BRAZILIAN AGRICULTURE IN A WORLD OF CARBON PRICING: CHALLENGES AND OPPORTUNITIES

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Executive Summary

The policy paper assesses the implications of the materialization of global carbon pricing schemes regarding the Brazilian agricultural and livestock sector. Through in-depth interviews with 17 Brazilian and international specialists in relation to carbon pricing from within academia, NGOs, and private companies, we present a structured synthesis of their perspectives about the potential for Brazilian agriculture to contribute to global GHG mitigation efforts through carbon financing.

With focus on the need to implement low-carbon practices within the Brazilian agricultural and livestock sector, the policy paper engages with this process of socio-technical transition within the institutional, economic, technical, and social dimensions. The interviewees' opinions and suggestions are presented to provide conceptual clarity, as well as practical solutions regarding the challenges and opportunities for carbon financing to stimulate low-carbon agriculture.

Within the institutional dimension, we examine the recent international institutional developments and the arrangements for global carbon pricing and carbon markets which they may produce. Moreover, we also assess the parallel institutional developments in Brazil, as well as the challenges of creating efficient systems for carbon pricing which incentivize improved sustainability performance while guaranteeing environmental integrity.

In the economic dimension, we provide an overview of the main drivers in terms of demand and supply for mitigation projects, and how Brazilian technological and natural resource endowments position the agricultural sector in terms of participating within these. In particular, we pay attention to the obstacles in terms of prices and incentives for agricultural and livestock producers to embrace low-carbon practices.

Amongst the challenges within the technical dimension, establishing appropriate and scalable systems for Monitoring, Reporting and Verification (MRV) stands as a critical task identified by a wide range of interviewees. Moreover, providing technical assistance for farmers to be able to adopt cutting edge practices and sustainable intensification constitutes an important goal.

Finally, within the social dimension, we treat the significance of cultural factors in determining farmers' willingness and ability to adopt sustainable production systems. Moreover, this section also presents important caveats and insights provided by the interviewees concerning the importance of ensuring that carbon mitigation projects generate positive social repercussions and co-benefits.

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Introduction

In recent years, anthropogenic climate change has accelerated to the point at which the likelihood of crucial planetary boundaries being exceeded has become increasingly evident.[1] Efforts to mitigate climate change will necessarily encompass the reorganization of economies worldwide, in order to allocate the costs of Greenhouse Gas Emissions (GHGs) amongst the responsible economic agents. Plans for defining a price on GHG emissions (henceforth, carbon pricing) as a means to internalize costs and suppress incentives to pollute have thereby gained momentum.[2]

Estimates suggest the necessary price range of emitting 1 ton of CO_2 to be around US$ 40-80 in 2020, and US$ 50-100 by 2030 if the planet is to stay below the crucial threshold of irreversible climate change.[3] Different carbon pricing schemes have already come into existence. By September 2021, 47 jurisdictions (countries, provinces or cities) worldwide had implemented carbon pricing schemes, with values of 1 ton of CO_2 equivalents varying from US$ 1, to as much as US$ 142, generating approximately US$ 57 billion in revenues.[4] That year, the number of carbon pricing initiatives worldwide reached 64, of which 33 were based on Emissions Trading Systems (ETS), while 31 relied on carbon taxes, covering 21.5% of global GHG emissions.[5] Although carbon pricing schemes have been most common in the developed world, developing countries, such as South Africa, Colombia, and Mexico have also adopted similar systems.[6] It is thereby expected that carbon pricing initiatives will disseminate in coming years and incorporate a wide array of different economies.

Although some carbon pricing initiatives based on ETS have been integrated, the general global picture is still characterized by highly heterogeneous and decentralized arrangements.[7] The Paris Agreement and the operationalization of Article 6 as agreed in Glasgow, will permit the international transfer of mitigation outcomes for countries to reach their nationally determined contributions (NDCs).[8]

Proponents of a system permitting trade in Internationally Transferred Mitigation Outcomes (ITMOs) characterize climate change as a market failure and highlight the need for internalization of mitigation costs by emitters through market mechanisms.[9] Studies suggest that adoption of ETS schemes based on Article 6, in theory, could reduce the costs of compliance with the goals in the Paris Agreement, with annual

1. IPCC (2021)
2. Bergh & Botzen (2020)
3. Stiglitz & Stern (2017)
4. Postic & Fetet (2021)
5. World Bank (2021)
6. Wang-Helmreich & Kreibich (2019); RSA (2019)
7. Forest Trends (2019)
8. UN (2015).
9. Hingne (2019); Newell et al. (2013)

reductions in expenditures reaching as much as US$ 250 billion by 2030 compared to a situation without the implementation of Article 6.[10] Some estimates even suggest a potential 40-60% reduction in overall mitigation costs by 2030 through the effective implementation of Article 6.[11]

To avoid leakage of production and economic activities to countries without ambitious mitigation targets, so-called "carbon clubs" have been suggested, which would rely on border carbon adjustments through taxes targeting these countries' exports.[12] Prospects of the materialization of a more integrated global carbon market have also faced skepticism and worries that the environmental integrity of this market could be compromised by weak accounting rules.[13] The complexity of integrating very heterogeneous pricing schemes and the dangers of financial speculation and perverse incentives[14] points to important risks and pitfalls associated with integration of carbon markets and will need to be thoroughly addressed by any future attempts to link pricing schemes. The accordance on Article 6 of the Paris Agreement nonetheless raises the need to engage with the implications of increased global carbon market integration, to assess the risks and opportunities for countries and economic sectors to contribute to global mitigation efforts.

Objectives

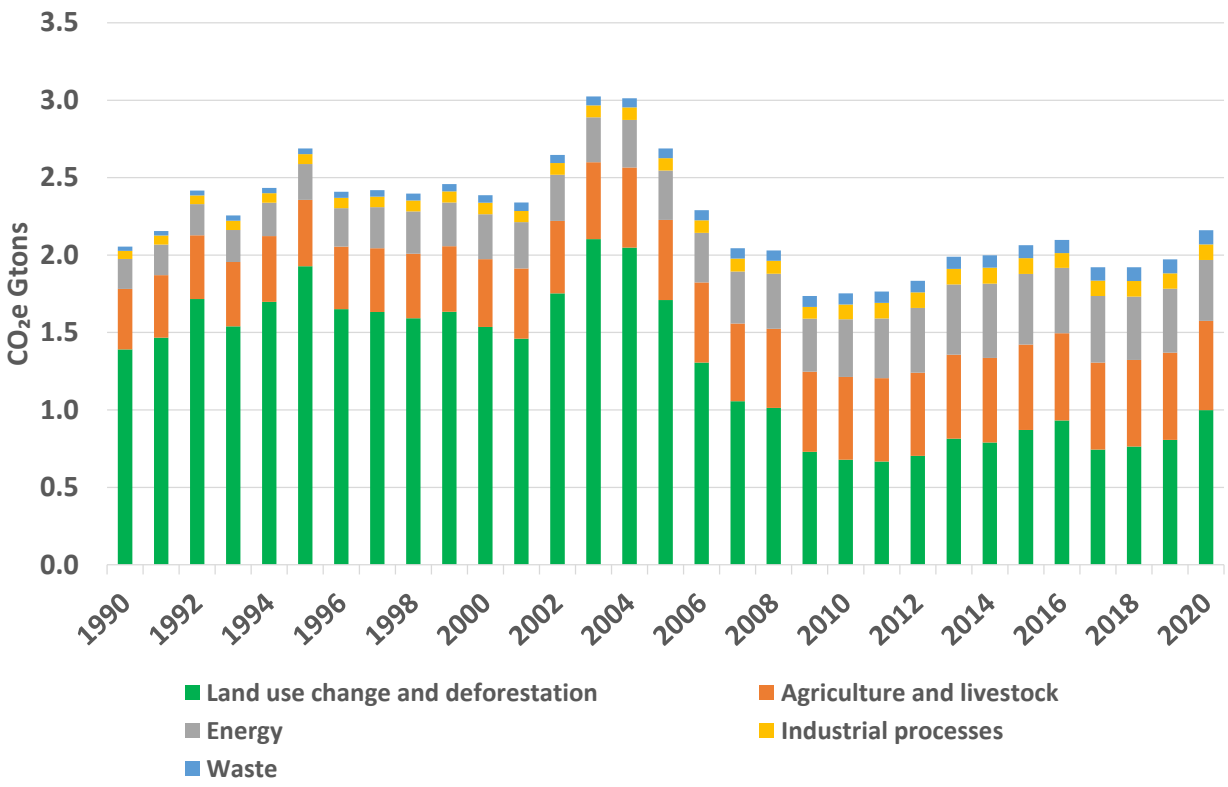
With this policy paper, **we seek to address the challenges and opportunities for the Brazilian agricultural and livestock sector to contribute to GHG mitigation efforts through an active engagement within carbon markets.** For this purpose, we examine the institutional, economic, technical, and social dimensions of carbon markets in order to provide informed assessments about the regulatory and organizational issues which need to be addressed. We mainly rely on insights gathered through in-depth interviews with leading Brazilian and international experts within the field of agriculture and carbon markets. Our aim is to provide a structured synthesis of these qualified assessments, but also to highlight any eventual divergences in the opinions and perspectives gathered through the interviews. The paper is structured to inform policy-makers and formulators, private actors, academics, and civil society within and outside Brazil about a highly timely issue in the global efforts to combat climate change.

10. Edmonds et al. (2019)
11. UNEP (2021)
12. Keohane et al. (2017); Bergh et al. (2020)
13. Schneider & Theuer (2018)
14. Stuart et al. (2017); Gulbrandsen (2017)

Brazil and the global carbon market(s)

Due to its size and extensive natural resource endowments, Brazil stands in a central position within the global climate regime, meaning that the country's course of action becomes important in either aggravating or mitigating the climate crisis. With its comparatively clean energy and transportation sector, the main source of Brazilian GHG contributions derives from agriculture and land use, which in 2020 was estimated at 73% of total emissions[15] (see Figure 1). Rising deforestation of the Amazon biome accounts for a significant share of these contributions, and also implies a risk of catalyzing important tipping points at which the dieback of the forest becomes irreversible.[16] Conservation of the inland *Cerrado* is also of central importance, as the region constitutes an important carbon sink and biodiversity hotspot.[17] As global attention increasingly has centered around the need to decouple soft-commodity production from deforestation,[18] similar conservation demands have been made in Brazil.[19]

Figure 1. Brazilian GHG estimated emissions by sector (in CO_2 equivalent Gtons)



Source: SEEG (2021)

15. SEEG (2021)
16. Lovejoy & Nobre (2018 & 2019).
17. PIK (2019); Strassburg et al. (2017); Trigueiro et al. (2020)
18. Thomson, E. (2020); Newton & Benzeev (2018); Taylor & Streck (2018); CERES (2020); Brown & Zarin (2013); Streck et al. (2016)
19. zu Ermgassen et al. (2019); Lima et al. (2019)

Brazilian agriculture stands in a key position, as sustainability measures within this sector would be important in mitigating Brazilian GHG emissions. Agricultural and livestock producers could thereby become part of the solution to this problem, as a huge conservation potential exists through the adoption of more modern and land-intensive production models,[20] and by introducing practices that increase carbon stocks in the soil.[21] While most of the current deforestation in the Amazon biome or the frontier regions of the Cerrado is illegal[22] and should be confronted through swift public action, Brazilian law permits deforestation under certain circumstances. Financial incentives can help spur above-the-law conservation and the adoption of sustainable practices with positive mitigation outcomes.[23] It is therefore essential to scrutinize both the challenges and potential of climate financing in fostering sustainable development within Brazilian agriculture.

Challenges spanning a wide range of thematic areas become evident with regards to the prospects of Brazil engaging actively within global carbon markets. These issues concern the definition of how to regulate these markets and Brazil's role in this process; the regulatory and legislative challenges within Brazil; the utilization of Brazilian natural endowments and application of innovative low-carbon production practices; guaranteeing the environmental integrity of mitigation projects; and creating a demand for carbon credits generated in Brazil.

An overview of the challenges for Brazil within global carbon markets

Although the **definition of a carbon market rule set** through the application of the Article 6 of the Paris Agreement was approved at the COP26 in Glasgow, the specific elaboration of the national institutional foundations can still be a defining feature of states' ability to engage within them. Assessing the process of materialization of the institutions aimed at furthering the integration of carbon markets thereby becomes an important initial analytical focus point.

Engaging with the **domestic regulatory and legislative challenges** is also key to permit domestic actors to engage within a more integrated global carbon market. In 2009, Brazil instituted a national policy for climate change, which has been viewed as an important institutional platform for structuring a Brazilian ETS mechanism.[24] In 2010, the Low Carbon Agriculture Plan (*Plano ABC*) was adopted, containing different measures to support mitigation efforts within the Brazilian agricultural sector. In 2021, the updated version "Plano ABC+" was launched. Moreover, the revision of the Brazilian Forest Code in 2012 also comprises provisions (Article 41) meant to facilitate Payments

20. Strassburg (2017); Nepstad et al. (2019); Ceddia et al. (2014); Vale et al. (2019); Soterroni et al. (2019); Silva et al. (2021); Gaast et al. (2016).
21. Pavão et al. (2020)
22. Valdlones et al. (2021)
23. Seymor & Harris (2019); Zycherman (2016); Muggah (2019); Carauta (2018)
24. Dahan et al. (2015)

for Environmental Services (PES).[25] The decentralized implementation of the Forest Code nonetheless lags much behind schedule.[26] Finally, Brazil has also been able to attract some US$ 2,2 billion in financing from the REDD+,[27] until spiking deforestation rates and governmental neglect of conservation efforts obstructed this mechanism.[28] Thus, certain institutional mechanisms for the implementation of carbon markets in Brazil do exist, although additional regulatory instruments likely will become necessary.

Brazilian natural resource endowments could provide certain comparative advantages for the country within global carbon markets. Land use initiatives, such as conservation and reforestation projects currently constitute some of the most economic alternatives for emissions reductions.[29] World Bank estimates thus suggest that 42% of carbon credits generated from 2015-2020 derive from forestry projects.[30] From being a source of net emissions early in this century, by 2030 forests could become an important carbon sink if proper governance arrangements are pursued.[31] Beyond forestry projects, the implementation of practices of low-carbon agriculture also contains a considerable potential for emissions reductions within Brazilian agriculture.[32] Nature-Based Solutions (NBS) which rely on natural processes to mitigate emissions, such as through the sequestration of CO_2 in the soil, have attracted significant attention in recent years and hold a clear potential for attracting climate investments.[33] Albeit still incipient, voluntary carbon markets already exist in Brazil and have been growing rapidly in recent years.[34] In 2015, in its first NDC for the Paris Agreement, Brazil set a goal of recovering 12 million hectares of deforested area by 2030. This reforestation, as well as further efforts going beyond legal obligations, holds a significant potential to spur job creation and local economic development.[35]

Ensuring the **environmental integrity** of carbon markets in Brazil also becomes crucial to guaranteeing the credibility of emissions reduction generated within the country. A key issue concerns the implementation of robust accounting standards to avoid double-counting of emissions credits.[36] Previous experiences with the linking of ETS systems demonstrate how integrity problems have led to steep drops in the price of emitting, risking undermining the entire pricing system.[37] Strict adherence to core principles for carbon credit generation, such as no double-counting, additionality, realistic baselines, no leakage, and permanence thereby become an indispensable

25. Brasil (2012)
26. Chiavari et al. (2020)
27. Gallo et al. (2020)
28. Bastida et al. (2017)
29. BRA (2020)
30. World Bank (2020)
31. Gaast et al. (2016)
32. de Moraes Sá et al. (2017); Newton et al. (2016)
33. Steer & Hanson (2021); Seymor & Langer (2021)
34. Wenzel (2021)
35. Kishinami & Watanabe (2016)
36. Schneider & Theuer (2018)
37. Ervine (2017)

requirement. The continuation of large-scale illegal deforestation is an obstacle to Brazilian participation within global carbon markets, as this could undermine the credibility of mitigation efforts.[38] Finally, social issues and attention to the role of small farmers and local communities within any future bioeconomy is also important to guarantee the wider socio-environmental integrity of mitigation projects.[39]

The **current and future demand for carbon credits** is essential in determining the speed and scope of mitigation projects in Brazil. Estimates suggest that the trade in certified emissions reductions with the operationalization of Article 6 could be in the range of US$ 58-167 billion from 2021-2030, - a large amount of which could befall Brazilian sellers.[40] Specific estimates of the Brazilian share have suggested a value of US$ 19-58 billion in this period.[41] However, the relative unpredictability of this demand in the short term could become an obstacle for investments in mitigation projects.[42] Currently, 75% of regulated emissions still trade at a value below US$ 10.[43] In the United States, carbon credits generated within the agricultural sector trade between US$ 15-20.[44] A potential driver of demand within the voluntary carbon market is the proliferation of "insetting", whereby companies seek to reduce the carbon footprint of their own value chain.[45] Moreover, agreements such as the CORSIA, through which the aviation industry is set to compensate for additional emissions from air travel, has also been estimated to generate a demand for 1,7-3,6 billion credits between 2021-2035.[46]

This overview of the challenges and opportunities for Brazilian agriculture to incorporate low-carbon practices, and the role carbon markets might play in this respect suggests that this regards a process related to a wider socio-technical change. This transformation encompasses developments within a range of different institutional, economic, technical, and social dimensions, that are marked by strong internal synergies. We thereby adopt such a multidimensional perspective to guide the current study, focusing on key factors and developments within these fields, and how they define the scope for the adoption of low-carbon agriculture and engagement within carbon markets.

Methodology

This paper is based on qualitative data gathered through semi-structured in-depth interviews with leading Brazilian and international experts in agriculture and carbon

38. Wenzel (2021)
39. Gebara et al. (2020)
40. Da Motta (2021)
41. Piris-Cabezas (2016)
42. Blaufelder et al. (2021)
43. Postic (2020)
44. Shockley & Snell (2021)
45. Seymor & Langer (2021)
46. Schneider (2019)

markets. The interviews provide us with important assessments and perspectives on the recent history and current state of materialization of carbon markets in Brazil, as well as the most important challenges to be overcome by the Brazilian agriculture and livestock sector. The interviews have been transcribed and coded to permit the identification of the central themes and key points presented by each interviewee. Hereafter, a structured comparison and categorization of the interviewees' statements according to their thematic content was made. This provided an overview of the issues marked by a certain degree of consensus amongst the interviewees, as well as diverging viewpoints. Both converging and diverging perceptions have been presented in the analytical sections to provide the reader with a nuanced perspective. Due to the Covid-19 pandemic in 2021, all interviews were conducted online and explicit permission to record and use the material was given by the interviewees. As can be read from Table 1, the interviewees comprised a broad span of individuals from different professional backgrounds.

Table 1. Interviewees and their professional background:

Professional background	Number of interviewees
Private certification organizations	2
Project implementation companies	4
NGOs	4
Public sector	1
Agronomist technicians and/or academics	4
Corporate sector	2

Source: authors' elaboration

The interviewees were selected through a snowball methodology which maintained the aim of ensuring a relatively balanced representation of different categories of stakeholders. In the following sections, we proceed to the analysis which is structured according to the institutional, economic, technical, and social dimension of carbon markets.

Dimensions			
Institutional	**Economic**	**Technical**	**Social**
- Article 6 implementation - Brazilian negotiation positions - Brazilian domestic institutional framework	- Supply factors: comparative advantages in natural resource endowments and technology - Demand factors	-Technical assistance -Monitoring, reporting and verification (MRV)	- Cultural factors - Co-benefits and commodification risks

The analysis highlights important insights presented by the interviewees in relation to these thematic areas, summarizes findings, and hereafter presents a range of policy recommendations based on a synthesis of these perspectives.

The institutional dimension of carbon markets

The creation of mechanisms for carbon pricing in specific countries and their global integration depends on the establishment of strong institutions to guarantee efficiency and environmental integrity. Current international developments within this field are likely to also spur the creation of arrangements for carbon pricing and emissions trading in Brazil. Domestic initiative is also key to enabling carbon financing to support mitigation projects in the country.

The movement towards global carbon markets

The importance of the implementation of Article 6 of the Paris Agreement with the establishment of mechanisms to support integrity as well as ambitious NDCs was strongly emphasized amongst many of the experts interviewed. Such an international institutional framework would need underpinning by regulated systems for carbon pricing and the domestic level. In a necessary process of transition towards decarbonization of economies, carbon trading mechanisms at the national or international level can play a temporary role in compensating for emissions that cannot be completely phased out in the short term.

Many of the interviewees highlighted that it was more likely that a global carbon market in practice would be constituted by many different carbon markets, with some varying degree of harmonization and fungibility. Some also stressed the importance of the further development of the voluntary market in parallel to the materialization of a regulated market, to permit companies to independently pursue reduction and mitigation strategies. In the Brazilian context, engagement within voluntary markets was also viewed as a means which could facilitate the transition towards a future regulated market.

A carbon project certifier defended a model according to which projects would not need to ensure corresponding adjustments, thereby assisting host countries – such as Brazil - in accomplishing their NDCs. He nonetheless stressed the vital importance of public engagement in creating comprehensive regulated carbon markets and characterized voluntary markets as an insufficient substitute growing due to government inaction. However, verification and certification instruments developed for voluntary markets could offer some useful instruments for the creation of regulated markets, especially in developing countries with limited institutional resources.

Brazil stands in a central position within international climate negotiations and could thereby influence rules for a future global carbon market. However, both previous and, especially, the current Brazilian administrations have been strongly criticized for their

negotiation positions. Many of our interviewees also denounced historical errors of Brazilian governments not to pursue rules which could facilitate international financing for climate mitigation projects within the forest and agricultural sectors. Strong political lobbying from the energy and manufacturing interest groups thus appears to have been successful in ensuring that the substantial emission reductions achieved in the field of land use from 2004-2012 would permit continued emissions by these sectors.

The Brazilian emphasis on carrying carbon credits from the old CDM over into a new emissions trading system was also met with a large amount of criticism by the interviewees, who highlighted this as a backwards-looking posture, and stressed that Brazil should have made better use of the CDM when it had the chance. The current Brazilian administration has also been met by a high degree of disapproval. This mainly concerns the Bolsonaro government's indifferent posture with regards to the challenges and opportunities produced by the climate negotiations and its downward adjustment of the Brazilian NDC. The Brazilian government's lack of any specific agenda and commitments ahead of the COP26 in November 2021, as well as its general track record within the field of climate and environment, was characterized in very serious terms as something which strongly undermined Brazilian international credibility.

Despite the current domestic political challenges, important lines of prospective action were also presented by the interviewees. Implementation of Article 6.2 of the Paris Agreement was thus highlighted as something which in the intermediate and long term could make Brazil a global supplier of carbon credits. Particularly NBS was highlighted as an area in which Brazil could become an important player. An urge for Brazil to resume its protagonism within climate negotiations in order to constructively engage with this agenda and harness its opportunities also appears to be evident. Opportunities also appear to be evident within existing regulated markets. Some ETS schemes thus permit compensation through projects undertaken in outside jurisdictions. A project developer thus stressed the paradox that Brazilian actors so far had not been very engaged in seeking out such opportunities, stressing how especially the Ministry of Foreign Affairs could contribute to these efforts. For Brazil to participate within an international regulated market based on ITMOs, the country would inevitably need to outperform its NDC in order to generate a marketable surplus of credits.

Box 1
Article 6.2 | Paris Agreement: "Parties shall, where engaging on a voluntary basis in cooperative approaches that involve the use of internationally transferred mitigation outcomes towards nationally determined contributions, promote sustainable development and ensure environmental integrity and transparency, including in governance, and shall apply robust accounting to ensure, inter alia, the avoidance of double counting, consistent with guidance adopted by the Conference of the Parties serving as the meeting of the Parties to this Agreement."

Regulatory mechanisms for carbon pricing in Brazil

Beyond international efforts to institutionalize such a mechanism, the ability of Brazilian agriculture to increase mitigation efforts through engagement in carbon markets also depends on converging institutional mechanisms at the domestic level. We were able to detect a widespread consensus around the pressing need for the implementation of some type of carbon pricing mechanism. This is due to the transitional nature of carbon markets as a means to bring economies to the stage of complete decarbonization. As an interviewee highlighted, "carbon markets, in my mind, have a limited shelf life, the concept, right. So, if we rely on a carbon market in 2050, game over(!)". Some of the experts consulted mentioned both a carbon tax and an ETS scheme as viable options. However, most interviewees appeared inclined towards an ETS mechanism, which also would help to stimulate demand for mitigation projects.

The Legal Draft 528, which currently circulates in the Brazilian Congress stipulates the eventual establishment of a domestic carbon market. However, the Brazilian government has been resistant to embrace its initial formulation. Moreover, alterations made during the process of transmission through the Brazilian Congress so far have significantly diluted the substance of the law. Some of the interviewees stressed that the size and heterogeneity of Brazil could mean that regional markets would be preferable, as it has been seen for example, in the United States or China.

A pressing concern regards the question about how to regulate the agricultural sector, which both directly through its production activities, but also indirectly through land-use change represents the largest source of Brazilian GHG emissions. The high number and diverse range of economic agents within the sector, as well as the incomplete implementation of rural registries, makes it extremely complex, - if not outright impossible, - to account for emissions from most agricultural and livestock producers.

One suggestion about taxing the highly emission-intensive Brazilian beef productions at the point of the slaughterhouse appears as a more practical option, but this would still only cover parts of the sector's total emissions, and not directly target associated land-use change. A critical obstacle appears to be the governmental disengagement in the issue, as well as the pushbacks from the Brazilian manufacturing industry against carbon pricing. This posture was strongly criticized by some of the interviewees, who emphasized how carbon-intensive international exports inevitably would be taxed, and that future competitiveness depended on the ability to apply low-carbon production practices. In this regard, carbon markets were highlighted as some of the most cost-efficient alternatives for internalizing this price.

A range of other institutional innovations for the facilitation of emissions reductions within Brazilian agriculture have been discussed. A suggestion for the inclusion of agriculture and livestock sectors within the wider Brazilian reduction scheme concerns

the elaboration of sectoral agreements, based on projected emissions and the construction of a consensus around effective reduction measures. Tax incentives for economic entities with a particularly ambitious climate profile have also been mentioned. An important issue identified by an interviewee concerns the enhancement of the business environment for mitigation projects. A range of experts consulted also pointed to the potential of developing existing legislation, not least the Brazilian Forest Code's Article 41, which concerns the issue of payments for environmental services.

Certification Integrity

A crucial precondition for the engagement of Brazilian agricultural and livestock sectors within carbon markets concerns the integrity of emissions reductions. Adopting robust methodologies for measurement, reporting, and verification (MRV) and adhering to the core principles for the **integrity** of carbon credits is therefore imperative. Global demand for the services provided by GHG crediting programs has spiked in recent years, far outpacing the certification capacity of established players within the field. This has led to the surge of a wide span of new and less consolidated certification standards, also within the field of agriculture. A project developer thus stressed how many substandard projects and attempts at greenwashing could be found within the voluntary market. Poor projects are often born out of conflicts of interest when the same actor who proposes the initiative also oversees the certification and commercialization of the credits generated.

An important concern was highlighted as **permanency**, and the ability to guarantee that the carbon sequestered for the emission of credits would effectively remain in the soil or biomass for a long time. With standard contract periods of minimum 20-30 years, this constitutes a significant challenge within agriculture, compared to forestry projects. Avoiding **double-counting** was also emphasized as highly essential by many interviewees. An important point also regards the general socio-environmental management practices of farmers, such as their legal compliance and respect for local communities land rights, which is key to ensuring the principle of **no-harm** within certification.

One of the most essential elements of integrity has to do with **additionality**. A critical task in this respect is to make producers understand that they will be more likely to monetize new carbon volumes effectively sequestered rather than converting existing stocks on their lands into profit opportunities. This relates to the fundamental purpose of carbon markets, which is to ensure that certified carbon projects lead to improved sustainability performance in terms of GHG emissions, rather than merely rewarding the perpetuation of status quo in terms of production practices. The issue of additionality also relates to certain specific characteristics of Brazilian agriculture, which makes this assessment increasingly complex. One example is no-till planting, which

has a positive carbon profile and therefore could be considered as a mitigation practice within agriculture worthy of carbon crediting. However, as approximately 85% of Brazilian farmers apply no-tilling, it is likely too common to be considered as additional. This apparent paradox was recognized by a certifier, who nonetheless highlighted that practices that already have reached the point of economic viability are normally not considered to require carbon-based financing. However, as noted by an agricultural technician, good quality no-till is adopted by only about 1/3 of farmers claiming to employ no-till, while the rest employ other types of minimum tillage, with different mitigation impacts, that are not essentially no-till. In this case frontrunners in the adoption of actual no-till could possibly make the case for additionality.

The most contentious issue related to additionality nonetheless concerns the payment for legally mandated conservation on private properties. This question divided the group of experts consulted who presented very different perspectives on the matter. Some highlighted the alleged worldwide uniqueness of the Brazilian Forest Code and the Legal Reserve requirement, which stipulates the need for private rural properties to conserve 20-80% of their area. The argument refers to the fact that part of the farmer's private property is being immobilized to ensure the protection of an area, which effectively generates collective benefits, thus leading to the claim of potential monetization. This perception is widespread within the Brazilian agribusiness sector and often strongly highlighted in sustainability debates.

Other observers nonetheless suggested that the preservation of native vegetation spanning beyond legal requirements was more likely to be considered in accordance with the additionality principle. The opportunity costs of leaving these areas intact could thereby make them eligible for carbon financing. An international project certifier was very emphatic about the need for projects to reach beyond legal adherence, stating how the lack of legal additionality constituted a criterion which by default excluded most projects from certification eligibility. Although he admitted that in certain rare situations, the case for exceptions could be made, he still noted, "I actually think that in the future, looking at a kind of Paris Agreement world, existing laws will have to be respected and be the baseline, whether they are enforced or not. And frankly speaking, I think they should be".

Beyond the question strictly related to additionality in a legal sense, another central aspect of the discussions about additionality as an integrity principle regards the issue of **carbon flows versus stocks**. Some interviewees who emphasized the importance of flows thus underlined how legally mandated afforestation projects for Legal Reserve restoration, which in practice nonetheless were very unlikely to take place, could be considered as additional. Emission of carbon credits could thereby spur mitigation efforts in contexts with counterfactual baseline scenarios in which reforestation could be considered improbable. Other interviewees were more inclined to stress the significance of carbon stocks, highlighting the importance of "putting a value on

standing forests''. This group pointed to the alleged perverse incentive for deforesters to get paid while landowners who have refrained from deforestation would be ineligible for carbon projects. The notion of "presumed deforestation" which underpins this perspective has nonetheless been met with a substantial amount of criticism, as expressed by a project manager, "I don't like it, because Russia might come one day and say 'I'm going to deforest half of the Soviet Union.' And who is going to say no; 'you got paid there in Brazil".

Payments for environmental services – an opportune but incipient market: Considering the Brazilian natural resource endowments, transactions in environmental services could correct market failures through monetary compensation of positive externalities. According to a project coordinator for an environmental NGO, "in a scenario of dramatic climate prospects, we are exporting our meat and soy to countries that are saving their natural resources, while in Brazil the loss of natural vegetation will have future economic consequences. Small, medium and large rural producers export water, carbon and other environmental services for free and no one is paying for them."

The market for payments for environmental services (PES) in Brazil is promising, but still very incipient. On the supply side, the transaction costs for producers to access this market are generally higher than the economic return. Furthermore, the reliance on public resources or philanthropy to be able to compensate for conservation efforts is very high. In this sense, there is a need for governance of environmental services that promotes a permanent structural change that does not depend on the contribution of external resources. In other words, offering medium-long term sustainability to PES projects.

In January 2021, the Law 14.119/21, concerning PES, was approved in Brazil. Legislation could serve to structure this market, - which is still very embryonic, - by facilitating its development in the medium and long term. It is necessary to define how the law can be used to obtain incentives for PES projects. Robust arrangements need to be created to provide incentives and attract financial resources, in light of the specific profile and characteristics of rural producers.

There are still few incentives (tax, credit, etc.) to be explored. The regulation intends to create a favorable environment based on contracts, methodologies, criteria and indicators for monitoring, among other elements necessary to receive incentives for programs and projects. The law also serves as a guideline for subnational initiatives.

On the demand side, for the PES to advance, increased organization would be needed, transparent and unbureaucratic pricing mechanisms would become necessary, as would robust but simple monitoring and measurement methodologies.

The economic dimension of carbon markets

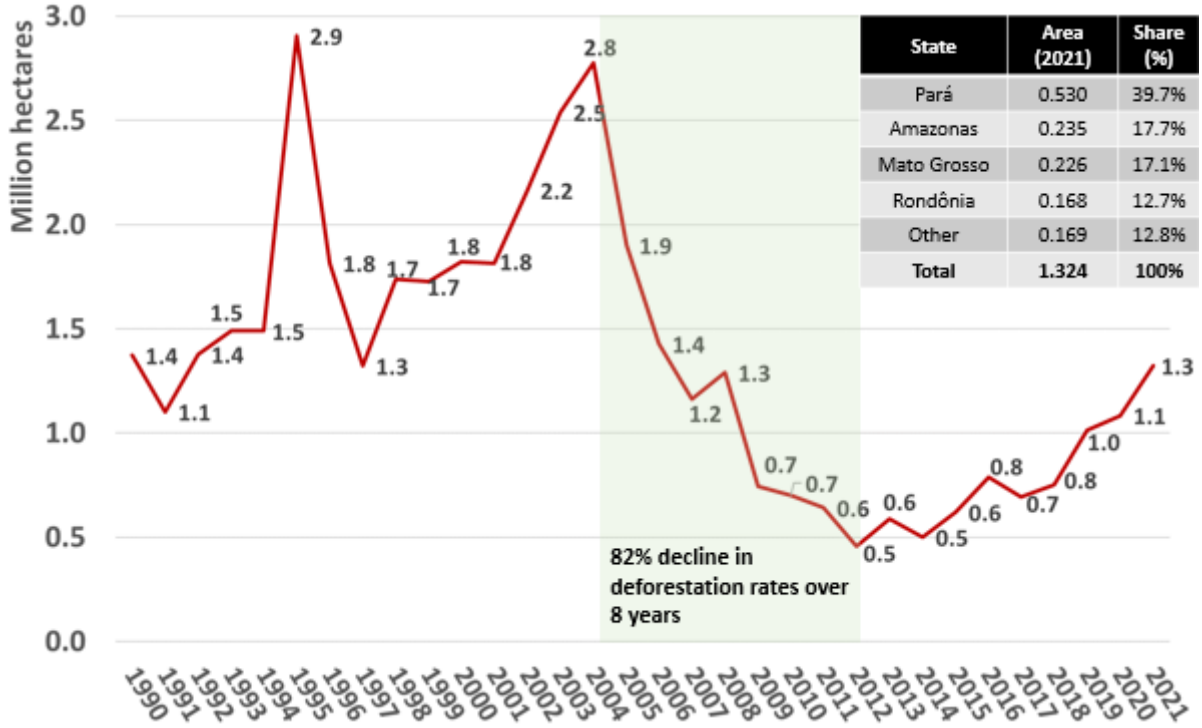
Our analysis of the economic factors which define the scope for the Brazilian agricultural and livestock sector's participation within carbon markets points to both challenges and opportunities on both the supply and demand side.

The supply side; comparative advantages

On the supply side, Brazil is characterized by a range of comparative advantages. These relate to the country's extensive natural resource endowments as well as its tropical agricultural technologies, and the potential scope for their implementation and contribution to mitigation efforts. Our interviews revealed a widespread perception of the Brazilian comparative advantage in forest conservation, as expressed by a forest project manager "we could be the Saudi Arabia of REDD if we want". Brazil thus stands in a position to become an important supplier of carbon credits through conservation and reforestation at a very low cost per ton of CO_2 sequestered. REDD+ initiatives were also emphasized as an area in which Brazil enjoyed substantial potential, although project development has thus far been relatively complex.

Reforestation projects can also play an important role in complementing agricultural production through the wide array of environmental co-benefits, such as biodiversity and water resource preservation. Such co-benefits also mean that monetization of carbon sequestration is only one amongst many potential gains. Conversely, the spiking deforestation rates were highlighted as a considerable liability, compromising the development of a green economy, as well as the future ecological base of Brazilian agriculture. In particular, the surging Amazon deforestation in recent years is a factor that has undermined Brazil's international position, and concomitantly also the country's ability to attract foreign investments within the agro-environmental field (see Figure 2).

Figure 2. Deforestation rate in the Legal Amazon since 1990 (in million hectares)



State	Area (2021)	Share (%)
Pará	0.530	39.7%
Amazonas	0.235	17.7%
Mato Grosso	0.226	17.1%
Rondônia	0.168	12.7%
Other	0.169	12.8%
Total	**1.324**	**100%**

Source: INPE (2021). Note: data from 2021 is temporary and based on INPE estimations. Definitive data will be released by INPE by mid-2022. For the full methodology see Câmara, Valeriano and Soares (2006).

Another important Brazilian comparative advantage highlighted by the group of interviewees concerns the mitigation potential through the implementation of sustainable agricultural land management to increase carbon stocks in the soil. This potential becomes even more significant considering that many farmers either do not adopt or only apply part of the wide range of existing sustainable practices, leaving a large room for improvements through all-around implementation. Increasing the soil organic matter is crucial in this regard, as it both serves to raise productivity and to sequester carbon. In this perspective, carbon mitigation often only becomes a secondary objective to productivity increases, as was highlighted by an agronomist:

"Ultimately, increasing carbon stocks in the soil means that it has more organic matter and, overall, the soil quality is higher and more conducive to plant development. I think the producer has to think about this aspect. Carbon is just an add-on, a bonus, an extra. He shouldn't think of carbon as an end, but as a consequence".

Efficient application of no-tilling is key to increasing soil organic matter. Compared to conventional practices when the soil is ploughed, no-till can lower CO_2 emissions by 0,5-0,6 ton/CO_2/year, as was highlighted by an agricultural technician interviewed. As a carbon sink, the soil is nonetheless finite, as CO_2 levels will tend to stabilize after 20-30 years of proper management. The integration of crops production with trees can nonetheless increase carbon stock deeper down than the topsoil layer. Another highly

important low-carbon practice that has been enhanced within Brazilian agriculture concerns biological nitrogen fixation. As nitrous oxide is one of the GHGs with the highest warming potential, the diminished usage, - or even phase-out - of nitrogen-based fertilizers contains an important mitigation potential. A more wide-ranging adoption of low-carbon techniques within Brazilian agriculture can thereby help to improve the sector's emissions profile. Some of the interviewees thus underscored the importance of carbon-based financing in spurring the acceleration of the proliferation of these practices.

Finally, many of the experts consulted also highlighted the substantial mitigation potential of sustainable intensification within the Brazilian livestock sector. Currently, land-use change is the main source of emissions in the country, and cattle production is by far the largest driver of this development. The large areas of degraded low-productivity pastures, comprising almost 100 million hectares[47], means that ample land resources could be made available for either agricultural production or afforestation projects if the overall efficiency of ranching was increased. Transitions towards well-managed pastures or integrated systems can easily raise productivity with some 400-500%, which underscores the substantial potential of land sparring, as noted by one interviewee. The elevated productivity, as well as the less harmful emissions profile of improved livestock production models makes such transitions prone to carbon-based financing. Projects based on different models for sustainable livestock intensification should thereby imply a strong mitigation potential and the generation of verified emissions reductions. The availability of extensive low-productivity pastures, abundant precipitation, combined with the existing know-how for modernization of the sector was thereby highlighted by an interviewee as a unique Brazilian characteristic and comparative advantage in relation to other Southern livestock producers, such as Australia.

The demand side

A series of factors on the demand side were also underscored by the interviewees. A clear disparity in the price of carbon credits generated in developing countries at around US$ 50 and in Brazil, where prices vary from US$ 5-7, is thereby evident. Higher prices, above US$ 10 were thereby strongly emphasized as an important factor in spurring mitigation efforts. The common saying in Brazil that "standings forests are worth less than cleared forests" was thereby invoked by an interviewee, and a certain degree of frustration with the hesitancy of developed countries to pay for environmental services and attributes was also evident from some conversations. Moreover, beyond its function as a carbon sink, the Amazon forest's co-benefits, such as biodiversity and its

47. Ferreira Junior et al. (2020)

climatological role as a water reservoir was also highlighted as characteristics that ought to increase the value of carbon credits generated through conservation projects in this biome. One suggestion thus highlighted how incremental parameters for carbon credit pricing could be adopted, meaning that beyond the baseline value of 1 ton of carbon, other attributes could add on to raise the value of the credit.

Projects within the agricultural sector nonetheless still face clear limitations related to the low carbon credit prices, as highlighted by a sustainability manager, "the guy who produces soybeans today is selling at around US$30 [per bag], producing 50 bags, you make US$1,500 per hectare. You will earn US$ 10 more per hectare with the carbon agenda. At 1,500 dollars per hectare, will you then care about 10 dollars?"[48]. Part of the reason for the low prices received by producers has been attributed to the many links in the carbon credit chain, and the variety of actors involved in project development, certification, and commercialization, etc. Domestic demand for carbon credits and environmental product features in Brazil has also been very low and is likely to grow only slowly. An interviewee thus stressed how most domestic demand currently was purely speculative, fed by the expectation of being able to sell carbon credits acquired at a current low price with a considerable margin in the future.

International demand from the voluntary market, on the other hand, was viewed as a more substantial future market driver. In line with their adoption of ESG commitments, many companies have made pledges to become net-zero emitters in the coming decades, which often would require significant compensations, especially through NBS. An estimate suggested that this could lead to an exponential increase in demand for carbon credits generated within the agricultural sector. Compensation through "insetting" by companies in the agricultural and food sector was viewed as a trend that could help increase future demand. An interviewee also emphasized that in his view, the main current problem was not on the demand side, but on the supply side, as projects over 1 million/T were nearly impossible to come by.

The lack of agents willing to undertake a thorough de-risking of projects was stressed as an important factor in this regard, as well as the continued obstacles for the development of large-scale projects within the agricultural sector. Generally, though, the voluntary market appears to be limited by companies' willingness to freely invest in compensating their emissions. Thus, while certain enterprises with large profit margins might prioritize allocating substantial resources to such projects, many are also constrained by demands for profit generation and shareholder compensations. This was accentuated in the words of a project certifier:

"I would like to see a regulated market. I think we can´t expect this problem to be solved by good will alone. Ultimately. So, voluntary markets are great, and that´s what we do. But, in the end of the day, that depends on a company doing the right thing, and we know that companies have a number of different

48. This speech is from May 2021

incentives on their plate; shareholders requiring them to do X, Y and C, and does that include climate protection? They are not going to do it. So, it is great for the "Naturas" of the world, it is great for the "Googles" of the world, who have a lot of extra money, they can invest in this stuff. But, you really do need to force some of the companies to really take action. So, to your question, you know, you could see a voluntary market in Brazil play out really well, so I will make to case for the voluntary market first. But I will caveat that to say that I think that we need to move quickly to a regulated market".

Consequently, a regulated carbon market with some degree of integration should contain a much more significant potential to raise demand for Brazilian carbon credits, compared to voluntary markets, - which also today is dwarfed by the volume within regulated markets. A combination of a regulated ETS scheme in Brazil and some form of Article 6 implementation could thereby pave the ground for an increased global demand for carbon credits, which could help spur adoption of conservation and low-carbon practices amongst Brazilian agricultural producers.

The technical dimension of carbon markets

The establishment of functional carbon markets, as well as the prospects of Brazilian agricultural and livestock producers engaging within this, also hinge on the proper management of a range of technical challenges. In this section, we review our interviewees' assessments of the importance of technical assistance and development of MRV methodologies.

Technical assistance

Technical assistance was highlighted by many of the interviewees as an important factor in spurring the proliferation of low carbon practices among Brazilian agricultural and livestock producers. This is due to the sector's extreme heterogeneity, meaning that while some farms adopt cutting-edge sustainable production practices, many producers still use extensive, low-productivity practices, including periodic stubble burnings. A widespread perception amongst the group of experts consulted was therefore that adoption of low-carbon agricultural practices offered a positive-sum solution with both environmental and economic benefits.

Precision agriculture and regenerative practices, such as no-till and biological nitrogen fixation are illustrative of important sustainable innovations with the potential to both raise productivity and generate carbon credits by lowering GHG emissions. However, while for example no-tilling has been widely adopted in Brazil, reaping the full sustainability benefits from this practice requires a degree of know-how that many farmers still do not possess. Technical assistance becomes central in this regard, as it

can help farmers adopt rotation based on a wider range of crops and move beyond simple double cropping.

Many interviewees emphasized livestock production, mainly beef, as a sector with a very large potential for improved technical management. Beef production is responsible for a substantial share of Brazilian GHG emissions through enteric fermentation and land-use change. The sector is also characterized by an enormous disparity between the least efficient and the most efficient producers. Thus, while some ranchers rely on periodic deforestation and rapid pasture degradation with low outputs and difficulties of reaching the breakeven point, others adopt efficient pasture management, modern breeding technologies and sometimes integration with crop and forestry systems. Sustainable intensification of beef production is key to raising profit margins. Many of the "low-hanging fruits" for emissions reduction can thereby be reached through improvements within the livestock sector.

Despite the significant potential for GHG reductions through sustainability improvements in the agricultural and livestock sector, within the group of experts consulted there was a widespread perception that carbon credits generated should be viewed as one amongst many other potential benefits. While recognizing the significant technical achievements made during the past 20 years, an interviewee thus highlighted the importance of adopting a prospective focus. He thus refuted the "opportunism" of seeking to monetize past reductions made as an unintended consequence of the implementation of more efficient production practices. He rather stressed that carbon credits should serve as a means to incentivize future sustainability improvements.

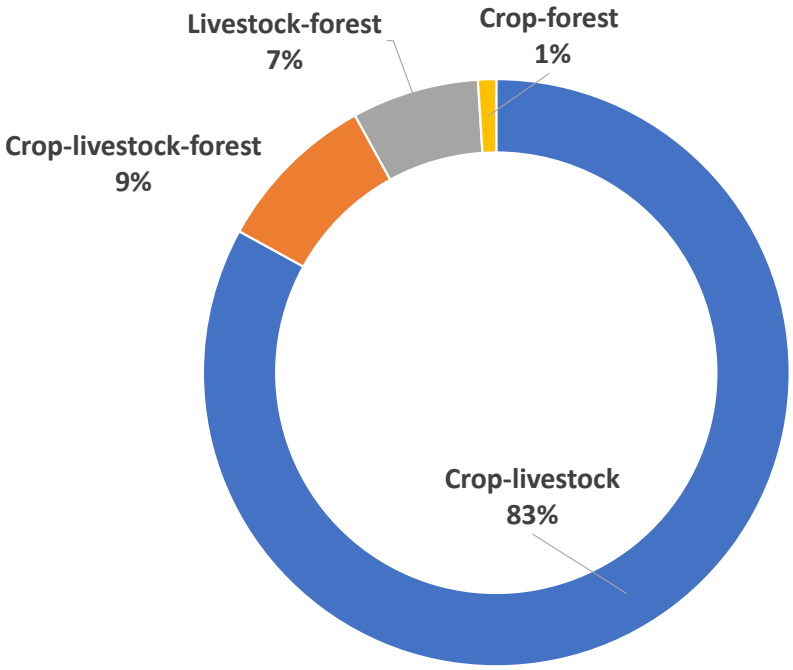
Crop-Livestock-Forest integration (CLFi) provides an example of the potential environmental benefits deriving from improved technical management. While the integration of crops and livestock production increases the productivity of both products and retains carbon in the top-soil layer, trees provide thermal comfort for the animals and increase carbon stocks in soil from 1-3 meters depth and in the above-ground vegetation. CLFi can thus help producers to move beyond monocultures while improving productivity and environmental performance. Eventually, this contains a potential for the production of premium products, such as Angus beef or noble tree sorts.

The implementation of CLFi nonetheless requires a deep technical understanding of both crop, livestock, and forestry, as well as the dynamics of the integration of these systems. As an interviewee stressed, the farmer "is no longer a rancher, nor a farmer; he is a CLFi producer". As 83%[49] of integrated systems currently are based only on crop and livestock integration, an important challenge concerns the introduction of the forestry component to increase carbon sequestration (see Figure 3). This step is nonetheless associated with a significant need for technical assistance, as it increases

49. Rede ILPF (2021)

the complexity of managing the three interconnected components within this production system.

Figure 3. Crop-livestock-forest integration configurations (in % of the production area)



Source: Rede ILPF (2021)

The workforce and dedication needed to successfully engage in CLFi thereby demands important management transitions, as highlighted by an agronomist "A guy who does livestock doesn't even go to the farm. He opened that area about 20 years ago, planted grass by airplane and never returned. With CLFi, he can't do that, his cash flow happens throughout the year, he needs to be dedicated to the farm". Successful CLFi adoption is nonetheless associated with significant financial returns. This is illustrated by an example presented of a ranch that before CLFi implementation operated at a loss of R$200/ha, but after this transition generated profits of R$7000/ha. The generation of carbon credits could thus serve as an additional pull factor by further raising the potential profits of these enterprises.

A bottleneck for the dissemination of sustainable production systems has in many cases been a lack of public engagement in this process, as well as poor project implementation. Lacking credit to cover the initial costs of adopting more sustainable and modern production systems was also stressed by some of the interviewees as an important obstacle. One interviewee highlighted how international capital generated through carbon credits might play an important role in spurring this transition, given the limited interest amongst Brazilian consumers in paying premium prices for sustainably produced products.

Measurement, reporting, and verification (MRV)

The creation of a robust system for measurement, reporting, and verification of emissions reductions made within the agricultural sector was stated as a central concern amongst many of the experts interviewed for this study. Consistent MRV systems thereby become an indispensable requirement for the ability to certify projects and emit carbon credits.

The establishment of strong MRV systems has nonetheless been associated with a range of challenges concerning their costs and complexity. As one sustainability project manager highlighted, MRV costs may even surpass the potential value of carbon credit emission in the case of many producers. While some actors with operations at a significant scale face lower relative expenses, or maybe even have working MRV systems, smaller entities frequently face high transaction costs. The barriers to entry constituted by elevated MRV prices mean that conservation projects often need to reach as much as 50.000 hectares to become profitable, according to an interviewee. While some projects in the forestry sector may reach this scale, similar initiatives within the agricultural sector often face additional obstacles related to the fragmentation of properties involving a larger number of producers. An interviewee thus stressed how forestry projects were facilitated by the small number of actors involved, with the opposite being the case concerning initiatives within agriculture that demanded significant coordination efforts.

Moreover, projects within agriculture are also marked by considerable complexities in terms of measuring emissions reductions relative to the forestry sector.Making reliable quantifications of soil carbon fluxes and below-ground dynamics requires more sophisticated methodologies than verification of changes in above-ground biomass. This tradeoff between project accessibility and robustness was illustrated by an agronomist, "the measurement, verification, or validation needs the be sufficiently simple to become comprehensive and democratic for more producers to embrace it, but also sufficiently robust for the buyer of the ensuing carbon credit to be convinced that it's actually going to stay there [in the ground].''

Guaranteeing robust MRV methodologies and practices is also crucial to avoid making projects prone to accusations of poor standards and/or greenwashing, which ultimately could undermine confidence in certification and more broadly, in carbon markets. The practice of labelling products as "low-carbon" or "carbon neutral" has also been associated with a significant risk of technical contestation and possibly negative public backlash. For example, the complexity of assessing the "carbon neutral" character of beef products produced in integrated systems, which depends on compiling the emissions profile from many diverse production activities might thereby not lead to labels that are sufficiently robust to prevail within international markets, although

attempts to define methodologies are being made. An agronomist also highlighted how practices often defended as climate-friendly, such as shortening the life-cycle of cattle from four to two years, in fact often means that producers simply increase the number of animals processed.

A central question concerning the scope for proliferating MRV access relates to the methodologies adopted. Different methodologies for carbon measurement in soils have been developed, but most farmers are unaware of how they work, let alone how to successfully implement them. However, conventional measures based on samples from ditches dug in the ground are not economic. The potential for scaling carbon measurement through satellite images appears to contain some promising prospects but has yet not been fully developed. A sustainability manager highlighted how his company was working with the Brazilian agricultural research agency, Embrapa, to develop a low-cost methodology that would be both scientifically robust and embraced by market actors. Another issue concerns the problems of accounting for GHG emission reductions in CO_2 equivalents, as this necessarily entails making uniform assessments based on greenhouse gases with very different properties.

Improving the consistency and accessibility of MRV systems depends on proper model development as well as the adaptation of these models to the Brazilian context. Embrapa has been engaged with a carbon life cycle analysis (LCA) based on data of the emissions profile of a wide range of agricultural processes and inputs. Improved technologies for making unspoiled soil samples are currently also under development, which could lower some MRV costs. Many of the interviewees' assessments converged around the need and the potential inherent in improved digitalization. In this regard, the availability of an abundant local dataset was strongly highlighted as a crucial factor in permitting the calibration of MRV models for initiatives taken within the Brazilian agricultural landscape. For this purpose, maps and datasets provided by Brazilian public environmental research agencies could play a key role. The need for a "carbon map" equivalent to existing comprehensive registries of land-use change or soil maps was also stressed by one interviewee. Digitalization also provides important tools to reduce bureaucracy and paperwork produced by the registration and licensing of emissions reduction projects.

An interviewee from an international certification organization underscored the potential of new methodologies for project certification within agriculture that rely on an incremental logic based on the number of mitigation activities undertaken by producers. Adoption of practices such as no-tilling, cover cropping, and fertilizer reductions would thereby constitute a sweep of activities that all contribute to a cumulative increase in the generation of carbon credits. The interviewee also highlighted the potential for the introduction of these methodologies in Brazil, as the highly industrialized modes of production in the country are similar to North American agriculture in relation to which the model was initially developed.

Beyond the purely technical aspects of increasing MRV accessibility to farmers, a series of organizational challenges also exist. Scaling the introduction of MRV systems amongst small and medium-sized operations is key to supporting the proliferation of mitigation projects. In this regard, the importance of defining collective platforms for MRV systems and certification was strongly emphasized by the experts consulted in this study. The necessary scale of projects means that they often need to encompass hundreds of rural producers, even amongst medium-sized establishments. As an executive from a Brazilian carbon project developer highlighted, most farmers do not possess either the know-how or the necessary resources to obtain certification for emissions reductions on an individual basis. The interviewee, therefore, stressed the need for an aggregator; a function that was likely to be assumed by producer cooperatives or input companies. The potential of cooperatives to undertake important coordination activities and lower certification costs was also underscored by other experts.

One interviewee defended a model for spurring CLFi adoption with MRV implementation according to which costs were divided between producers, investors, and a non-profit network with the purpose of supporting this development. Such investment models based on carbon credit generation aiming at the voluntary market are currently under development, and plans for integration within a future regulated market are being reviewed. In that regard, the importance of "midfielders" with knowledge of the market was strongly emphasized by another interviewee.

Sectoral dialogues aiming at bringing key stakeholders together in order to further the understanding of the potential of collective action at the producer level was similarly highlighted as a promising course of action by a project developer. Finally, some interviewees also pinpointed the risk that benefits from carbon credit generation would be reaped by first movers from multinational companies and large agribusiness entities. Producer and credit cooperatives could play an important role in facilitating producers' links to this market, and hereby demonstrate the advantages of implementation of more sustainable production systems at the level of farmers.

The social dimension of carbon markets

An important sustainability aspect to assess with regards to the growth of global carbon markets concerns the social dimension. Social factors are thereby important in determining the conditions for the dissemination of carbon initiatives but are also crucial to keep in mind in the planning of mitigation projects.

Cultural factors

A common emphasis amongst the experts consulted regarding the challenges for the adoption of low-carbon practices within Brazilian agriculture was related to the skepticism and a somewhat conservative mindset amongst producers. The routinely ploughing of fields, as well as the overuse of fertilizers, was provided as an example of persistent practices rooted in outdated modes of production which compromised both productivity as well as the environment. Particularly, livestock production was highlighted as an important case of a sector with substantial scope for improvement, which in large measure hinged upon a change in mindset amongst ranchers. As cattle heading often has been a secondary activity on properties that relied on the periodic burnings of fields and incorporation of native vegetation with very low profit margins, the transition towards professional ranching practices contains both economic and environmental benefits.

Increased use of more qualified personnel in intensified livestock production also contains a series of potentially positive social impacts through growing formal and well-paid employment. In this perspective, the ability to generate carbon credits is only one amongst many benefits of transformations within livestock production and efforts to approach the production possibility frontier within the sector. An agronomist thus highlighted the importance of abandoning ranching based on territorial expansion often driven by speculative motivations, "You don't really have cheap land anymore. The Amazon is taboo; the guy who wants to produce in the Amazon he makes a pact with the devil […] So expansion is not going to continue along the same path as it did 50 years ago." He also highlighted how the growing knowledge about how to improve cattle production eventually was likely to lead to transformations within the sector.

Apart from the persistent resistance to adopt more sustainable production practices amongst some Brazilian rural producers, engagement with carbon markets faces a range of additional challenges. As one interviewee stressed, the notion of carbon markets is still relatively abstract to many farmers[50], who fear that changes can compromise their output. Carbon credit projects have thus often lacked 'proof of concept' which would serve to spark more widespread adoption within the agricultural and livestock sectors. Behavioral change thereby often depends on the ability to demonstrate that this transformation is associated with agronomic benefits, which often might take some time to become clearly visible. Property successions may become key in this regard, as new generations of farmers are more susceptible to technological innovations and socio-environmental concerns assume management.

50. According to the McKinsey's report "The Brazilian Farmer's Mind in the Digital Era - Pulse 2021" almost 70% of Brazilian farmers claimed not to have the understanding of carbon credits to engage in this activity

Co-benefits, inclusion, and carbon commodification

The question of the existence of socio-environmental co-benefits from carbon projects and the implications of increasing commodification of carbon credits are central to a broader assessment of the social impacts of these initiatives. Many of the interviewees tended to stress the potential co-benefits of carbon credits generated in Brazil, such as local community inclusion and biodiversity preservation. In this perspective, carbon credits may provide a vehicle for the pricing of services with a more abstract value, such as ecosystem services. Compared to other types of mitigation projects, such as renewable energy, NBS-based projects have thus been defended as being of a higher quality due to their various co-benefits, and consequently, as being worthy of price premiums.

Despite the emphasis on co-benefits, some of the interviewees nonetheless underscored a wider trend within carbon markets to move towards a higher degree of commodification of carbon credits, which has been highlighted as a necessary step for the market to gain volume and scale. This implies that co-benefits would be more likely to be found within market niches, while the certification of the brunt of carbon credits would rely on a more common baseline of basic criteria determining their marketability. In this regard, the Taskforce on Scaling Voluntary Carbon Markets is currently developing a set of Core Carbon Principles (CCPs) for the establishment of common quality parameters for carbon credits, which likely will spur the movement towards increased commodification.

Commodification of the carbon market has been met with a certain degree of preoccupation with regards to the potentially negative impacts of mitigation projects due to their separation from other socio-environmental objectives. An interviewee did recognize this risk but strongly highlighted that in the majority of cases, co-benefits would likely be positive, and also underscored the high degree of transparency within carbon projects which exceeded that within many other economic sectors. Another interviewee also underscored the "no-harm" principle, which means that standard certification for carbon credits already do not permit negative social impacts from carbon projects. Finally, a project certifier also defended that while carbon projects should not necessarily imply positive co-benefits, their compliance with a baseline of quality criteria was unnegotiable, as was the case with the no-harm principle. However, he stressed that in practice, the specific tailoring of projects, such as those for forest conservation, end up becoming development projects through their eventual generation of positive socio-environmental co-benefits, such as local community inclusion.

Finally, the previously mentioned need for scale to make carbon projects economically viable could easily mean that mainly large market players reap their benefits. From a social perspective, this further underscores the importance of developing MRV systems

accessible for small and medium-sized producers to avoid that large market players capture a disproportionate amount of resources destined for carbon financing. Tailoring projects to include this group of producers thus also becomes crucial to guarantee local support, and in a broader sense, the legitimacy and long-term sustainability of carbon projects.

Summary and policy recommendations

Based on the insights and perspectives shared by our interviewees, we present a series of policy recommendations for the engagement of the Brazilian agricultural and livestock sector with a future carbon market.

- The movement towards carbon pricing is a structural trend which will mark the global economy for decades to come. Consequently, Brazil should take serious steps towards establishing a regulated carbon pricing scheme (ETS or carbon tax) to make the responsible economic agents internalize emissions costs and to signal the country's commitment to climate mitigation;
- Brazilian carbon pricing schemes should be based on ambitious and unambiguous NDCs, with comprehensive and coverage of all economic sectors, and robust accounting practices. An ambitious baseline for emissions reduction is also essential in this regard;
- While the large number of actors within the Brazilian agricultural and livestock sector makes the implementation of conventional ETS and/or carbon taxes complicated, focalized taxes on specific supply-chain actors with high emissions and extensive land holdings appear more viable to implement. Sector-wide agreements for the reduction of emissions in agricultural production and through land use also provide potentially important frameworks for mitigation action;
- Insofar as the Brazilian legislative framework will permit the entry of international climate financing, administrative procedures should be streamlined, and unnecessary bureaucracy avoided in order to facilitate initiatives aiming at climate mitigation;
- Brazil should assume a pro-active position within all levels of the climate agenda in order to seek out opportunities for international financing for mitigation projects, especially if this can be guaranteed without the more politically controversial ITMO obligations;
- Adhering to the principles of environmental integrity is crucial to ensure the credibility of mitigation projects and their eventual commercial viability. While the additionality case for projects based on legal compliance (such as legal reserve

conservation) seems very weak, above-the-law projects could be eligible for carbon financing;

- Brazil enjoys significant comparative advantages in relation to both the agricultural, forestry, and livestock sectors. Generation of carbon credits can therefore provide an important means of assistance for early adopters of sustainable technologies and production practices. It is more unlikely that the case for additionality can be made when such technologies become common practice;
- Projects with the potential for climate mitigation within the Brazilian agricultural and livestock sectors often depend on technical assistance and practical know-how, such as for example, successful CLFi implementation. The public sector should engage in actions with private actors to ensure the training of sufficient personnel with these capabilities to assist rural producers' transition towards low-carbon production models;
- Lowering MRV costs is crucial to ensuring the scaling of carbon-financed mitigation projects within Brazilian agriculture. This is especially important with regards to small and medium sized rural establishments. On the technical level, digitalization and adoption and contextual adaptation of cutting-edge certification methodologies can help in this regard, while rural cooperatives can become important players in confronting this organizational challenge;
- Investment in R&D to develop cheap and easy means for scaling carbon measurement technologies, especially considering tropical characteristics, is crucial to foster agricultural and livestock sector engagement within the carbon market;
- Culturally rooted skepticism amongst rural producers about engaging with more sustainable production practices constitutes a factor that slows down their dissemination. It is therefore important to disseminate knowledge of successful cases of sustainable productive transitions and the role which carbon financing might play in this process;
- Carbon projects can provide a range of important socio-environmental co-benefits, which in turn also might raise their monetary value. However, with the likely increase in commodification of carbon credits, it is important that projects undertaken adhere strictly to integrity principles and avoid any potential collateral harm.

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