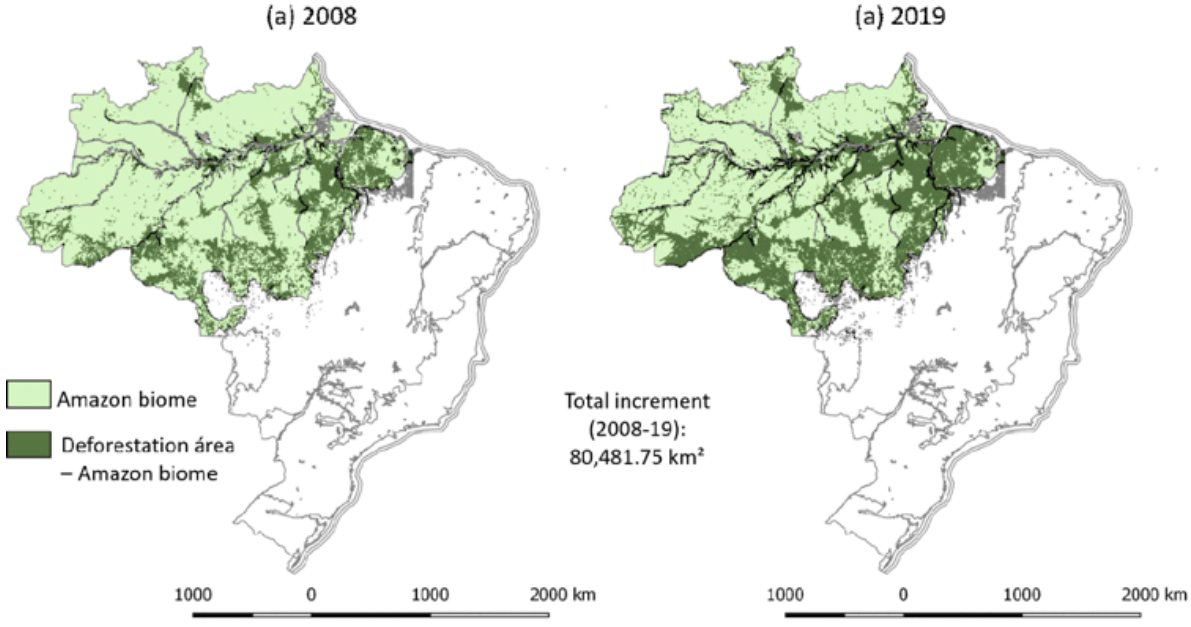
Figure 2 - Accumulated deforestation in the Amazon Biome and annual increase area (in million hectares from 2008)



Source: authors' elaboration based on Prodes data (INPE, 2020). Note: (i) the annual deforestation increase detected by satellite images is corrected to avoid the effect of deforestation covered by clouds. The corrected number thus constitutes the final annual deforestation rate; (ii) data from 2020 is temporary and based on INPE projections. Definitive data will be released by INPE by mid-2021. For the full methodology see Câmara et al. (2006).

The following maps provide a territorial overview of deforestation that has occurred within the Amazon biome throughout the past decade. As can be seen on Figure 3, much deforestation is concentrated in the Southern and Southeastern fringes of the biome.

Figure 3 - Illustrative maps of the advance of deforestation in the Amazon biome between 2008 and 2019



Source: authors elaboration based on Prodes data (INPE, 2020).

Table 1 presents the deforestation in the Brazilian Amazon biome distributed on states' participation. Nearly half of the deforested areas in the Brazilian Amazon were concentrated in the state of Pará (46.3%), which also accounted for the largest share in the period from 2008-2020 (44.2%). Mato Grosso is the state with the second highest deforestation rates, accounting for 17.5% in 2020 and 18.8% in the period from 2008-2020. The third and fourth-largest contributors in 2020 are Amazonas (13.3%) and Rondônia (12.6%), which, respectively, accounted for 11.2% and 13.7% in the period from 2008-2020. Observing the development in deforestation rates from 2008-2020, the largest growth detected is in Amazonas and Acre.

Table 1 – States within the Amazon biome and trends in deforestation (2020 and accumulated, in thousand hectares and %)

	2020		2008-2020		
	Increase in deforested area	Share (%)	Accumulated area	Share (%)	% Change
Pará	453.2	46.3%	3,986.6	44.2%	-1.7%
Mato Grosso	171.2	17.5%	1,695.6	18.8%	-4.5%
Amazonas	129.9	13.3%	1,012.5	11.2%	6.0%
Rondônia	123.2	12.6%	1,240.9	13.7%	1.0%
Acre	55.5	5.7%	438.4	4.9%	5.1%
Roraima	30.0	3.1%	305.9	3.4%	-5.9%
Maranhão	14.6	1.5%	281.6	3.1%	-11.7%
Tocantins	0.3	0.0%	22.8	0.3%	-19.3%
Amapá	0.1	0.0%	41.9	0.5%	-28.0%
Total	**978**	-	**9,026.3**	-	-

Source: authors elaboration based on Prodes data (INPE, 2020). Note: data from 2020 is temporary and based on INPE estimations. Definitive data will be released by INPE by mid-2021.

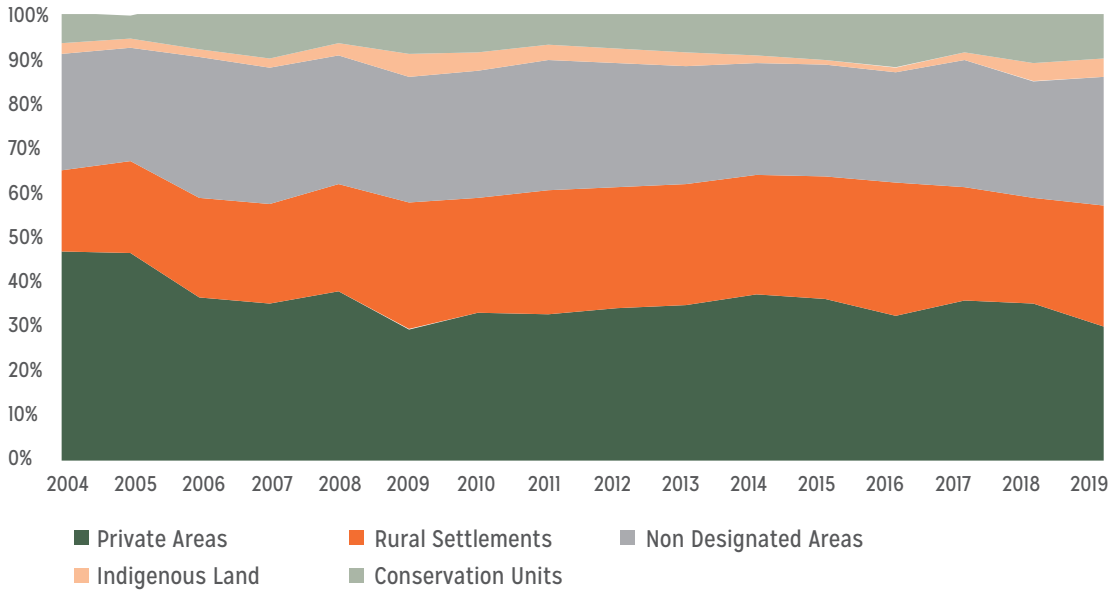
Cattle ranching is the most important economic activity in the State of Pará, which constituted 10% of Brazilian cattle in 2019. The State of Mato Grosso, on the other hand, is home to 14% of the Brazilian cattle herd[34] and in 2020, it was the largest grain and oilseed producer with 28% of total production[35].

Figure 4 illustrates where deforestation has occurred in the Amazon according to the land use categories. Most of the recent deforestation in the Legal Amazon has occurred on non-designated public lands, private lands, and within rural settlements. While deforestation on private properties in 2004 accounted for nearly 50% of total deforestation, this number had fallen to about 30% in 2019.

34. Abiec (2020)

35. Conab (2020)

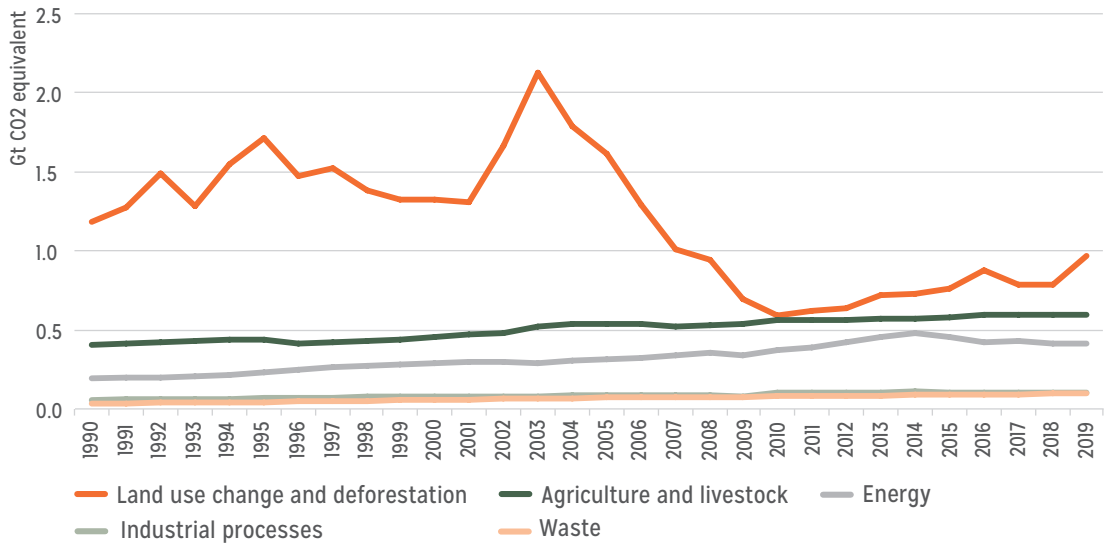
Figure 4 - Deforestation in the Legal Amazon according to land use categories



Source: authors' calculation based on PPCDAm (2019). Note: for 2018 and 2019, "private areas" correspond to the areas of CAR and "without information". Adjustments were made due to missing data for 2014.

Most of the deforested Amazon biome has either been abandoned or turned into low productivity pasture[36]. Therefore, except for soybean planting, marked by a productivity level close to the national average, the deforested areas within the Amazon biome are dedicated to unproductive economic activities. The rapid deforestation and expansion of agricultural and livestock production in recent decades means that agriculture and land use changes together account for more than 70% of Brazilian GHG emissions. Those activities thereby surpass energy production, industrial processes and waste management as the largest sources of Brazilian GHG emissions.

Figure 5 - Brazilian GHG emissions per source (in Gt CO_2 equivalent)

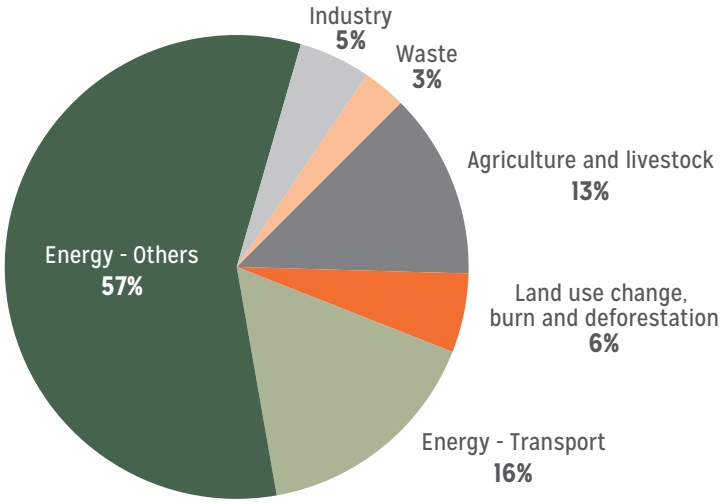


Source: Observatório do Clima (2020). Note: energy includes transportation and other uses.

36. Valentim & Andrade (2015); Dias-Filho & Lopes (2020)

Comparing the Brazilian GHG emissions profile to the main global emission sources, agriculture and land use changes represent a much larger share than the global average, which is close to 20%. On the other hand, the Brazilian energy matrix is much less emission-intensive than the world average. Globally, the energy sector thus represents 57% of GHG emissions and transportation represents 16% (see Figure 6) while in Brazil transportation represents 9%, and energy only accounts for 10%. That is, the electricity production in Brazil accounts for a significantly smaller share of emissions.

Figure 6 - Global GHG emissions per source 2016 (in %)



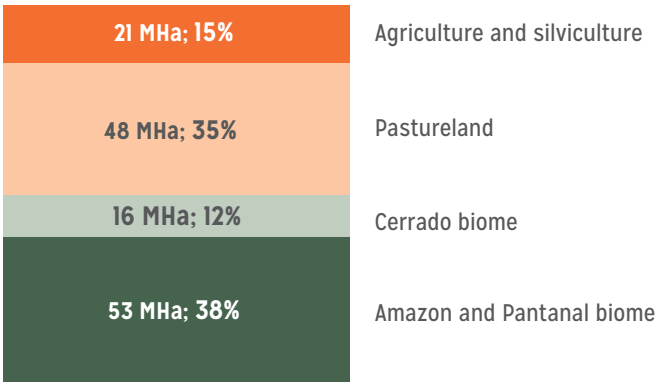
Source: World in Data (2020)

The large proportionate share of emissions represented by the agricultural and livestock sector, as well as the often-related dynamics of land-use change thereby further underscores the impact that interventions in this field can imply as part of Brazilian efforts to combat climate change. Brazil is currently the 6th largest GHG emitter, with 2.2 Gt CO_2 equivalent annually (in 2019), behind China, USA, India, Russia and Indonesia. While many of the largest GHG emissions globally can be explained by large population pools, intense industrialization, or an extreme reliance on fossil fuels, Brazilian emissions are mainly due to harmful land-use practices and outdated production models in parts of its agricultural and livestock sector. As we shall argue in the following section, with some further development and scaling of existing technical innovations and governance instruments, Brazil should be able to significantly decrease its GHG emissions from agriculture and land-use changes. Targeted action could thereby make it possible for Brazil to substantially reduce its contributions to global climate change.

Box 1 – Agricultural intensification and land use within the historical Brazilian agricultural frontier

Development of agriculture in the Amazon biome does not need to depend on deforestation of native vegetation but can grow through modernization and intensification of production practices on already deforested lands. Expansion within the historical frontier region, the Center-West, is not dependent on advancing on non-anthropized areas of the three biomes which together constitute the region - the Amazon, the Cerrado, and the Pantanal. The region in question comprises 138 million hectares distributed according to the scheme.

Land use in the Center-West Region



Source: Pessôa (2020).

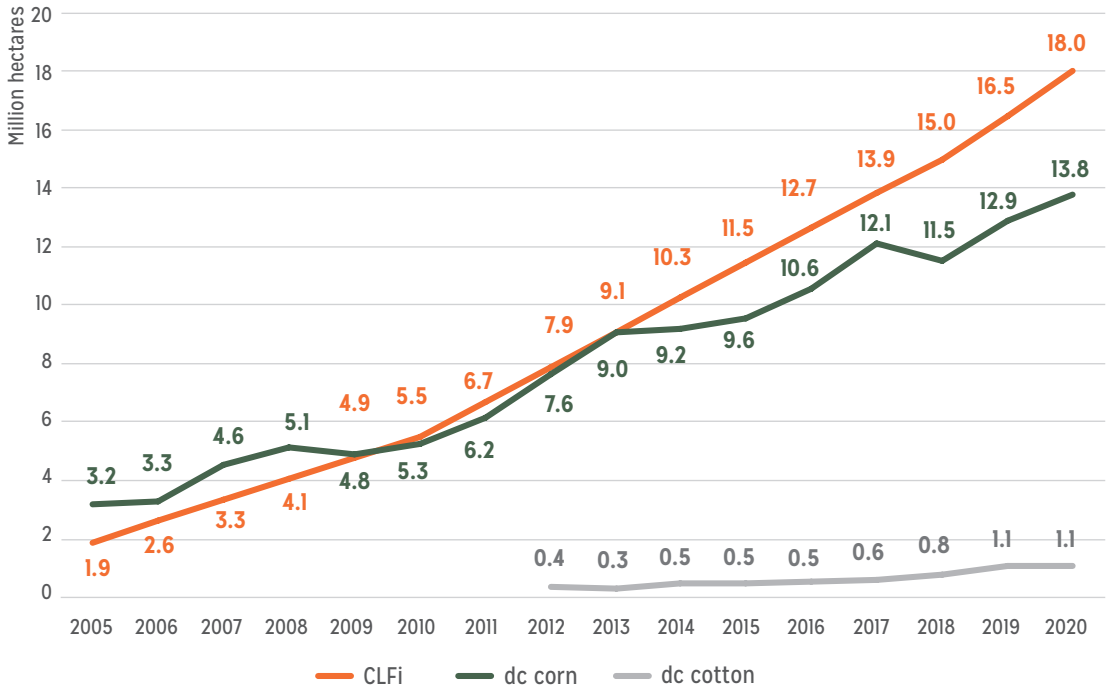
Areas that have not yet been anthropized representes around 50%.Within the entire Center-West region, it is estimated that around 55 million hectares display a high or medium degree of suitability for agricultural production, comprising 16 million hectares in the Cerrado and 38 million of pastures, of which 16 million are considered as highly suitable.

The projected incorporation of areas for agricultural production over the coming 10 years in this region is estimated at around 5 million hectares. Expecting that conversion of pasture lands into cultivated areas will be the driver of production expansion, - as it was the case with 90% of the area incorporated into agricultural production in the Center-West region over the past decade -, these areas are likely to be pastures with a high degree of suitability for agricultural production.

Land use in Brazil has intensified as this asset has increased in value. In the harvest season 1999/2000, 18% of the Brazilian territory planted with grains was double cropped, a number which over a 20-year period increased to 42%. In the Center-West, double-cropping occupies 60% of planted areas. Another example of intensification of land use in Brazil is the Crop-Livestock-Forest Integration (CLFi) system which rose from 1.9 million hectares in 2005 to 15 million in 2018 (Embrapa, 2020b).

The following Figure A crosses the double-cropped area for corn and cotton production planted in Brazil and the estimates for the area with CLFi. The rapid increase in the area on which these high-yield production methods have proliferated underscores how ample possibilities exist for expansion of agricultural production through implementation of innovative production practices without depending on deforestation.

Figure A – Evolution of the areas of CLFi (crop-livestock-forest integration systems) and double-cropping (corn and cotton) in Brazil from 2005 to 2020 (in million hectares)



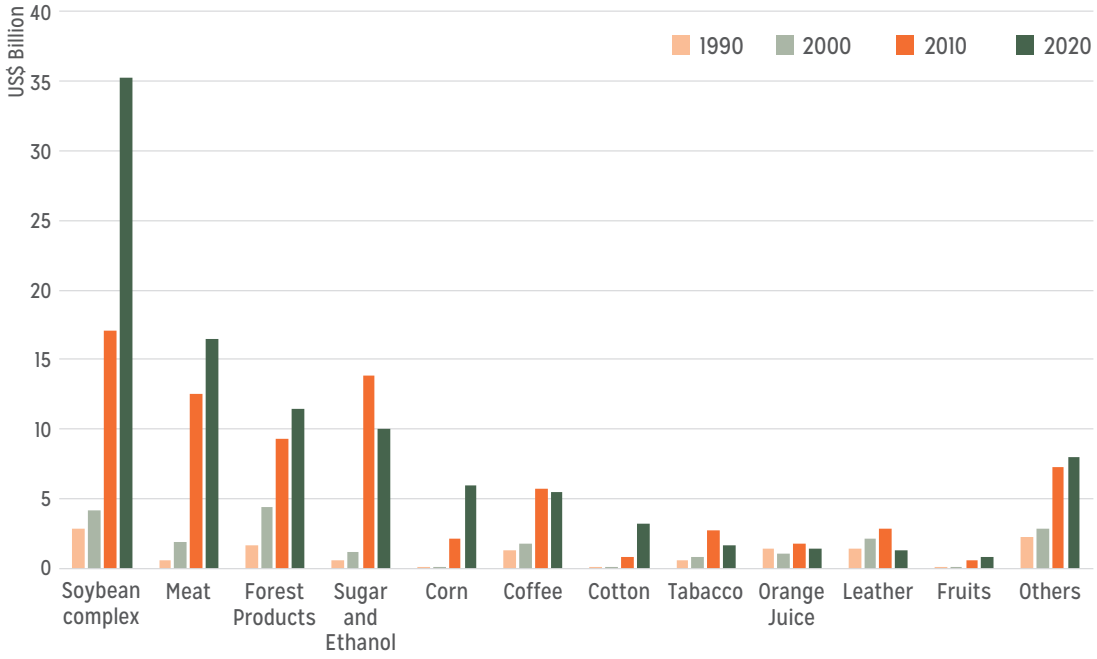
Source: authors' elaboration based on Rede ILPF (2020), Conab (2020) and Agrocosult (personal communication, January 29, 2021). Note: 2019 and 2020 data for CLFi refers to author´s projections

Private initiatives in the soy sector

Since the development of new varieties of soybeans adapted to tropical conditions, the area dedicated to soy cultivation has seen a significant increase, both in absolute terms and as a share of the total area dedicated to crop production in Brazil. Between 1976 and 2019, soybean production grew from roughly 7 million hectares to nearly 37 million hectares, resulting in a production volume that rose from 12 million tons to 125 million tons in the same period. While the planted area rose little more than five times, production underwent a ten-fold increase. The increase in soybean production has been of much economic importance to Brazil, constituting a central pillar within agro-industrial development and an important source of external revenues, reaching US$35 billion in 2020[37]. Figure 7 shows the importance of soy and meat within Brazilian agro-exports. Figure 8 illustrates the significant growth of Brazil as a global soy exporter in recent decades. In the past years, Brazil has even overtaken the United States to become the main global exporter of soybeans.

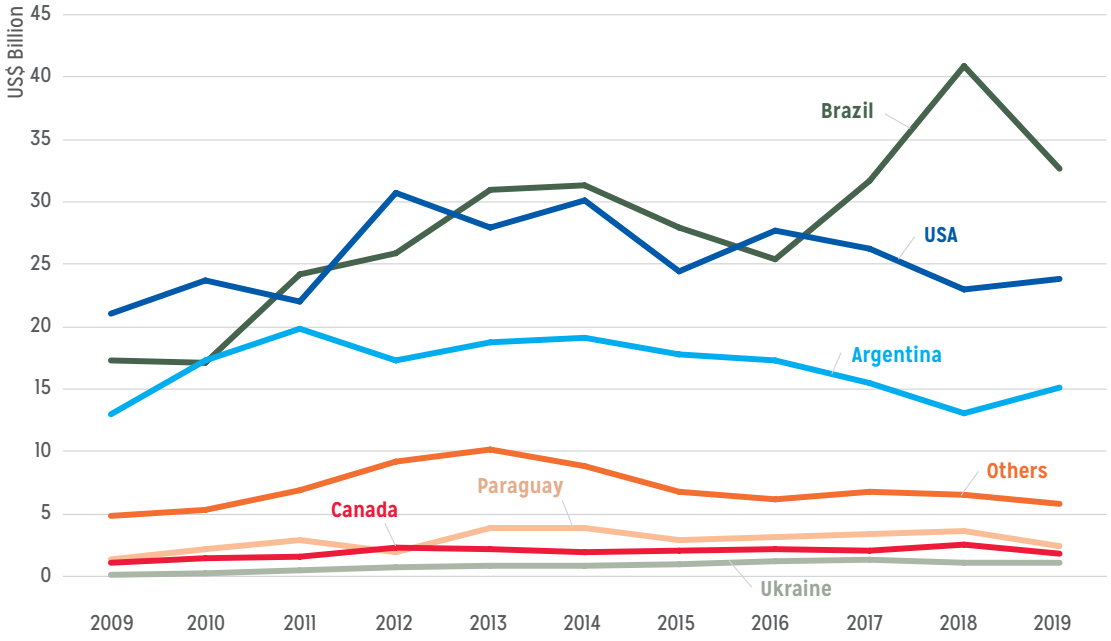
37. Abiove (2020a)

Figure 7 – Main Brazilian agri-export products from 1990 to 2020 (in US$ billion)



Source: author's elaboration based on UN COMTRADE (2020). Note: meat includes beef, poultry, and pork.

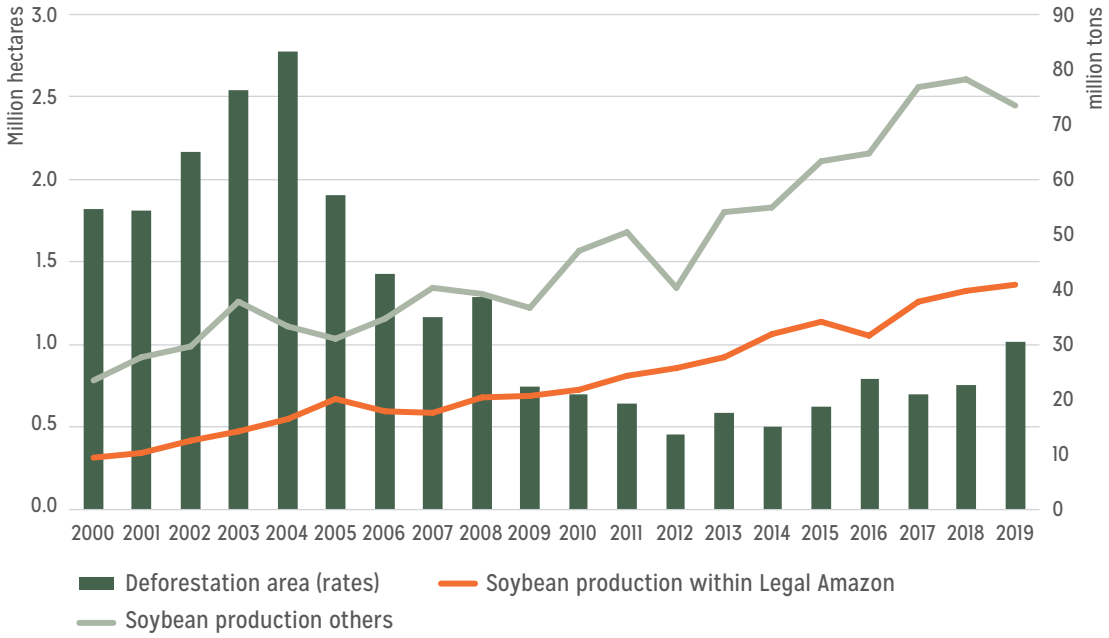
Figure 8 – Main global soybean exporters between 2009 and 2019 (in US$ billion)



Source: author's elaboration based on UN COMTRADE (2020)

Yet, the scale of the expansion of soy production has also raised environmental preoccupations, related to soil fertility[38], pesticide and herbicide use[39], and biodiversity loss[40], albeit important innovations for mitigating these have been made[41]. The most pressing aspect regarding the environmental impact does nonetheless regard land-use dynamics and potential for deforestation. The bulk of the incorporation of native areas for Brazilian soybean production took place within the inland Cerrado biome, where large-scale agricultural production underwent significant productivity increases[42] and marginal expansion costs for soy production were amongst the lowest in the world[43]. Since the developmental period, state-led initiatives to integrate remote regions within the Amazon through infrastructure provision have also facilitated the growth of agriculture within these territories[44]. The competitive advantages created hereafter led private actors to take over, and areas within the Amazon have now been incorporated into the soy complex, which is illustrated by the orange line in Figure 9.

Figure 9 - Deforested area in the Legal Amazon (in million hectares) and soy volume produced within the region from 2000 to 2019 (in million tons)



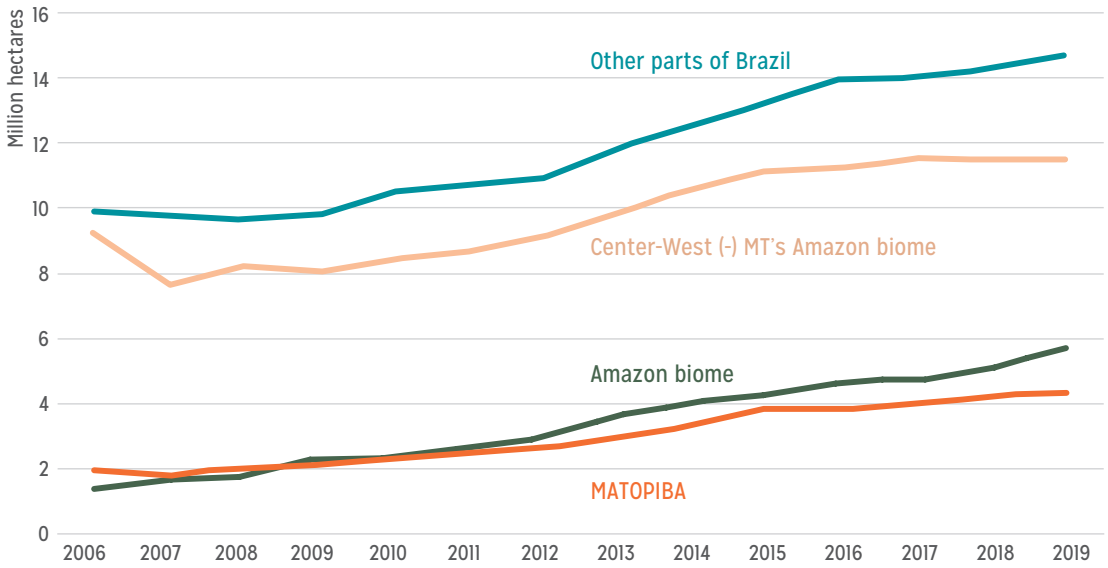
Source: authors' elaboration based on INPE (2020) and the Municipal Agricultural Survey/PAM (IBGE, 2020a)

As can be seen in Figure 9, soybean production in the Legal Amazon has risen significantly since 2000. As one of the largest soy producing regions globally, the State of Mato Grosso alone encompasses nearly two-thirds of the soybean area in the Center-West region. Roughly half of the territory of Mato Grosso (MT) is part of the Cerrado biome, which also is where most of the soy expansion has occurred. The Northernmost part of the state is nonetheless considered as native Amazon biome and occupies a critical position as a frontier zone for

38. Cavalett (2008); Merten & Minella (2013, p.44)
39. Barreto & Ribeiro (2006, p.5); Meyer & Cederberg (2011, p.5)
40. Lima et al. (2019); Soterroni et al. (2019)
41. Balbino et al. (2011); Flores et al. (2007); Júnior et al. (2014)
42. Gasques et al. (2004); Rada (2013)
43. Economist (2010)
44. Chaddad (2016, p.113); Sauer (2018)

soy production. The following Figure 10 illustrates the growth of the soybean planted area in selected producer regions.

Figure 10 - Soy production area by producing regions, between 2006 and 2019



Source: authors' elaboration based on the Municipal Agricultural Survey/PAM (IBGE, 2020a) and Agrosatélite (2020, apud Abiove, 2020b)[45]
Note: PAM is elaborated annually through a systematic survey of production based on questionnaires and statistical surveys related to the agricultural sector. The complete methodology can be conferred on the IBGE website. Agrosatélite/Abiove perform the mapping and survey of data on soybean crops and deforestation areas by reading satellite images and identifying image polygons. The complete methodology applied for this mapping can be viewed at Abiove website.

It should be noted that soybean production also has expanded significantly in Matopiba, which often is considered as the most important Brazilian agricultural frontier. It comprises the Cerrado biome of the states of Maranhão, Tocantins, Piauí, and Bahia and accounts for a large share of the Brazilian production of grains and fibers. Until recently, Matopiba was not considered as a significant agricultural production region and has attracted attention due to its increasing productivity.

The Soy Moratorium and other sectoral initiatives

The spike in the soybean area which can be detected from around 2005 attracted much international attention and preoccupations related to the impacts of soy production on Amazon biome deforestation. This eventually resulted in a joint initiative by retailers and traders within the soy industry and different civil society actors to halt soy-induced deforestation of the Amazon. The **Soy Moratorium of 2006** thus implied the commitment by traders not to buy soy from areas in the Amazon biome deforested after June of that year. The agreement was initially meant as a temporary measure to halt deforestation, but after ten years in effect, in 2016, it was extended for an indefinite period. The cultivated area in the Amazon biome has increased from 1.14 million hectares in the crop season 2005/06 to 5 million hectares in 2018/19. However, even as the total soy area in the Amazon biome has expanded with some 260% since 2006, only slightly more than 1% comes from newly

45. The Mato Grosso Amazon biome refers to the municipalities in Mato Grosso that are part of the Amazon biome and produce soy.

deforested areas[46]. A recent study estimates that the moratorium prevented deforestation of approximately 18,000 square kilometers of forest[47]. Hence, the Soy Moratorium is widely believed to have been a great success in decoupling soy production from Amazon deforestation[48].

Along with the Soy Moratorium, other private sector initiatives were undertaken in conjunction with the introduction of public policies with a conservationist aim. The synergies between these two sources of regulatory formation minded at tackling the Amazon deforestation thus appear to have been highly important in ensuring these initiatives' relative success[49]. The newly spiking rates of deforestation from 2019 create a highly complex situation, as the public regulatory initiative and enforcement have been stalled due to the lack of enforcement of existing regulation on behalf of the current Brazilian administration, even as international pressure and threats of sanctions against Brazilian agriculture increase. In this context, private actors within the agricultural sector stand in a central position to confront the risks of deforestation, especially concerning a highly sensitive and politically salient region such as the Amazon.

From the turn of the millennium, the Brazilian soy sector has been consolidated around a small number of traders, whose sourcing decisions, therefore, become crucial in influencing market uptake[50]. The so-called "Big-6" – Archer Daniel Midlands (ADM), Bunge, Cargill, Louis Dreyfus (LDC), Amaggi, and COFCO – are the most influential grain and oilseed traders in Brazil. These companies face exposure to a risk of native vegetation conversion of 1.32 million hectares, depending on the areas of the country from which they source[51]. As was highlighted by an interviewee from one of the traders, these companies are all confronted with increasingly strong pressure from global clients who seek to entirely eliminate deforestation from their supply chains. In large measure, the relative success of the Soy Moratorium is due to the market power which these companies wield, as they represent a very substantial share of total soy uptake in the Amazon.

Despite the achievements of the Soy Moratorium in decoupling large parts of soy production from Amazon deforestation, certain loopholes still need to be addressed. A central problem concerns the "leakage" of soy from areas embargoed by the Soy Moratorium which is sold to traders in the name of third-party producers, thus, evading the traders' formal control mechanisms to ensure zero-deforestation. Problems with indirect deforestation also exist, referring to the native vegetation conversion induced by soy expansion on pasture lands. The incorporation of pastures for soy cultivation may hereby produce indirect pressure for opening new areas for livestock production[52].

Guaranteeing the deforestation-free origins of soy has also been difficult in cases when multiple properties are owned by the same producer, mainly due to administrative complications. Studies from Mato Grosso have found that many farmers who infringe existing federal laws for deforestation continue to sell produce from areas recently deforested to the traders. This implies a high risk of "laundering" of soy grown within embargoed areas[53]. An interviewee from a soy trader also emphasized the complexity of monitoring all of the soy which the company received, as at least 30% of the volumes traded by the company came

46. Greenpeace (2020)
47. Heilmayr et al. (2020)
48. Rausch & Gibbs (2016); Gollnow et al. (2018); WWF (2016)
49. Nepstad et al. (2014)
50. Albano & de Sá (2011); Sauer & Leite (2012)
51. Soterroni et al. (2019)
52. Rausch & Gibbs (2016); Gollnow et al. (2018); Sauer (2018)
53. Rausch & Gibbs (2016)

from indirect suppliers, brokered by cooperatives, aggregators, and other third parties. In the case of Louis Dreyfuss, for example, the amount of soy sold through indirect suppliers is around 50%[54]. Whether the reliance on indirect suppliers is associated with deforestation risks depends heavily on the degree of consolidation of soy production in any given region. Sourcing from indirect suppliers in less consolidated frontier regions thereby implies a substantially higher risk of deforestation. The use of third parties in soybeans trade is more prevalent in Southern producer regions, which tend to be highly consolidated and therefore marked by low rates of deforestation risks. Within the Amazon and Cerrado biomes, direct transactions between farmers and traders tend to be the norm. For example, Archer Daniel Midlands estimates that the company's indirect supplies only constitute between 3-5% in the Amazon biome and approximately 10% in Cerrado. According to the Louis Dreyfuss report on soy sustainability, 3% of its entire sourced volume in Brazil is acquired through indirect suppliers in the Amazon biome. It should also be noted that often, these intermediaries are also signatories of the Soy Moratorium and other regional commitments to avoid deforestation. A representative from Archer Daniel Midlands thus underscored the company's policy of requiring zero-deforestation products from their indirect suppliers within the Amazon.

Box 2 - Traceability and monitoring of the soybean supply chain

Grain Traders have taken steps to proactively engage with the environmental risks within their supply chains, seeking to disassociate them from deforestation, especially within the Amazon biome, but increasingly also in the Cerrado. As part of these efforts, some traders have presented public commitments to ensure traceability and complete monitoring of their supply chains. Others have taken actions aimed at high-risk biomes regarding deforestation and native vegetation conversion, albeit, without presenting specific target numbers for deforestation-free supply chains. The mapping which permits tracing and monitoring of supply chains is based on suppliers' identification and registry within geolocation systems (address, rural environmental registry - CAR, geolocation, etc.). Knowledge of this information makes it possible for companies to trace soy shipments to the point of its production. Monitoring, in turn, refers to the assessment of the environmental impact of production and whether soy cultivation has expanded on recently deforested lands. Land-use changes and agricultural expansion is thereby monitored through geospatial instruments. Traceability and monitoring strategies differ between traders, both concerning the geographical scope, but also on the level of detail of the mapping. This can either be on the municipal level (less detailed), or through GPS "single points" (georeferenced points with a medium degree of detailing). Finally, polygon level monitoring (the most detailed) permits the observation of deforestation of specific areas within the rural property. Table 2 presents the commitments and advances made by the Big-6 in Brazil in relation to the initiatives aiming at traceability and monitoring of the soy chain with specific regards to direct suppliers.

*Part of the existing literature often questions the risks of deforestation assumed by traders with base in information of soy traceability at the municipal level (Economist, 2020) or farm level (Rajão, R. et al., 2020). It is nonetheless important to highlight that the Soy Moratorium only comprises the areas (polygons) in which soy is planted, and not of other crops within a given property. In other words, signatories cannot be compromised by deforestation occurring within a supplying property, but in areas occupied by other activities.

54. LDC (2020)

Table 2 – Objectives and measures for reaching zero-deforestation amongst the Big-6 soy traders in Brazil

Trader	Goal for the mapping of the chain (only direct suppliers)	Progress of mapping (1)	Progress of monitoring (2)	Goal for zero-DCF (deforestation and conversion free) supply chains	Progress of DCF	Detailing	Observations
Cargill	N/A	100%	-	2030	96.1% (a)	GPS single points at the farm-level	(a) estimates based on the company's methodology. For the entire country.
Bunge	N/A	100%	95% (b)	2025	-		(b) on the farm-level in production areas of Cerrado in the states of MATOPIBA + MT
ADM	100% by June 2021	95% MT 95% MS 100% (c)	100% (d)	-	-	Remote sensing of polygons at the farm-level (c)	(c) 25 municipalities in the Cerrado (MATOPIBA+MT) defined by the Soft Commodity Forum (d) according to the following commitments: The Soy Moratorium; areas embargoed by IBAMA, pact for the eradication of slave labour, the Green Protocol for Grains in Pará, the internal goal for 100% of polygons free from deforestation
LDC	50% until the end of 2020 (c)	100% (c) 70% (e)	-	-	99% (c)	Remote sensing of polygons at the farm-level (c) and to municipality level for the remainder	(e) considering the entire sourced volume
Amaggi	100% without definitive date	98% (f)	98% (f)	2025	99% (f) (h)	Remote sensing of polygons at the farm-level *	(f) Amazon Biome and MT (g) indirect suppliers (h) deforestation and conversion free from 2017
COFCO	100% until 2023	-	-	85% of direct suppliers in MATOPIBA region until 2021	-	-	-

Source: author's elaboration based on public available latest versions of reports from the companies. Cargill (2021), Bunge (2020), ADM (2020), LDC (2020). Amaggi (2020), COFCO (2020)

Notes: (1) progress of mapping refers to extension of the identification and registry from all the direct suppliers; (2) Progress of monitoring refers to the % of suppliers of which Traders have access to information about environmental performance (whether soy cultivation has expanded on recently deforested lands).

In January 2021, the soybean traders, CJ Selecta, Caramuru and Imcopa announced a commitment to zero deforestation supply chains in a move that presses larger companies to accelerate environmental commitments. The promise involves a veto on the sale of soybeans grown on deforested and converted lands after August 2020 throughout Brazil, which goes beyond previous agreements which applied only to the Amazon biome.[55]

55. Reuters (2021)

Furthermore, although the soy market is largely controlled by the Big-6, other actors who do not adhere to the Soy Moratorium, and who are not members of the National Association of Cereal Exporters (Anec) or of the Brazilian Vegetable Oil Producers Association (Abiove) also operate within this. They are the main parties responsible for purchasing and shipping soy from deforested areas to other parts of the country, - although the volumes of soy produced on lands deforested in this biome after 2006 are very modest. Since the Soy Moratorium, the proportion of soy traded through small traders not committed to the Moratorium has also risen from around 5% in 2006 to approximately 10-15% today. A representative from the soy sector thereby connects the increasing presence of such traders within the Amazon biome to the Soy Moratorium. It should be noted that between the crop seasons of 2012/13 and 2018/19, the soybean area in nonconformity with the Moratorium (areas deforested after July 2008) increased from 11,197 to 88,234 hectares[56] [57]. Of this area, around 85% of deforestation was estimated to be illegal. Although it represents less than 2% of the current soy area in the biome, non-compliance has been increasing gradually. Some soy farmers have expressed their discontent with the Soy Moratorium, since the zero-deforestation commitment reaches beyond legal obligations established within the Brazilian Forest Code[58]. Hence, in 2019, the soy farmers' association (Aprosoja) threatened a legal challenge against the Soy Moratorium[59].

While technically feasible, the task of ensuring a consistent decoupling of soy production from Amazon deforestation implies the need to address a complex set of problems throughout different instances of the production, supply chain, and existing monitoring and command and control instruments. The initial success of the Soy Moratorium has been attributed to a mix of public and private initiatives, and the synergies produced between them[60]. Current efforts will need to draw on these experiences. On the private level, the Big-6 have all adhered to certification systems comprising a range of social and environmental sustainability criteria, amongst which zero-deforestation is common. Yet, for the time being, certified soy only serves niche markets, and frequently faces the problem of lacking market uptake, meaning that it only constitutes a very small share of traded soy[61]. This is due to supply of certified soy outpacing demand, as the former has grown around 30% annually while the latter has increased 8-10%. Premiums for RTRS certified soy, for example, tend not to surpass 1%[62]. A representative from the soy sector nonetheless highlights that the main benefits from soy certification are to be found in the process of adapting operations to Brazilian legal requirements, which implies the overhaul of a series of social and environmental criteria. A large share of certification costs is thereby constituted not by auditing, but by adaption to existing legal standards. Our interviewee also underscores how the strong international focus on Amazon conservation means that international buyers often apply a very exclusive focus on deforestation-free products, without equally emphasizing a series of social and environmental issues which certification standards address.

Beyond certification, individual traders have been adopting strategies to ensure deforestation-free supply chains with different deadlines until 2030, at the latest (See box 2). Varying in their specific formulations from one trader to another, these commitments

56. Abiove (2020b)

57. Although the Soy Moratorium was declared in 2006, following the sanction of the new Forest Code in May 2012 (crop season 2012/13), the reference date for the Moratorium changed to July 22, 2008. The compliance check was carried out based on the selection of the 95 main producing municipalities that represent about 98% of the soy area in the Amazon biome (Abiove, 2020b).

58. The traders' commitment is not to buy soy from deforested areas in the Amazon biome as of July 2008, while the regulation allows farmers in general to deforest up to 20% of their area.

59. Aprosoja (2019)

60. Rausch & Gibbs (2016)

61. Schilling-Vacaflor et al. (2020, p.15); Tholen & Lenstra (2013); Schleifer (2017)

62. RTRS certified soy refers to soy certified by the Roundtable of Responsible Soy, a multistakeholder initiative seeking to promote responsible soy production through certification according to a range of specified sustainability criteria.

both encompass legal as well as illegal deforestation, and soy which has been sourced from outside the Amazon biome. The commitments made by some traders to reach completely deforestation-free supply chains thus elevate this criterion to define their operational baseline. Although this does not eliminate issues of leakage and laundering of soy, it redirects the problem towards monitoring and compliance mechanisms, which all have seen significant technical improvements in recent years. The scope of the initiatives aiming at completely deforestation-free supply chains is thereby likely to have a strong impact in terms of ensuring the continued decoupling of soy production from deforestation, both within and outside the Amazon biome. This is in large measure due to the market power of the traders, with soy processing and international shipping being heavily concentrated on the Big-6.

Distributing the costs of zero-deforestation

International investors and consumers, mainly from Europe, have been extremely averse towards any kind of association with deforestation, - a trend which only has become more accentuated in recent years. This has frequently been expressed through company policies of non-tolerance towards both legal and illegal deforestation[63]. Yet, these actors have often also avoided assuming costs to ensure zero-deforestation, such as payments for environmental services. An interviewee participating in the "Cerrado Working Group" underlines how this group presented a proposal for the creation of a compensation fund for soy producers with a surplus of forest beyond legal obligations to a coalition formed by 160 retailers, food processers, and investors. Yet, within the latter, only three eventually expressed an effective commitment to provide financing for such a mechanism. In a letter published in the Financial Times, Abiove bemoaned that "the level of commitment, both in the number of companies and in the number of resources (US$20 million), is clearly far below what is necessary". Abiove calculated the amount needed to be closer to US$300 million[64].

This exemplifies the difficulties which traders often encounter in terms of engaging with producers while still seeking to incorporate demands presented by international stakeholders. The general lack of will to pay for environmental attributes thus raises a certain degree of skepticism amongst producers about the potential for monetary compensation for refraining from legal deforestation.

As previously mentioned, public regulatory action in many cases constitutes an indispensable support for private initiative. As 85% of the areas in the Amazon biome in non-compliance with the Soy Moratorium are illegally deforested, effective implementation of existing legislation would by itself constitute a very significant step towards curtailing remaining problems. The role of public institutions could also become important through the enhancement of existing monitoring instruments. Hence, difficulties to trace the origins of soy production from farms that sell through different channels could be diminished through a unified public registry[65]. New monitoring instruments based on machine learning exist for predicting land use change and vegetation conversion, which constitute important mechanisms for public actors to enhance command and control systems to combat deforestation[66]. The creation of a unified monitoring and tracing mechanism would inevitably be associated with concerns regarding the data of production volumes and would need sector-wide coordination and

63. Mercopress (2020); Handelsverband (2020)
64. Nassar (2021)
65. Rausch & Gibbs (2016)
66. Frey, et al. (2020)

backing. Land registration has proven to be an essential pillar in the conservation efforts in recent decades and has been highlighted as a central means in preservation efforts directed at the Amazon[67]. Targeting undesignated public lands is fundamental in this respect, as the allocation of status as public forest holds the potential to both support conservation efforts by avoiding speculation, but also by stimulating a bioeconomy. Another important aspect in this regard concerns the possibility for re-inclusion of embargoed properties. The exclusion of many properties due to infringements of native vegetation requirements thus often dates back to previous owners. In these cases, current proprietors are frequently not aware of embargoes. Acceleration of agreements with the Federal Environmental Agency, IBAMA, through which landowners commit to restoring all illegally deforested lands can thereby help to reinsert producers within compliant supply chains while generating positive environmental results. As an interviewee from an agricultural consultation bureau highlighted, CAR registration has proven to be unnecessarily slow, and the attribution of this responsibility to individual states has led to many cases of inefficiency. Moreover, as Azevedo et al. (2017) emphasize, currently, due to a lack of monitoring and enforcement on behalf of authorities, the general incentive structure for producers often does not favor compliance with the Forest Code, including the restoration of illegally deforested areas.

Striking a balance between monitoring and punitive measures on one hand, and positive incentives and initiatives aiming at behavioral change on the other becomes essential. Experiences from the state of Pará suggest that landscapes approaches encompassing the use of credit can be highly efficient to incentivize, support, and reward positive environmental performance. An Amaggi representative also underscores the need for a more sectoral encompassing approach to regional environmental governance, emphasizing how problems with illegal logging or pasture-related deforestation easily can compromise the sustainability profile of nearby soy producers. Landscapes approaches thereby constitute a potentially important instrument to guarantee environmental compliance within the soy sector through positive incentives.

Command and control efforts can thereby not stand alone and need to be supplemented with positive incentives which permit the adoption of more modern production practices through targeted credit provision. Success with decoupling of soy production from deforestation since 2006 has thereby depended in large measure on private initiatives aiming at environmental risk management in combination with regulation. A more sustainable long-term development should not solely rely on punitive measures, and will need to be more strongly based on positive incentives from both commodity buyers, regulatory agencies, and financial institutions[68]. The existing Forest Code already sets out the basic principles of a system for environmental reserve quotas, encompassing mechanisms for monetary compensation for preservation of lands which producers otherwise would be entitled to legally deforest. In January 2021, the law N° 14.119 concerning payments for environmental services was passed. The law provides a regulatory framework for long-term conservation projects and permits public payments for environmental services, although important parts, such as fiscal incentives, were met with a presidential veto. In parallel to this governmental initiative, different regional initiatives are also in course, though the general picture of these efforts is more punctual and disperse. Completing the process of demarcating the Legal Reserve through the Environmental Reserve Registry (CAR) is important in this regard, as it permits accounting for the volume of CO_2 emission reductions obtained through different sustainability initiatives and preservation efforts. These reductions can thereby be converted into tradeable carbon credits under existing schemes defined within the multilateral climate change regime.

67. Alix-Garcia et al. (2018)

68. Nepstad et al. (2014)

It is imperative to device positive incentives to promote a higher degree of engagement in conservation efforts on behalf of producers. This group's discontent with the private environmental standard setting is echoed within governmental rhetoric, which might feed unproductive conflicts. Central to these grievances is the perception of the Soy Moratorium as a de-facto appropriation of part of their property, given that no compensation mechanisms exist for the foregone production on deforested areas[69]. This conflict gained public visibility through the split between the soy producer organization, Aprosoja, and the pan-sectorial agribusiness organization, Abag. Aprosoja has pressed for relaxation of environmental norms and claimed that producers' perspectives have not been sufficiently heeded, accusing Abag of negatively framing this group. Faced with environmental demands emanating both from actors at the national and international level, Aprosoja appears to have adopted a somewhat parochial stance, blaming these entities of conceding to a global agenda essentially driven by protectionist concerns. Abag has adopted a more strategic perspective of the growing significance of environmental issues internationally and is more sensitive to potential reputational fallouts. In order to address broader environmental problems, Abag has sought close engagement with financial stakeholders, the NGO community, and other civil society entities, among the latter, *Coalizão Brasil, Clima, Florestas e Agricultura*. Abag and other entities within the soy sector, such as the soy trader's sectoral organization, Abiove, have increasingly sought to rally actors and sub-sectoral agribusiness organizations around a sustainable development agenda. This engagement is grounded in the perspective that Brazil has the potential not only to be an important player within agriculture but also in the environmental field. These entities have thereby distanced themselves from the more deregulation-oriented and denialist perspectives within the sector and underscored the need to advance within the sustainability agenda in order to position Brazil as an agro-environmental power.

Box 3 – The Brazilian Forest Code: some achievements and challenges ahead

The Brazilian Forest Code is one of the main instruments for environmental regulation of agricultural production. This legal framework was the result of more than 6 years of deliberations with hundreds of public audiences. It was approved in 2012 by the Chamber of Deputies and the Senate. Shortly thereafter, four petitions stressing the law's unconstitutional nature were delivered to the Supreme Court, which contested practically all of the central elements of the recently approved law. Only in 2018, the law was deemed constitutional with the recognition of nearly all of its dispositions. The Forest Code hereby became an essential guideline for land-use practices in Brazil, and in a global comparative perspective, it constitutes a highly comprehensive and strict regulatory framework, demanding that all rural properties conserve a certain percentage of native vegetation, referred to as the Legal Reserve, to protect biodiversity (Chiavari & Lopes, 2017). Until the present moment, this has been a mandatory requirement without financial compensation.

69. Different estimates with respect to the native vegetation area preserved within private properties exist. The most optimistic is approximately 218 million hectares of native vegetation being preserved by rural producers, ranchers, and foresters (Embrapa Territorial, 2018). Yet, analysis of CAR registries by the Brazilian Forest Service (*Serviço Florestal Brasileiro* - SFB, 2020) points to an area of around 121 million hectares. It will only be possible to obtain a more definitive number for the preservation of native vegetation on private properties with the advance of validation and the qualification of registries.

In order to advance with the implementation of the law, more than R$100 million in public funds have already been invested in the creation of electronic monitoring systems (Mapa, personal communication, November 06, 2020). The CAR which is amongst the largest digital public registers of information about the use and occupation of rural properties in the world and one of the main instruments created by the law. Yet, advances are still to be made in the implementation of the CAR in order to integrate information on the property-level and thereby create a robust database to support environmental and economic planning and combating deforestation through control and monitoring. The main challenge regards the analysis of CAR data, as this is a self-declarational registry. More than 6.4 million properties are inscribed in the CAR, although, according to the Agricultural and Livestock Survey of 2017, in Brazil, there are only approximately 5.1 million rural properties. This difference is attributed to multiple registries and unauthorized overlaps with public lands. It is estimated that 11.6 million hectares, which correspond to around 110 thousand registers in the CAR database, are overlapping with non-designated public state and federal forests (Azevedo-Ramos, et al., 2020), and that of this total, more than 2.6 million have already been deforested. In 2019, more than 50% of deforestation took place on non-designated public lands (29%), and on other public lands, such as settlements (27%). Only around 3% of the total volume of CARs has been analyzed and validated, which reveals the scale of the efforts which still need to be made. The Environmental Conformity Program - PRA is the stage which follows upon the registry. 58% of producers inscribed in the CAR declare interest in adhering to the PRA (Mapa, personal communication, November 06, 2020). Hereafter, the third step would consist in the use of economic instruments to incentivize adhesion to the Environmental Reserve Quota (*Cota de Reserva Ambiental* - CRA), which the government plans to launch in 2021.

One of the central objectives of the Ministry of Agriculture and Livestock is to contribute to the implementation of the Forest Code through analysis of CAR data, and hereby ensure a higher degree of certainty regarding land tenure. For this purpose, a technological solution of remote sensing through artificial intelligence is being developed, the Dynamized Analysis of CAR, which is planned to be implemented throughout 2021 within all Federal Entities. This technology could reduce the time of analysis for validation of CAR registries and consequently also the public resources allocated to this purpose, and thereby diminish juridical insecurity (Mapa, personal communication, November 06, 2020).

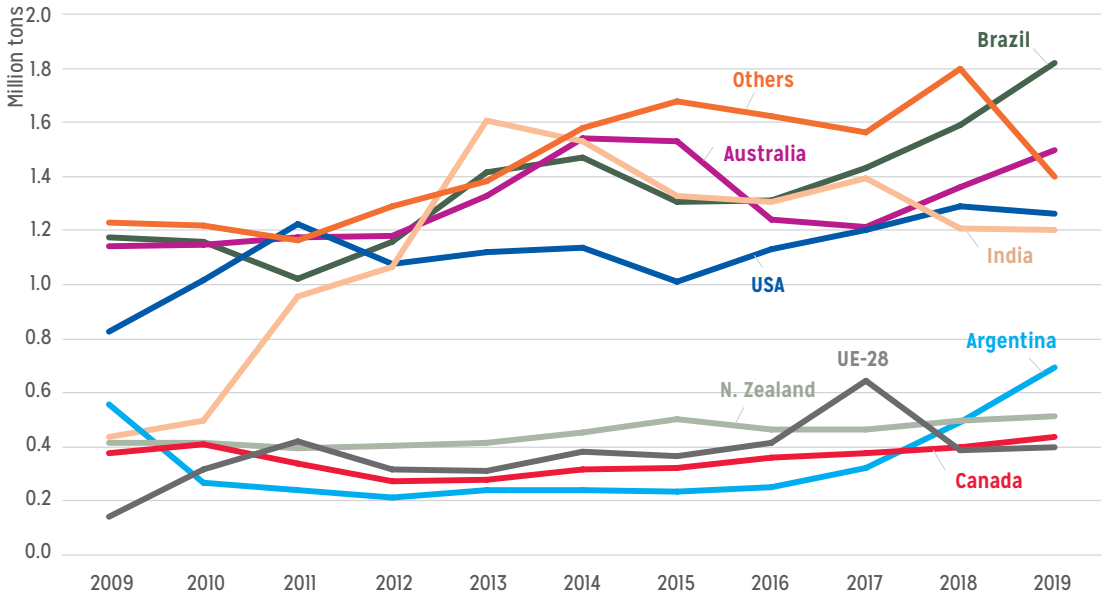
Private initiatives in the beef sector

Brazil produces more than 10 million tons of beef annually, of which little more than 20% is exported to a range of countries worldwide. In 2020, this trade generated almost US$8.5 billion in foreign revenues[70]. Figure 11 and Figure 12 present the recent evolution of the main global beef exporters in volume and value.

Decoupling of beef production from deforestation of the Amazon constitutes one of the most important challenges in terms of conserving this biome. As forms of cattle raising vary significantly, a large potential for conservation through a change in modes of production exists, as archaic and inefficient models widespread within the region can be substituted by more modern practices. Yet, the complexities which characterize the application of instruments of monitoring and tracing are nonetheless highly pronounced within the cattle sector, meaning that this area becomes important to address in the conservation of the Amazon.

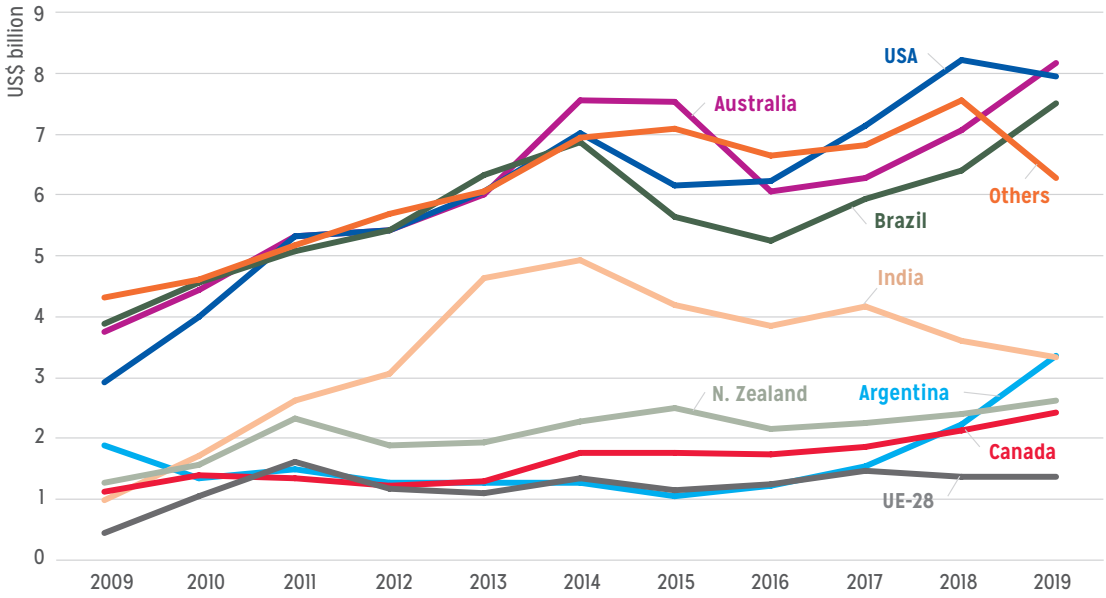
70. Abiec (2020)

Figure 11 - Main global beef exporters between 2009 and 2019 (in tons)



Source: authors' elaboration based on UN COMTRADE (2020)

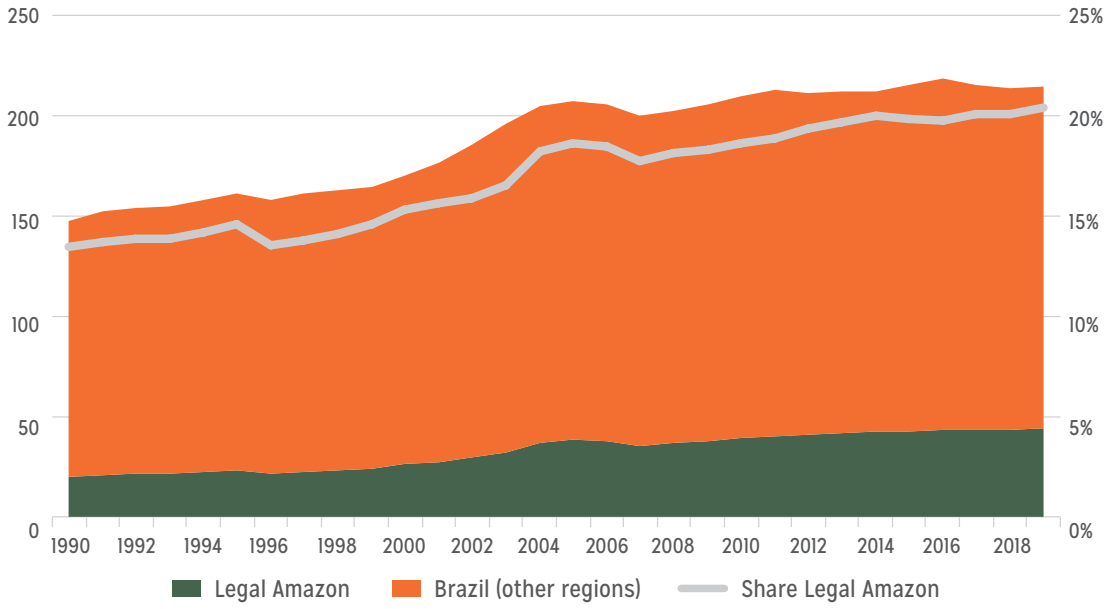
Figure 12 - Main global beef exporters between 2009 and 2019 (in US$ billion)



Source: authors' elaboration based on UN COMTRADE (2020)

In recent decades, the Amazon region has become a frontier for the expansion of cattle ranching. As can be seen in Figure 13, while the total Brazilian cattle herd rose around 46% in the period, within the Legal Amazon, this increase was around 120%.

Figure 13 – Evolution of the effective Legal Amazon and Brazilian cattle herd between 1990 and 2019 (million head) and share of the Legal Amazon



Source: authors' elaboration based on the Municipal Livestock Survey/PPM (IBGE, 2020b)

The states within the Legal Amazon represent a very large share of the increase in Brazilian cattle production over the past three decades. This has spurred much preoccupation both at the domestic and the international level concerning the impacts of this development on the Amazon biome. Historically, cattle ranching has been used in this region as a means to making claims to illegally cleared areas, as the registry of animals on a piece of land can help the farmer obtain property rights[71]. The increased amount of attention to this issue from both public and private actors in 2009 led to an agreement known as the *Termos de Ajuste de Conduta* (TAC), between the Public Federal Prosecutors Office (MPF) and the main slaughterhouses, by which the latter committed themselves not to purchase beef from illegally deforested areas within the Legal Amazon. A representative from the beef sector thus highlights how the juridical activism on behalf of the MPF was crucial in spurring sectoral action. The MPF also directly contacted supermarkets, highlighting the fines for selling meat from illegally deforested areas and singled out specific actors responsible for infractions.

Also in 2009, the so-called "G4 Cattle Agreement" between Greenpeace, JBS, Minerva, Marfig, and Bertin was celebrated, which went even further and called for a complete halt to sourcing from areas deforested after 2009[72]. The G4 relied on deforestation monitoring based on public satellite images which were triangulated with land registers in order to detect whether supplying properties adhered to the agreement. These initiatives appear to have had a strong effect on the behavior of suppliers, as the number of properties where direct deforestation could be registered fell from 26% in 2009 to 4% in 2013[73]. It is important to note that the significance of pasture clearances as a driver of deforestation in the Legal Amazon already was undergoing a decline from a peak of close to 2 million hectares in the period from 2001-2005. These initiatives nonetheless appear to have been essential in

71. Zycherman (2016, p.74); Silva et al. (2020)

72. Still in 2009, JBS announced the acquisition of the Bertin Group, which at the time was the second largest beef company in Brazil, surpassed only by JBS. In 2013, this merger was approved by the regulating agency, making JBS the largest beef company in the world.

73. Gibbs et al. (2016, p.36)

terms of ensuring a lower level of cattle-driven deforestation below 0.5 million hectares annually from 2010 and onwards[74].

Despite the efforts made and the results obtained in decoupling Amazon deforestation from cattle ranching, this objective has so far only been partially accomplished. If it is to be reached, there is still a need to face some of the inherent complexities that are closely related to the cycles of cattle raising. While some livestock producers undertake all of the phases of the production cycle, from the birth to the point at which the cattle is ready for slaughter, others specialize exclusively in raising calves until the age of six to ten months. Another group of ranchers purchases the calves for fattening and manage the successive phases until slaughter. Hence, three types of properties characterize the livestock sector: complete cycles, raising/ breeding, and fattening[75]. Figure 14 illustrates this division of the phases of production:

Figure 14 – Types of cattle suppliers

Source: authors' elaboration

Since 2009, when the first steps towards monitoring of supply chains were taken, traceability of producers selling directly to slaughterhouses has advanced. Yet, the systems based on calf raising (indirect suppliers) are not very visible, as slaughterhouses do not interact directly with them. This complexity limits the reach and the efficiency of the control of their origins meant to prevent animals raised in deforested areas from entering compliant supply chains. Therefore, as existing agreements only contain the potential to embargo properties, but not the cattle, this opens a loophole for cattle to be raised on non-compliant properties and hereafter sold to compliant ones. This type of cattle "laundering" may either happen as ranchers move their herd around between the two types of properties, or as middlemen buy calves raised on non-compliant properties and sell them through compliant operations[76]. These practices have resulted in many cases when the large slaughterhouses unknowingly have been selling beef from cattle raised on illegally deforested areas[77]. Another problem relates to the sale of cattle from non-compliant properties through unregulated supply chains aimed at the domestic market, thereby escaping monitoring mechanisms[78]. Reports also exist of how monitoring failures in recent years have lead slaughterhouses to purchase beef from directly supplying ranches responsible for 17,000 hectares of deforestation in the state of Pará, - a number reaching 116,000 hectares in the case of indirect suppliers[79]. The specific

74. Seymor & Harris (2019, p.757)
75. Coalizão (2020)
76. Gibbs et al. (2016, p.39)
77. Economist (2020)
78. Gibbs et al. (2016, p.39)
79. Watanabe (2020)

extent of possible sales from non-compliant properties, as well as the legal status of the suppliers in question, is nonetheless associated with a certain degree of uncertainty.

Moreover, exclusion is often not an effective means to avoid deforestation from cattle ranching. As highlighted by an industry representative interviewed, embargoed properties continue to sell their cattle; ranchers can be excluded from compliant supply chains, but not entirely from their business activity. Non-compliant cattle production is therefore likely to continue, which points towards the limitations of combating deforestation exclusively through moratoriums. Given that Minerva, JBS, and Marfrig together represent less than half of the domestic market, sufficient opportunities exist for farmers to sell their products through alternative channels. Due mainly to laundering and leakage, existing monitoring mechanisms only capture around 10-15% of Amazon biome deforestation driven by cattle ranching[80]. As an interviewee from the beef sector highlighted, the type of deforestation control mechanisms based on supply chain exclusion which has prevailed in recent years has led to a large triangulation[81] scheme to evade existing regulation.

Agreements with focus on the Amazon have advanced in recent years. In 2020, the same actors who had signed the Beef Moratorium and the G4 Agreement in 2009, - NGOs, slaughterhouses, the Federal Public Prosecutor, and retailers - redefined the commitments from 2009 according to more streamlined compliance criteria. The goal was to unify procedures and methodologies in a monitoring protocol which would function as a pre-competitive element between slaughterhouses[82]. Even so, the limited effectiveness of the initiatives within the beef supply chains, especially compared to similar initiatives within soy supply chains, means that, directly or indirectly, cattle ranching as an economic activity is currently the largest driver of deforestation in the Amazon[83]. Studies indicate that 65% of the Amazon deforestation between 2004-2014, was due to the conversion of native vegetation into pastures[84]. While land speculation eventually might have constituted the main motivation in many cases, the role of cattle herding as a means to making land claims cannot be neglected. Moreover, interactions between different agricultural and livestock activities can also lead to indirect pressures on native vegetation. Initiatives to halt deforestation from soy production have thereby led to increased cultivation on pasture lands, which to some extent appears to have driven pastures into native vegetation areas within properties[85].

A general overview nonetheless reveals that the pasture-driven deforestation is highly concentrated in very few municipalities. Studies of Chinese CO_2 emissions risk from imported Brazilian beef indicate that of 1,200 exporting municipalities, 50% of all emissions can be traced to twenty-five municipalities, while 25% are concentrated in only five[86]. The high degree of concentration of pasture-driven deforestation on a very limited range of municipalities both highlights how the negative backlash affecting the entire sector in fact is relatively concentrated on specific groups of non-compliant actors, but also that targeted action to address problems in these areas is essential. Hence, monitoring systems of livestock suppliers in the Amazon still face challenges such as the identification of the origin of animals, and with regards to territorial knowledge to understand how

80. Economist (2020)

81. Triangulation refers to the use of third-party direct suppliers to sell noncompliant products. This is also known as "laundering".

82. The protocol was developed as part of the *Boi na Linha* project by IMAFLORA, seeking to strengthen the beef sector's social and environmental commitments through cooperation with the slaughterhouses, Federal State prosecutors, NGOs, and retailers in the improvement of criteria and technical instruments for monitoring and verification.

83. Seymor & Harris (2019)

84. Armelin et al. (2020); TerraClass (2016)

85. Gollnow et al. (2018)

86. Trase (2020a)

nonconformities occur. Engaging with these issues also permits treating other related problems. Amongst these challenges, productivity improvement is essential as it helps in order to lower the need to incorporate new land areas. This comprises technical assistance in the management of pasture quality and animal genetics which holds the potential to significantly increase output.

Tracing, monitoring, and supply chain governance

On the level of supply chains, an important task relates to the establishment and refinement of instruments to guarantee behavior consistent with zero-deforestation commitments on behalf of actors on different levels of the beef chain. **Traceability** of both **direct and indirect suppliers** constitutes an essential challenge on the road to meeting these objectives[87]. Different public instruments exist which together can help enhance traceability, such as the **Rural Environmental Registry (CAR)**, which registers the extent of properties and their distribution of vegetation, as well as the **Livestock Transit Guide (GTA)**, which tracks the movements of animals with sanitary concerns in mind. Yet, as the CAR is based on information provided by ranchers, the system contains a loophole for individual producers to deforest at the fringes of their properties without being detected. Alone, the CAR therefore implies some shortcomings which make it important to cross data from this system with georeferenced measurements and images of the individual property[88]. As highlighted by a representative from the beef sector, the GTA could potentially be expanded to be used for environmental purposes. Yet, this could lead to resistance towards using it amongst ranchers, which would increase sanitary risks if these producers consequently chose not to register within the GTA. Moreover, as GTA data is not publicly available, confidentiality constitutes a central premise for producers to allow for access to this information. A possible solution could be found in the use of blockchain technology to consult traceability information while still guaranteeing data confidentiality[89].

Solutions to combat deforestation through the commitments signed by slaughterhouses are in large measure defined by suppliers' characteristics. In an area in which the majority of suppliers engage with the full cycle of cattle raising, and the proportion of indirect suppliers therefore is lower, strategies tend to differ from approaches adopted in areas with a large number of indirect suppliers. For instance, in Pará, 60% of properties do not engage with the full cycle, while in Rondônia, this number is around 37%. Slaughterhouses with a mainly indirect network of suppliers tend to rely more on command and control-based solutions and public regulation. This group of slaughterhouses also tends to be favorable towards mechanisms which are based on connecting GTAs, CARs, and the IBAMA list of embargoed producers.

The *Serviço Brasileiro de Rastreabilidade da Cadeia Produtiva de Bovinos e Bubalinos* (Sisbov) constitutes another system for tracing the movements of individual bovine animals, which originally was devised as a means to comply with European sanitary requirements in order to enter this market. From initially being relatively expensive, registration and tracing through Sisbov has become more accessible, albeit it is still a costly alternative for small producers, and does require a certain degree of technical capacity to be implemented[90]. Based on similar monitoring mechanisms in other countries, an interviewee from the beef

87. Eramgassen (2020); Armelin (2020); Coalizão (2020)
88. Armelin (2020)
89. Coalizão (2020)
90. Coalizão (2020)

sector highlights how the Sisbov contains a potential for satellite-based tracking of animals, thus ensuring their legal origin throughout the supply chain. While there still is some debate about how best to use existing systems such as CAR, GTA, and Sisbov, it is clear that from a technical perspective, these existing instruments provide the essential building blocks for a comprehensive system for tracing and monitoring of cattle in Brazil. A series of questions nonetheless remain, related to implementation, cost distribution, and compensations, as well as the disproportionate burdens which this could imply for small producers lacking technical skills.

The limits of existing means of public control and the pressures for zero-deforestation from upstream supply chain actors have also made slaughterhouses install control systems which complement public regulatory instruments. Slaughterhouses' increasing focus on deforestation-free supply chains means that it should only be a matter of time before this goal is achieved, as exemplified by Marfrig and JBS who announced the ambition to attain this objective in the Amazon biome before 2025[91]. However, despite the potential to diminish deforestation, the way in which control and monitoring of the beef chain has been implemented has led to the exclusion of many small and medium-sized producers.

Initiatives undertaken since the signature of the TAC in 2009 have in large measure been aimed at exclusion. By itself, that would not necessarily constitute a problem if it led to a higher degree of efficiency and if alternatives were available for excluded producers. Yet, frequently, excluded producers have had no other alternatives than continuing environmental harmful production practices as suppliers of non-compliant slaughterhouses. Yet, albeit an unintended consequence, exclusive reliance on private initiative also holds the risk of accentuating the current situation of parallel supply chains. An interviewee thus emphasizes how the exporting slaughterhouses could end up with supply chains shielded from deforestation risks, while domestic supply chains characterized by illegality and lax control systems remain in effect. It is also highly likely that reputational risks would continue to spill over from the second to the first part of the sector, thus constraining the international market opportunities of deforestation-free beef products.

Driven by the complexity of livestock production, by the interposition of highly technically diverse production systems, and by a chain-organization based on spot market negotiations, and given the absence of contracts and confidence, exclusion has become the adverse consequence of monitoring and control within beef supply chains. Consequently, efficient and modern producers have managed to incorporate conservation norms, while small and medium-sized producers have been excluded, which eventually could result in a vicious cycle in which the lack of adoption of zero-deforestation commitments leads to competitiveness losses amongst compliant adapters, which eventually could weaken their adhesion to voluntary commitments[92]. On the other hand, a consequence which already is becoming evident is the bifurcation of the chain into two tracks; one "above the law", comprising of large players capable of complying with socio-environmental and sanitary standards and inserted within global markets; and another falling short of such good practices, marked by a scarcity of credit and technical knowledge, as well as other vital resources necessary for efficient and sustainable production.

A sectoral representative thus underscores how her company's strategy has focused on reinsertion of previously excluded properties in combination with improved traceability systems. Due to mounting international pressures, she also underlines how the large slaughterhouses are very likely to follow suit. Such initiatives on behalf of private actors

91. Marfrig (2020a); JBS (2020)

92. Coalizão(2020)

are essential steps on the road to a decoupling of cattle production from deforestation. It should be highlighted that public regulatory monitoring efforts provide an indispensable legal baseline on top of which private efforts can build, and hereby ideally create important synergies. Without commitment on behalf of public actors, private initiative will face the constraints provided by skewed incentives due to lacking legal enforcement, as well as the coordination problems created by the absence of mandatory sector-wide systems for information gathering and dissemination.

Box 4 - Sustainability initiatives within the beef chain: Marfrig and JBS action plans

Marfrig monitors its suppliers via georeferencing and geo-monitoring by satellite, comprising an area of 26 million hectares within the Amazon biome. The company, however, recognizes problems of visibility of its indirect suppliers which are spread over an extensive territory, marked by socioeconomic vulnerability and institutional fragility. Marfrig affirms its **zero-deforestation** commitment which is to be reached through **complete traceability within its supply chain in the Amazon by 2025** and 2030 in relation to the Cerrado. To reach this goal, in July 2020 the company launched a 5-year plan with deadlines and objectives spanning 10 years into the future. The plan encompasses a joint engagement with different supply chain stakeholders and is based on adherence to environmental legislation and a range of sustainability criteria. Technology packages and resources are made available to help ranchers make the transition from low to high productivity pastures. The plan is structured according to the three different axes of: 1) innovative financial mechanisms, 2) technical assistance, and 3) monitoring of indirect suppliers. It is expected that traceability will be reached by 2025 through a series of complementary instruments such as: GPS cattle tracking; satellite monitoring of land-use change; georeferencing of supplier properties; blockchain systems and risk mapping which crosses vegetation areas with suppliers, thus permitting the identification of areas more susceptible to deforestation. The plan comprises initiatives aimed at raising profits and financing for small producers, such as payment for environmental services, attenuation of losses due to embargoes, and a program for the reinsertion of producers within supply chains. Regarding technical assistance, it proposes the development of a precompetitive long-term model for the creation of a network for intensification and restoration. To gain scale, the company plans to rely on external resources as well as knowledge and public engagement through and command and control instruments. In 2020, Marfrig and Embrapa engaged in a partnership to launch different brands of beef, such as carbon-neutral beef, meat from animals raised in silvo-pastoral systems, and verified by independent auditors. Marfrig has invested around R$10 million in research, property certification, branding, and standard development. Embrapa, in turn, has been involved in this project through 12 research centers and a network of around 150 researchers. JBS' engagement with sustainability in the Amazon has been expressed through the "Together for the Amazon" program, constituted by 4 strategic pillars. The first concerns the **sustainability of the cattle chain** and is based on three initiatives. The first relates to the creation of the "**JBS Green Platform**" which crosses information about direct suppliers with GTA data to **identify and analyze indirect suppliers**. To guarantee

confidentiality and security in the access to information and transparency in the analysis of suppliers, the platform adopts a blockchain system. The plan is that direct suppliers to JBS should be able to pick their suppliers of calves according to the company's sustainable sourcing policy. In the final implementation phase, direct suppliers' adhesion to the Green Platform becomes a mandatory condition. The successful implementation of this initiative would thereby make it possible for the company to reach the point of **100% monitoring of its supply chain within the Amazon until the end of 2025**. The second initiative concerns the **sharing of this monitoring system**, with producers, financial institutions, and other companies who seek to adopt socio-environmental criteria in relation to their value chains. The third initiative involves the support and inclusion of producers through education initiatives to prevent deforestation and to engage ranchers within the JBS Green Platform. For this purpose, the company commits to providing agricultural equipment and technical assistance to help producers with the regularization and management of their properties, and also promises to maintain investments in the development of digital platforms in order to regulate non-compliant properties. The other three pillars of the "Together for the Amazon" program are comprised by the JBS Amazon Foundation, which aims to support conservation and restoration efforts, economic development of communities, and scientific and technological development. The Fund is planned to reach R$1 billion until 2030.

Source: Marfrig (2020a, 2020b); Embrapa (2020c); JBS (2020)

Landscapes approaches

As we have seen, commitments strictly focused on traceability can produce contradictory results, which on the one hand contribute to the preservation of native vegetation on some properties, but on the other, maintain non-compliant ranchers within an inefficient production model without access to the means to break the pattern of continuing deforestation as pastures become rapidly degraded. This situation highlights the need to change the drivers which have marked the period from 2009 by emphasizing the sustainable reinclusion of excluded properties. This would imply the need for a system for reinsertion of embargoed properties, through the adaption of their modes of production towards more sustainable practices, which do not rely on the periodic clearings of new pastures. Durable long-term solutions would thereby need to move beyond the "one-size-fits-all", and seek to adapt to the heterogeneities of each region. Productive diversification and the creation of linkages to other chains can also be an essential part of this process.

An innovative and potentially impactful instrument to the environmental governance of upstream supply chains in the beef sector is the landscapes approach. Rather than aiming at specific sectors and distinguishing producers within a given area according to their adherence to a set of chain-based regulations, the landscape approach brings a wide range of stakeholders together in the certification of entire regions. Through this approach, deliberations between producers, traders, slaughterhouses, smallholders, civil society actors, and local authorities aim towards ensuring that a range of social, environmental, and production-related standards are met, eventually leading to the establishment

of Verified Sourcing Areas (VSA)[93]. These areas, which are demarcated by very specific territorial boundaries of the municipality or region, make close monitoring of each producer redundant, as the VSA seal in itself guarantees that essential sustainability criteria are met. This status thereby helps connect local producers to global markets, and importantly, also facilitates premium payments and credit from financial institutions as environmental risks are significantly reduced. Landscapes approaches thereby apply a more holistic perspective on environmental governance and through a series of positive incentives these initiatives can also enjoy a higher degree of legitimacy and subsequent efficiency, as they are embraced by local stakeholders.

Important experiences with landscape approaches have been made in Mato Grosso, where the regional government has presented a plan comprising of: restoration and crop expansion on degraded pastures; elevation of the amount of sustainably managed forests; elimination of illegal deforestation and the significant reduction of legal deforestation, and finally; the guarantee of access to credit and regularization of smallholder plots. The IDH Sustainable Trade Initiative is engaged in the local implementation of these objectives through a landscape approach, ensuring that productivity increases are pursued in conjunction with the improvement of essential socio-environmental indicators[94]. Livestock producers who as part of a wider landscape approach initiative reduce deforestation by adopting more efficient and sustainable production practices could also become part of a climate financing program[95]. In sum, landscape approaches can help avert the compliant vs. non-compliant bifurcation of supply chains and problems of relying overtly on sanctioning and exclusion of non-compliant producers, as they present a regulatory instrument based on mixed-incentives with a potential for gaining crucial local support. Such a focus could hereby enhance the sustainable transformation of landscapes and would not be exclusively restricted to chains coordinated by a specific group of companies.

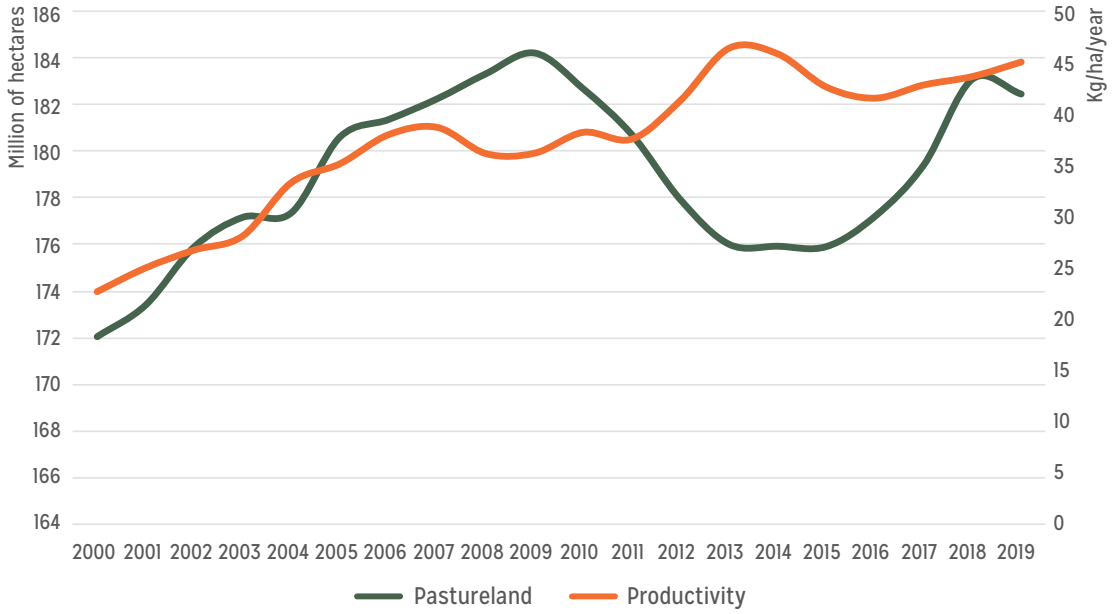
Curbing deforestation through sustainable intensification

Sustainable intensification, - referring to the increased efficiency and decreased environmental impact of livestock operations through more modern production practices, - constitutes another central pillar in the strategy for decoupling of cattle production from Amazon deforestation[96]. Historically, cattle ranching has often been adopted as a means to hold on to recently deforested land before selling it for more profitable uses. Combined with the low input costs for rudimentary cattle herding, abundant land availability for a long time resulted in a very low break-even point for this kind of ranching, and a depressed level of productivity. Yet, in recent years, many livestock producers have aspired towards some kind of sustainable intensification of production practices in a situation in which they have been impeded from clearing new areas through deforestation. The avoidance of pasture degradation is a highly important means to prevent pressures for cattle expansion into native vegetation[97]. What is more, of the lands deforested in the Amazon biome in the period from 1988-2014, only 14% have been converted into more productive operations[98]. Estimates indicate that a risk of increased deforestation of 4 million hectares of native Amazon forest

93. IDH (2020)
94. IDH (2019)
95. Nepstad. et al. (2014, p.1123)
96. Kappen et al. (2020)
97. Silva et al. (2020)
98. Valor (2020)

could be avoided if only 21% of livestock producers raised their production from 60 kg to the level of 150 kg per hectare annually common amongst moderately efficient producers[99]. It is important to keep in mind that sustainable intensification already has wielded a significant impact on Brazilian cattle herding. Hence, until the early 2000s, productivity increased at the same pace as the pasture area. Yet, from this point and onwards, productivity has spiked, while the total pasture area has remained largely at constant levels[100] (see Figure 15). Much deforestation has thereby been avoided. Yet, a significant potential exists for increasing productivity, especially in sensitive areas, which could diminish pressures on native vegetation.

Figure 15 – Evolution of the pasture area (in million hectares) and productivity (in kilos of carcass per hectare annually) between 2000 and 2019 in Brazil



Source: authors' elaboration based on Lapig (2020) and IBGE (2020c)

Environmental impacts of beef production in Brazil vary dramatically according to the modes of production. Degraded pastures constitute the most environmentally harmful mode of production, followed by stable pastures and confinement. According to studies conducted by Pavão et al. (2020), well-managed pastures and integrated systems can even have a positive net GHG emissions profile, as the biomass in these systems absorbs more CO_2 compared to the equivalent in GHGs emitted by cows and inputs to these systems. This is reflected in analyses of GHG emissions measured in CO_2 equivalent generated per kilo of beef produced in different livestock production systems, as can be seen in Figure 16.

99. Stabile et al. (2020)
100. Silva et al. (2020, p.2)

Figure 16 - GHG Emission intensity of Brazilian beef (Kg of CO_2 equivalent per Kg of beef - excluding deforestation)

Source: Pavão et al. (2020)

As beef production in some places is directly associated with deforestation, the incorporation of this measure into the calculus of GHG emissions generated by the production of 1 kilo of beef rises considerably. This is especially relevant with regards to degraded and stable pastures, which despite significant reductions in recent years still are associated with a very large amount of GHG emissions as measured in CO_2 equivalents, which can be seen in Figure 17.

Figure 17 - GHG Emission intensity of Brazilian beef (Kg of CO_2 equivalent per Kg of beef - including deforestation)

Source: Pavão et al. (2020)

Assessing the lifecycle GHG emissions from beef production in CO_2 equivalents is a relatively complex process, and the above-mentioned numbers should thereby be taken with some degree of caution, - especially with regards to estimates pointing towards positive emission profiles from transitions towards integrated systems. Yet, the data in Figures 16 and 17 nonetheless serves to underscore the staggering variations in GHG emissions from Brazilian beef production depending on the specific production model adopted.

Comparisons of land prices in the Brazilian Amazon and cost estimates from deforestation in this biome in GHG emissions also clearly illustrates how incorporation of environmental externalities completely changes the broader economic picture of deforestation-dependent development. Nepstad (2020) thus illustrates how costs of deforestation of the Amazon biome far exceed land values. Presupposing a carbon price of US$100 per ton of CO_2, the approximately 500 tons of CO_2 emitted by deforestation of one hectare results in environmental costs of US$50,000; more than 100 times the traded value of one hectare of native vegetation, and approximately 35 times the price of a cleared hectare in this biome.

Despite the huge potential for reduction of GHG emissions from adopting more sustainable production models such as integrated systems or well-managed pastures, producers are often not very attentive to such benefits. An agricultural technician interviewed thus underlined how ranchers had to be convinced by arguments highlighting the advantages in terms of production increases, product quality, as well as water resource and soil conservation. About GHG emissions, the interviewee thus stated that “producers are generally not very worried about those gases”. Yet, as we shall see in the following section about payments for environmental services, product features such as carbon-neutrality could gain a strong commercial potential within consumer markets where carbon taxes or a strong climate consciousness significantly impact purchasing decisions. Currently, many Brazilian livestock producers face dwindling profits or are effectively running deficits. In such a situation, the adoption of modern and more environmentally friendly production systems thereby appears to be imperative by both increasing productivity and by providing improved marketing conditions.

Sustainable intensification also becomes highly relevant regarding small producers within the region, who have accounted for an increasing share of deforestation, even as large producers have diminished theirs[101]. Families living in agricultural settlements in the Amazon region have very low incomes, close to the minimum wage, which constitutes a great impediment to the implementation of more efficient and modern production practices[102]. Empirical evidence thus underscores how sustainable intensification amongst smallholders does not follow automatically from the imposition of environmental restrictions limiting expansion through deforestation, but rather hinges on the availability of the necessary means for these producers to intensify their ranching[103]. Provision of credit and technical assistance to raise productivity amongst small and medium-sized producers is therefore an important part of conservation efforts[104]. Increasing such efforts becomes extremely important as part of a more holistic sustainability strategy aiming not only at ecosystem conservation but also on ensuring livelihoods for smallholders and other groups at the margins of agro-industrial development in the Amazon region, as we shall see in the coming sections.

101. Zycherman (2016, p.77)
102. Mapa (2020a)
103. Thaler (2017)
104. Stabile et al. (2020)

Box 5 - Pasture dynamics and the ABC Plan

The Low Carbon Agriculture Plan is a center-piece of the efforts to mitigate greenhouse gas emissions while maintaining productivity growth within Brazilian agriculture. It contains credit lines with favorable interest rates to producers who recover pastures or forests or adopt low-carbon technologies. The Plan also contains a strong focus on technology proliferation and technical training, rural development, and land tenure guarantees. All of the plan's central elements aim towards carbon mitigation. Each of the initiatives encompassed by the plan contains goals for territorial expansion and GHG mitigation. The following Table A presents the estimated progress of the ABC Plan between 2010 and 2018 with regards to the commitments related to pastures.

Table A: Goals within the ABC plan and the state of their advancement

	Expansion in area (in million hectares)		Mitigation potential (million of Mg of CO_2 equivalent)	
Commitments for 2020	Aim	Reached	Potential goal	% of the average obtained in relation to the medium level
Restoration of pastures	15	10.45 (2010-17)	83 - 104	43 - 62%
CLFi and agroforestry systems	4	5.83 (2010-16)	18 - 22	111 - 182%

Source: adapted from Mapa (2020b) and Lima et al. (2020). Note: carbon mitigation potential is calculated comparatively between different methodologies (coefficients), which nonetheless need to be improved in order to track and monitor the advance of pasture restoration and other initiatives. For more details, confer: https://www.gov.br/agricultura/pt-br/assuntos/sustentabilidade/plano-abc/plano-abc-em-numeros/arquivos/esumodaadooemitigaodegasesdeefeitosestufapelastecnologiasdoPlanoABCPerodo2010a2018nov.pdf

As illustrated, goals for CLFi and agroforestry systems within the plan need to be elevated, and efforts to restore degraded pastures and forests intensified[105]. Incentivizing these measures, the Plan contains a significant potential to mitigate the greenhouse gas emissions of Brazilian agriculture. In a recent study, assessments by Ferreira Junior et al. (2020) estimate a small decline in the total pastures area in Brazil from 171.6 to 170.7 between 2010-2018.[106] In this period, 31.7 million hectares of pastures were either abandoned or converted to other uses, while 30.8 hectares were converted to pastures. The spatial distribution shows how pastures have been converted to agriculture in areas with appropriate infrastructure and high soil suitability, while expanding on areas with low land prices within the agricultural frontier[107]. Of the pasturelands abandoned or converted into other purposes, 66% presented signs of degradation in 2010. Of the 34% of pastures converted into other purposes, and which did not present signs of degradation, a significant share was identified within the Amazon biome. The study, which analyzed 98% of the areas mapped as pastures in 2018, categorizes areas without indications of changes or degradation in the period from 2010 to 2018 analyzed as "stable". The illustration shows how the category with a stable degree

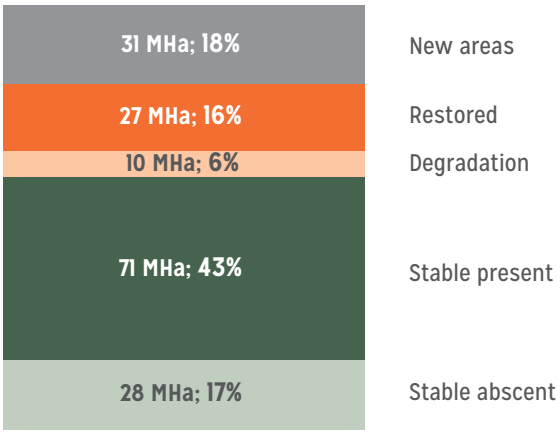
105. It should be kept in mind that the process of pasture recovery does not yield immediate results but spans from 3 to 5 years.

106. These areas relate to the pixel resolution of the satellite images mapping pastures. When corrected through statistical methods, these areas, respectively, constitute close to 182 and 183 million hectares, as can be seen on Figure 15.

107. Ferreira Junior et al. (2020)

of degradation represents 43%, while areas presenting indications of change, such as degradation or recovery, represent 22%. In this case, the areas with pasture recovery in the period analyzed exceed the areas displaying indications of degradation.

Pastureland use change from 2010 to 2018



Source: Ferreira Junior et al. (2020).

It is worthy of notice that the areas of 26.8 million hectares of recovered pastures from 2010-2018 surpasses the level registered within the ABC Plan and the goal within this[108]. The study also registered a reduction of the area with signs of severe degradation of around 9.6 million hectares. New areas registered between 2010-2018 constitute 18%, and are mainly concentrated in the North of the country. The degree of pasture degradation for areas in properties adhering to the ABC was assessed based on CAR data. A decrease in the level of pasture degradation was observed, as is shown in Table B.

Table B - Pasture dynamics within the contracts of ABC Plan

Category	2010	2018
Non-degraded	0.9%	0.8%
Slightly degraded	31.0%	39.8%
Moderately degraded	33.8%	34.2%
Severe degradation	34.3%	25.2%

Source: Ferreira Junior et al. (2020)

108. According to experts from Embrapa and AgroÍcone, the pasture area effectively recovered in Brazil since 2010 is better reflected by data from Ferreira Junior et al. (2020). While this publication is based on satellite images, the monitoring of the goals of the ABC Plan is based on information on credit lines for pasture recovery and on the stocking rate of animals. An Embrapa expert highlights that half of the pastures recovery in Brazil takes place using resources that do not pass through traditional bank credit lines.

Payment for environmental services

An important aspect complementing sustainable intensification concerns payment for environmental services. This becomes highly relevant as part of the general need to define governance arrangements for beef production which rely both on effective command and control mechanisms, as well as positive compliance incentives. Environmental services could span over a series of different means, including the retention of carbon dioxide in soils and in the preservation of vegetation which could otherwise be legally deforested. GHG mitigation strategies within the livestock sector depend in large measure on proper pasture management. While managed pasture lands have a positive carbon sequestration capacity of up to 3 ton per year, degraded pastures often release as much as 4 ton of CO_2 per year, resulting in a net gain of 7 ton of CO_2 annually by restoring degraded pastures[109]. At an average price of US$350 for the restoration of one hectare of pastureland, the net carbon gains alone should provide an important incentive to channel resources towards this goal. As previously mentioned regarding sustainable intensification, well-managed pastures are also significantly more productive, meaning that pastures can be freed up for either agricultural production or reforestation projects. Considering the inevitable methane emissions caused by beef production, reforestation projects on previously degraded pastures become important in order to compensate for increases in the number of cattle due to increased productivity. Moreover, as treated in the section on sustainable intensification, carbon neutral beef should be able to attract substantial price premiums, - especially if carbon taxes are implemented at the retail level in consumer countries.

Given the current archaic mode of cattle production in most deforested areas of the Amazon, as well as the timid economic gains from these activities, a significant potential appears to exist for payment for environmental services to become more attractive than inefficient pastorage. Schemes are still in their infancy, and efforts should be speeded up for devising instruments to ensure sustainable intensification and preservation of native vegetation. Under the Paris Agreement, Brazil has committed to restoring 15 million hectares of degraded pasturelands by 2030[110]. Payments for environmental services aimed at improved pasture management are essential to reach this goal, but also to foster economic development in low-income rural areas. As around 80 million hectares of pastures in Brazil are degraded[111], ambitious climate mitigation efforts should aim far beyond the restoration of 15 million hectares, by channeling resources towards large-scale efforts of completely phasing out inefficient and environmentally harmful modes of pastorage in the long term.

A problem concerning the payment for environmental services based on contributions from developed countries, is that this group often eschews costs, which frequently befall developing states[112]. This has also been the case with Brazilian beef. An interviewee thereby highlights how European retailers often have made environmental demands directed at suppliers without ensuing price compensations. Schemes in line with REDD+ could provide important tools for increasing preservation through environmental services, and certain experiences have been made with international retailers supporting projects in the Xingu region[113]. Yet, as highlighted by a private sector consultant, payment for environmental services to a wide extent hinges on transparency, credibility, and reliability of mitigation/ sequestration schemes. Hence, in the absence of these features, and in a situation of

109. Embrapa (2016)
110. Brazil (2015)
111. Ferreira Junior et al., (2020)
112. Webber (2020)
113. Coalizão (2020)

generally increasing deforestation, international stakeholders will be very hesitant to commit themselves financially. The interviewee underlined how earlier moments of euphoria about prospects for profiting from environmental conservation had been followed by realizations that more robust instruments and methodologies were needed to verify and document GHG reductions. Carbon credits thereby depend on environmental integrity, meaning that effective implementation of sector-wide conservation measures embedded in public law becomes imperative for markets for monetization of environmental services to materialize on a large scale.

Inclusive approaches to sustainability within the beef chain

Targeting small and medium-sized properties constitutes an important specific challenge to combat pasture-driven deforestation. Thus, while deforestation amongst large ranchers fell 63% from 2004-2011, rates amongst small-scale ranchers rose with 69% in the same period[114]. Of the 166,906 properties officially registered and georeferenced in the Brazilian Legal Amazon, small and medium operations of until 4 fiscal modules (160-440 hectares) constitute 88% of the establishments in the region, and 38% of the area dedicated to farming and livestock production[115]. Due to the complexities associated with compliance with existing zero-deforestation initiatives, many small and medium-sized producers have become excluded from formal supply chains[116]. A sectoral representative interviewed thus underscored how slaughterhouses' zero-deforestation commitments led to the sudden exclusion of thousands of suppliers without any prior dialogue. Hence, as environmental sanctions obstruct access to credit, many farmers paradoxically remain dependent on inefficient unsustainable modes of production[117]. An interviewee from the livestock sector thus underscores the low level of technical knowledge of many small producers. This eventually results in a vicious cycle, through which the quick degradation of pasture lands resulting from predatory uses and slash-and-burn practices leads to pressures for opening new lands.

Technical assistance and credit provision can help to change this dynamic. Yet, to be able to access credit, small farmers within the Amazon depend on land entitlement[118]. There are currently close to 1 million farmers in the Legal Amazon in around 2,300 settlements without land titles and therefore excluded from credit access. Studies show that deforestation in areas without land entitlement surpasses the rate in areas with entitlement by some 134%[119]. Legal proposals to guarantee land entitlement in the Amazon are circulating in the Brazilian Congress. Yet, these have been subjected to a certain measure of critique, as regularization of large and recently deforested land areas could create perverse incentives for speculators and land grabbers to continue illegal deforestation. To provide land entitlement for small farmers who have a long-standing claim to areas of a limited extension, while still ensuring punishment for recent illegally deforested and extensive appropriations by land grabbers, the final legal draft would need to limit entitlements to small plots deforested in the more distant past. The fact that 86% of demands for land titles in the Legal Amazon derive from producers with until 4 modules, and that most rural properties can be found in this category, points to this as a level which could help avert the legalization of large-scale

114. Zycherman (2016, p.77)
115. Mapa (2020a, p.8)
116. Coalizão (2020)
117. Zycherman (2016, p.80)
118. Silva et al., (2020)
119. Mapa (2020a)

illegal appropriations by land speculators. Thus, to reach an effective decoupling of cattle herding and deforestation amongst small and medium-sized producers, monitoring and enforcement measures need to be combined with incentives and the provision of resources to stimulate more efficient livestock production, eventually reducing pressures for territorial expansion. An industry representative thus highlighted how the slaughterhouse at which she worked was engaged in pilot projects in local communities to help suppliers modernize their production methods. Other studies of the effects of credit provision and technical assistance to small producers show very significant results, with annual household income more than doubling and deforestation rates falling 79%[120]. This also underscores how raising the level of public rural credit allocated to smallholders, combined with targeting of Amazon settlements could have an extremely positive effect in terms of confronting deforestation while ensuring social development within the region.

120. Stabile et al. (2020, p.4)

Conclusions

The Brazilian soy and beef sectors stand in a key position to address the current challenges of deforestation of the Amazon biome. In this paper, we have assessed the recent historical experiences, current challenges, and potential pathways ahead. While public engagement is fundamental as an indispensable backdrop for private initiative, the latter has developed systems of environmental management and risk control with the potential to make a difference, especially if they are appropriately combined with public initiative. We stress a range of important takeaways from this study:

- Environmental issues have reached an unprecedented significance for Brazilian agriculture. This is part of a wider structural movement on the global level, which is bound to gradually intensify as the effects of climate change become increasingly evident.

- Global concerns about Amazon deforestation have created a series of demands for action channeled through supply chains, investment decisions, and at the official level, meaning that Brazilian performance in confronting this issue will have wide-reaching economic and political implications.

- Lacking commitment to upholding environmental legislation on behalf of public authorities has presented a need for private actors to respond to sustainability-related concerns through private initiative. The soy and beef sectors stand in a central position to ensure zero-deforestation of the Amazon biome, and existing sectorial initiatives have shown significant results in this regard, albeit further action is needed.

- The Soy Moratorium has been successful in decoupling soy expansion from Amazon biome deforestation, in large measure due to the high degree of consolidation of soy trading on the six major market participants, who all have adhered to the Moratorium.

- Beyond the Soy Moratorium, some traders have established deadlines for reaching completely deforestation-free supply chains, varying from 2025 to 2030. Such initiatives could help strengthen conservation efforts, also beyond the Amazon, but a variation in the methodologies adopted makes it difficult to assess the degree of effective progress towards zero-deforestation supply chains.

- Demands for completely deforestation-free products spanning beyond strictly legal requirements have been challenged by producers who perceive this as a de-facto confiscation of productive lands which could otherwise be legally deforested. Continuing problems of soy leakage and laundering, as well as the increase to 88,234 hectares of soybean area in non-conformity with the Moratorium could reflect such discontent.

- Distribution of costs for zero-deforestation tends to be disproportionately concentrated on upstream producers, as mechanisms for payments for environmental services have seen slow advances, not least because of the reluctance of downstream actors, such as retailers, to assume financial burdens.

- The question of zero-deforestation, and in a wider sense, adherence to sustainability agendas, has produced a cleavage within the Brazilian soy sector between proponents and opponents to this course of action, which could compromise sector-wide initiatives to curtail deforestation.

- Together, the Beef Moratorium and the Cattle Agreement have had a significant effect in terms of combatting Amazon deforestation within regulated supply chains. Yet, rather than spurring adhesion, the exclusion of a large number of suppliers has often had the effect of pushing them into a non-compliant supply network, as this group often lacks the technical knowledge to transition towards a more sustainable production model.

- The increasing amount of private sector standards and demands above what is legally required has resulted in a highly complex situation, which eventually could lead to the exclusion of small and medium producers and increase land concentration on large producers.

- The inherent complexities of the beef sector, due to the dispersion of cattle production cycles on different ranches means that problems of laundering and leakage continue to affect slaughterhouses. Consequently, only part of cattle-drive deforestation in the Amazon is captured by existing monitoring mechanisms.

- Traceability within the beef chain is technically viable through different combinations of existing instruments, such as GTA, CAR, Sisbov, and other monitoring tools. Large slaughterhouses have already defined plans for reaching complete traceability and monitoring of suppliers in the Legal Amazon by 2025.

- Signs of a “double track system” have become evident within both the soy and beef sectors, with one track “above the law”, characterized by large internationally connected producers, and a track below or exclusively compliant to the law, marked by small companies focused on the domestic market. This implies a risk of the creation of “sustainability niches” at the cost of a more general sustainable development, something which also might compromise small producers.

- Encompassing various economic activities and socio-environmental dimensions, landscapes approaches provide a more holistic approach to regional sustainability governance. Through the Verified Sourcing Areas (VSA) certification, complexities related to close individual monitoring of each producer can be partially overcome. Moreover, this label also provides an important new quality parameter for beef.

- Sustainable intensification and implementation of integrated systems within beef production contains a very substantial potential to both increase productivity while lowering greenhouse gas emissions and preserving biodiverse landscapes. As more

modern and less land-intensive production practices are adopted, restoration of native vegetation on abandoned pastures becomes viable.

- So far, payments for environmental services within the beef sector have not seen significant advances. Despite the potential which such payments imply for carbon mitigation and other sustainability-related goals, mechanisms to distribute costs along the supply chains are still not fully developed.

- Lack of land entitlement, capital and know-how, as well as exclusion from formal supply chains has left many small and medium-sized ranchers in a vicious circle of low-productivity and environmentally harmful production. Experiences with the provision of inputs and technical know-how combined with land regularization show how settlements have been able to drastically reduce deforestation while raising their income.

Policy recommendations

The soy and beef sectors can potentially both play key roles in the efforts to decouple Amazon biome deforestation from agricultural and livestock production. The issues treated in this report highlight the complexities associated with addressing this challenge, due to the number of stakeholders and the currently fragmented regulatory environment. Yet, a series of valuable experiences and effective measures have nonetheless been undertaken by private actors in recent years, which may serve an important function in guiding additional efforts towards zero-deforestation. Based on our analysis, we present the following policy recommendations for how private sector interventions can help support Amazon deforestation decoupling from Brazilian soy and beef production:

- Brazilian agribusiness should seek a strategic engagement with sustainability-related concerns and assume a pro-active position by incorporating this agenda as a central element of its future development. Existing experiences of innovative governance initiatives and production models provide a strong point of departure for this line of action.

- Industry initiatives to guarantee completely deforestation-free soy chains contain a significant potential to consolidate and advance conservation efforts. Instruments aiming at monitoring and traceability should be enhanced in order to avoid leakages and laundering of soy and streamlined and transparent methodologies should be adopted to facilitate assessments of progress made towards zero-deforestation supply chains.

- To avoid backlash from producers, initiatives within the soy sector containing conservation requirements above the law should seek to incorporate a system of positive incentives like payment for environmental services and similar schemes which would permit a more equitable distribution of costs throughout the supply chain.

- Adherence to the rural environmental registry (CAR) is essential, and public authorities need to allocate sufficient resources to accelerate this process. This would also offer the chance for positive-sum dynamics, through reinsertion of previously embargoed properties within soy supply chains through the restoration of deforested areas.

- Current advances towards traceability by slaughterhouses through use of a combination of public and private monitoring data are important measures to ensure decoupling of beef production from Amazon deforestation. However, data confidentiality and close contact with suppliers in the implementation of these systems are key factors to ensure transparency and avoid backlash from producers.

- Involvement of soy producers and cattle ranchers is a key part of effective zero-deforestation commitments. In cases when adherence to this goal is obstructed by a lack of technical knowledge amongst suppliers, upstream actors should seek constructive engagement to provide producers with these capabilities. In cases of blatant transgressions, supply chain exclusion should still be applied as a corrective measure.

- Landscapes approaches provide important governance instruments to tackle a wide range of sustainability-related criteria spanning beyond an exclusive focus on deforestation. What is more, Verified Sourcing Areas also provide an important alternative approach to dealing with the complexities of monitoring individual producers.

- Sustainable intensification within beef production should be scaled up on all levels, and implementation of integrated systems proliferated more widely. Due to the low average productivity levels within the beef sector and the ample availability of degraded and low-productivity pastures, there is a need for investment in modern production practices to reduce carbon emissions from production activities, free lands for agricultural expansion and reforestation, preserve biodiversity, and raise farmers' income.

- Experiences from integration within the Brazilian poultry chain could inspire the promotion of changes within the beef chain. The management of technical assistance, sanitary issues, and financing through industry coordination could serve as an example for the adoption of a more integrated model between ranchers and slaughterhouses.

- It also becomes vital to engage other supply chain actors in order to minimize the damages caused by exclusion. The necessary technification required for the producers to break the vicious cycle of low productivity and environmental degradation requires both financing and direct assistance, such as genetic improvement of animals and better pasture management.

- Payments for environmental services are an important way to accelerate the scaling of sustainable production practices within the beef sector. For this purpose, costs of transition to these production models should be more evenly distributed throughout the supply chain through premium payments for products such as carbon-neutral beef produced in CLFi systems.

- Targeting small and medium-sized producers with credit, knowhow, and attribution of land rights (in a manner and extent which avoids incentivizing further deforestation) is essential to break vicious production cycles marked by low productivity and environmental degradation. Existing experiences demonstrating the positive-sum outcomes of such interventions within settlements in the Legal Amazon should be scaled up and public resources allocated for this purpose.

- Existing experiences show that private engagement in combating Amazon biome deforestation is key, but loses traction without a baseline of effective public regulation. Alone, private initiative will thereby not be sufficient in order to address the problem of Amazon biome deforestation, meaning that public engagement through command-and-control measures becomes imperative to confront this challenge.

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