



SUSTAINABILITY IN THE BEEF PRODUCTION CHAIN

A ROADMAP FOR BRAZIL AND LESSONS LEARNED FROM P4F

EDITORIAL BOARD & STAFF

THE STUDY HEREIN WAS COMMISSIONED BY THE PARTNERSHIPS FOR FORESTS (P4F) PROGRAM TO AGROICONE. SINCE 2018, P4F HAS BEEN WORKING WITH THE BEEF SUPPLY CHAIN IN BRAZIL, ONE OF ITS FOUR PRIORITY SECTORS.

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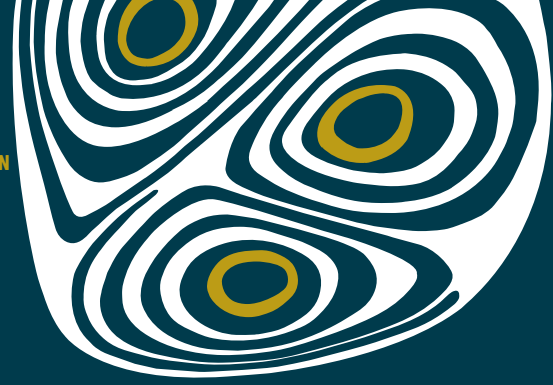
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Introduction Letter from P4F

Partnerships for Forests (P4F) is a programme funded by the UK government, aimed at accelerating initiatives that promote sustainable land use and economic development through collaboration between the public and private sectors and civil society. Its goal is to contribute to deforestation reduction.

In Brazil, P4F has prioritized its activities in four key sectors: non-timber forest products, economic models for forest recovery, responsible expansion of soybean cultivation in already open areas, and the promotion of sustainable livestock farming.

Livestock farming is currently the predominant land use in Brazil, covering an extensive area of 151 million hectares (Mapbiomas, 2022). In 2021 alone, the industry generated R\$ 913 billion in revenue (ABIEC, 2022).

However, the livestock sector is associated with practices that lead to environmental degradation and biodiversity loss, both legal and illegal. These practices include illegal occupation of public lands for pasture creation and subsequent land market transactions, deforestation of riparian forests affecting water systems, and the absence of sustainable farming practices. These challenges must be addressed as the sector strives to modernize and meet demands of rigorous markets that value product quality and origin.

The good news is that there is significant potential for increased productivity in the livestock sector. This potential can generate substantial

returns throughout the supply chain by supporting investments in sustainable practices on the ground, particularly among cattle ranchers. Encouragingly, the sector has already begun a gradual but consistent shift towards sustainability.

Since P4F's inception in Brazil in 2018, we have conducted a comprehensive sector analysis and developed a theory of change to guide our interventions. Through this process, we have reviewed numerous livestock project proposals and prioritized six projects for development, approval, and implementation. These projects have yielded tangible results and made a positive impact.

To gain a deeper understanding of the current state of cattle ranching and identify, by location and rationale, changes that have occurred since our programme's launch, we commissioned a study conducted by Agroicone, an organization renowned for its expertise in the sector. The study provides a detailed description of the sector's present situation and future trends, offering valuable insights to institutions and professionals dedicated to modernizing livestock farming for enhanced sustainability, social inclusion, and shared value creation. The report also outlines six key challenges facing the sector and proposes strategies to overcome each of them. Latest data demonstrates that our portfolio has a share of responsibility regarding the observed positive changes in this scenario. This report is yet another contribution for further advancements that we hope to observe in this sector, still in the short term.

1. Executive Summary

Displaying considerable room to increase productivity and profitability and to contribute to overcoming Brazil's environmental and climate challenges, transforming cattle ranching into a sustainable activity is a strategic agenda for the country. The challenge, however, is not small.

DIAGNOSIS AND BARRIERS

- Home to a herd of more than 224 million heads of cattle, Brazil is the largest beef exporter in the world. However, Brazilian cattle ranching, in general, is still low on technology and productivity. Thus, the activity – although so important for our economy – is often associated with deforestation and greenhouse gas emissions.
- Due to the headway in discussions on climate change, civil society and the consumer and financial markets are increasingly aware of the importance of sustainable cattle ranching. That has pressured the beef production chain to take more and more actions towards transparency and sustainability.
- The adoption of technologies and good agricultural practices (GAPs) has increased, and results are starting to become visible both for the environment and for rural producers. An analysis of recent years shows a relevant increase in productivity, possibly due to better management, which allows slaughtering cattle in less time and at heavier weight. That also means more cattle in smaller space, which reduces the pressure to clear new areas for pasture, contributing to zero deforestation.
- Despite the obvious gains, disseminating good practices to cattle ranchers remains a challenge. It is essential to deepen the understanding of the subject, considering the different production cycles and the different profiles of producers. Although having common characteristics, “cattle ranchers” consist of a mixed audience, tending to be averse to risk and novelty.
- The adoption of good agricultural practices is a decision that comes from rural producers themselves. The other links in the chain, such as slaughterhouses and retailers – although being able to offer incentives –, have a limited capacity to influence this process.
- The decision on how to produce is strictly economic. The possibility of making fictitious profits (the perception of profit by cattle ranchers comes from the frequent failure to incorporate land and/or labor costs in their financial analyses, which distorts real results) makes this decision-making change even more complex. Therefore, a set of instruments and incentives are needed to reverse such process.
- Even with investment financing programs available for sustainability purposes and a greater incentive network due to institutional evolution and the sustainable business environment, there is still a barrier for rural producers to access these instruments.



- Certifications and Payment for Environmental Services (PES) may be alternatives to encourage the technological transition towards a more sustainable production. However, access barriers and the difficulty in paying the opportunity cost are still limiting.
- Traceability and monitoring of the beef production chain, especially of indirect suppliers, remain a major challenge for the transparency of its social and environmental attributes, even with technological developments and increased initiatives aimed at solving the problem. There is a dispersion among the players, who do not act in a connected manner, requiring greater coordination between the links in the chain.
- The channeling of efforts that combine short-term alternatives – monitoring production cycles via Animal Transit Guide (GTA) and Rural Environmental Registry (CAR) – with individual traceability in regions of greater social

and environmental risk must be prioritized. Parallel to that, those same tools must be improved individually, aiming at accelerating adoption, increasing precision, and reducing the possibilities of fraud.

- P4F has been working decisively, mobilizing efforts around the promotion of integration between players in the chain, normative homogenization, support for value-adding business models, and the creation of methodologies to measure carbon in cattle ranching production systems and monitoring tools.

CHALLENGES AND STRATEGIES

The table below summarizes the seven main challenges mapped, as well as the strategies for overcoming them. Throughout the report, potential players for engagement, implementation time, and degree of complexity for execution are also addressed.

CHALLENGE **Accelerating the attraction of producers to adopt GAPs**

- STRATEGIES**
- Mobilize local players and institutions that support the beef production chain that have capillarity in the territory in favor of the adoption of GAPs
 - Identify and engage key players and producers, who have recognized influence in the sector, aimed at spreading information in a natural way

CHALLENGE **Giving scale to productive sustainability initiatives and actions**

- STRATEGIES**
- Provide technical support for rural producers to adopt GAPs
 - Support value-adding business models
 - Assess the potential of financial instruments with sustainable purposes in promoting value-adding business models

CHALLENGE	Access to subsidy and risk reduction in financing operations
STRATEGIES	<ul style="list-style-type: none"> ▪ Assist producers in accessing credit by spreading information ▪ Train technical assistants to set up investment projects ▪ Support initiatives aimed at reducing transaction costs in credit operations ▪ Support the creation of de-risking instruments, such as endowments and blended finance ▪ Support initiatives that improve the underwriting of social and environmental risks in credit operations ▪ Support initiatives that differentiate financing conditions by management strategy and social and environmental aspects
CHALLENGE	Difficulty in measuring the environmental and climate contributions of adopting GAPs
STRATEGIES	<ul style="list-style-type: none"> ▪ Support research institutions engaged in creating emission methodologies ▪ Promote the integration of research institutions engaged in creating methodologies ▪ Analyze ways to incorporate these methodologies into sustainable finance and PES instruments and certifications
CHALLENGE	Scale limitation of PES instruments and certifications
STRATEGIES	<ul style="list-style-type: none"> ▪ Assist the beef production chain in strengthening PES instruments and obtaining certifications as part of the loyalty mechanisms for cattle ranchers
CHALLENGE	Traceability and monitoring
STRATEGIES	<ul style="list-style-type: none"> ▪ Assist states in information management ▪ Support the integration between Rural Environmental Registry (CAR) and Animal Transit Guide (GTA) ▪ Design a unique social and environmental compliance check platform ▪ Auxiliar os frigoríficos de menor porte na construção de compromissos voluntários ▪ Assist smaller slaughterhouses in making voluntary commitments ▪ Support a national individual traceability policy, especially in municipalities with a high social and environmental risk ▪ Support adding value to individual traceability by reducing information asymmetries ▪ Disseminate individual traceability as a benefit, working as a management tool for the activity and property
CHALLENGE	Deforestation command and control
STRATEGIES	<ul style="list-style-type: none"> ▪ Implement the Action Plan for the Prevention and Control of Deforestation in the Amazon

Source: Study results. Development: Agroicone/ complete version in chapter 10

By taking these efforts, Brazilian cattle ranching can continue to evolve in productivity and efficiency, contributing to income generation, business development, and new sources of foreign

currency, and may become one of the country's key strategies for reducing deforestation, preserving biodiversity, conserving water resources, and transitioning to a modern low-carbon economy.

2. Cattle ranching production in Brazil⁽¹⁾

Brazil has an important comparative advantage in beef livestock – the world’s largest cattle herd and extensive pasturelands, even if somewhat degraded. There is great potential for productivity increases, reducing pressure on clearing new areas and reducing greenhouse gas (GHG) emissions from such activity.

The country’s production has been recording productivity gains in recent years, showing increases in cattle herd and decreases in pasturelands. However, such dynamics is not homogeneous across Brazilian regions; for example, while the Midwest is aligned with and strengthens this trend, the North recorded productivity gains but followed by an increase in pasturelands.

The beef cattle ranching production process is divided into different cycles (breeding, rearing, and/or fattening/finishing), each with their own peculiarities.

It is noted that, by adopting better production practices, emissions fall followed by production gains. That is, cattle ranching production and sustainability should not be seen in an antagonistic way!

Brazil is among the main beef producers in the world, being home to a cattle herd of more than 224 million heads (IBGE, 2022), occupying an area of more than 151 million hectares of pastures (Mapbiomas, 2022). In addition, the country is an important world player in beef production. In 2021, it was the largest exporter, selling 25.3% of its national beef supply abroad, that is, production plus imports (Brazilian Beef Exporters Association – ABIEC, 2022). The importance of beef cattle ranching is also reflected in the national GDP. CEPEA’s estimates for the 2021 GDP

indicate that the “cattle ranching sector”⁽²⁾ represented 26% of the national agribusiness GDP, or almost 7% of the Brazilian GDP (Center for Advanced Studies on Applied Economics – CEPEA, 2022).

All this comparative advantage in the production of beef, however, is overshadowed by the low productivity, by the adverse socioeconomic situation of most cattle ranchers (especially small ones) and, more recently, by the negative externalities to which the activity is associated.

(1) This section was prepared by Agroicone based on a study developed by Agrosuisse to compose this report.

(2) To estimate the GDP of agriculture and livestock, CEPEA’s research team divides the sector into two major production branches for analysis purposes, the agricultural branch (agriculture) and the livestock branch (livestock) (CEPEA, 2017, p. 4). The livestock branch represents “the set of production chains of animal-based products” (CEPEA, 2017, p. 5).

SUSTAINABILITY IN THE BEEF PRODUCTION CHAIN

The sector is one of the main emitters of greenhouse gases (GHG) in Brazil (Potenza et al., 2021), which, according to data from the World Bank (2022), is the 12th largest global GHG emitter. Here, agriculture and livestock is the second largest GHG emitter, second only to emissions from changes in land use (deforestation), accounting for 25% of total gross emissions (601 MtCO₂e).

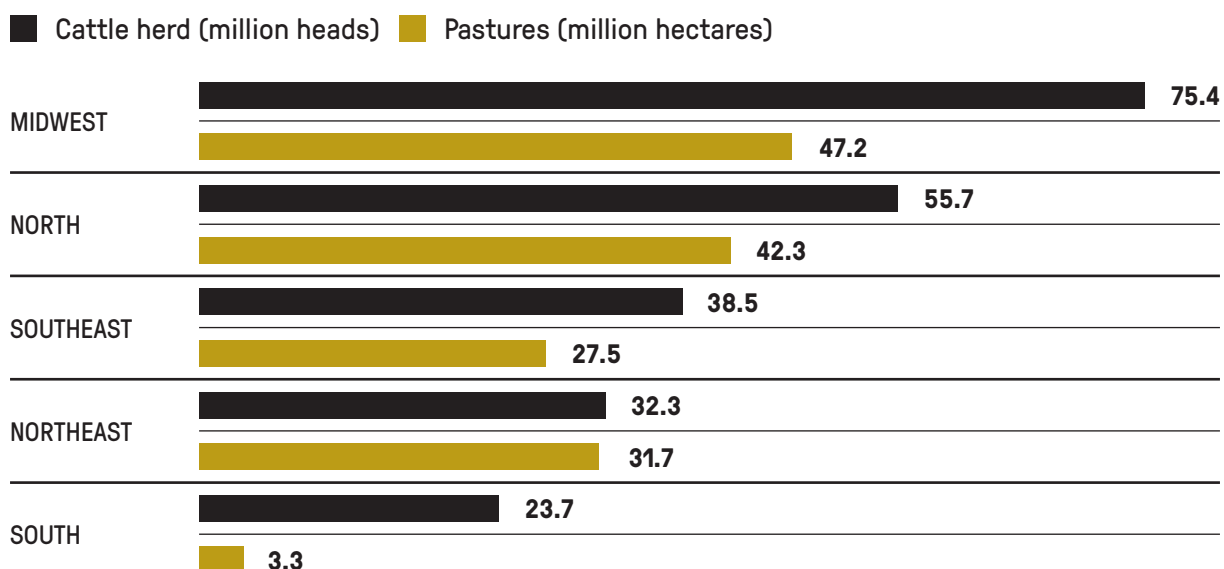
When separately analyzing the emissions of the agriculture and livestock sector, it is noted that beef cattle ranching stands out mainly due to the enteric fermentation of cattle (Margulis, 2018). In 2021, the enteric fermentation resulting from the digestive process of these ruminant animals was responsible for the emission of 383 MtCO₂e (64% of the total emissions of the agriculture and livestock sector), a 3% increase compared to 2020 (SEEG, 2022). In addition to the GHG emissions resulting from the beef cattle production activity itself, studies have shown that beef cattle ranching is associated with part of

the deforestation that has occurred in Brazil. The low average rate of cattle ranching productivity is related to deforestation because this limited productivity stimulates the advance in areas of native vegetation (Margulis and Miranda, 2018; Potenza et al., 2021).

Given this scenario of economic importance of such activity, a virtuous trend can be observed in recent years, either in the production aspect or in the search for the reduction of negative environmental externalities. This trend is due both to establishing a more intensive beef cattle ranching, adopting technologies and good practices, and to market pressures.

In 2021, the Brazilian cattle herd was mostly found in the Midwest and North regions, amounting approximately 131 million heads (58.4%). This concentration pattern is also observed in pasturelands, covering 89 million hectares in these regions (59%). Figure 1 presents the cattle herd and pasture distribution by region in Brazil.

Figure 1 - Distribution of beef cattle herd and pasturelands by region in 2021⁽³⁾



Sources: IBGE, Mapbiomas. Development: Agroicone

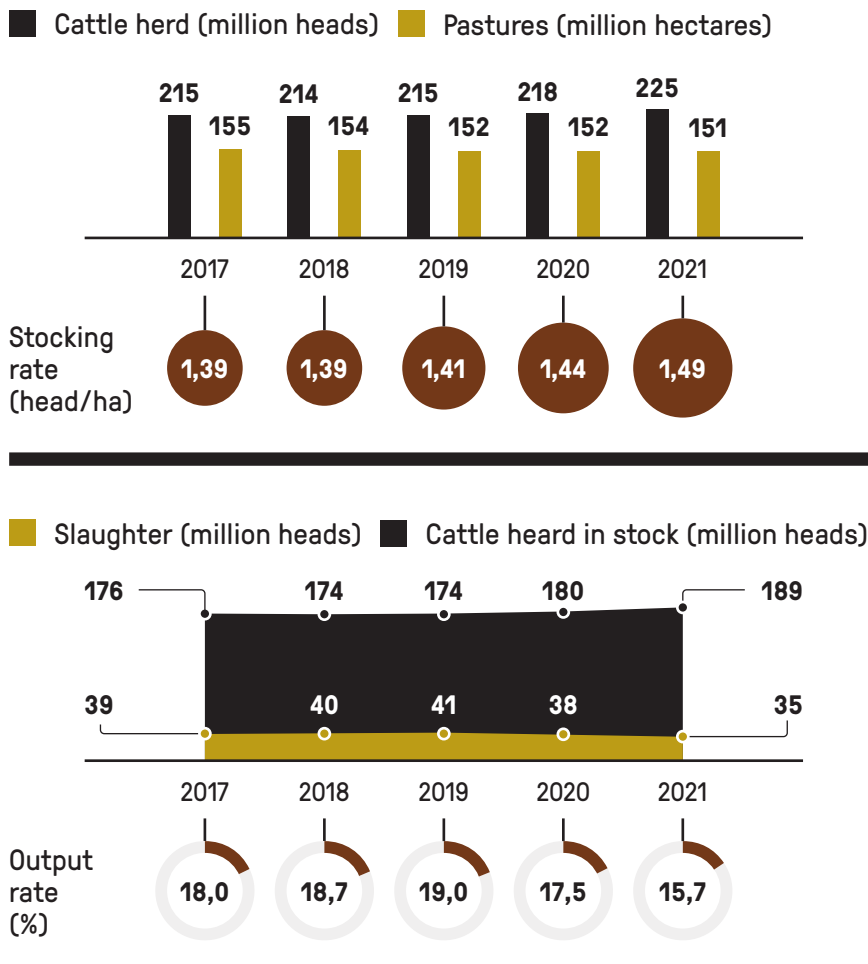
(3) The pasturelands in the South region are underestimated since areas of grassland formation that are used for grazing are disregarded. Only pasturelands identified by Mapbiomas (Collection 6) were considered.

Due to the great importance of cattle ranching in the Midwest and North regions, they both were defined as the focus of this analysis. These regions have been going through different processes. While the first registers a reduction in pasturelands, the second shows increases, especially due to deforestation, transitioning from areas of native vegetation to pasturelands⁽⁴⁾.

indicators for Brazilian cattle ranching from 2017 to 2021. The support capacity of pastures, the stocking rate (heads/hectare of pasture), showed an important growth, from 1.39 heads/hectare to 1.49. Such dynamics was due to the growth of cattle herds with a reduction in pasturelands. It is noteworthy to mention the reduction of degraded pasturelands (Figure B1 in annex), which allows for greater fodder production throughout the year, ensuring greater support capacity.

Figure 2 shows the dynamics of productivity

Figure 2 - Brazilian cattle ranching productivity indicators



Note: Each arroba (@) equals 14.7 kg; stocking rate is calculated as the ratio of total herd and pastureland per year; output rate is calculated as the ratio of the number of heads slaughtered and the total herd per year; @/head/year is the ratio of beef production in carcass equivalent (in arrobas) by the number of animals slaughtered per year; @/ha/year is the ratio of beef production in carcass equivalent (in arrobas) by pastureland per year. It is worth noting that IBGE's slaughter data was considered, not including informal or non-inspected slaughter. Source: IBGE, Mapbiomas (Collection 6), IHS Markit (2022). Development: Agroicone

(4) Between 2015 and 2020 alone, more than 5 million hectares of native vegetation were converted into pastures (Mapbiomas, 2023).

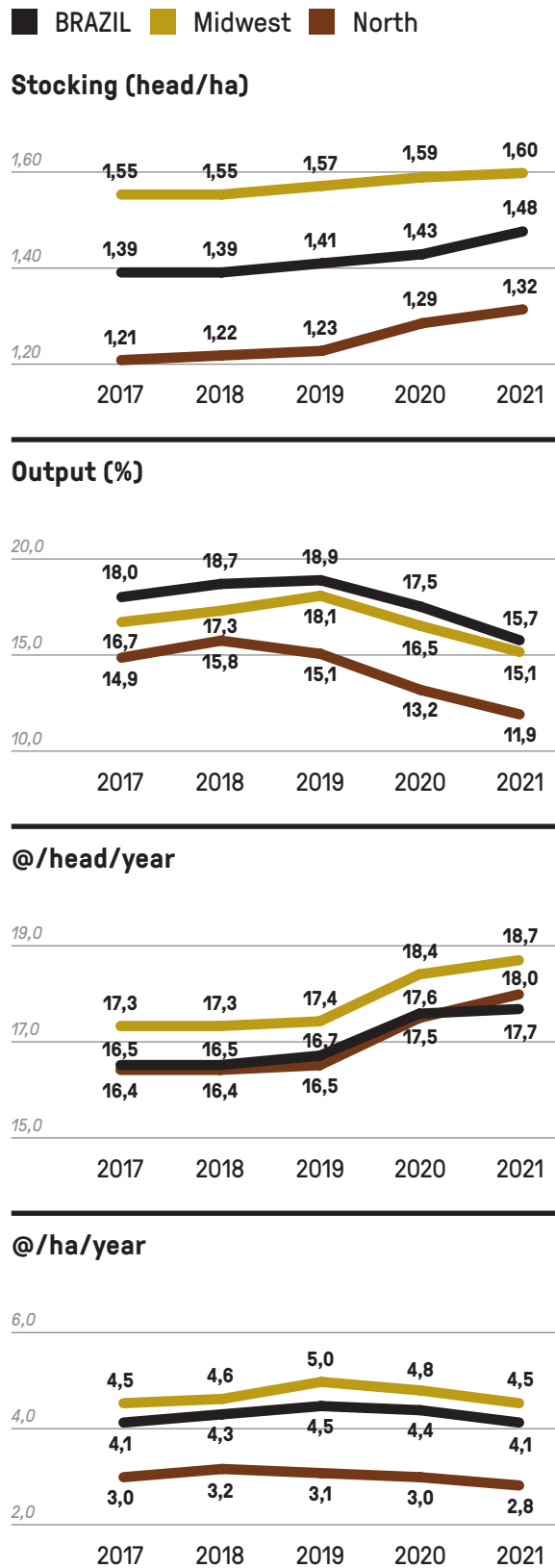
The output rate (number of slaughtered animals/herd) peaked in 2019, reaching 18.95% of the total cattle herd. This is due to the increase in exports to China, which pressured prices and changed the decision-making of producers to slaughter females to obtain extraordinary short-term gains. Such dynamics becomes reality in the reduction of slaughter rate in subsequent years, precisely for cattle herd formation after the slaughter of females. This reduction trend in post-2019 slaughters is reflected in productivity measured by @ slaughtered/ha/year. Once slaughter dropped at a higher rate than the drop in pasturelands, a specific drop is observed in arrobas of beef produced per hectare.

However, if the productivity per slaughtered animal (@/animal/year) is analyzed over the years, a significant increase can be seen, possibly the result of better management that allows an animal to be slaughtered in less time and at heavier weight.

The dynamics of aggregate productivity, however, is different in the pattern observed in the Brazilian regions. The support capacity measured by the stocking rate, for example, is higher in the Midwest region compared to the North region (and to Brazil). While in the Midwest pasturelands reduced and the cattle herd increased, the North region recorded an increase in the cattle herd along with the increase in pasturelands. That is, while the Midwest has been transforming pasturelands into areas for other uses and increasing the cattle herd with productivity gains, the North region grows both in cattle herd and in pasturelands. This means an “extensive” stocking growth, which also includes the transition from areas of native vegetation to pasturelands in northern Brazil.



Figure 3 - Productivity indicators for North and Midwest regions



Source: IBGE, Mapbiomas (Collection 6), IHS Markit (2022)

This dynamics in the stocking rate is even reflected in the productivity per hectare (@/ha/year) in the North region, which is much lower in relation to both Brazil and the Midwest. Even so, it is worth mentioning the gain in terms of average weight of slaughtered animals (@/head/year) in the North region, which, since 2019, has been growing at significant rates, reaching 18.7@ per slaughtered animal.

This entire overview must still be observed from the perspective of cattle ranching in its different production cycles. Since cattle ranching production is divided into several cycles (breeding, rearing, fattening), there is a wide variation in productivity according to the characteristics of the business, that is, which model, production cycle and production system, and which product is sold by cattle ranchers.

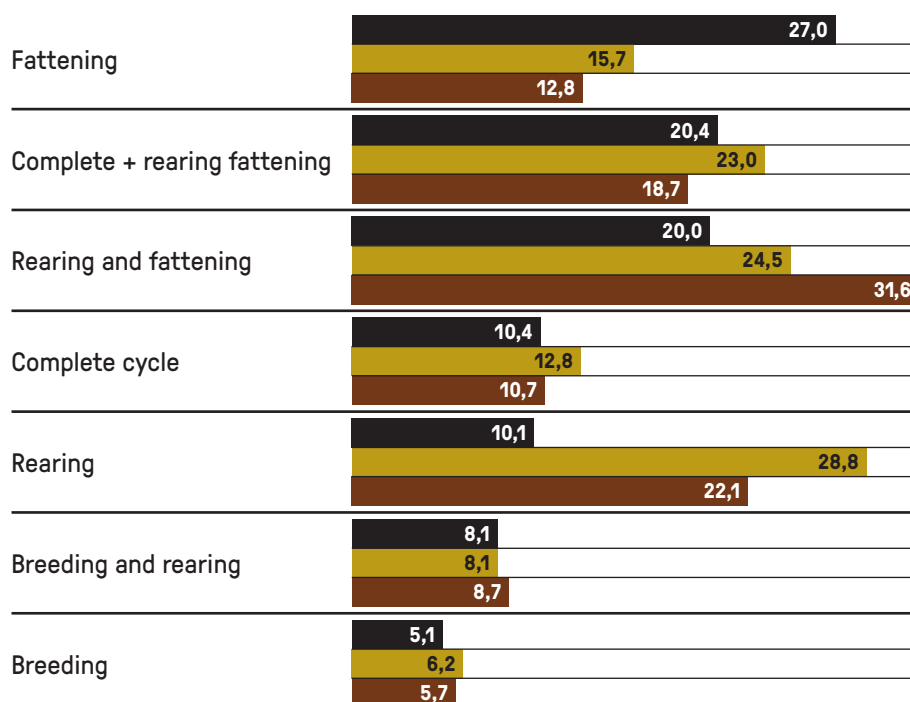
In systems exclusive to the breeding production cycle – production of calves and weaned heifers for sale and culling animals (older and reproduction animals) – productivity proves to be below systems

that include the rearing and/or fattening cycles. That is because the production systems of each cattle ranching production cycle have different characteristics regarding the calculation of technical and economic results. In the case of breeding, this is characterized by the mobilization of capital in breeders (cows and heifers). With that, the stock is immobilized in the field. This cattle rancher, many times, whenever necessary, increases the culling of females to balance the cash flow. The rearing and/or fattening systems, in their turn, are characterized as working capital, and the result is reflected in greater productivity due to the objective of these production cycles (weight gain and animal finishing).

In the example below (Figure 4), Rally da Pecuária⁽⁵⁾ calculated the result of each cattle ranching production cycle and respective productivity for three years. The result demonstrates that rearing and fattening promote weight gains per hectare per year above those for breeding or the complete cycle (breeding, rearing, and fattening).

Figure 4 - Productivity (@/ha/year) by cattle ranching production cycle

■ 2018
■ 2019
■ 2021



Note: In 2020, there was no data collection due to the pandemic
Sources: Rally da Pecuária/Athenagro (2021)

(5) Rally da Pecuária – 2021 results; year of 2018 = 2,702 heads; 2019 = 1,854 heads and 2020 = 1,621 heads; <https://rallydapecuaria.com.br/>. It is worth mentioning that Rally da Pecuária reflects research results, limited to the universe of its respondents.

In an analysis on the productivity of the complete cattle ranching production cycle, an increase can be seen from 2014 to 2018, from 8.8 to 10.35 @/ha/year. After such period, in 2019, an increase to 12.81 @/ha/year for the sale of females (cows and heifers) due to the buying pressure of the Chinese market, in 2020/2021 it returns to the level of 2018, due to climate issues and retention of females, and it stabilizes in 2021 at 10.75 @/ha/year (Rally Da Pecuária/Athenagro, 2021). Table 1 presents the summary of results in the years surveyed.

Table 1 - Productivity (in live weight gain per hectare per year) in complete cycle – breeding, rearing, and fattening

Productivity	@/ha/year
2014	8,80
2015	8,66
2016	10,60
2017	8,33
2018	10,35
2019	12,81
2021	10,75

Source: Rally da Pecuária/Athenagro (2021)

Understanding the relationship between cattle ranching production and sustainability should not be something dual and antagonistic, since the search for increases in productivity directly impacts the sustainability in the beef production chain. The central issue revolves around how to facilitate this technological transition by adopting good practices while guaranteeing a deforestation-free chain, all of that considering the social aspects involved in the different cattle

ranching production cycles.

Production increases allow a greater intensification of production per unit of area, thus reducing the pressure to clear new areas. Pasture rotation strategies, integrated production with agriculture and/or forestry, animal genetics, management of zootechnical and production indicators, and animal diet are examples of initiatives that would allow producers to better manage the soil, preserving its fertility while reducing the need to clear new areas and even allowing the transition of cleared areas to other uses.

Combining productivity and mitigation of the negative environmental impacts of beef cattle ranching makes this activity one of the main candidates to stop being part of the problem and to become part of the solution. Table 2 illustrates quite well the potential of genetic, pasture and diet management strategies to reduce GHG emissions, in addition to a significant increase in animal weight gain (Congio, 2023).

Table 2 - Management strategies and their impacts on emissions and productivity

Methane mitigation strategy	Emission reduction (%)	Productivity gains (%)
Animal genetics	-38	+99
Continuous managed pastures	-22	+22
Rotated managed pastures	-35	+71
Proper protein in diet	-10	+12
Increase in feeding	-37	+171

Source: Congio (2023)

SUSTAINABILITY IN THE BEEF PRODUCTION CHAIN

This potential is also evident for estimates in Brazil. Under management strategies and use of good practices, an optimized scenario was drawn up compared to the production performance of Brazilian cattle ranching in 2022, as shown in Table 3.

Therefore, a modest average productivity growth can be observed in recent years. That growth took place differently between the Midwest and North regions. In the first one, there was an increase in productivity aimed at reducing pasturelands and increasing the weight of slaughtered animals. In the second one, there is an increase in productivity, but followed by an expansion of pasturelands, especially over forests, that is, via deforestation. This movement towards increasing production was largely due to market pressure, especially for beef to China,

slaughtered at up to 30 months of age. Thus, this growth in productivity was relegated to more knowledgeable producers. On the other hand, smaller producers, especially breeding producers, still face difficulties in terms of productivity.

Even so, it is possible to observe the great potential that Brazil has in solving its environmental problems while obtaining extraordinary gains in productivity. That does not mean that the challenge is small, quite the contrary. Strategies that encourage good practices as well as environmental compliance instruments that are not mutually exclusive are fundamental to solving this equation. Identifying means of disseminating good practices to producers has great potential for promoting productivity gains, reducing the negative environmental externalities associated with cattle ranching.

Table 3 - Cattle ranching productivity in the current scenario vs. optimized scenario

Indicators	Unit	2022 Average	Optimized
Productivity	@arroba/ha/year	4,6	10,7
Slaughter rate (%)	% cattle slaughtered	22	28,7
Final weight	@arrobas	19	22
Slaughter age	Months	34	26
Animal stock	Head/hectare	1,3	1,7
Animal stock	Animal unit /hectare	1	1,2
Output	% production/stock	30,3	10,2
Annual emissions per hectare	Kg CO ₂ eq/hectare	2.373	3.060
Annual emissions per kg of carcass	Kg CO ₂ eq/kg of carcass	34,49	18,98

Source: Athenagro Consultoria (2022)



3. The role of Good Agricultural Practices (GAP) and what has been done in this regard

In order to gain productivity and reduce the negative impacts of cattle ranching, adopting good agricultural practices is necessary. Although consolidated technologies adapted to the Brazilian reality are already available, there is still much room for gains in productive efficiency. However, challenges persist.

Adopting good agricultural practices⁽⁶⁾ is one of the fundamental points for the transition to sustainable cattle ranching. This process must be seen from the perspective of technological innovation, which depends on two dynamics that complement each other:

- Supply of technologies, management strategies, new cultures, and innovations, which impact the degree of accessibility of these technologies from an economic point of view.
- Dissemination and adoption among producers via technical assistance and rural extension support.

This diffusion of GAPs among cattle ranchers should be seen from the perspective of different production cycles and different profiles of producers. That is, **the dissemination strategies must be customized, depending on the regional, productive, and socioeconomic characteristics of ranchers.** Cruz (2020) collected seven good practices in beef cattle ranching with the

(6) Good Agricultural Practices (GAPs) refer to the set of norms and procedures to be observed by rural producers in favor of a profitable and productive production system, but which ensures the supply of safe food originating from sustainable production systems (do Valle, et al. 2011).

potential to be GHG mitigation measures. These practices are foreseen in the scientific literature from 2008 to 2018, and have great potential to reduce GHG emissions in Brazilian beef cattle ranching. They are:

1. Confinement systems.
2. Integration systems.
3. Methane vaccine.
4. Diet for cattle.
5. Genetic improvement.
6. Pasture management.
7. Treatment of animal waste.

3.1. How the chain and its different links have been mobilizing to disseminate GAPs

Efforts are being made to adopt good agricultural practices and disseminate them. Embrapa plays a central role, but technical assistance and slaughterhouses also play key roles in such process.

conservative, risk-averse and resistant to novelties, which makes the entire dissemination process even more complex.

In other words, identifying the ongoing initiatives that seek to design new technologies as well as their dissemination is essential to understand successful stories and to map out potential action strategies with the final target audience, that is, cattle ranchers.

To this end, a broad mapping⁽⁷⁾ was conducted to identify which field strategies are being adopted

to disseminate GAPs among rural producers from 2018 to 2022. A total of 42 ongoing instruments have been identified since 2018, related to the promotion of good practices in cattle ranching, under the responsibility of 43 different institutions. These instruments were divided into 12 subcategories, whose description, number of instruments, the most common type of institution, and an instrument example can be seen in Table 4.

Table 4 - Number of instruments, main type of institution, and outstanding instrument by subcategories in good practices

Subcategory	Description	Number of instruments	Main type of institution	Outstanding Instrument
TECHNICAL ASSISTANCE	Instruments aimed at offering ATER* to producers from a productive and social and environmental point of view	11	Associations/ unions	Green offices
INTEGRATED SYSTEMS	Research regarding production and environmental impacts of integration systems	6	Research Institutions	Pontal System
DIET	Research and food supplements regarding beef cattle diet and its impact on enteric fermentation and emissions	4	Slaughterhouses	Bovaer
CONFINEMENT	Confinement productive protocols, confinement with traceability and premium payment to producers	4	Slaughterhouses	Boi 777
DEGRADED PASTURES	Technical assistance and research projects aimed at recovering degraded pastures	3	Associations/ unions	Pasto Forte
ICLFS**	Research projects related to the productive and environmental potential of ICLFS	3	Instituições de Pesquisa	IPF Pampa
HEALTH	Projects related to management strategies that impact herd health	3	Research Institutions	Lone Tick System
PASTURE MANAGEMENT	Research related to pasture management strategies and their productive and environmental impacts	3	Research Institutions	Pasto sobre Pasto
MANAGEMENT	Instrument for managing aspects of sustainability and continuous improvement	1	Research Institution	GIPS
EMISSIONS	Project to quantify and monitor emissions from properties that adopt good practices	1	Associations/ unions	Carbono Araguaia
GENETIC IMPROVEMENT	Research that relates genetic improvement and methane emissions	1	Research Institution	Gas Emission Test (PEG)
INTENSIVE FINISHING	Pasture management system for intensive finishing	1	Research Institution	Intensive Pasture Finishing (TIP)

* Technical Assistance and Rural Extension ** Integrated Crop-Livestock-Forestry Systems

Note: Reading Appendix A is recommended to learn more about the methodology used, as well as its limitations.

Source: Study results. Development: Agroicone

(7) For initiative mapping, a news "scraping" model was designed in predefined information vehicles using a dictionary of terms, also predefined, related to cattle ranching for the following topics: "good practices", "monitoring and traceability", "payment for environmental services", "certification", "sustainable finance," and "agricultural policy". All news has been compiled and categorized. To learn more, see Appendix A.

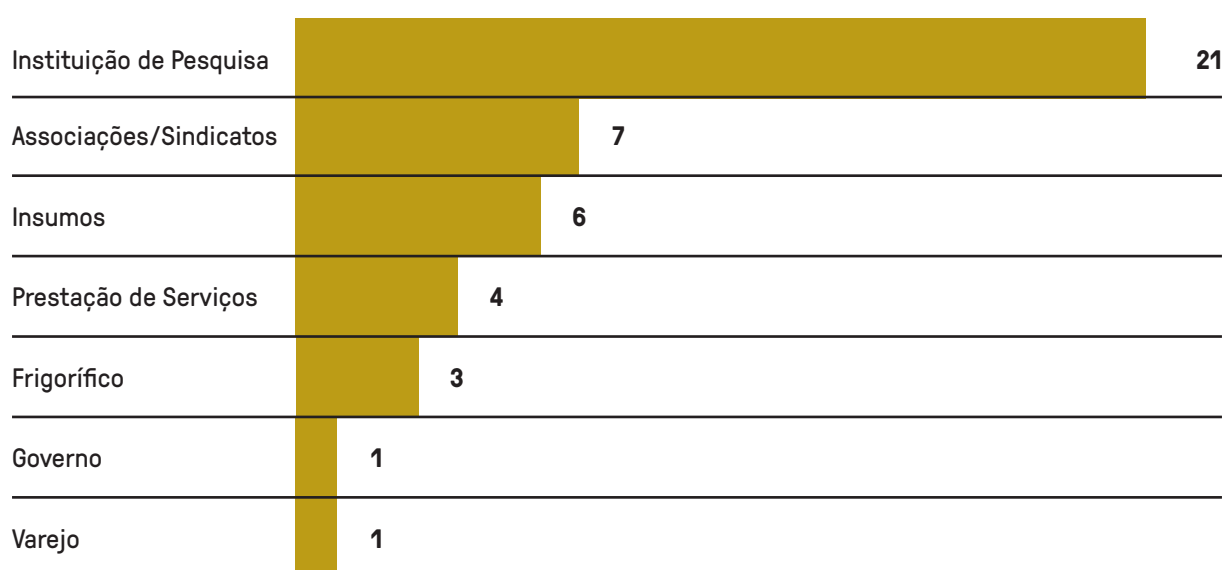
Most of the efforts identified refer to research agendas that seek to create, validate, and identify productive and environmental impacts when adopting good practices. That can even be noted on Figure 5 that shows the number of institutions involved in good practice tools by type of institution.

Ten Embrapa units engaged in this type of research were identified, with highlight to Agrosilvopastoral, Pecuária Sudeste and Pecuária Sul. Projects that assess the productive and environmental impact of integrated systems and their potential combinations (Pontal System, IPF Pampa), research that assesses the impact of management on animal health, such as a system that controls ticks not using pesticides (Lone Tick System), management strategies to avoid emptying pastures (Pasto Sobre Pasto), incentives for animal improvement by designing a breeder classification system by emission levels (Gas Emissions Test), and pasture productive intensification systems with animal supplementation (Intensive Pasture Finishing)

are some of the initiatives with which Embrapa units have been engaging. In other words, Embrapa plays a central role in the production dynamics in those territories, providing cattle ranchers with technology and services.

On the other hand, initiatives aimed at offering technical assistance have rural associations and unions as their main agents, in partnership with input companies and slaughterhouses. A highlight, for example, to the Green Offices, an initiative by the multinational JBS, which offers technical assistance aimed at the environmental regularization of properties currently on the fringe of the beef production chain due to environmental violations. In addition, the fundamental role of local institutions is highlighted, such as the Association of Breeders of Mato Grosso (ACRIMAT), the Federation of Agriculture and Livestock of the State of Mato Grosso (FAMATO) and the Institute of Agriculture and Livestock Economy of Mato Grosso (IMEA), in initiatives aimed at providing producers with direct assistance regarding technical support in the field.

Figure 5 - Number of institutions involved in good practice tools by type of institution



Note: Reading Appendix A is recommended to learn more about the methodology used, as well as its limitations.

Source: Study results. Development: Agroicone



Technical assistance and rural extension are one of the major bottlenecks for Brazilian cattle ranching. According to the Agriculture and Livestock Census (2017), 19% of establishments whose main activity was cattle ranching received some type of technical guidance. That number goes to 17% when it comes to family cattle ranching. In other words, identifying means of disseminating knowledge in the field is essential for promoting GAPs.

According to the National Treasury database, in 2021, only R\$50.5 million were spent on technical assistance and rural extension in Brazil. Souza et al. (2022b) reinforce the importance of technical assistance to small producers in the transition to low-carbon technologies, such as recovery of degraded pasturelands. The study shows the case of the ABC Cerrado Project, which provided training and technical assistance to rural producers so they could adopt sustainable practices.

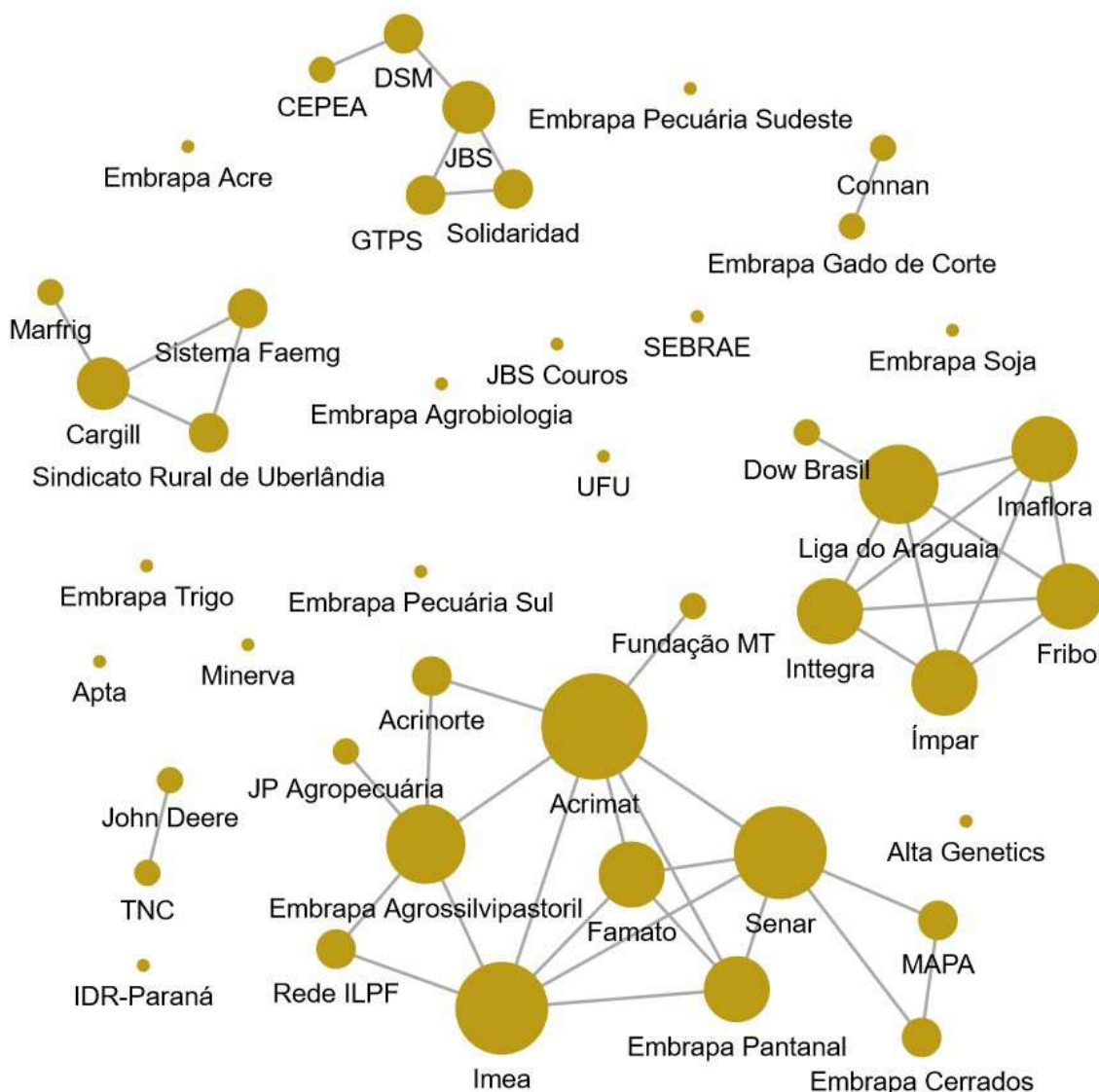
Slaughterhouses also show to be interested in testing options for supplements in the cattle herd diet, potentially reducing emissions. Initiatives such as Bovaer or Silvair promise to reduce emissions from enteric fermentation without

productivity loss. However, such initiatives are still pilots and only represent costs to producers. Reflecting on ways to monetize this reduction in emissions via diet is essential so that cattle ranchers can consider this idea.

Slaughterhouses are also involved in actions linked to intensive finishing via confinement. Confinement – which registered an increase of 27.9% between 2017 and 2021, with 6.73 million heads in 2021 (IHS Markit, 2022) – is considered a great laboratory for testing management strategies aimed at increasing productivity and reducing emissions. In addition to production protocols (such as Boi 777, a protocol for producing an animal of 21 arrobas in up to 2 years), price differentiation strategies via traceability, monitoring, and quality assurance are observed.

The challenge of disseminating good practices among ranchers is huge, given the great heterogeneity and different production cycles of the activity. To respond to this challenge, a great collective engagement of the various entities involved, directly or indirectly, in the production process is necessary. Figure 6 shows how institutions have been organizing themselves in different initiatives aimed at disseminating GAPs.

Figure 6 - Social network of institutions involved in good practice tools



Note: Reading Appendix A is recommended to learn more about the methodology used, as well as its limitations. Source: Study results. Development: Agroicone

Based on this survey, a greater capacity for integration between institutions located in the state of Mato Grosso can be observed. It is worth mentioning the central role of institutions such as ACRIMAT, FAMATO and Embrapa Agrossilvipastoril. At the same time, it is possible to observe a process of isolation from the other Embrapa units, especially the Pecuária Sul and Pecuária Sudeste units, which are responsible for many tools, but do not partner with any other institution (at least they were not identified in

this survey).

The search for greater integration between institutions to join efforts is fundamental for disseminating GAPs. Even so, the main challenge lies in the decision-making from the producer's economic point of view. Deciding on investing in pasture management, a better diet, genetics, or integrated systems depends on their ability to mobilize resources, risk aversion and economic incentives.

3.2. Decision-making process for investments from the perspective of cattle ranchers – examples of field research

Adopting good agricultural practices by producers is a strictly economic decision, which depends on several factors, such as the availability of cleared areas, agricultural suitability of these areas, land prices, and the presence of agricultural groups in the region. Without economic incentives, overcoming inertia is even more complex. The possibility of measuring fictitious profits remains a reality for many producers. To better explain that, some field results are presented.

The producer's decision-making process varies according to the availability of cleared areas, the suitability of these areas for agriculture, land prices, and even the presence of large agricultural groups in the region. Field research carried out by Agroicone in the state of Mato Grosso in three specific regions – São Félix do Araguaia, Alta Floresta, and Paranatinga⁽⁸⁾ - identified that the conversion process of degraded pasturelands into crops is inexorable and irreversible. That occurs because pastures, when degraded, make extensive cattle ranching economically unfeasible. In addition, investments in recovering pastures for cattle ranching production have shown a long payback. Thus, it becomes more appealing for cattle ranchers to lease/sell their degraded pasturelands or to start

working on agriculture as a way of recovering the areas and intensifying production (integrated systems). The three regions have been going through this process but showing important differences.

SÃO FÉLIX DO ARAGUAIA

The wide range of cleared areas with degraded pastures and the high suitability for agriculture in these areas have been attracting large, highly capitalized agricultural groups with an aggressive purchase/lease strategy. Cattle ranchers, in their turn, not willing to bear the costs of recovering and maintaining pastures, consider selling or leasing these areas as more advantageous, leaving the activity. That is, in this region, a broad process of conversion of degraded pastures to agriculture is underway, promoting the exit of cattle ranchers from the activity.

ALTA FLORESTA

In this region, the process takes place in a different way. Due to the reduction in logistics costs regarding the ports of Santarém and Miritituba, both in the state of Pará, the option of recovering pastures by using agriculture became economically viable. Accountable for the largest areas of suitable degraded pastures already occupied by large agricultural groups, medium producers have been adopting integrated systems as an alternative to recover degraded areas, since the payback of recovering traditional pastures is greater when compared to the recovery process using agriculture. This process has been taking place gradually by introducing agriculture in small areas within properties each year, by usually using their own resources.

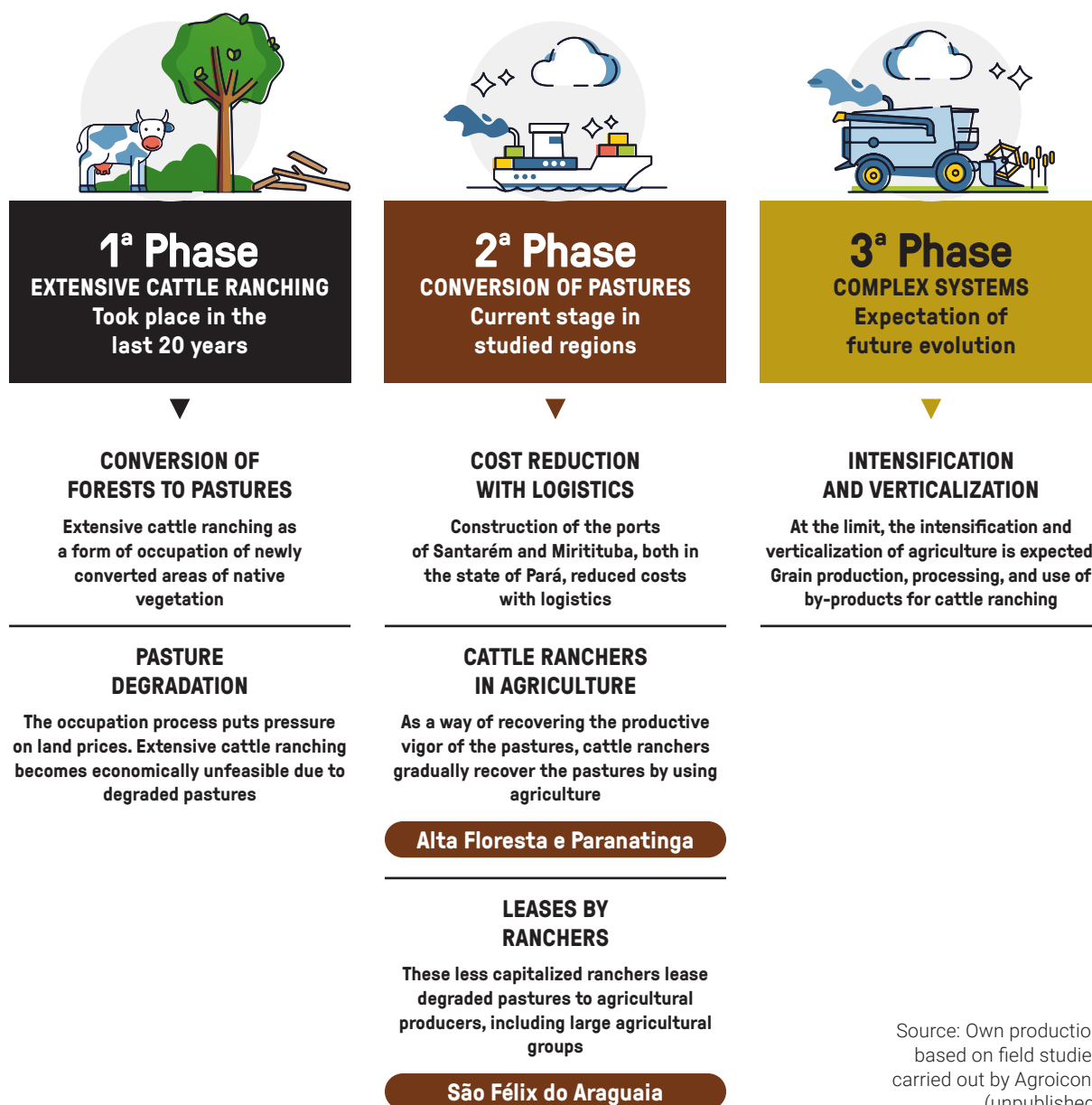
(8) In this survey carried out by Agroicone and partners in early 2022, regions with a concentration of degraded pasturelands suitable for grain products in the state of Mato Grosso were identified, divided according to the municipalities that comprise: "Alta Floresta": Alta Floresta, Novo Mundo, Paranaíta, Carlinda, Nova Canaã do Norte, Itaúba, Cláudia, Nova Santa Helena, Terra Nova do Norte, Colíder, Nova Guarita, Matupá, and Guarantã do Norte; "São Félix do Araguaia": São Félix do Araguaia, Alto da Boa Vista, Serra Nova Dourada, Bom Jesus do Araguaia, Canabrava do Norte, Luciara, Porto Alegre do Norte, Santa Terezinha, Confresa, Vila Rica, Santa Cruz do Xingu, Novo Santo Antônio; "Paranatinga": Paranatinga, Gaúcha do Norte, Canarana, Água Boa, Nova Nazaré, Nova Xavantina, Campinápolis, Santo Antônio do Leste, Nova São Joaquim.

PARANATINGA

Here, a process similar to that of Alta Floresta is observed, where ranchers recover the quality of pasturelands via integrated systems. However, counting on a smaller area of degraded pasture suitable for agriculture (compared to Alta Floresta) and facing more risk-averse producers, this conversion process has been taking place more slowly. Furthermore, the region has had more cases of environmental embargoes due to illegal deforestation.

At the limit, the expectation is that, with the expansion of the corn ethanol industry, agriculture and livestock production in these regions will become increasingly vertical, having three harvests a year, and using the by-product of the industry (DDG – Dried Distillers Grains) as a nutritional source for beef cattle when they are not grazing. Figure 7 presents a summary of the ongoing transformation in these regions of Mato Grosso.

Figure 7 - Soil use and expectations for the future in the regions studied



Source: Own production based on field studies carried out by Agroicone (unpublished)

The decision of rural producers when it comes to investments allocated to the recovery of degraded areas goes through an analysis of land prices, availability of cleared areas, existence of areas of excess native vegetation in Legal Reserves eligible for clearing, availability of resources for financing, and alternative occupation of such area – for example, the transition to other uses, such as soybean production, or the creation of integrated systems (ICLS).

In a series of business cases⁽⁹⁾ focused on the Cerrado, Harfuch et al. (2021) analyzed the decision-making processes of rural producers in recovering degraded pastures for three different regions:

1. **Intensification of cattle ranching in the Guariroba Basin (MS).**
2. **Recovery of pasturelands via leasing for soybean production in the municipality of Araguaçu (TO).**
3. **Recovery of degraded pasturelands through integrated systems (ICLS) in the municipality of Canarana (MT).**

Table 5 presents the economic indicators for each of the decisions for the three regions.

In the case of the Guariroba Basin, a region of extensive cattle ranching for breeding, it is observed that the profitability of the base scenario (with low productivity due to degraded pastures) is extremely low, largely determined by the genuine appreciation of the land along the years. If a producer invests in pasture recovery, the results obtained are positive, arising from the increase in productivity (from 1.49 head/ha to 3.58 head/ha). The scenario with investment credit is even more advantageous, since it allows to leverage cash

flow combined with greater flexibility of the grace period to pay for the financing.

In the case of Araguaçu, in its turn, producers have the option of recovering pastures or leasing part of these degraded areas for soybean expansion. The production system evaluated was that of breeding, more common in the region. Results show that choosing to recover pastures is economically attractive, as return is positive. However, the best strategy identified is leasing (with or without financing), since it allows an income capable of financing part of the investments in pasture recovery and improving the property.

Finally, the case of Canarana considered the soybean expansion process over cleared areas for pastures. That use is preferable rather than occupancy areas of excess native vegetation, when recovering pastures with integrated systems can be an economically viable alternative. Faced with the option of advancing on degraded pastures for Integrated Crop-Livestock Systems (ICLS) or soybean monoculture, economic results demonstrate that the first alternative is preferable.

All these examples, however, come across a number of challenges. Producers' aversion to risk, limited access to credit and technical assistance, land occupation, supply of cleared areas, and appreciation of areas are some of the factors that have an impact on the opportunity costs of investing in pasture recovery.

In other words, an arrangement of public policies aimed at promoting GAPs and creating the necessary boundary conditions for their adoption is essential.

(9) To see the complete study, in further detail on the hypotheses and assumptions of each of the business cases, access at: <https://www.agroicone.com.br/wp-content/uploads/2021/12/Recuperacao-de-areas-degradadas-e-reabilitacao-do-solo-no-Cerrado-brasileiro.pdf>

SUSTAINABILITY IN THE BEEF PRODUCTION CHAIN

To this end, the next section discusses some agricultural policy instruments, in particular the ABC+ Plan and its investment financing line, the ABC+ Program. In addition, the section provides an

overview of the private finance scenario aimed at sustainable cattle ranching, either in terms of the business environment and institutional apparatus or drawing examples of available financial products.

Table 5 - Economic indicators for each of the scenarios for the three regions studied⁽¹⁰⁾, from the perspective of cattle ranchers (Guariroba and Araguaçu) and from the perspective of soybean producers (Canarana), 2019/2020 harvest year

Region	Scenario	Production area	Stocking	NPV ⁽¹¹⁾ (R\$ thousand)	WACC ⁽¹²⁾	IIR ⁽¹³⁾	Return (Years)
BACIA DO GUARIROBA (MS)	Base	242 ha of pastures	1.49 head/ha from 1st to 15th year	372	2.42%	3.50%	14,6
	Pasture recovery – no credit	242 ha of pastures	1.49 head/ha 1st year; 3.58 head/ha from 5th year	1,395	2.49%	9.60%	14
	Pasture recovery – with credit	242 ha of pastures	1.49 head/ha 1st year; 3.58 head/ha from 5th year	1,557	2.49%	29.10%	11
ARAGUAÇU (TO)	Base	250 ha of pastures	1.24 head/ha	389	2.42%	3.50%	
	Pasture recovery – no credit	250 ha of pastures	1.24 head/ha 1st year; 3.58 head/ha from 5th year	1,126	2.23%	8.50%	14,1
	Pasture recovery and lease for soybean production – no credit	125 ha of pastures and 125 ha for soybeans	1.24 head/ha 1st year; 3.58 head/ha from 5th year	2,894	2.23%	17.10%	12,7
	Pasture recovery – with credit	250 ha of pastures	1.24 head/ha 1st year; 3.58 head/ha from 5th year	1,202	2.23%	10.70%	14,1
	Pasture recovery and lease for soybean production – with credit	125 ha of pastures and 125 ha for soybeans	1.24 head/ha 1st year; 3.58 head/ha from 5th year	2,939	2.23%	20.50%	12,6
CANARANA (MT)	Lease of pasturelands for implementation of ICLS, including pasture recovery	3.872 ha of ILP + 1.500 ha for soybeans	0 ton/ha for 65 sacks/ha (soybeans) in the 6th year; 0.9 UA/ha for 1.5 UA/ha in the 4th year (pastures)	16,000	3.10%	10.20%	10,9
	Lease of pasturelands for soybean expansion	5.372 ha for soybeans	0 ton/ha for 65 sacks/ha in the 6th year (soybeans). Growth rate: 2%/year	9,000	3.10%	7.70%	12,3

Source: Harfuch et al. (2021)

(10) For all scenarios, a variation in the real land price of 2.5% per year is assumed, in addition to appreciation due to the change in land use (such as degraded pasture to recovered pasture, depending on each scenario). All projects assessed assume a period of 15 years. It is worth noting that these analyzes were based on economic indicators for the 2019/2020 harvest.

(11) VPL = Valor Presente Líquido.

(12) WACC = Custo Médio Ponderado do Capital, em português.

(13) TIR = Taxa Interna de Retorno



4. How to leverage the adoption of good practices with agricultural policy and financing

4.1. The ABC+ Plan and the rural credit policy for sustainability purposes

Good public policy instruments already exist for the adoption of good agricultural practices.

The ABC+ Plan, Brazil's main strategy for mitigating and adapting to climate change in the agriculture and livestock sector, has two important investment credit instruments: the ABC+ Program and the PRONAF ABC+.

However, although fundamental, these programs are insufficient in terms of volume of resources and even demand.

As part of the Brazilian strategy for the agricultural sector and changes in land use regarding the commitments made in the National Policy on Climate Change (PNMC), in 2010, Brazil launched the "Sectoral Plan for the Mitigation and Adaptation to Climate Change for the Consolidation of a Low-Carbon Economy in Agriculture" (*ABC Plan*), establishing voluntary targets⁽¹⁴⁾ for the reduction of GHG emissions in agriculture from 2010 to 2020, as well as a set of strategies and actions to achieve them.

At the end of its cycle, the ABC Plan was successful in achieving its goals, having around 52

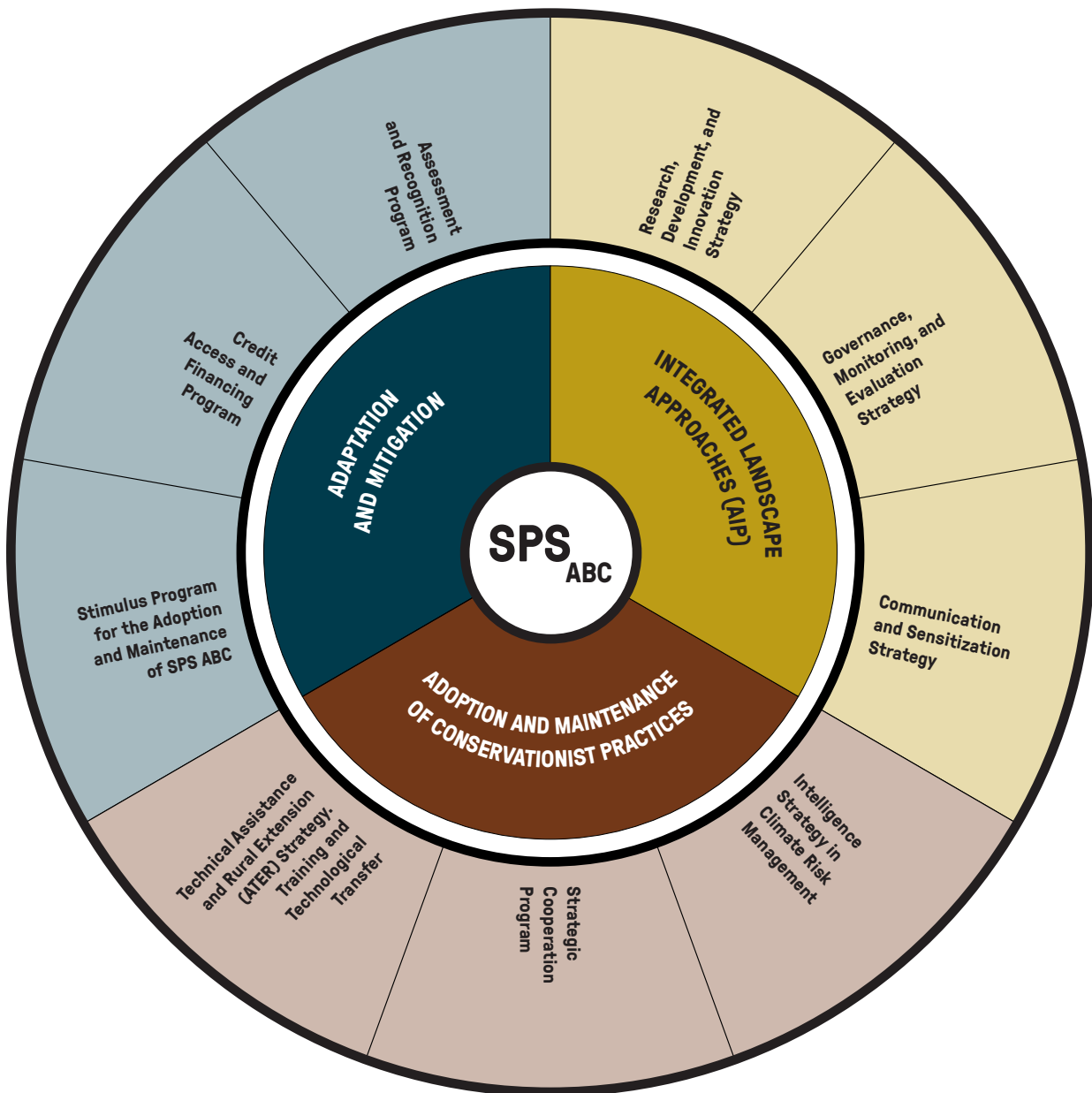
million hectares with some technology promoted by the Plan, and mitigation of around 170 million CO₂eq. ((Ministry of Agriculture, Livestock and Supply – MAPA, 2021b). As a way of reaffirming the commitment to decarbonize the agriculture and livestock activity, as well as giving continuity to the virtuous process initiated in the first cycle of the Plan, in addition to being part of the Nationally Determined Contribution (NDC) strategies presented by Brazil in the Paris Agreement, in 2021, the "Sectoral Plan for Adaptation to Climate Change and Low-Carbon Emissions in Agriculture and Livestock aimed at Sustainable Development – *2020-2030 ABC+ Plan*".

The ABC+ Plan has three conceptual bases that govern the entire creation of programs, strategies, actions, and activities: 1) Integrated Landscape Approaches (AIP), where the agriculture and livestock activity is part of a landscape in a synergistic, systemic, and dynamic manner; 2) Combination of adaptation and mitigation, taking into account that not only the reduction of emissions is enough but the search for resilient systems to climate changes is also fundamental; 3) Adoption and maintenance of Sustainable Systems, Practices, Products, and Production Processes (SPSABC), conceptual basis already contained in the first Plan, which demonstrates the incentive to adopt technologies and conservationist practices that reduce soil mobilization, allow maintenance of the organic matter, and seek species diversification. Figure 8 shows conceptual bases, programs, and strategies of the 2020-2030 ABC+ Plan.

(14) The goals for the first decennium were:

- (i) Recover 15 million ha of degraded pasturelands;
- (ii) Implement 4 million ha of integrated systems (crop-livestock-forestry and their combinations);
- (iii) Increase no-till farming by 8 million ha;
- (iv) Increase the biological nitrogen fixation (BNF) technique by 5.5 million ha more;
- (v) Expand planted forests by 3 million ha;
- (vi) Improve animal waste management for bioenergy by 4.4 million m³.

Figure 8 - Conceptual bases, programs, and strategies of the 2020-2030 ABC+ Plan



Source: BRASIL (2021)

The 2020-2030 ABC+ Plan presents more ambitious goals when compared to its first cycle, expecting to reach 72.68 million hectares, where cattle ranching plays a fundamental role in such process. The goals, which are related to the SPSABC promoted by the Plan, are: recover 30 million ha of degraded pasturelands; expand by 10 million ha of integrated systems (crop-livestock-forestry and their combinations);

increase no-till farming areas by 12.58 million ha; expand agroforestry systems by 0.10 million hectares; increase the area of planted forests by 4 million ha; expand the use of bio-inputs by 13 million hectares; implement irrigated systems on 3 million hectares; adopt the Intensive Finishing (TI) of 5 million animals; implement waste management from animal production by 208.40 million m³.

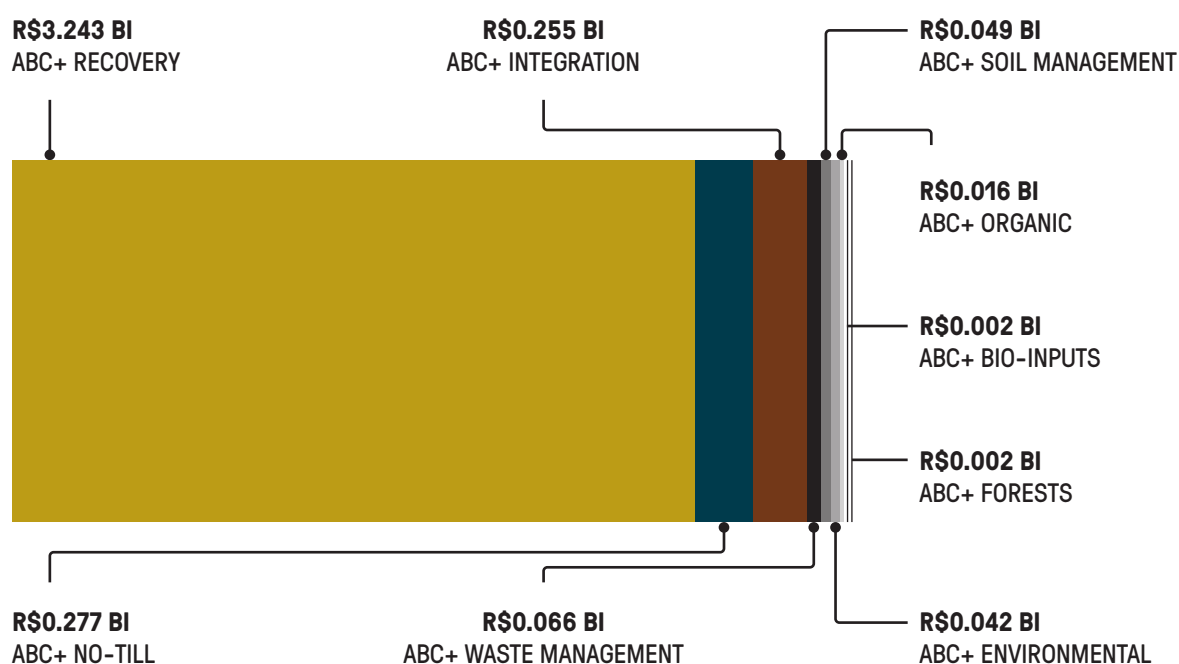
SUSTAINABILITY IN THE BEEF PRODUCTION CHAIN

However, the ABC+ Plan is impossible to be materialized without rural producers and their willingness to engage in the technological transition. One of the great challenges for this process is exactly budget constraints, aversion to risk, and lack of information regarding the characteristics of the credit policy, especially among small and medium producers and ranchers. To this end, since 2011, the main agricultural policy instrument available to the Plan is the ABC+ Program, an investment credit line aimed at promoting the SPSABC, focusing on medium-sized rural producers.

From 2018 to March 2023, R\$3.95 billion were allocated to cattle ranching, distributed in nine different subprograms (Figure 9). Despite the wide range of subprograms for different purposes, a large concentration of resources for the pasture recovery subprogram (ABC+ Recovery) is noted.



Figure 9 - Distribution of the ABC+ Program resources for cattle ranching by subprogram between 2018 and 2023 (March)



Sources: Banco Central do Brasil, SICOR. Accessed on April 5, 2023. Development: Agroicone

In addition to the ABC+ Program, the 2022/2023 Crop Plan sought to rename other financing lines aligned with the precepts advocated by the ABC+ Plan, especially those aimed at the family agriculture audience. From the analysis of the purposes of some financing lines of the National Program for Strengthening Family Farming (PRONAF), those highly correlated to the conceptual bases of the ABC+ Plan were identified. They are: PRONAF ABC+ Bioeconomy, PRONAF ABC+ Agroecology, PRONAF ABC+ Forests, and PRONAF ABC+ Semiarid. Table 6 summarizes purposes, volume of resources, and main financed products for PRONAF ABC+ credit lines between 2018 and 2023.

These existing PRONAF financing lines have purposes aligned with sustainable and resilient agriculture and livestock production and, therefore, received the ABC+ label. However, they still represent a minority of the total resources for investment in PRONAF. Over the last five harvest years, the participation of PRONAF ABC+ in relation to total PRONAF resources for investments reached its peak in the 2022/2023 harvest (until March 2023), representing 4.85% of total resources (R\$396 million).

The concentration of resources for cattle ranching aimed at recovering pastures is perfectly justified by the size of the pastureland somewhat degraded in Brazil.

Table 6 - PRONAF ABC+ credit lines, their purposes, volume of resources, and main financed products between 2018 and 2023 (until March 2023)

PRONAF investment credit line	Purposes	Volume of resources (2018-2023)	Main financed product (2018-2023)
PRONAF ABC+ Forests	Agroforestry systems; sustainable extractive exploitation; recomposition of Permanent Preservation Areas (APPs) and Legal Reserves (RL); recovery of degraded areas; enrichment of forest areas	R\$ 0,6 million	Terraces, gates, cattle grids, corrals, feeders, fences (R\$210,000)
PRONAF ABC+ Agroecology	Agroecological production systems or in transition; organic systems	R\$ 12 million	Beef cattle (R\$3.3 mi)
PRONAF ABC+ Bioeconomy	Renewable energy; sustainable extractive system; environmental technologies; recovery of Permanent Preservation Areas (APPs) and Legal Reserves (RL); forest seedling nurseries; forestry; agroforestry systems; rural tourism; bio-inputs.	R\$ 880 million	Rural electrification (R\$454 mi); renewable energy (R\$308 mi)
PRONAF ABC+ Semiarid	Projects for coexistence with the semiarid region (resilience) focused on the sustainability of agroecosystems	R\$ 548 million	Lake, tank, barrels, canals, reservoirs (R\$135 mi)

Sources: Banco Central do Brasil, SICOR. Accessed on April 5, 2023. Development: Agroicone

There are around 95.5 million hectares (62.8% of the total pastureland), according to Mapbiomas (Collection 6). According to IHS Markit (2022), the costs to recover or restore pasturelands in 2021 ranged from R\$2,804.40 to R\$9,523.00 per hectare, depending on the fodder and system implemented, not considering other improvements (such as construction of paddocks for rotational grazing, water troughs, feeders, etc.).

To have an idea of the dimension of such challenge, considering an average cost of R\$4,000.00/ha for a semi-intensive system, recovering degraded pasturelands would cost 100 times more than the volume of resources allocated to the ABC+ Program for cattle ranching since 2018, totaling R\$382 billion. It is worth remembering that it is not just the ABC+ Program that finances the recovery of pastures and that, clearly, the volume of subsidized rural credit resources should be much greater for the proportion of this challenge or even to reach the targets of the ABC+ Plan by 2030. Thus, fostering a private financing environment

in the context of agriculture and livestock for sustainability purposes becomes imperative.

4.2. The private sustainable finance environment in Brazil

Despite the insufficiency of credit resources with economic subsidy for sustainability purposes, there is a significant growth of private finance in Brazil, which is due to the recent review of regulations.

Fortunately, a process of review of the regulatory environment has been under way in recent years, which has allowed expanding the ability to attract private resources to create new financial products and even products that are already widely known by the Brazilian public. This new institutional environment has been promoting a true revolution in private finance for the sector. Table 7 presents the evolution of the main financial instruments operated in Brazil.

Table 7 - Variation in fundraising by type of instrument⁽¹⁵⁾

Instrument and Period analyzed	Initial amount (R\$ billion)	Final amount (R\$ billion)	Variation (%)
Rural Product Note - CPR (8/2020 - 10/2022)	17.0	203.7	1.100
Agribusiness Letter of Credit - LCA (1/2019 - 10/2022)	69.7	326.1	368
Agribusiness Receivables Certificates - CRA (1/2019 - 10/2022)	36.0	96.8	169
Certificate of Agribusiness Credit Rights - CDCA (1/2019 - 10/2022)	6.7	27.6	311
Investment Fund in Agroindustrial Production Chains - FIAGRO⁽¹⁶⁾ (1/2019 - 12/2022)	-	10.34	-

Source: Mazzillo Júnior (2022)

(15) Table in its entirety from the Charter of Agriculture published in Revista de Política Agrícola (RPA), V.31, N. 4 (2022) by former Secretary of Agricultural Policy José Angelo Mazzillo Júnior. Access at: <https://seer.sede.embrapa.br/index.php/RPA/article/view/1851/pdf>

(16) Amounts updated for 12/2022. From the news published by Valor Econômico newspaper that can be accessed at: <https://valor.globo.com/agronegocios/noticia/2023/01/19/patrimonio-liquido-de-fundos-do-agro-ja-passa-de-r-10-bilhoes.ghtml>

The so-called Agro Laws elasticized the ways of raising funds. For example, [Law 13,986, of April 7, 2020](#) guarantees legal security for operations with Rural Product Notes (CPRs) backed by dollars. On the other hand, [Law 14,130, of March 29, 2021](#)⁽¹⁷⁾, lays down the institutional principles of the Investment Fund in Agroindustrial Production Chains (FIAGRO), which consists of an investment fund in real estate assets or activities related to the production sector, consisting of three categories: Credit Rights (FIAGRO – FIDC), Real Estate (FIAGRO – FII), and Equity (FIAGRO – FIP). Finally, Law 14,421, of July 20, 2022, expands the scope of products and activities subject to the issuance of Rural Product Notes (CPRs), even allowing the transaction of

ecosystem services, such as carbon.

In addition, classic instruments such as Agribusiness Receivables Certificates (CRAs), Certificate of Agribusiness Credit Rights (CDCAs) and Agribusiness Credit Letters (LCAs) recorded extraordinary variations in traded inventories, as noted in Table 7. All this process has been opening a wide window of opportunity, not only in the agribusiness financing process itself but in the possibility of combining it with agriculture and livestock activities that produce positive environmental externalities. Table 8 presents a set of private financial instruments issued in recent years with enormous potential to promote sustainable agriculture and livestock in Brazil.

Table 8 - Private financing instruments for sustainability purposes in agriculture and livestock – examples

Instrument	Subcategory	Responsible for the management of the initiative	Instrument definition
VERTENTES PROJECT	Blended Finance	MAPA*; CNA*; World Bank	Allocation of R\$130 million to fight desertification, promote the sustainable management of soybean production and cattle ranching chains, recover degraded areas, reduce greenhouse gases emissions, and protect biodiversity.
CRA - E-CTARE	CRA	E-ctare; Ecoagro; Banco Alfa	R\$50 million in Agribusiness Receivables Certificate (CRA) for the E-ctare startup, which operates in rural credit. Reduction of transaction costs for rural credit operations. It is expected to facilitate the credit process for small producers.
AGBI III CARBONO FIAGRO FIP	Fiagro	AGBI	First FIAGRO with sustainability label. It followed Climate Bonds Initiative (CBI) and Sustainability Related Financial Disclosure (SRFD) parameters. Commitment to zero net deforestation, replanting twice as many cleared lands after 2012, use of ICLFS. Fund buys farms with degraded pastures for conversion into cropland

* Ministry of Agriculture, Livestock and Supply ** Brazilian Confederation of Agriculture and Livestock

(17) The Securities and Exchange Commission – SEC should *regulate FIAGRO in 2023*, as part of SEC's 2023 Regulatory Agenda

SUSTAINABILITY IN THE BEEF PRODUCTION CHAIN

Instrument	Subcategory	Responsible for the management of the initiative	Instrument definition
CRA - MITRE AGRO	CRA	Mitra Agro; Itaú BBA; Bradesco BBI; Santander; BTG; ABC	Company focused on crop-livestock integration. Agribusiness Receivables Certificates (CRA) issued to finance irrigated planting, expanding 40% to 50% of the irrigated area.
CPR RESERVA LEGAL+	CPR	Itaú BBA	R\$1.4 million bond to fund cattle confinement in Mato Grosso do Sul. The bond provides for an economic benefit for the commitment not to suppress native vegetation in excess of 30%. Bond without carbon surplus, which reduces transaction costs.
LCA VERDE - BB	LCA	Banco do Brasil	R\$1.2 billion raised via LCA Verde. These resources are directed to low-carbon agriculture and livestock operations, renewable energies, and other lines that meet ESG criteria.
LIVESTOCK INSURANCE AGAINST FOOT-AND-MOUTH DISEASE	Rural insurance	Fairfax	First livestock insurance against foot-and-mouth disease in the world. The calculation of the insurance value considered factors such as georeferencing of properties and the quality of agriculture and livestock defense work in the state.
PASTAGEM PROTEGIDA - INDEX	Rural insurance	Scor; IRB Brasil; Essor	Parametric pasture insurance. It uses the Airbus Defense and Space Grassland Production Index. It will cover pasture losses caused by climate events, especially drought.
FORESTRY AND CLIMATE CHANGE FUND	Venture capital	KPTL; Fundo Vale; Troposlab; Imaflora; Resultante	Impact investment fund that will allocate R\$200 million to startups that present reforestation solutions, working in the field of bioeconomy, recovery and conservation of forests, carbon, and regenerative economy.
BNDES NET ZERO COMMITMENT	Voluntary commitments	BNDES	The Brazilian Development Bank (BNDES) is committed to becoming carbon neutral by 2050 – which involves not only its direct emissions but, mainly, the challenge of decarbonizing the portfolio of more than R\$450 billion in direct and indirect loans, in addition to other almost R\$70 billion in equity stake. Thus, the bank encourages sustainable business, including in Brazilian cattle ranching.
IFACC	Voluntary commitments	TNC; TFA; UNEP	Launched during COP-26, IFACC (Innovative Finance for the Amazon, Cerrado and Chaco) is a partnership between The Nature Conservancy (TNC), Tropical Forest Alliance (TFA), and the United Nations Environment Programme (UNEP) that will encourage raising US\$10 billion by 2025. The resources will finance deforestation-free cattle ranching and soybean cultivation in these three South American biomes.

SUSTAINABILITY IN THE BEEF PRODUCTION CHAIN

Instrument	Subcategory	Responsible for the management of the initiative	Instrument definition
BLENDED FINANCE BB AND WORLD BANK	Blended finance	Banco do Brasil	The World Bank released US\$500 million for Banco do Brasil to expand financing linked to sustainable goals and boost access to the carbon credits market by the private sector. The project will adopt an approach that requires companies to have decarbonization plans in order to gain access to long-term credit. BB will provide its clients with packages that include financing with support for access to the carbon markets by means of what it called a “one-stop shop,” from measuring the carbon footprint to generating “high integrity” credits. The initiative is interesting especially for small and medium-sized companies, which tend to have difficulties in conducting these operations. Incentive for companies to adopt low-carbon technologies / actions, in addition to stimulating the national carbon market.
INVESTMENT IN PRIVATE EQUITY FUND	Private Equity	BNDES	The Brazilian Development Bank (BNDES) approved a contribution of up to R\$150 million in the second fund of GEF Capital Partners aimed at climate change solutions, which intends to raise up to R\$1 billion. The fund is aimed at investments in the energy, agribusiness, and urban solutions sectors (such as waste management and smart cities) and at climate solutions. Potential to make investments more affordable in technology that is not carbon-intensive in Brazilian cattle ranching or in sectors that may affect cattle ranching, such as bioenergy.
LIVING FOREST	Philanthropic fund	BNDES	A philanthropic fund that will bring together donation resources from the BNDES itself (which, by statute, must allocate part of the profit to philanthropy) and from partner companies. The structure is that of a ‘matchfund’, that is, for every R\$1 from the private sector, the bank allocates R\$1. Focus on small producers is a great differential of this fund. The goal is to restore between 16,000 and 33,000 hectares of forests – one hectare is equivalent to the area of a soccer field – and to capture up to 9 million tons of CO2. It is focused on small rural properties, Indigenous and quilombola lands, contributing to mitigating producers / part of society with less resources to make a sustainable transition.

SUSTAINABILITY IN THE BEEF PRODUCTION CHAIN

Instrument	Subcategory	Responsible for the management of the initiative	Instrument definition
CRA VERDE TOBASA	CRA	Tobasa	Issuing a green bond (CRA Verde) of R\$32 million will finance production based on sustainable extractivism that favors crop-livestock-forestry integration. Tobasa's raw material comes mainly from cattle ranching areas – ranchers receive an amount to free the access and activity for extractivists. Therefore, it is possible to guarantee sustainable management of the native forest combined with cattle ranching production.
THE AMAZON REFORESTATION FUND	Investment fund	Mombank	Mombak – a startup that wants to generate carbon credits from reforestation – is raising a fund aimed at investors looking for greenhouse gas removal assets. It wants to work in third-party areas, that is, establishing partnerships with rural producers. Parallel to that, the company wants to offer a cattle ranching intensification program to owners, who will be able to produce more arrobas of cattle per hectare and, thus, maintain revenue from sales to slaughterhouses and avoid potential leaks.
AMAZON PLAN	Voluntary commitments	Bradesco; Itaú; Santander	Support new business generation models that reconcile development and conservation. Focus on four lines of action: meatpacking industry, sustainable crops, land tenure regulation, and bioeconomy. The main objective is to stop illegal deforestation in the Amazon.
HUB CNA DIGITAL	Incubator	Brazilian Confederation of Agriculture and Livestock (CNA)	Connect startups, companies, investors, technology institutes, and universities to identify solutions that help rural producers in the country. The initiative will have five challenges: connectivity in the field, parametric insurance, animal traceability, e-commerce, and payment for environmental services. A total of R\$150,000 support per challenge.
COLMEIA UP	Incubator	Embrapa Recursos Genéticos e Biotecnologia	Support for the development of technologies for agriculture and livestock traceability methods using nanotechnology. In the short term, this support is not financial but sharing knowledge, innovation assets, and infrastructure.

SUSTAINABILITY IN THE BEEF PRODUCTION CHAIN

Instrument	Subcategory	Responsible for the management of the initiative	Instrument definition
IFACC COMMITMENT	Voluntary commitments	&Green; AGR13; DuAgro; Grupo Gaia; JGP; Syngenta; Sustainable Investment Management; VERT; IFACC	Eight financial institutions and agribusiness companies announced a US\$3 billion commitment – with more than US\$200 million in disbursements through 2022 – to finance the deforestation-free production of soybean and beef cattle and the conversion of natural habitats in South America.
CPR VERDE	CPR	ME; Ministry of Agriculture, Livestock and Supply (MAPA)	Creation of a new type of rural producer note, CPR Verde, which allows financing areas of environmental preservation via payment for environmental services.
BLENDED FINANCE RONCADOR &GREEN	Blended Finance	Fazenda Roncador; &Green; Bradesco	Blended finance mechanism between &Green and Bradesco to finance the restoration of 60,000 hectares of pastures and introduce a crop-livestock integration system. A total of R\$200 million – R\$50 million from &Green and R\$150 million from Bradesco.
SUSTAINABLE AGRICULTURE FINANCE FACILITY	FIDC	Rede ILPF; Bradesco; Ceptis; Cocamar; John Deere; Soesp; Syngenta; Embrapa Agrossilvipastoril; JGP	Credit rights investment fund for financing producers who join the ICLFS (Integrated Crop-Livestock-Forestry Systems), who will be certified and have access to credit for the purchase of inputs. The Fund buys credit rights, such as receivables from resellers of agriculture and livestock inputs that sell to certified producers.

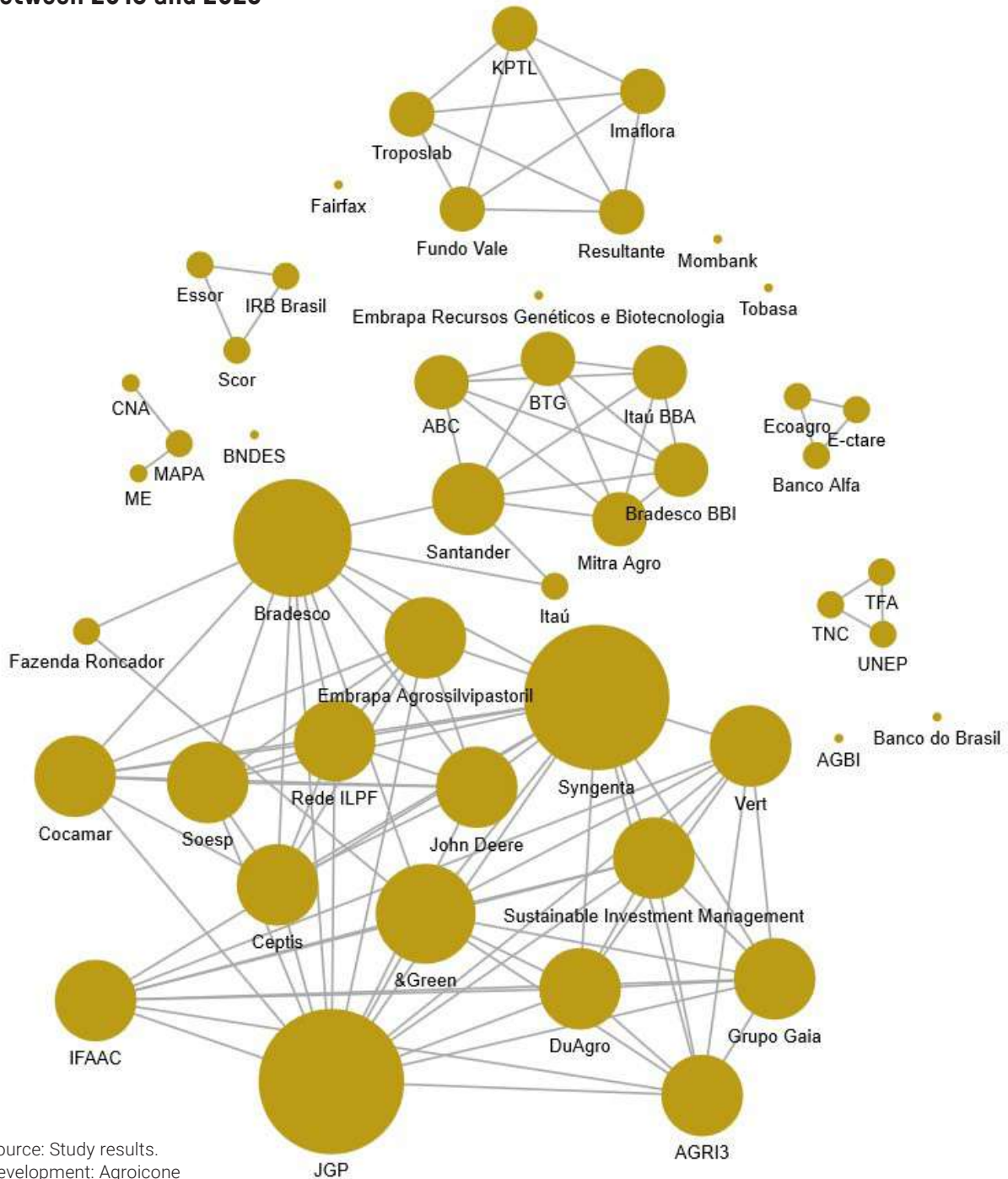
Note: Reading Appendix A is recommended to learn more about the methodology used, as well as its limitations.
Source: Study results. Development: Agroicone

In all, 23 interventions focused on sustainable finance were identified, ranging from voluntary commitments, blended finance arrangements, classic financial products such as LCAs, CRAs, CPRs, investment funds to rural insurance instruments, all focused on sustainable cattle ranching.

It is also observed that, for the 23 interventions, there are 47 related institutions, involving financial institutions, research institutions, input

companies and technological solutions, among other players. All this engagement demonstrates the need to share risks in the realm of sustainable finance. Such instruments are still recent and, therefore, pose greater risk. Moreover, there is a whole transaction cost involved in developing these instruments that require a broader involvement of different institutions (fiduciary agents, financial institutions, securitization companies, etc.). Figure 10 shows how this network of players connects.

Figure 10 - Social network of sustainable finance for cattle ranching in Brazil between 2018 and 2023



Source: Study results.
Development: Agroicone

Accompanying this process, the country's monetary authority, Banco Central do Brasil, has also been developing a propositional agenda regarding environmental, social, and climate sustainability in its operations. By means of the BC# Sustainability initiative, launched in 2021,

these actions can be divided into four large groups:

1. **Minimum social and environmental compliance.**
2. **Monitoring.**
3. **Transparency and reduction of information asymmetries.**
4. **Incentives.**

The first pillar – minimum social and environmental compliance – refers to the competence of the Central Bank to regulate all rural credit operations conducted in Brazil. When an operation is approved by a commercial bank, it is evaluated by the Central Bank, which considers more than 1,300 filters, including the environmental and social compliance of the property. In other words, the Central Bank works as a “second line of defense,” limiting non-compliant operations.

In terms of monitoring, the Central Bank has been signing some cooperation agreements with the various government bodies intended to improving data cross-referencing, as well as incorporating technological developments that allow for more accurate monitoring of rural credit operations and agriculture and livestock businesses. An example of that is the incorporation of the Rural Environmental Registry (CAR) into the system (SICOR) to serve as a basis for monitoring not only the financed area but the property as a whole.

In the third pillar, transparency and reduction of information asymmetries, one of the great innovations in 2022 was the open banking implementation. In that system, information from credit operations and producers belong to producers themselves, thus increasing their negotiation power with the financial market. In addition, the Central Bank made public information on credit operations with some type of public subsidy. All these initiatives reduce information asymmetry, also decreasing transaction costs and, consequently, improving financing conditions.

Finally, the fourth pillar, incentives, faced the greatest difficulties. It can be said that the Central Bank is intended to attack transaction costs, providing the market and civil society with more information on the credit operations conducted, giving the market itself the power to decide which incentives are more convenient for these sustainable operations.



4.3. Challenges in fostering financing to cattle ranchers

There are challenges to foster financing for cattle ranchers, both in terms of demand and credit supply. In demand, one can observe that there are three types of producers, each with their own characteristics and needs. In supply, the ability to identify sustainability issues in the credit policy itself needs to be improved.

Even with a consolidated public policy structure, financing programs aimed at social and environmental purposes, as well as an evolution from the institutional and business environment focused on sustainable finance perspective, a major barrier to access to these environments by rural producers is observed, especially that of cattle ranchers.

According to the Agriculture and Livestock Census (2017), only about 16% of establishments whose main activity was cattle ranching obtained some type of financing. If we consider only financing for investment purposes, this number drops by 10.8% of establishments. That is, to promote the technological transition to sustainable cattle ranching, unlocking access to credit is needed for cattle ranchers.

However, a wide heterogeneity of producers demands customized actions, depending on the producer's profile. In a simplified way, it is possible to divide cattle ranchers into three distinct groups, with different challenges:

“Marginalized”

PRODUCERS WITHOUT ENVIRONMENTAL AND LAND TENURE REGULATION, POSSIBLY WITH AN EMBARGO AND, CONSEQUENTLY, ON THE FRINGE OF PUBLIC POLICIES, ESPECIALLY CREDIT

At first, they must be provided with conditions to leave marginality, that is, to go through the process of environmental and land tenure regulation. Thus, promoting investments that increase productivity and generate positive environmental impacts is more complex for this group.

“Eligible non-borrowers”

REGULATED PRODUCERS, THEREFORE, ELIGIBLE TO TAKE CREDIT, BUT WHO ARE RISK-AVERSE AND HAVE LOW PRODUCTIVITY. IT ALSO INCLUDES THOSE PRODUCERS WHO NEED A GUARANTOR, SINCE A PROPERTY OF UP TO 4 FISCAL MODULES CANNOT BE PLEDGED

Producers who fit this profile either have difficulty in obtaining guarantees (since they are small producers) or are risk averse. For them, the technical assistance and rural extension service may be enough for greater engagement in investment interventions in the activity. Another solution would be developing endowments (not necessarily only for small producers) that could reduce risks for financial institutions while reducing the risk aversion of this group of producers.

“Eligible borrowers”

PRODUCERS WHO HAVE ALREADY GONE THROUGH THE FINANCIALIZATION PROCESS, ARE REGULATED AND ALREADY TAKE OUT FINANCING, WHETHER PUBLIC OR PRIVATE

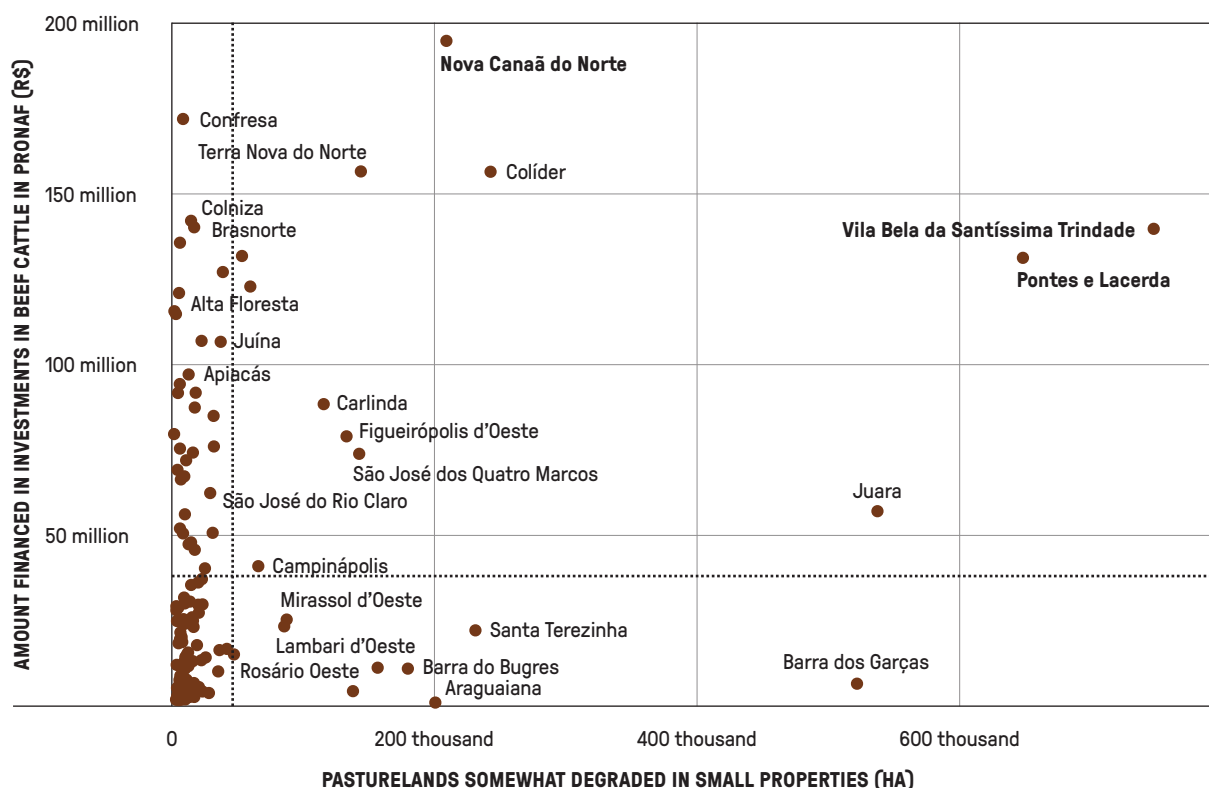
For this group, usually more tech-savvy, it is necessary to focus efforts on the effectiveness of investments, especially for sustainability purposes. Intensification of production with integrated systems, intensive finishing, and management of animal production waste could be encouraged for this group.

From the perspective of supply, in addition to expanding the volume of resources for sustainability purposes within the scope of agricultural policy (since 2018, only R\$3.95 billion have been allocated in the ABC+ Program for cattle ranching), it is necessary to reflect on the potential negative externalities with which investment resources may be associated.

For example, until December 2022, R\$5.95 billion in beef cattle investments (18% of the total controlled resources for investments in the 2022/2023 harvest) and R\$ 24.88 billion in beef cattle costs (30% of the total resources controlled for funding in the 2022/2023 harvest) were allocated. The question that remains is: Is this the most efficient allocation of credit to promote sustainable cattle ranching?

Figure 11 shows an exercise that combines the pasturelands somewhat degraded (moderate and severe) in small properties with the resources contracted for investments in beef cattle via PRONAF in the state of Mato Grosso (Agroicone, 2023). This exercise illustrates how it is possible to incorporate the risk of negative externalities of some financed products into the credit granting analysis if they are not combined with other products such as “pastures” and “soil correction.”

Figure 11 - Financing for “beef cattle” in PRONAF investment credit lines and degraded pastures in small properties⁽¹⁸⁾ by municipality in Mato Grosso State



Sources: Banco Central do Brasil, SICOR, Lapig/UFG and SiCAR. Accessed on January 20, 2023. Development: Agroicone

Municipalities such as Vila Bela da Santíssima Trindade, Pontes e Lacerda, Colíder and Canaã do Norte, for example, contracted a high volume of investment resources for beef cattle via PRONAF and, at the same time, have extensive areas of degraded pastures in small properties. Even not analyzing the allocation of resources by property, it can be said that this allocation is “suboptimal,” since it puts pressure on the land asset, possibly accelerating the process of pasture degradation.

The same reasoning can be applied to costing (and investment) for the soybean crop, which has been continuously expanding the planted area. Once it is possible to evaluate the quality

of pastures over time, it would be possible to verify whether the current planting of a soybean area takes place in an area whose previous use was for pastures somewhat degraded. That is, these situations would be preferable to those in already consolidated soybean areas, since they would encourage the transition from degraded to arable lands.

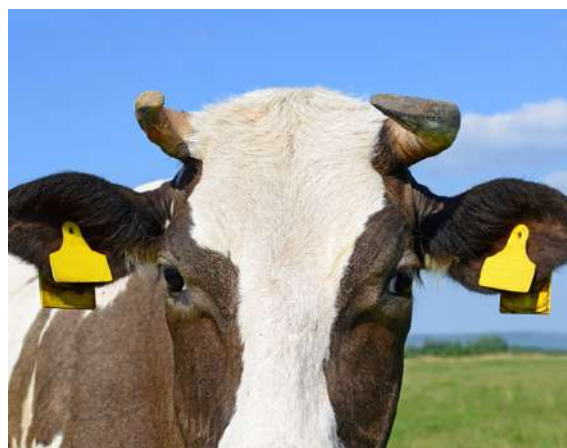
Such verification has the potential to increase transaction costs, however, to a lesser extent than self-reporting information. Such analyzes only require checking the geodetic coordinates or even the municipality in which the operation is located.

(18) This analysis was conducted by crossing information from the Rural Environmental Registry (CAR) with the pasture quality mapping. Three sensitivities are worth highlighting: i) The criterion of up to 4 fiscal modules was used, since there is no classification of properties by family or non-family; ii) Since the CAR is mostly not validated, the mapping overestimates pasturelands due to possible overlaps and border areas; iii) Since there is the possibility of declaring multiple CARs for a single property, the number of small properties may be overestimated.



5. Other forms of incentives: Certifications and PES

The technological transition to sustainable cattle ranching depends mainly on the rural producer’s decision to invest in this process. In a context of uncertainties, ranchers’ aversion to risk, lengthy period for financial return of such investments, budgetary restrictions of the Crop Plan and low volume of resources to finance individual producers, any and all incentive instruments are welcome. To this end, some initiatives have emerged in recent years aimed at differentiating producers (and their products) by management strategies and social and environmental aspects. That is the case of certifications and Payment for Environmental Services (PES) systems.



To reach more demanding markets, it is necessary to guarantee that the beef produced meets environmental, quality, and health aspects, and certification systems could attest to these aspects. Through independent certifiers, rural producers who adopt best practices, invest in genetics, and preserve the environment may differentiate their products. In addition, certifications follow traceability, being related instruments and used in a complementary way, since a certifiable production is also traceable.

5.1. Certifications

The several types of existing certifications are much more focused on quality and health issues, making social and environmental issues underrepresented.

In recent years, several certification systems have been identified, which attest to multiple aspects related to the cattle ranching, such as traceability, health, quality, and sustainability. Table 9 summarizes some of the certification systems that have emerged in recent years, according to the methodology presented in Appendix A.

Table 9 - Certification systems identified between 2018 and 2022 with their respective subcategory and definition

Instrument	Subcategory	Institutions	Instrument definition
Agri Trace Animal Traceability	Traceability	CNA	Tool that allows the certification of the entire beef production chain, from the origin of animals to the end product for consumers, adding value to the cattle herd of cattle ranchers who take part in certification programs. More than 8,500 producers are registered.

SUSTAINABILITY IN THE BEEF PRODUCTION CHAIN

Instrument	Subcategory	Institutions	Instrument definition
World Organization for Animal Health (WOAH) certification	Health	World Organization for Animal Health (WOAH)	Certification given to six Brazilian states free of foot-and-mouth disease without vaccination. Positive impact on beef exports.
Halal beef certification	Health	Ministry of Agriculture, Livestock and Supply (MAPA)	Negotiations to open foreign markets. Guarantee of health and traceability via certification, consolidating Brazil as the largest exporter of halal beef in the world.
ISO 17025 Certification	Health	JBS	International norm for quality management systems for laboratories. The certification determines which criteria laboratories that analyze food and products from the animal production chain must follow to guarantee that the steps have been fulfilled within criteria that provide quality, health, traceability, and reliability.
Angus Protocol	Quality	CNA	Use of the methodology and control that the Brazilian Angus Association uses for beef certification, considering all the procedures of the descriptive memorial, and the Angus Protocol, which guarantees the required quality standard.
Low-Carbon Brazilian Beef (LCBB) Protocol	Sustainability	Embrapa Gado de Corte	Production protocol aimed at increasing productivity linked to greater carbon storage in the soil. It gathers all the guidelines and possibilities of production systems, in addition to being a guide for certified production.
Hereford Certified Beef Protocol	Quality	ABHB; CNA; Minerva	Price premium system for Hereford and Braford carcasses. The idea is to expand the genetic improvement of cattle herds.
Organic certification protocol	Organic	ABPO	The protocol relies on processes of good agricultural practices, traceability since its origin, certification conducted through an audit by a recognized third-party company accredited by international standards.
Regulation for the Recognition of Premium Beef from the South of Brazil	Quality	Apropampa; Aprocima; Embrapa Pecuária Sul	The initiative is intended to distinguish and value the quality of beef produced in the state of Rio Grande do Sul, differentiating the products and giving national and international prominence to the beef sector in Rio Grande do Sul by means of a certification label. It considers environmental, health, animal welfare, traceability aspects, among others.

SUSTAINABILITY IN THE BEEF PRODUCTION CHAIN

Instrument	Subcategory	Institutions	Instrument definition
Angus Sustainability Label	Quality	Angus Brazilian Association	Certification system backed abroad. It assesses issues such as preservation of vegetation at springs and in natural reserve areas, proper disposal of empty containers of pesticides and medications, use of fires, recovery plan for degraded areas, hiring duly registered employees, and animal anti-stress measures.
Sustainable Production of Calves System	Sustainability	IDH, Acrimat, Carrefour. Protocol managed by CNA	Production protocol intended to guarantee social and environmental responsibility criteria from birth to slaughter.

Note: Reading Appendix A is recommended to learn more about the methodology used, as well as its limitations.
Source: Study results. Development: Agroicone

Some certifications are intended to guarantee the health of the beef for international markets. That is the case, for example, of the certification by the World Organization for Animal Health (WOAH) regarding foot-and-mouth disease, and the ISO 1725 Certification for the quality assurance and health management of laboratories that analyze food of animal origin.

Others, such as the “Hereford Certified Beef Protocol” and the “Angus Protocol,” attest, in addition to the guarantee of good quality genetics, that the beef was produced following strict criteria of good practices. Finally, some certification systems are designed to ensure that the beef produced is in line with sustainable production, such as the “Low-Carbon Brazilian Beef (LCBB) Protocol”, the “Angus Sustainability Label,” and the “Organic Certification Protocol”, which take into account issues of management, food, land use, and deforestation as certifiable criteria.

Also noteworthy is the Sustainable Calves, which is a protocol that describes how processes of the “Sustainable Production of Calves System” work and establishes a label that certifies the sustainable production of calves in Brazil. The Brazilian Confederation of Agriculture and

Livestock (CNA) is currently the manager of this protocol, which was conceived with the specific objective of guaranteeing the certification of social and environmental responsibility criteria, since the birth of cattle and buffaloes, and their respective appreciation of the end product. The bonus suggested by the “Sustainable Production of Calves System” is an additional 5% of live weight for animals in the Zero Deforestation Module, based on the price practiced in the local market. Such bonus is paid exclusively between sellers and buyers of the identified calves.

Low-Carbon Brazilian Beef (LCBB), in its turn, is a technical guideline, developed by Embrapa Pecuária de Corte in 2020, to label the production of low-carbon beef (pasture-raised). It includes technical procedures for soil carbon accounting, recovery and management of pastures, integrated crop-livestock systems, enteric methane emissions by beef cattle, and reduction of carbon emissions. Producers who voluntarily adhere to the Brazilian low-carbon beef protocol can receive a certification that differentiates them from traditional cattle ranching production systems. So far, there are no incentives related to this certification, but financial institutions seek social and environmental attributes for rural financing and may have incentives in the future.



Even with the increase in certification instruments, especially regarding providing for the foreign market, the low reach of these instruments among common cattle ranchers is observed. This is especially due to excessive costs and low marginal impact on prices. Reflecting on ways to expand access, while differentiating prices and offering broader incentives could make this type of instrument more popular.

5.2. Payment for Environmental Services (PES)

PES instruments are emerging, but they are still much more linked to the forest asset than to cattle ranching itself. The great challenge of PES is to pay for the opportunity cost of producers, which varies depending on the pattern of occupation of the area, the availability of excess native vegetation that is subject to deforestation, among others.

A synergistic relationship between the agriculture and livestock activity and the landscape can provide ecosystem services whose value, despite difficult pricing, exists and directly impacts on environmental and productive aspects. An agriculture and livestock system that values soil and water conservation is a good example.

A broad effort to price the value that these ecosystem services have has been observed currently. The best-priced service so far is carbon, which can be linked both to productive activity (for example, via direct planting strategies or well-managed pastures) and to environmental assets, especially forests and mangroves.

Instruments aimed at pricing environmental services and their consequent payment, PESs emerge as tools capable of rewarding and encouraging those who provide environmental services, improving the profitability of agriculture and livestock activities, and the protection and sustainable use of natural resources. This is a strategy for conserving natural resources and encouraging good agricultural practices that has been gaining prominence and is related to the beef production chain by means of the voluntary carbon market.

The voluntary carbon market in the Agriculture, Forestry and Other Land Uses (AFOLU) sector has seen its emissions of credits increase eightfold in the past two years. It is driven by organizations demonstrating their voluntary contribution to climate change mitigation and features greater flexibility and less complexity compared to the regulated carbon market, which is not subject to mandatory legislation or regulation linked to the Kyoto Protocol.

The rules that govern the voluntary carbon market are defined by norms that establish criteria and procedures for the development of projects, although many of these requirements are taken from the rules of the Clean Development Mechanism (CDM).

There is currently a growing demand for carbon credits in the voluntary market, which, in 2021, reached almost US\$2 billion (Donofrio et al., 2022). In the context of the Science-Based Targets Initiative, which supports the setting of science-based targets, there are 1,813 companies with emission neutrality targets (Science Based Targets, 2023). In the UNFCCC Race to Zero campaign, 5,235 companies, 1,049 cities, 441 of the major investors, and 1,039 higher education institutions are committed to reducing emissions, which reinforces the importance of the voluntary market (UNFCCC, 2022). There are 68 carbon pricing mechanisms in the world, 36 of which are carbon taxes and 32 of which are emissions trading systems (World Bank, 2022).

The definition of the approach to be adopted for the Brazilian carbon market remains open-ended. However, the publication of Decree 11,075/2022 establishes procedures for the preparation of Sectoral Plans to Mitigate Climate Change and institutes the National System for Reducing Greenhouse Gas Emissions (SINARE), initial steps towards the regulated carbon market. It is still uncertain how the national market will be and whether the sectors will have mandatory emission reduction targets.

In Brazil and around the world, PES initiatives aimed directly at cattle ranching are still scarce. The lack of methodologies that estimate carbon storage in the soil under pastures, the reduction of emissions by diet and genetics are still challenges for the evolution of such instruments. However, there are some initiatives that can indirectly benefit cattle ranchers, especially those who conserve natural resources. Table 10 presents a compilation of initiatives and instruments aimed at payment for environmental/ecosystem services that can benefit the beef production chain.

Table 10 - PES initiatives that can benefit cattle ranching in Brazil

Instrument	Subcategory	Institutions	Instrument definition
Biomass' PES	Carbon credits	Biomass; Itaú; Santander; Rabobank; Suzano; Vale; Marfrig	The company's objective is to facilitate the reforestation and conservation of up to 4 million hectares in Brazil and remove or avoid the emission of 900 million tons of GHG in 20 years. Carbon capture through reforestation and, later, carbon credit issuance.
Carbonnext's PES	REDD+	Carbonnext	The company is a project developer – it identifies opportunities and takes action to keep forests standing, which will later generate carbon credits. A project-development company to generate carbon credits with the preservation of the Amazon.
Carbon credit by methane reduction via additives - BrCarbon	Carbon credits	BrCarbon	Application of additives in cattle feeding to reduce methane emissions. Carbon credit issuance from such process.

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Instrument	Subcategory	Institutions	Instrument definition
Carbon credit purchase - BNDES	Carbon credits	BNDES	It works as a market promoter, not only guaranteeing capital to put projects into practice but also approving quality standards for initiatives to reduce greenhouse gas emissions. Investment of up to R\$300 million in the acquisition of these carbon market credit bonds over the next three years.
Future Agro	Carbon credits	Future Carbon	It works in the monetization of more sustainable alternatives for companies and in the relationship with investors interested in this market. Future Carbon wants to tie up these ends, bringing capital to finance carbon projects through a financial structuring area, while connecting buying and selling companies and the technical team to make it work – in a model that it named “one-stop-shop on carbon.” Future Agro will be responsible for carbon in agribusiness, including alternatives such as regenerative agriculture and carbon stock in the soil and low-carbon cattle ranching.
Brazilian Initiative for the Voluntary Carbon Market	Carbon credits	Amaggi; Auren; B3; Bayer; BNDES; CBA; Dow; Natura; Rabobank; Raízen; Votorantim; Vale	McKinsey & Company is the content coordinator of the initiative. Among the objectives are expanding the supply through the best certification/verification processes, developing the necessary financial instruments to align demand and supply, setting requirements for a high integrity market (technical, environmental and social), exploring the main fiscal implications, designing an independent governance body to coordinate the market, and developing the engagement strategy with key players.
Carbonflor’s PES	Ecosystem services	Eccon; Votorantim’s Reserves	New carbon methodology for areas of native vegetation with less deforestation pressure. REDD+ instruments are more common in large areas with an elevated risk of deforestation. It takes other ecosystem services into account when pricing carbon credits.
CBA’s and Votorantim’s PES	REDD+	CBA; Votorantim’s Reserves	The solution creates a bond based on the metrics known by the market, the tons of carbon that are no longer emitted by avoiding deforestation, but associated with payment for environmental services (PES) provided by forests, such as maintaining biodiversity, water cycle, etc. Methodology for the Cerrado biome.

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Instrument	Subcategory	Institutions	Instrument definition
re.green	Carbon credits	re.green; Lanx Capital; BW; Gávea Investimentos; Dynamo	Restoration model developed by re.green, in which it buys land that has been converted into pasture and does all the restoration of native vegetation, focusing on biodiversity and benefits to local communities. At the end of the process, it gives up the land and transforms it into Conservation Units, guaranteeing the perpetuity of forests.
Votorantim's Reserves	REDD+	Votorantim's Reserves	Company intended to make money by selling products and services associated with the maintenance of native vegetation. Solutions already have their way paved, such as land leasing to offset legal reserves – in which landowners with reserve liabilities can rent them from third parties to comply with legislation –, ecotourism and services for reforestation.
MyCarbon's carbon credit	Carbon credits	MyCarbon; Minerva	Trading carbon credits from properties that adopt GAPs. It operates in partnership with Minerva's Renew Program.

Note: Reading Appendix A is recommended to learn more about the methodology used, as well as its limitations.
Source: Study results. Development: Agroicone

One of the initiatives directly related to the beef production chain that monetizes the reduction of emissions from enteric fermentation is being developed by BrCarbon. From the reduction of emissions via additives in cattle feed, the company hopes to be able to issue carbon credits from this intervention in cattle feed supplementation. Another, by MyCarbon (a subsidiary of Minerva), seeks to sell carbon credits by measuring carbon emissions on properties with cattle ranching. This initiative is a partnership with the Renew Program, which works with Minerva's supplier farms to develop sustainable cattle ranching.

The other identified initiatives seek to issue carbon bonds via restoration of native vegetation and reforestation, with different arrangements among themselves, from the acquisition of areas with liabilities from Permanent Preservation Areas (APP) and Legal Reserve to the creation of partnerships with rural producers who are

in areas subject to restoration. In addition, there are initiatives for Reducing Emissions from Deforestation and Forest Degradation that include conservation and sustainable management of forests, known by the acronym REDD+. They also have different arrangements, such as methodologies for carbon credit issuance for regions with less pressure for deforestation. The surplus of these credits would come not only from avoided deforestation but from the different ecosystem services that this native vegetation provides.

Even so, creating a perennial and consolidated PES market requires the adoption of pricing methodologies for ecosystem services and the broad organization of the productive and financial sector to develop tradable products with guaranteed credit quality, as well as investment in technology. There are initiatives that already offer carbon credits and PES, but such instruments still lack demand.

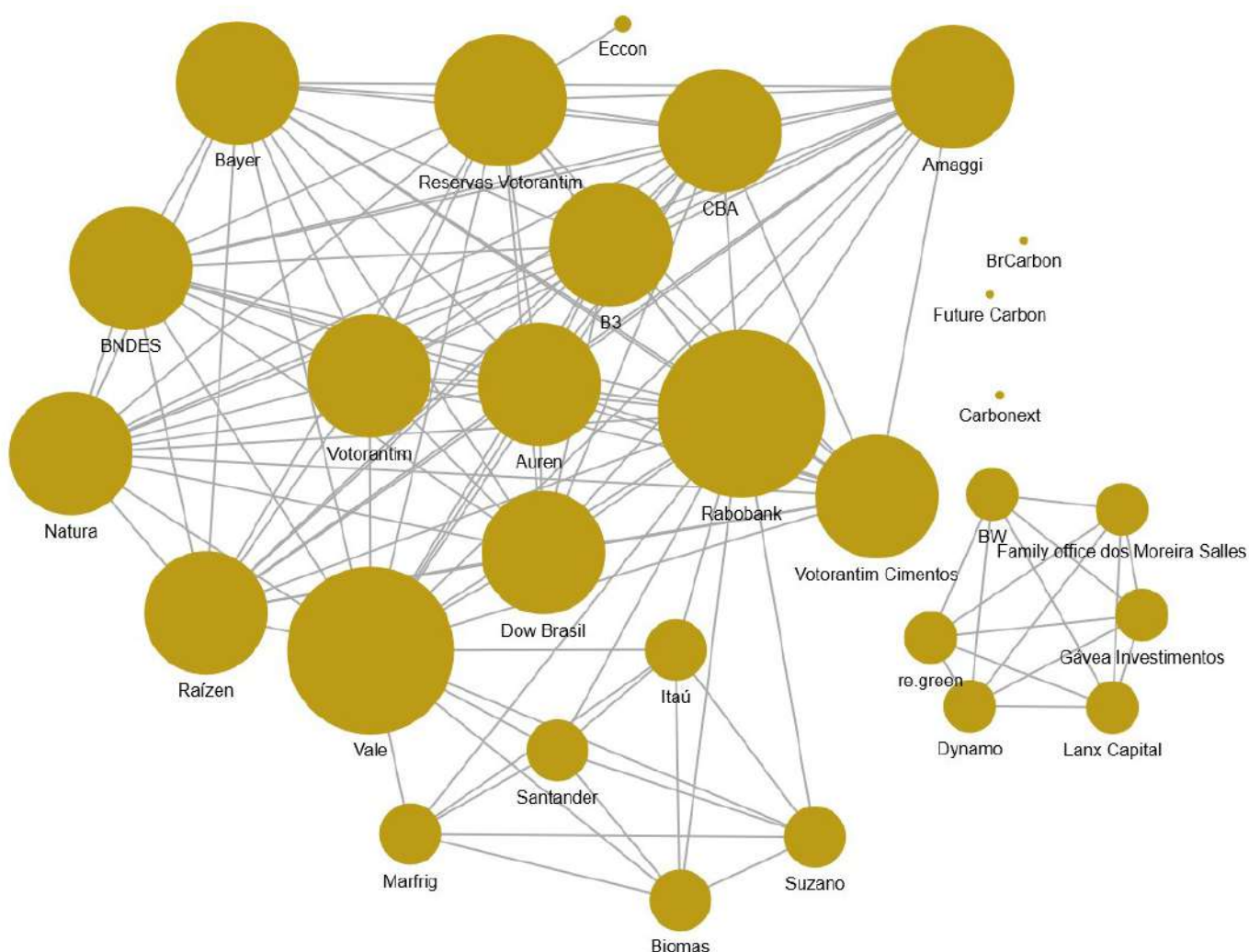
The uncertainties surrounding the future of PES and the carbon market even reflect on the integrated way in which players organize themselves, which can be observed in the social network of institutions involved in PES instruments in Brazil. The high level of integration indicates the need for a collective effort to materialize such initiatives, as well as to share risks due to information asymmetries and the expectations that have not yet materialized in this type of market.

The long path of PES instruments as strategies

for pricing environmental assets can be exemplified in the case of avoided deforestation, even more so in regions where the risk of legal deforestation is remarkably high, as in the case of the Cerrado.

The challenge increases depending on the observed land use pattern. According to the availability of cleared areas with multiple uses, the opportunity cost of areas with remaining excess native vegetation (therefore, subject to legal deforestation) only increases, imposing even greater deforestation pressure.

Figure 12 - Social network of institutions involved in PES instruments between 2018 and 2023



Note: Reading Appendix A is recommended to learn more about the methodology used, as well as its limitations.
Source: Study results. Development: Agroicone

In regions with availability of cleared areas for agriculture and livestock use, soybean farmers, for instance, can choose to expand their production over degraded pasturelands via leasing or productive arrangements with cattle ranchers. On the other hand, in regions consolidated only with agriculture, such offer of cleared areas is much smaller, remaining, therefore, the advance on areas of excess native vegetation. For those regions whose legal deforestation pressure is high due to the pattern of land use and the availability of areas of excess native vegetation, PES appears as an alternative.

In this case, despite being a reality and a market in full expansion, the carbon market (and consequently PES) is still unable to pay for the opportunity cost of areas of excess native vegetation, mainly in those regions with a low supply of areas consolidated with multiple activities. Furthermore, long-term (10-30 years) non-deforestation commitment contracts reduce the attractiveness of these arrangements.

In spite of that, PES is seen as a voluntary and market solution capable of reducing legal deforestation, both in the short and long term, even if it does not compensate the opportunity cost for rural producers.

This fact is due to information asymmetry. Rural producers with excess of Legal Reserve have two options – either exercise their right to use and deforest the area to earn current income from the agriculture and livestock activity or keep it standing expecting to earn current income (below the opportunity cost) and future income via PES. Producers who choose

to exploit their excess native vegetation will not be able to enter the environmental market (as well as the carbon market) if this becomes reality at more attractive prices in the future. That is, producers who choose to wait maintain the opportunity to profit from the native vegetation standing and still avoid potential market access restrictions.

Even so, given the rural producers' preference for earning current income, even expecting the carbon market to evolve, it is more advantageous to advance on areas of excess native vegetation. This decision is even more obvious (from an economic point of view) when considering the case of soybeans in agricultural frontier regions, such as Matopiba – a region formed mostly by areas of Cerrado in the states of Maranhão, Tocantins, Piauí, and Bahia.

Based on a set of interviews conducted in 2021 with soybean farmers in the Matopiba region, it was identified that they would be willing to not advance on excess of native vegetation as long as they received at least eight sacks of soybeans/ha/year.

Assuming an intervention that combines Payments for Environmental Services (from avoided deforestation), technical assistance, and a 50% discount on production costs via barter, these combined instruments would be sufficient to cover only 50% of the opportunity cost (using costs and prices of the 2021/2022 harvest for the west of Bahia)⁽¹⁹⁾. This demonstrates the need, at least currently, to combine incentive instruments to reverse (or delay) the producers' decision to advance production over areas of excess native vegetation.

(19) This exercise was carried out with the following assumptions, according to interviews with soybean farmers in western Bahia: i) Opportunity cost of the hectare of excess Legal Reserve equivalent to eight sacks of soybeans per hectare or R\$1,336 per hectare per year (soybean price of R\$167/sack); ii) Carbon equivalent price of R\$26 per ton for 20 years or R\$1.30 per ton per year; iii) Native vegetation emission factor (Cerrado/Matopiba) for an annual crop of 220 t/CO₂eq/ha; iv) Estimated value of PES linked to carbon by avoided deforestation of R\$286/ha/year; v) Soybean production cost in the 2021/2022 harvest of R\$5,490/ha (Bahia); vi) A 50% reduction in the equivalent interest rate of the barter in relation to the financed cost, of R\$357/ha (assuming the financing of the cost is 100% via barter); and vii) Incentive in the cost of technical assistance of R\$27.50/ha. It is worth mentioning that this amount used as an opportunity cost disregarded the appreciation of land prices after changes in use (native vegetation into annual crops).



6. The last frontier: How to achieve a deforestation-free, socially fair, monitorable, and traceable cattle ranching

The need to monitor deforestation in the beef production chain is an old discussion, but one that has been taking new shapes after voluntary commitments by slaughterhouses.

The decision to use the traceability of cattle ranching production cycles via Animal Transit Guide (GTA) combined with monitoring deforestation with the Rural Environmental Registry (CAR) was a short-term alternative which poses its own risks.

Individual traceability developed to meet the monitoring of sustainability criteria is the final solution, directed towards at least regions of greater social and environmental risk.

Deforestation is among the main challenges of the beef production chain, more specifically illegal deforestation. With international markets exerting excessive pressure on Brazil, the links in the chain (especially slaughterhouses and retailers) have been moving towards ensuring the monitoring and traceability of production, from the first production cycle (breeding) to slaughter.

First, it is necessary to explain that there is an important conceptual difference between monitoring and traceability. Traceability refers to the ability to identify the product in time and space, from origin to distribution. On the other hand, monitoring refers to the location of food production or processing and the ability to verify social and environmental compliance and good practices in these environments (GTPS, 2022).

The traceability of the beef production value chain is a complex task, considering the size of the Brazilian cattle industry and its heterogeneity.

Brazil has 2.5 million rural properties linked to cattle ranching (IBGE, 2017), which are dedicated to the different beef cattle production cycles (reproduction/breeding, rearing, fattening/finishing) using multiple production systems and technologies and having different profiles of cattle ranchers (from micro to large producers), intermediaries, among others.

The development of traceability systems in the beef production chain in Brazil began in 2000, due to pressure from foreign markets, mainly from the European Union, in view of the demands for sanitary control aimed at greater food safety for the consumer market (RAMOS et al., 2020). The traceability system in Brazil is characterized by the legal framework of the Brazilian Traceability System for the Cattle and Buffalo Chain (Sisbov), in 2002.

Globally, animal identification and traceability are recognized as key factors in human health management.

For this reason, several global organizations have established international guidelines for animal identification. The World Organization for Animal Health (WOAH), currently with 175 member countries, published a set of general principles on identification and traceability of animals aimed at disease prevention and control based on the Animal Health Code. The WOAH recommends procedures for the unique identification of animals or batches, the implementation of animal traceability, the registration of animal births, and all their movement (SCHROEDER; TONSOR, 2012).

The main beef exporting countries have created animal traceability systems to improve their sanitary controls and ensure the growth of the export market. Increasingly, importing countries adopt traceability systems in their productions, becoming market access requirements (SCHROEDER; TONSOR, 2012). In this scenario, Brazil has been making efforts to meet the demands of the new markets, and several initiatives intended to develop monitoring and traceability systems have been adopted by the various segments of the beef production chain. These initiatives make up the actions that establish good practices and, consequently, promote improvements to production systems.

Since 2009, there has been pressure to expand the traceability of Brazilian beef beyond sanitary criteria, strengthening the monitoring of social and environmental issues, especially related to deforestation. At the time, the country's largest slaughterhouses signed agreements with civil society and the Federal Department of Justice (MPF) to monitor beef cattle suppliers, mainly intended to avoid the direct purchase of animals from farms in the Amazon biome with illegal deforestation. These initiatives are shown in Figure 13. Among these measures, the Conduct Adjustment Agreement (TAC) and the Public Livestock Commitment (CPP) stand out; whereas TAC is an initiative of the Federal Department

of Justice (MPF) and CPP a voluntary protocol initiated by Greenpeace.

Among these measures, the TACs that aim to establish conditions and criteria for the purchase of cattle in the Amazon region stand out. In them, companies are voluntarily responsible for preventing the sale of beef cattle from producers involved in irregularities (whether environmental, land use, or social). After the TACs were developed, in 2009, there was greater pressure for animal traceability on their origin related to deforestation in the Amazon.

Since 2009, these two models have been developed – Sisbov, meeting the requirements for the foreign market (mainly related to health criteria for the European Union), and the voluntary agreements of the TAC, to meet the legal framework of the domestic market. Both seek to control the quality of the beef, both sanitary and environmental. Due to the complexity of the chain, considering the agreements negotiated, the Brazilian model was faced with two situations: producers who produce and supply animals to be exported to the European market are obliged to be registered with Sisbov, with individual identification of the animals; and producers who produce for the internal and external market (outside Europe) and, by participating voluntarily, comply with the principles and rules of voluntary agreements applicable to batches of animals supplied to slaughterhouses (RAMOS et al., 2020).



Figure 13 - Evolution of monitoring and traceability of the beef production chain to fight deforestation



Source: Adapted from Harfuch (2021)

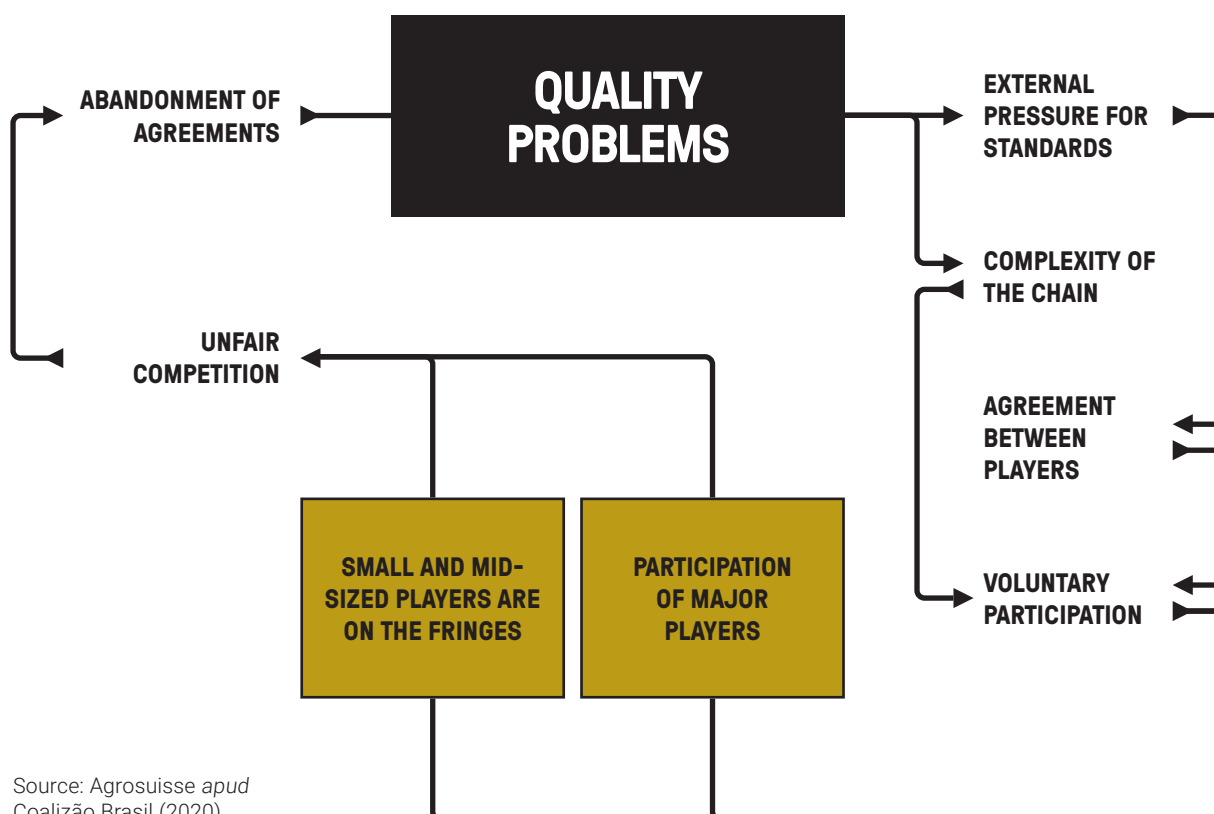
Monitoring mechanisms by legal and official instruments of the beef production chain are based on: (i) Forest Code; (ii) Rural Environmental Registry (CAR); (iii) Sanitary surveillance system through the Animal Transit Guide (GTA). The Forest Code (Law No. 12,651/2012) presents the regulatory framework and the process that rural properties or possessions must follow to comply with environmental requirements. The Rural Environmental Registry (CAR), where producers themselves provide information to the system, is the first step. On the other hand, the Animal Transit Guide (GTA) is the document proving the origin of the animals (in batch) for sanitary purposes.

Despite that, there are challenges for the implementation of combined monitoring and traceability systems in the beef production chain in Brazil, which are related to social and environmental

requirements, legal, technological, commercial and market issues, internal and external, that is, a complexity of relationships that demand time and effort for an adequate flow and framework for the beef production chain.

Furthermore, the cycle of implementation and abandonment of measures and rules for social and environmental and sanitary quality control comes across the complexity of the chain and a dispersion of production regarding producers excluded from monitoring and traceability processes (RAMOS et al., 2020). That situation represents the rationale for Sisbov to become mandatory only for animals destined for exports and voluntary for others. In voluntary agreements, by signing the TACs, the industry's participation was significant; at the time, it represented 70% of the slaughter capacity in the Brazilian Amazon (BARRETO et al., 2017).

Figure 14 - Cycle of implementation and abandonment of quality control measures in the beef production chain in Brazil



Source: Agrosuisse apud Coalizão Brasil (2020)



Despite the challenges, recent studies suggest that the extension of voluntary agreements between major slaughterhouses has been effective in reducing deforestation in their supply chains, although the TACs have been shown to be less effective. Critical reviews were less enthusiastic about the effectiveness of voluntary agreements between slaughterhouses of G4 nations, including the case of Global Witness (2020). In this context, there are difficulties in complying with the new European Union legislation on the necessary steps to control the entry of beef and other commodities associated with deforestation in the country (RALEIRA et. al, 2022; MAY and OZINGA, 2022).

However, this tool was unable to address perhaps the main challenge of monitoring and traceability in the beef production chain, which is the issue of indirect suppliers. Since an animal can go through several properties throughout the production cycle, the ability of slaughterhouses to monitor their indirect suppliers is limited, making the first cycles of cattle ranching production (breeding and/or rearing) more exposed to social and environmental risks.

Faced with pressure from the market and from civil society itself, slaughterhouses were forced to sign voluntary commitments of zero net emissions. To achieve that objective, it was necessary to build instruments capable of monitoring deforestation associated with the chain. In the absence of individual traceability tools, the main initiatives of the slaughterhouses focused on monitoring cattle ranching production cycles, especially those most exposed to the risk of deforestation (breeding) since they are not yet being monitored. Most of

these initiatives still use the Animal Transit Guide (GTA) as main information, attesting that this is an instrument already used to trace the movement of animal batches (for sanitary purposes), and that it is widely disseminated among producers, and the Rural Environmental Registry (CAR) to monitor social and environmental criteria.

Despite being a feasible solution, the debate about the use of the GTA to compose the monitoring of social and environmental aspects and its implications has been gaining ground. The GTA – as a self-declaration instrument – naturally poses a high moral hazard. For sanitary purposes, the ranchers' willingness to omit (or forge) information is lower once they have little incentive to do so. However, with the use of the GTA as part of the monitoring of illegal deforestation, producers can still adopt an opportunistic behavior, issuing "fake" GTAs. This scale movement could compromise the health of cattle herds and increase the exposure of the system as a whole to health risk. The use of the GTA as a tool for monitoring social and environmental compliance can also increase the process of cattle "laundering," as non-compliant producers have the possibility of selling their animals through intermediaries, issuing the GTA of batches of animals from a compliant property.

That does not mean that the current initiatives that seek to monitor and trace cattle ranching production cycles are not important. They can help in greater transparency of instruments such as the CAR and the GTA itself. However, devoting efforts only to these initiatives and ignoring the fact that the solution lies in the individual traceability of animals can mean a missed opportunity⁽²⁰⁾.

(20) The debate around the GTA vs. individual traceability is explored more purposefully in the following section.

6.1. Initiatives aimed at monitoring and traceability in cattle ranching

Faced with market pressures, the different links in the beef production chain, as well as their support institutions, have been organizing themselves to build various technology-based instruments to address

this immense challenge of traceability, especially for those small producers who are indirect suppliers. Initiatives range from voluntary commitments to actions aimed at monitoring social and environmental aspects of the property and traceability, whether of the cattle ranching production cycles or individually. Table 11 presents the initiatives identified for the period from 2018 to 2023.

Table 11 - Traceability and monitoring instruments for the beef production chain between 2018 and 2023

Instrument	Subcategory	Institutions	Instrument definition
Monitoring via drones	Traceability	Embrapa Pecuária Sudeste	Research on the use of drones in cattle herd monitoring. Several challenges are pointed out, however, there is the potential to monitor and detect diseases and anomalies for the benefit of animal health.
Bovine Electronic Platform (BEP)	Traceability	Embrapa Gado de Corte; Indext; UFMS	Development of a device that measures respiratory rate, heart rate, surface temperature of the skin, room temperature, relative air humidity, and solar radiation with no need for an implant.
SMGeo Prospec	Monitoring	Niceplanet Tecnologia	Application that allows rural producers to conduct detailed geospatial research, with access to histories and social and environmental analyzes of the farms, using only SICAR or data from those responsible and reported on SICAR.
Marfrig Verde+	Voluntary commitments	Marfrig	Marfrig Verde+ is a plan to ensure that 100% of the slaughterhouse's production chain is sustainable, traced and deforestation-free by 2030. The goal is to reduce the intensity of emissions by 33% for each animal slaughtered by 2035.
Arezzo traceability	Traceability	Arezzo	The Arezzo&Co group, one of the largest shoe manufacturers in the country, wants to trace and monitor the origin of its main raw material – leather. The technology chosen by Arezzo is the same as that used by companies such as JBS and Marfrig – blockchain, to validate and provide transparency to the various steps through which the leather goes along the chain until it becomes a shoe in the company's factories, most of which are located in Vale dos Sinos, in Rio Grande do Sul.
Green passport	Monitoring	IMAC	Eliminate illegal deforestation from cattle ranching properties and ensure complete social and environmental monitoring of production and beef quality in the state of Mato Grosso.

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Instrument	Subcategory	Institutions	Instrument definition
Net Zero Commitment - Minerva	Voluntary commitments	Minerva	Monitoring of deforestation in the supply chain and eradication of illegal deforestation; traceability of all cattle for slaughter; support provision to verify emissions on farms and to restore native vegetation; payment to suppliers for adopting sustainable production practices.
Visipeç	Monitoring	Minerva; National Wildlife Federation; University of Wisconsin-Madison; Amigos da Terra	A new monitoring tool that works in a complementary way to the monitoring systems used by slaughterhouses in Brazil. The objective of the tool is to help reduce risks of exposure to deforestation present in the initial stages of the supply chain. For such, it crosses information from public databases (such as GTA and CAR), providing regularly updated data in an integrated tool.
Safe beef	Traceability	iRancho; BR Angels; AgroVen	Blockchain platform with the potential to trace the origin of the cattle from birth.
Monitoring Protocol of Beef Suppliers in Retail	Protocol	Imaflora; Abras	Standardized protocol for the retail sector, of voluntary participation, to verify whether the beef they buy from slaughterhouses from the Amazon is related to irregularities such as deforestation and slave labor. The lack of standardization of processes between companies created difficulties in comparative performance analysis. Protocol proposes three levels of demand in relation to beef suppliers, from the essential to the most demanding.
Virtual fence	Traceability	MSD Saúde Animal	Cattle management with integrated systems with no need for physical fences. Collar that produces electrical stimuli that drive cattle through virtual paddocks. Producers can track the position of each animal. Expected to facilitate rotational grazing and integrated ICLFS systems.
Transparent Livestock Platform	Monitoring	JBS	Integrate all direct and indirect beef suppliers to monitor social and environmental risks in the agriculture and livestock production chain via blockchain technology.
PREM MT	Monitoring	IMAC; MPF; Acrimat; Sindifrigio; SEMA; Agrottools	Virtual geomonitoring platform developed by Agrottools for Imac intended to monitor the environmental regeneration of deforested areas of blocked rural properties. PREM makes it possible to reinsert cattle ranchers into the formal market, as long as they commit to isolate the deforested area without authorization from the competent bodies.

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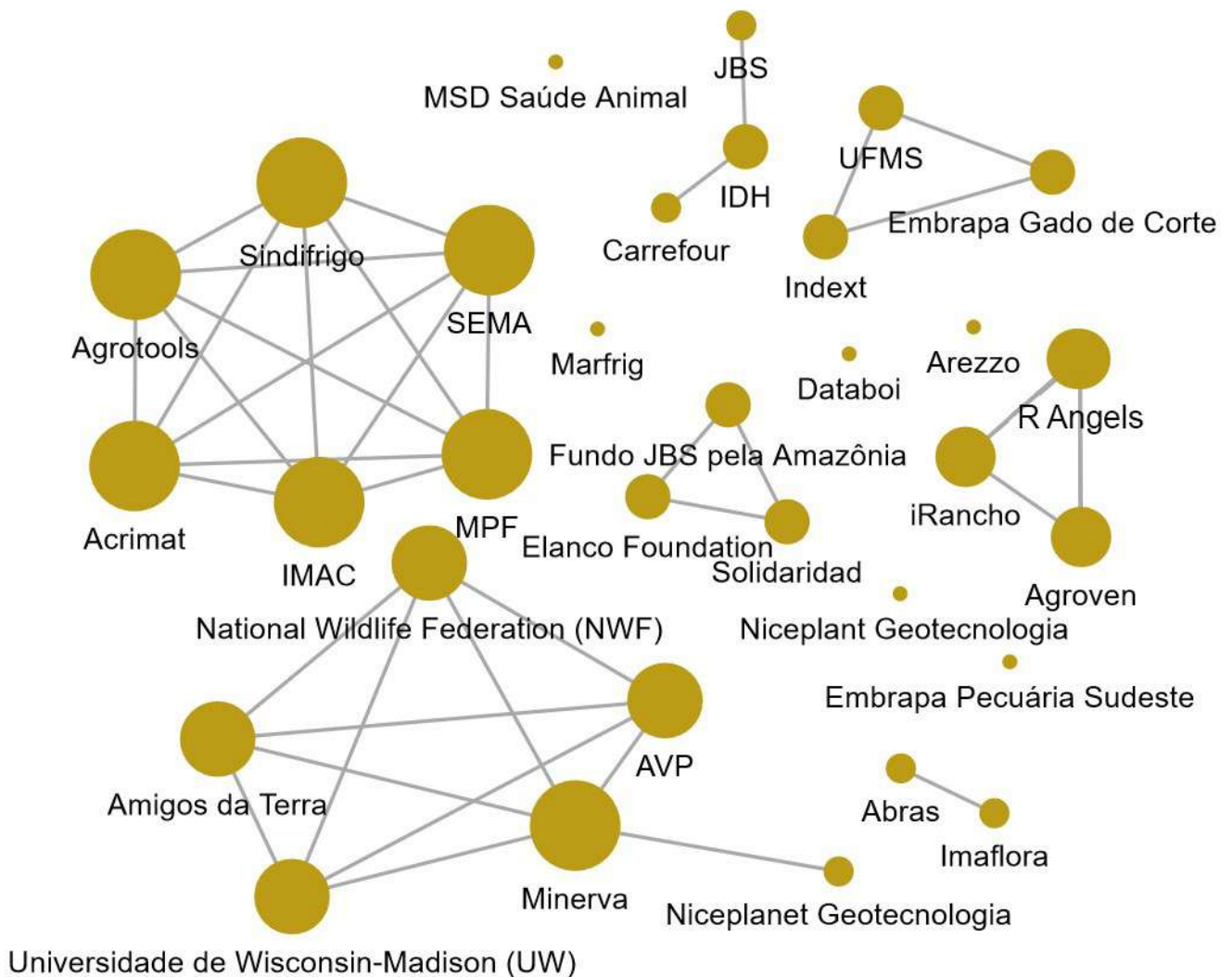
Instrument	Subcategory	Institutions	Instrument definition
Linha Sabor & Qualidade	Traceability	Carrefour; IDH	Line of products from 450 farms of up to 300 ha. Around 6,000 cattle were slaughtered guaranteeing the origin and traceability of the beef. Products with QR Code that informs the origin and the path to slaughter.
MSD Saúde Animal Intelligence	Traceability	MSD Saúde Animal	Tool that allows identifying physiological, pathological, health, nutritional, and reproductive aspects, enabling assertive interventions. Management software that collects all information 24 hours a day, generating reports.
Net Zero Commitment - JBS	Voluntary commitments	JBS	JBS issued a statement together with other large companies committing to develop a sectoral roadmap to restrain global warming to 1.5°C above pre-industrial levels. In addition, the company is committed to becoming a net zero carbon company by 2040.
Databoi	Traceability	Databoi	This method makes the individual identification by the animal's snout, recording each eventuality of the animal, and promoting a complete and effective management both for purchase and for sale, as well as a better control and identification of each of them.
Amazônia Connect	Traceability	Solidaridad; JBS Fund for the Amazon; Elanco Foundation	Offer of technical assistance and a digital platform for cattle herd traceability to small producers. JBS Fund for the Amazon and Elanco Foundation committed to investing R\$25 million by 2026 to serve 1,500 families, intended to preserve more than 20,000 hectares of forests.
SMGeo Indireto App	Monitoring	Niceplanet Geotecnologia	The application allows producers to consult the social and environmental situation of the farms with which they do business, assessing whether the cattle was produced in deforestation-free locations by adopting good practices.
Green Seal - Pará	Monitoring	SEMAS; CIT; NICFI; Climate and Land Use Alliance; Amazon	Social and environmental data integration platform that subsidizes the monitoring and evaluation of sustainable agriculture and livestock development policies and the fight against illegal deforestation in Pará.
Conecta	Monitoring	Safe Trace; Amigos da Terra; P4F	Monitoring platform with Blockchain technology that allows monitoring social and environmental and health aspects of cattle ranching. It places producers at the center of the issue by collecting production and property data and information. It allows the evaluation of cattle ranching production cycles, comprehending all links in the beef production chain.

Source: Study results. Development: Agroicone

Despite the wide range of initiatives aimed at solving the complex equation of traceability and monitoring of the beef production chain, a dispersion among players is observed, who seek individualized solutions without greater integration. In a total of 21 instruments mapped under the management of 31 different institutions, it is possible to observe a pattern of low connectivity between players. Figure 15 shows the social network of traceability and monitoring initiatives in the beef production chain in Brazil.

The low level of integration between the players in the chain, as well as the efforts of the main players directed towards instruments that monitor and trace cattle ranching production reflect the urgent process that the sector has been facing regarding deforestation. The next section presents the vision of this ongoing process from the perspective of the players, as well as the challenges, opportunities, and future observations on how the issue of sustainability in the beef production chain stands.

Figure 15 - Social network of traceability and monitoring initiatives in Brazil



Note: Reading Appendix A is recommended to learn more about the methodology used, as well as its limitations.
Source: Study results. Development: Agroicone



7. The role of players promoting a sustainable beef production chain

Understanding the main challenges and opportunities of the beef production chain regarding sustainability has to do with listening to its players.

Faced with the complexity of the beef production chain, its different production cycles, as well as the different links in this chain, a set of eight interviews was carried out with different players (slaughterhouses and retailers, beef industry association, Federal Department of Justice, institutions supporting the beef production chain, and financial institutions). The purpose of the interviews was to identify together with each player the initiatives on the themes (good agricultural practices, payment for environmental services, certifications, sustainable finance, traceability, and monitoring) and address the challenges and opportunities in each of them, when relevant.

The following description does not reflect the opinions of the institutions and players interviewed individually, and the results of the interviews were compiled for each link in the chain, based on Agroicone's understanding.

7.1. Slaughterhouses

Faced with market pressures, slaughterhouses have been positioning themselves both in promoting good practices intended to increase the productivity of cattle ranchers and in seeking to eliminate deforestation associated with the beef production chain.

These companies have been working in the field, with direct assistance programs for producers, offering technical assistance and

support for environmental and land tenure regularization. In the latter, the synergistic work of slaughterhouses with public authorities is essential, from government programs to inspection bodies. Reducing the transaction costs of the environmental regularization process, which gives due speed to the processes, is fundamental and a sign of sharing responsibilities, both by the production sector and by the governments. Even so, this process with the government takes time since there is heterogeneity between federation units in terms of technical and technological capacity.

In addition, the process of disseminating GAPs in the field faces challenges. Slaughterhouses do not have decision-making power over the way in which cattle ranchers will conduct their activity, working, thus, on a more informative and formative strategy. In addition, the difficulty in differentiating prices and the low loyalty of suppliers reduce the margin of slaughterhouses in granting aid and incentives directed to cattle ranchers. The international market itself has little inclination to award Brazilian beef for sustainability attributes. It is worth remembering that differentiation exists for aspects of product quality and animal genetics; however, that does not occur for the social and environmental aspects of beef, which is where the challenge arises.

Such difficulty in price differentiation also has to do with the chain's inability to produce information that benefits its reputation.



Quantifying positive environmental and social aspects, such as the number of producers that adopt GAPs or the balance of GHG emissions involved in these systems, would contribute both to balancing the debate on the impacts produced by the chain and would allow the development of instruments for incentives and price differentiation, which may even increase the loyalty of suppliers to slaughterhouses. Even so, from the point of view of slaughterhouses, the best possible prize lies in increased productivity.

To this end, the increase in productivity in cattle ranching is directly linked to market movements and pressures. A good example are exports to China and the “30-month rule”. Due to this commercial requirement, producers and the chain took some actions to meet such requirement, which triggered an increase in productivity in a brief period of time.

With regard to green financial instruments, slaughterhouses have been positioning themselves when it comes to issuing these instruments. However, this process is still seminal and with no

gains in scale. In an unpredictable global economic scenario, there is still great uncertainty about the destiny of sustainable finance.

Deforestation is currently the major source of pressure from civil society, markets (especially the European market), and governments regarding the beef production chain. As a way of addressing it, the major slaughterhouses have launched voluntary commitments to zero deforestation (at distinct levels) and to have zero net emissions by 2030. To this end, multiple traceability and monitoring strategies are being adopted, however, in a disintegrated manner and without a single articulation between (and within) the links in the chain.

Faced with the urgency of the issue, as well as the difficulties in tracing cattle individually, the major slaughterhouses chose to monitor the different production cycles of cattle ranching, especially the first ones (breeding and rearing), since the fattening and the complete cycle are already monitored by slaughterhouses, mainly via Animal Transit Guide (GTA)⁽²¹⁾.

(21) The whole debate on the relationship between individual traceability vs. GTA has already been conducted in the section about monitoring/traceability.

Despite the existence of moral hazard in this instrument, since it is self-declaratory, the practice of slaughterhouses has shown that this risk is lower than expected. Linking the Animal Transit Guide (GTA) to the Rural Environmental Registry (CAR) number, for example, could further facilitate the use of the first as part of the social and environmental compliance monitoring instrument.

However, sparse non-centralized initiatives are subject to the risk of non-comparability, which can make it difficult to evaluate these initiatives. This dispersion is precisely due to the lack of coordination in the chain, as well as the detachment of public power as the entity also responsible for the current situation. A unified platform, which standardizes

processes and criteria, managed independently or by the government, where slaughterhouses, producers or any common individual could access property information regarding its social and environmental situation, could be a pre-competitive solution. That is, it could help smaller slaughterhouses in the process of monitoring social and environmental compliance in their supplier network.

7.2. Retailers

The capacity of the retail sector to influence the production of beef cattle is even smaller than that of slaughterhouses, precisely because they do not directly deal with rural producers.



Even so, retail has been developing purchasing policies that consider issues such as deforestation, slave labor, animal welfare, and biodiversity for several chains considered risky. Thus, the role of retailers focuses more on monitoring the beef production chain rather than working alongside the production process.

By establishing the minimum criteria and necessary requirements for marketing together with slaughterhouses through a purchasing policy, the relationship between such retailer and slaughterhouses has intensified, seeking joint solutions to shared challenges. This process even benefited from the standardization of rules and criteria for monitoring and auditing promoted by Beef on Track⁽²²⁾, considered a major milestone.

The process between retailers and slaughterhouses gets past signing commitments, and letter of ethics, and hiring a geomonitoring company with a monitoring system so that retailers, through purchase notes, can identify from which farms the purchased beef comes. A rechecking of the information is conducted to confirm the analyzes made by slaughterhouses. In case of non-compliance, suppliers are blocked.

This entire process indicates that the direct supplier issue is, at least partially, overcome. The big challenge lies in indirect suppliers, especially in the Amazon region, as well as in the legal deforestation of the Cerrado. Solving this equation is extremely complex, and retail is less able to work it out.

The scenario points to a need for a synergistic and coordinated relationship between the links in the chain and governments, engaging in broad dialogue and collective development since the challenge is extremely complex. Even more so in

this context of new international regulations, such as those of the European Union, which largely neglect the size of the social burden produced by a process of embargo and marginalization of producers. That is, greater unity and coordination between the links in the chain is needed.

To this end, an initiative to standardize processes and consolidate a single database for access by all links in the chain could be of immense value. There are even examples in other chains of integrated and unified systems, such as the textile production chain.

7.3. Beef Industry Association

Regarding the role of good agricultural practices and the relationship between slaughterhouses and producers in this field, each slaughterhouse has its own set of strategies and guidelines. Price differentiation is due to quality and genetics, where slaughterhouses intensify their work together with producers by sharing technology and standardizing products. However, price differentiation based on social and environmental aspects still faces challenges.

Developing economic incentives to change cattle ranchers' decision-making process on how to produce may be a consequence of the voluntary commitments signed by slaughterhouses to zero net emissions. To fulfill these commitments, slaughterhouses will have to seek solutions to reward and retain producers who adopt GAPs and have environmental additionalities. An alternative contribution to this process would be developing payment for environmental services (PES) instruments as a way of valuing producers and retaining them as suppliers.

(22) Normative standardization protocol for the deforestation monitoring and auditing process in slaughterhouses in the Amazon region. It will be discussed more fully in the next section.

However, such strategies still face the main challenges of the chain – traceability and monitoring. In addition, initiatives that seek to monitor cattle ranching production cycles are considered palliative due to the use of GTAs and the low capacity of governments to adequately and homogeneously manage information. Consequently, the solution to this issue lies in individual traceability, such as via cattle herd ear tagging.

Since individual traceability is still a reality only for highly tech-savvy producers, who use it as a tool for property management and productivity gains, reflecting on a solution that encourages and democratizes the use of ear tagging for animal traceability since their birth is needed.

By taking advantage of this information asymmetry throughout the production cycles and links in the chain, the entity has been advocating for the possibility of adding value to individual traceability. By means of ear tagging, each animal would be linked not only to its own information but information about the properties where it went through. Social and environmental and productive issues could be added so that the purchasing value of an ear-tagged animal would be coupled with the value of social and environmental and productive information included in individual traceability, rewarding producers throughout the beef cattle production cycle.

This incentive would also lead to an important increase in productivity since individual traceability allows producers to have greater control of and knowledge about their zootechnical and productivity indicators.

Furthermore, collective and coordinated action between the links in the chain and especially governments is essential. The

concept of a single platform for accessing and managing data on social and environmental compliance is also a demand that requires an extraordinarily strong public policy arm to be put into practice.

The diagnosis that public power participation in the development of traceability policies is essential is also consistent with the political moment. The new government cycle – in view of its possibility of restructuring and strengthening bodies and institutions –, as well as the increase in local initiatives aimed at environmental regularization and all the pressure suffered by the chain can culminate in initiatives that produce a broad impact of dissociating cattle ranching production and deforestation.

7.4. Supervisory body

In Brazil, the agriculture and livestock activity, in general, has an enormous potential for productivity increases that zero the need to clear new areas. Obviously, for this scenario to consolidate, some effort is necessary, precisely due to the productive, social, and economic heterogeneity in the field.

That process becomes even more complex in the Amazon, where the combination of weak land tenure legislation, difficult access, and huge areas subject to (illegal) exploitation makes cattle ranching mainly extensive. It is cheaper to advance on public areas (with or without allocation) than to recover degraded pasturelands to increase productivity.

This entire process dates back decades but recorded important reductions from 2009 onwards with the action of the Federal Department of Justice (MPF) to edit the Conduct Adjustment Agreement (TAC) along with slaughterhouses.



The TAC – an instrument instituted to fight illegal deforestation after 2008 – was based on four fundamental pillars: i) The Rural Environmental Registry (CAR); ii) The commitment not to deforest; iii) The payment of 5% of the Ibama fine (which is equivalent to R\$250/ha, much lower than previously charged); iv) The non-allocation of deforested areas for productive purposes (“golden rule”).

This institutional framework allowed deforestation to fall to levels never seen before (so far), considered the main emission reduction program in history, based on the combination of public policy in direct

partnership with the beef production chain.

Even though it was very successful in its early years, the TAC presents three fundamental weaknesses ever since the beginning: Non-validation of the CAR, which still slips despite the existence of a Federal Department of Justice’s report with the step-by-step process for validation; non-incidence on indirect suppliers, since the audit process falls only on direct suppliers; chance for opportunistic producers who, once blocked, “launders” the cattle and continues illegally supplying animals to slaughterhouses.

To this end, the strategic, coordinated, and synergistic action of the entire chain is fundamental, together with governments and the Federal Department of Justice, to overcome the weaknesses of the TAC, especially regarding indirect suppliers, as well as in the standardization of processes (such as Beef on Track). The initiatives presented so far, arising from the voluntary commitments signed by slaughterhouses, are based on the GTA, an instrument that is less suitable for monitoring deforestation, as it poses high moral hazard.

Some argue that the moral hazard exposure of GTAs is not that high; others that the use of GTAs as part of deforestation monitoring may cause greater exposure to health risk. The great systemic risk of using GTAs to monitor deforestation is precisely increasing moral hazard as a whole, thus intensifying the process of cattle laundering.

Initiatives that seek to monitor and trace production cycles are welcome, as they provide more transparency to the CAR and to the GTA itself. However, they should not be seen as an end in themselves and should not be the sole focus of efforts, as it is happening nowadays. Therefore, the Federal Department of Justice advocates for a public policy of individual traceability.

Should this traceability be applied to the entire beef cattle herd in Brazil? The answer is no. Traceability should be mandatory only in municipalities identified as "high risk of deforestation" (in fact, such mapping has already been conducted by Agroicone within the scope of the Marfrig Verde+ Program and has been made available to several players).

Finally, the carbon market may prove to be an alternative to discourage deforestation and promote environmental restoration. Despite seeming to be an opportunity, this market remains ethereal, especially from the rural producers' point of view.



7.5. Institutions supporting the beef production chain

The relationship between slaughterhouses and ranchers is often complex, since it is a commercial relationship and both parties are defending their own interest. This is one of the reasons why producers oppose initiatives to promote GAPs by slaughterhouses. Thus, local institutions with broad access to producers are essential in the process of disseminating GAPs, as well as environmental regularization, and, consequently, traceability and monitoring initiatives.

This is observed in institutions that operate in the state of Mato Grosso. Operating extensively in the territory via technical cooperation signed with governments, the Federal Department of Justice, slaughterhouses, and research institutions, they are fundamental for all field engagement alongside with cattle ranchers.

Some examples of joint initiatives that exemplify the importance of local institutions in collaborating with producers and building bridges between them and the other links in the chain are Pasto Forte, the Reinsertion and Monitoring Program (PREM) and the Green Passport.

Pasto Forte – a project aimed at offering technical assistance and rural extension to recover degraded pastures – works decisively in the territory to provide multiple services ranging from soil analysis to technical, economic, and sustainability assessments.

PREM – which is part of the Green Passport – consists of a wide engagement to reinsert producers blocked by slaughterhouses in the state of Mato Grosso. Based on a process that has a low transaction cost, thanks to partnerships with the Federal Department of Justice and the Secretary of the State for the Environment (SEMA-MT), producers who want to be regularized must join the platform (designed by Agrottools), comply with all the requirements and meet their financial commitments with environmental agencies (cost of R\$250/ha). The entire cost involved in the auditing process is subsidized by slaughterhouses, which conduct all the work of identifying these producers, for example, via the JBS Green Offices.

Once reinserted into the formal market, producers are expected to enter the Green Passport, a protocol that should guarantee social and environmental compliance and beef quality, making room for instruments to differentiate producers and, consequently, incentives.

In addition, Payment for Environmental Services (PES) instruments can be an alternative to reward producers who provide ecosystem services from their production system. Despite emerging, this type of initiative has been spreading and taking shape and should become a clearer reality for rural producers in the coming years. However, a greater effort is needed to develop and validate methodologies that are adaptable to the context of Brazilian tropical agriculture and livestock.

All this effort to bring together producers around the sustainability agenda promoted by the links in the chain is only possible, therefore, having local

institutions with wide access to producers and who daily deal with the arduous task of providing direct and acceptable information, in addition to services and support.

7.6. Financial institutions

In the wake of commitments signed by slaughterhouses, financial institutions have also been taking actions towards that direction. Through the Amazon Plan, large financial institutions committed themselves not to finance slaughterhouses unable to demonstrate the absence of illegal deforestation in their supply chain by 2025. It is expected that, in the short term, there will be disinvestment, given the size of the challenge. However, they consider this movement to be the greatest action taken by the financial market in favor of reducing deforestation in the beef production chain.

In addition, the Brazilian Federation of Banks (Febraban) is taking action to develop a common protocol inspired by Beef on Track and the Indirect Supplier Working Group (GTFI) to finance the beef production chain, considering deforestation and its monitoring. The initiative might be incorporated into Febraban's Self-Regulation System, which has a social and environmental branch.

The common rule developed by Febraban can foster partnerships with institutions that support the beef production chain, since this relationship between banks and slaughterhouses will require technical support to incorporate such rule. In addition, this new regulation will require support from the entire chain in favor of enabling conditions. Issues such as improving systems, making better use of the CAR and the GTA, supporting medium-sized slaughterhouses in making commitments and purchasing policies, among other conditioning factors, will require technical support from organizations such as P4F to ensure these actions are credible and concrete.



Another critical point is the issue of cattle suppliers blocked due to social and environmental non-compliance. It is not in the interest of the financial sector, nor of the other links in the beef production chain and governments, to exclude producers from the formal market. Which strategies can financial institutions adopt to bring producers to formality? The answer goes through a close relationship with slaughterhouses, and that is extremely necessary.

Actions have already been announced (such as support for Green Offices). However, for interventions to achieve scale, it is necessary to develop financial instruments with slaughterhouses guaranteeing a de-risking of operations while the government provides legal security and public policy instruments to support this process of environmental regularization. Today, rural producers in the Amazon biome who have environmental embargoes, slave labor, land tenure irregularities, and/or whose Rural Environmental Registry (CAR) overlaps with Conservation Units, Indigenous and quilombola lands cannot access rural credit.

Identifying promising business models that can leverage sustainability actions and increase good practices in cattle ranching is also necessary. Peca and Caaporã are good examples. How to raise funds for this type of business model? Is it possible to use this context of classic financial products with green labels, such as CRAs, FIDCs, FIAGROs to leverage similar business models

across the territory? Reflecting on these questions can be a great opportunity to direct resources towards sustainable cattle ranching.

This process would become even more robust with the expansion of efforts to measure carbon in agriculture and livestock. This measurement would bring ballast for sustainable enterprises to raise funds. How to expand efforts to measure carbon emissions in cattle ranching and couple these models to financial products without increasing transaction costs? Based on this, to what extent could these emission methodologies contribute to payment for environmental services instruments? All these efforts are at stake, with some scattered initiatives, but greatly expected to materialize. An example is the initiative of a calculator of emissions in cattle ranching that is under development, financed by the BNDES.

The challenge of deforestation is current, requiring, therefore, a vision of urgency. To this end, the Animal Transit Guide (GTA) and its combination with the Rural Environmental Registry (CAR) emerge as a short-term alternative to solve, even partially, the issue of monitoring deforestation in the chain. That does not mean that efforts in favor of individual traceability cannot prosper, quite the contrary. In fact, political will is needed to build a national policy of individual traceability. If the ability to measure the ecosystem services provided by the agriculture and livestock prospers, it is even possible to reflect on tax incentive strategies, for instance.



8. Challenges and opportunities from the perspective of players

Promoting a sustainable beef production chain requires joint efforts from all links in the chain in productivity increases through the adoption of GAPs by cattle ranchers, in addition to traceability and monitoring instruments. Encouraging the technological transition to a more sustainable standard is, initially, an economic decision relegated to rural producers, and the other links in the chain have limited capacity to influence such decision.

Slaughterhouses have been working in the territory, disseminating information, providing technical assistance, and encouraging production protocols. However, due to the low loyalty of suppliers, slaughterhouses have less incentives related to price/producer differentiation, which occurs for quality differentiation, not for social and environmental aspects.

In the field of monitoring and traceability, slaughterhouses, faced with the need to fulfill their voluntary commitments, are racing against time to present the market with solutions capable of guaranteeing social and environmental compliance. However, efforts are focused on monitoring cattle ranching production cycles instead of individual traceability.

Retail, in its turn, is less able to intervene in the field since they do not deal directly with rural producers. Thus, they devote a great deal of effort to social and environmental monitoring of direct suppliers.

The issue of indirect suppliers remains the main challenge of deforestation traceability and monitoring associated with the beef production chain. The lengthy process of the CAR validation and the cattle “laundering” arising from the opportunistic behavior of those embargoed or blocked by slaughterhouses

complement such challenging scenario.

Even so, the search for solutions gets past the collective action between the links in the chain in partnership with support institutions with large-scale operations in the territory and engagement with producers. Successful interventions, especially in Mato Grosso, between slaughterhouses, retailers, the Federal Department of Justice, and support institutions, demonstrate that it is possible to provide technical assistance in favor of technological transition, in addition to promoting environmental regularization and reinsertion of producers currently on the fringes of the formal beef production chain.

Figure 16 presents the compilation of strengths, weaknesses, opportunities, and threats (SWOT matrix) identified in the speeches of the interviewed players in the chain. It is possible to observe that the main strength of Brazilian cattle ranching is its lushness. Owing the largest commercial cattle herd in the world and huge pasturelands somewhat degraded, Brazilian cattle ranching already plays a significant role in the world beef production and has enormous potential for productivity increases. The wide availability of technology, genetics, and management strategies consolidated and adapted to tropical cattle ranching places Brazil in a strategic position, both from a productive and environmental point of view.

However, a low productivity arising from a large heterogeneity of producers is observed. The process of marginalization of embargoed or blocked producers, as well as a culture of risk aversion for production investment decisions and a lack of synergistic leadership between governments and other links in the chain represent the main weaknesses of Brazilian cattle ranching in the search for a highly sustainable and productive activity.

Figure 16 - SWOT analysis matrix according to players in the beef production chain

	POSITIVE	NEGATIVE
ENDOGENOUS	<p style="text-align: center;">STRENGTHS</p> <p>Comparative advantage in cattle ranching, with technologies, genetics, and consolidated management strategies. Unified monitoring protocol of suppliers.</p>	<p style="text-align: center;">WEAKNESSES</p> <p>Low productivity. Risk-averse culture of cattle ranchers. Exclusionary process for producers. Lack of leadership and coordination between the links in the chain and governments.</p>
EXOGENOUS	<p style="text-align: center;">OPPORTUNITIES</p> <p>Opportunity to guide the global debate on sustainability in cattle farming. Favorable political environment for a traceability policy.</p>	<p style="text-align: center;">THREATS</p> <p>Political, market, and health risk. Pressures from non-tariff barriers. Legal insecurity.</p>

Source: Study results. Development: Agroicone

Even so, the current scenario may represent an important moment for the beef production chain. Faced with the change in the government cycle, a window of opportunity opens up to structure a more consolidated governance around the issue, especially in efforts to reintroduce embargoed or blocked producers and a traceability public policy. Furthermore, a tremendous effort is needed to communicate and develop science and information to convey to the world the sustainability attributes of Brazilian cattle ranching and to better position ourselves in the international debate on the issue.

That strategic positioning in the international debate is essential to mitigate one of the main threats identified, which are market risks and the imposition of non-tariff barriers to international trade, as is the case of the new European legislation. Furthermore, the health risks involved in cattle ranching production can never be ignored. To this end, reflection on the role of the GTA in the context of animal health and its use to monitor social and environmental compliance must be a priority.

That is, articulated actions that promote the dissemination of GAPs aimed at production

increases, linked to environmental regularization and the reintegration of marginalized producers should guide interventions in beef cattle ranching in Brazil, especially in regions with an elevated risk of deforestation. Ongoing initiatives with these objectives may have an “expiration date,” given the commitments signed by different links in the beef production chain.

In spite of the GTA and the CAR being currently the information available, although not publicly accessible, they were pointed out as a short-term solution, the path to be pursued is a perennial solution. To this end, the development of a unified data platform managed by governments to consult the social and environmental situation of the properties throughout the chain, and the promotion of individual traceability, adding value to the social and environmental and productive information of the property, stand out. A public policy of individual traceability in regions of high social and environmental risk and the promotion of collective action together with institutions that support the chain with local operations go exactly in the direction of taking advantage of the strengths and overcoming the weaknesses of the chain to mitigate risks.



9. P4F’s portfolio and the diagnosis of the sustainable beef production chain in Brazil

The diagnosis presented contemplates the Brazilian cattle ranching production and discusses the main sustainability-oriented aspects in the beef production chain. Several initiatives were raised on the topics of good agricultural practices, sustainable finance, agricultural policy, certifications, payment for environmental services, traceability, and monitoring. In this broad context, P4F has been working in a decisive manner.

This section seeks to discuss how the six projects supported by P4F fit into this diagnosis for the sector. The following subsections are divided

by supported project. To facilitate understanding, Table 12 compiles general aspects of supported projects and their impacts.

Table 12 - Analysis of projects supported by P4F

Project	Challenge	Target audience	P4F's support	Main impact
Pecsa	Scalability in the adoption of GAPs	Cattle ranchers	Improvement of productive management and ESG; study of GHG emissions; support in attracting new investors.	Identification that value-adding business models based on conveyance have the potential to leverage the adoption of GAPs.
Carbon Methodology	Absence of a methodology for measuring GHG emissions for pasture-raised intensification models	Cattle ranchers; financial Institutions; carbon credit market	Development of emissions methodology for intensive cattle ranching; support in Verra's evidentiary process; methodology test on a ranch in northern Tocantins.	Opportunity to measure GHG emissions in cattle ranching. Implications in terms of solid grounds for Brazil's positioning in the global debate and for PES and sustainable finance instruments. Reduced payback period for ranchers who invest in GAP.

SUSTAINABILITY IN THE BEEF PRODUCTION CHAIN

Project	Challenge	Target audience	P4F's support	Main impact
Responsible Beef Partnership	Low mobilization of the public sector and producers in relation to environmental compliance	Cattle ranchers; governments; slaughterhouses; institutions supporting the beef production chain	Development of Conecta and dissemination among producers; mobilization of local players and the public sector around the environmental compliance agenda.	Work with rural producers, governments, and slaughterhouses in favor of environmental regularization.
Conecta	Lack of a traceability and monitoring service since its origin	Cattle ranchers; slaughterhouses; retailers	Business plan development; business plan practice.	Technological solution for monitoring and traceability of cattle ranching production cycles.
Beef on Track	Lack of coordination between governments and the beef production chain in favor of the TAC	Governments; slaughterhouses; retailers; MPF	Bring the Federal Department of Justice (MPF) of the Amazonian states and slaughterhouses closer to standardized monitoring and auditing protocols; incentive for all Tier 1 slaughterhouses and 50 Tier 2 slaughterhouses to adopt the unified protocol; support by means of training and qualification.	Great milestone in terms of normative homogenization and standardization of processes.
Brazil-China TFA	Lack of harmonization of sustainability processes and protocols in international trade	Beef import market	Creation of the Beef Alliance with a homogeneous monitoring protocol between Brazil and China; implementation and monitoring of a pilot commercial transaction, following the established protocol.	Opportunity to standardize processes and social and environmental criteria in the international market. Possibility of expansion to other countries/blocks.

9.1. Pecsá

Pecuária Sustentável da Amazônia (Pecsá) is a cattle ranching management and partnership firm whose main objective is to improve the control of operational activities of extensive beef cattle ranches to make the

production system more intensive and sustainable. Pecsá took full control of the ranch management for six to ten years, developing pasture recovery, the intensification of cattle ranching production, the reforestation of areas with environmental liabilities, and the training of the ranch staff.

Ranchers contributed with the area and part of the ranch cattle herd, used to intensify the production system (P4F, 2022).

P4F's support to Pecsa included:

- **Operational and management improvement with information systems and ESG standards to ensure the intensification of cattle ranching in a sustainable manner.**
- **Support for an emissions study comparing different production models (semi-intensive OR intensive OR extensive).**
- **Support for attracting different investors.**

The production model advocated by Pecsa, based on the intensification of pasture-raised and the restoration of environmental liabilities, followed the best regarding the adoption of good practices in cattle ranching. The economic feasibility and productivity gains compared to the traditional extensive model were evident, as part of the support provided by P4F. In addition, the conveyance strategy, by producers, of the production management reduces the impact of risk aversion related to investments, allowing greater scalability.

A critical point to be taken into account is the possibility of including integrated systems (ICLS, ICLFS, etc.) in the production process in this type of business model. The decision to recover pastures by including agriculture is economically feasible and more profitable compared to pasture recovery exclusively for cattle ranching production. The forestry component, on the other hand, is a little more complex, since it depends on the demand for the wood produced in this type of system (this very challenge was observed in protocols such as Carbon Neutral Brazilian Beef, for example).

Another effort compatible with the movements collected by the diagnosis conducted is designing monitoring platforms for social and environmental and productive criteria for the property level. A wide range of such initiatives were identified, but they always come across a factor – low accessibility to common producers. Reflecting on tools that expand the producers' capacity to monitor social and environmental aspects, zootechnical and productive indicators that are adapted to their reality are needed.

The business model based on the conveyance of property management has enormous potential, once it directly attacks one of the bottlenecks for the technological transition in cattle ranching, which is the risk aversion of common producers. However, such operation requires both the availability of innovative entrepreneurs and risk-takers and an important volume of resources, both for making the necessary investments and for funding the operation itself. In the context in which sustainable finance thrives, especially the Investment Fund in Agroindustrial Production Chains (FIAGRO), it would be possible to raise funds for value-adding business models based on conveyance. If linked to a direct component of payment for environmental services, that business model becomes even more attractive, as demonstrated by the analysis of carbon emissions supported by P4F for Pecsa and which culminated in the Carbon Methodology project (presented as follows).

It is also important to understand the role that companies with business models similar to Pecsa could play in the territories they are located. In regions whose technological transition is not yet underway, this business model would serve as a leverage, a reference unit, by incorporating areas into the very operation and serving as a model for other producers who are willing to engage in the adoption of GAPs.



9.2. Carbon Methodology

The objective of this project is to create a methodology for estimating GHG emissions for the intensification of cattle ranching, considering aspects of the Brazilian production. Intensifying extensive pasture production systems (adopted on a large scale in Brazil) has enormous potential in increasing productivity and reducing emissions per animal, as well as reducing the pressure to clear new areas. P4F has been supporting this project, in partnership with Imaflora, focusing on the following actions:

- **Develop the methodology for generating carbon credits for intensive cattle ranching systems and subsequent approval by Verra/VCS.**
- **Conduct all necessary steps for the new methodology to be approved by Verra, including external audit and public consultation.**
- **Test the methodology on a beef cattle ranch in the state of Tocantins (P4F, 2022).**

The methodology for estimating total emissions per kilogram of beef produced in pasture-raised systems has enormous potential, as already demonstrated in Pecsá's operations. The methodology, in addition to opening up the possibility of pricing the ecosystem services part of intensified cattle ranching, increasing the potential income from the activity for cattle ranchers, would also allow for a better foundation and communication of the sector before the international community and civil society as a whole regarding cattle ranching advances towards sustainable production.

Pointed out by many players as one of the main challenges of the cattle ranching sector, improving communication regarding the sustainable components of Brazilian cattle ranching, based on scientific evidence and with institutional support, is essential for Brazil to better position itself in the climate agenda and its interlocution with agriculture and livestock. The sector is currently adopting a responsive approach, seeking to respond to market pressures.

The evolution of communication efforts and knowledge building will allow the sector (and the country) to guide the debate and demonstrate the unique sustainable aspects that Brazilian agriculture and livestock has.

Despite being one of the few efforts aimed at quantifying and pricing the dynamics of carbon directly linked to cattle ranching (most PES efforts are focused on forest carbon), there are some institutions devoting research efforts towards the environmental and economic validation of production systems in cattle ranching, with emphasis on the ICLFS Network and Embrapa Gado de Corte and Agrossilvipastoril units. To this end, the search for other players that support the beef production chain, the promotion of their integration and the incentive to knowledge building that is capable of repositioning Brazil in the cattle ranching debate and its relationship with the climate is fundamental for the sustainable development of this sector.

It is important to highlight the BNDES initiative to develop a carbon calculator for cattle ranching, whose consultancy took place in the second half of 2022. The expectation is to advance in the development of a methodology that estimates GHG emissions for cattle ranching, both beef cattle and dairy cattle, in their different production models. Reflecting on the efforts supported by P4F and how they can interact with the BNDES tool and other Embrapa initiatives is essential to advance this agenda in a coordinated manner.

9.3. Responsible Beef Partnership

The Responsible Beef Partnership is intended to support the public sector in improving the administrative path for cattle ranchers to regularize their environmental liabilities and return to the regular sale of beef cattle. The project seeks to converge the players in the beef production value chain to improve the flow of data between the

links in the chain and establish a more controlled business environment. That was the scenario in which The Nature Conservancy (TNC), Amigos da Terra and Safe Trace, supported by P4F, developed the initiative (P4F, 2022).

P4F supported the first phase to develop what would become the Conecta monitoring system. A total of 85 cattle ranchers were engaged to adopt it, 150 cattle ranchers received training in financial management, good practices, pasture management in eight municipalities in the state of Pará.

The second phase, in its turn, consisted of seeking to strengthen the administrative path between the various entities in the public and private sector, intended to make feasible the effective regularization of environmental accountability and the reinsertion of blocked and/or embargoed cattle ranchers. To this end, the project joined local initiatives such as Sustainable Territories in the state of Pará and Produce, Conserve, Include Strategy (PCI) in Mato Grosso.

Reversing the process of exclusion of cattle ranchers who do not comply with social and environmental aspects involves, first of all, an intense process of convincing. Because, even on the fringes, producers still manage to access markets informally, with little incentive to return to legality. Therefore, intense action is needed in the territory, offering information and technical and legal assistance to promote the reintegration of cattle ranchers who were blocked by slaughterhouses.

By mobilizing the various links in the chain, as well as supporting institutions and especially governments and their local initiatives, the Responsible Beef Partnership understood that it is impossible to solve the issue of blocked suppliers without taking action directly in the territory. Such action takes place by means of partnerships with institutions with broad access to rural producers, whereas slaughterhouses work as intermediaries in this process.

Attracting support institutions that operate in the territory is essential for this process of reintegrating producers into the formal market. In more organized states of the Amazon biome, such as Pará and Mato Grosso, that relationship is facilitated. Identifying institutions capable of providing support in other Amazonian states is essential to contribute to the reintegration process. Moreover, technical support to states with less information management capacity, both from GTAs and CARs, should be a priority precisely to reduce transaction costs linked to the environmental regularization process.

The Responsible Beef Partnership is also the local action arm for mobilizing producers to join the Conecta platform (presented as follows). Understanding technological solutions for property management and traceability and monitoring as purposes in themselves, not worrying about

adapting these recent technologies to the producers' context, poses an elevated risk of being frustrated. Thus, attracting more producers to Conecta gets past working in the field with producers, understanding their demands and needs and incorporating them into the context of the very platform.

9.4. Conecta

The Conecta Platform is a monitoring tool that allows slaughterhouses to identify the origin of cattle for beef production. This tool enables slaughterhouses to know whether the beef cattle they buy come from properties that comply with the Forest Code, in addition to allowing ranchers who comply with Brazilian environmental legislation to prove their social and environmental situation.



The tool places cattle ranchers at the center of the deforestation monitoring solution, asking them to have access information from their ranches, stored in secure databases (inaccessible by platforms other than the official one at Conecta). On the other hand, slaughterhouses can also set the sustainability criteria they wish to choose when selecting suppliers and ensure that their commitments are fulfilled with beef production chain partners (retailers, exporters, etc.) (P4F, 2022).

In the first phase, P4F supported Conecta during 2021 and 2022 to make a business plan, defining clear benefits for its customers and an engagement strategy with slaughterhouses in the Amazon to strengthen the commitment of the TAC signed since 2009.

In the second phase, the P4F is supporting the monitoring system to put the business plan into practice, getting involved with the slaughterhouse purchasing teams and reaching out to cattle ranchers, providing material for them to access the Conecta app and use the information to qualify their products. At the same time, they will also be able to access information about suppliers, providing a valuable service to the beef production value chain by monitoring it since its origin.

Faced with the difficulties of using individual traceability instruments for Brazilian cattle ranching, the solution of monitoring and evaluating cattle ranching production cycles seems to be the most feasible available. Despite the moral hazard and the potential increase in this risk when using it as part of the instrument for monitoring deforestation (including health risk), the GTA is today the only information that connects the batch of beef cattle traded to the property by the CAR and is largely used in cattle ranching. Therefore, in an urgent scenario of compliance with the voluntary commitments signed by slaughterhouses, the investment in Conecta is

right due to the unavailability of an immediate alternative.

That does not mean that arguments for individual traceability should be ignored. In fact, the only way to address the issue of deforestation associated with cattle ranching is the combination of individual traceability and monitoring of social and environmental aspects. Both initiatives are complementary. Monitoring production cycles, in addition to providing more information on the dynamics of deforestation, can provide markets and civil society with greater transparency for both the CAR and the GTA. Furthermore, incorporating the CAR itself into the GTA could improve this process.

Still, it takes a mature commitment and coordination between the links in the chain and governments in promoting a national policy of individual traceability. Such policy must prioritize regions at a higher risk of deforestation and provide a single consultation system for all links in the chain. In addition, incentives should be provided for producers to conduct individual traceability.

9.5. Beef on Track

The Accountable Beef Value Chain – or Beef on Track – is a project to engage the beef production chain, the Federal Department of Justice, and civil society around a standardized and unified protocol for monitoring the origin of beef cattle and audit of the Conduct Adjustment Agreements (TAC). This monitoring and auditing protocol is aimed at 50 slaughterhouses operating in the Amazon region and will make most of the beef produced in the region follow the same origination criteria, in addition to allowing better monitoring of beef origination practices when it comes to deforestation and other social and environmental criteria.

In this context of engagement with the public sector and the main slaughterhouses, P4F supported actions aimed at:

- **Confirming the commitment of the Federal Department of Justice of the Amazonian states around standardized and homogeneous monitoring and auditing protocols with slaughterhouses.**
- **Encouraging all Tier 1 slaughterhouses and 50 Tier 2 slaughterhouses to adopt the unified protocol.**
- **Supporting the initiative through training and qualification to assist in the implementation and improvement of activities related to the application of the unified protocol.**

Perhaps the main milestone in favor of the institutionalization of the TAC as a pre-competitive instrument, Beef on Track proved to be key in the process of mobilization and interconnection between the links in the chain, especially slaughterhouses, retailers, and governments. In addition to an important forum for debate, working in partnership with the Federal Department of Justice allowed for the homogenization of processes around standardized monitoring and auditing protocols, thus reducing transaction costs, and allowing for greater commitment by the Amazonian states and the links in the chain with the TACs.

As a lesson learned from the project and a great challenge, it is necessary to reflect on the arrangement of such initiative to guarantee the participation of more companies in the auditing process and, at the same time, a plan for the reintegration of those producers who were excluded from the supply to slaughterhouses.

Additionally, two points deserve attention and efforts. The first is the heterogeneity of the

states regarding their capacity to manage territory and property information. There are many state gaps with regard to the CAR, the processes of environmental regularization of producers blocked by social and environmental criteria, and the very GTAs that limit the effectiveness of Beef on Track while making the process of engagement with the players of these states lengthy. Therefore, reflecting on ways to reduce this transaction cost is essential.

The second point, which would have the potential to leverage the project, is the inclusion of rural producers in this process. In this first cycle, the project sought to mobilize the different links in the chain and governments in favor of the TAC. Rural producers are the main interested party in this process and, therefore, incorporating them into the debate is essential. To this end, a broad field action with local institutions supporting the chain is fundamental.

Furthermore, setting “Beef on Track” as a great forum for debate, due to its consolidation as a broad space for discussion of the implementation of the TAC and the impacts of cattle ranching on deforestation, has also brought international recognition. Even so, despite the unified procedures, the impacts of the initiative on the dynamics of deforestation are still uncertain.

9.6. Brazil-China TFA

The purpose of the Brazil-China TFA project is to support the improvement of environmental standards for Brazilian beef exports to China. The Tropical Forest Alliance, together with partners WWF and Imaflora, seeks to establish a clear value proposition for slaughterhouses and traders and enhance the environmental commitments already being implemented in Brazil and develop the China Meat Association (CMA) standard for the Beef Alliance.



P4F is supporting the initiative to:

- **Establish the Beef Alliance with a sustainability component, adopting pre-established monitoring protocols in China and Brazil, ensuring a transparency and auditing platform agreed upon by all stakeholders.**
- **Implement and monitor a pilot commercial transaction, following the protocol established with one stakeholder in Brazil and one in China to ensure that sustainability criteria are being followed.**

Considering that Brazil is one of the largest exporters of beef, it is imperative to build bridges and engagement between the links in the chain and the countries that import Brazilian beef. By establishing these ties there is better preparation of Brazilian players as well as a better understanding of the importing country regarding the nuances related to the beef production chain in Brazil.

This effort to improve communication around establishing monitoring and purchase protocols is essential to promote better conditions for Brazil to structure the terms of the agenda. Under pressure,

better communicating what is being done in Brazil is fundamental, as well as ensuring efforts for greater development of information and science around Brazilian cattle ranching, its productive potential, and its ability to circumvent its negative externalities.

Additionally, it is necessary to analyze how the countries that import Brazilian beef can cooperate with Brazil aiming at a traceability policy or mechanism that provides deforestation-free products. Improving the capacity of governments to generate reliable and verifiable information is essential, whether it is in monitoring cattle suppliers via a single platform, reinserting blocked producers and/or adopting GAPs and production protocols. In practice, given the challenges inherent in the objective of guaranteeing products that do not come from newly deforested areas, it is important to combine incentives and share costs along the entire value chain, from producers to consumers. It is worth pointing out that the creation of regulations and standards for monitoring and traceability will tend to create different requirements, operating procedures, and costs, generating a fragmentation of measures that aim to achieve the same objective, which has the potential to create non-tariff barriers to international trade.



10. Strategies to achieve a sustainable beef production chain

Strategies related to the seven main challenges of the beef production chain are presented in a descriptive way as follows:

1. Accelerating the attraction of producers to adopt GAPs
2. Giving scale to productive sustainability initiatives and actions
3. Access to subsidy and risk reduction in financing operations
4. Difficulty in measuring the environmental and climate contributions of adopting GAPs
5. Scale limitation of PES instruments and certifications
6. Traceability and monitoring
7. Deforestation command and control

Based on the presented diagnosis, this section seeks to discuss alternatives and strategies to promote a sustainable, productive, and deforestation-free beef production chain. The subsections will be divided based on the challenges identified throughout

the diagnostic process. Table 13 summarizes the strategies to reach the sustainable beef production chain, considering each identified challenge and the players to be engaged in, the implementation time, and the level of complexity for such process.

Table 13 - Strategies for promoting a sustainable beef production chain

Challenge	Strategies	Players needed	Implementation time	Level of complexity
Accelerating the attraction of producers to adopt GAPs	Mobilize local players and institutions supporting the beef production chain that have capillarity in the territory in favor of the adoption of GAPs	Slaughterhouses; associations; unions; city governments; Departments of Agriculture and Environment; Technical Assistance and Rural Extension (ATER) companies; support and research institutions	Mid-term	Medium
	Identify players and key producers intended to promote the dissemination of information in a natural manner	Producers who adopt good practices and who are a reference in local communities	Mid-term	Low

SUSTAINABILITY IN THE BEEF PRODUCTION CHAIN

Challenge	Strategies	Players needed	Implementation time	Level of complexity
Giving scale to productive sustainability initiatives and actions	Provide technical support for rural producers to adopt GAPs	Slaughterhouses; ATER companies; support and research institutions	Long-term	Low
	Support value-adding business models	Financial institutions; institutions supporting the beef production chain; startups	Mid-term	High
	Assess the potential of financial instruments with sustainable purposes in promoting value-adding business models	Financial institutions; startups; institutions supporting the beef production chain	Mid-term	High
Access to subsidy and risk reduction in financing operations	Assist producers in accessing credit by spreading information	Financial institutions; institutions supporting the beef production chain; cattle ranchers; ATER companies	Short-term	Low
	Train technical assistants to set up investment projects	ATER companies; institutions supporting the beef production chain	Short-term	Medium
	Support initiatives aimed at reducing transaction costs in credit operations	Startups; financial institutions	Short-term	Medium
	Support the creation of risk-reducing instruments, such as endowments and blended finance	Financial institutions; institutions supporting the beef production chain	Mid-term	High
	Support initiatives that improve the underwriting of social and environmental risks in credit operations	Financial institutions; institutions supporting the beef production chain	Mid-term	High
	Support initiatives that differentiate financing conditions by management strategy and social and environmental aspects	Financial institutions; institutions supporting the beef production chain	Mid-term	High
	Difficulty in measuring the environmental and climate contributions of adopting GAPs	Support research institutions engaged in creating emission methodologies	Research institutions; slaughterhouses; institutions supporting the beef production chain	Short-term
Promote the integration of research institutions engaged in creating methodologies		Research institutions; slaughterhouses; institutions supporting the beef production chain	Short-term	Medium

SUSTAINABILITY IN THE BEEF PRODUCTION CHAIN

Challenge	Strategies	Players needed	Implementation time	Level of complexity
Difficulty in measuring the environmental and climate contributions of adopting GAPs	Analyze ways to incorporate these methodologies into sustainable finance and PES instruments and certifications	Research institutions; slaughterhouses; institutions supporting the beef production chain; financial institutions	Mid-term	High
Scale limitation of PES instruments and certifications	Assist the beef production chain in strengthening PES instruments and obtaining certifications as part of the loyalty mechanisms for cattle ranchers	Certifiers; slaughterhouses; institutions supporting the beef production chain	Mid-term	High
Traceability and monitoring	Assist states in information management	Departments of Agriculture and Environment; institutions supporting the beef production chain; slaughterhouses	Mid-term	High
	Support the integration between Rural Environmental Registry (CAR) and Animal Transit Guide (GTA)	Departments of Agriculture and Environment; institutions supporting the beef production chain; slaughterhouses	Mid-term	High
	Design a unique social and environmental compliance check platform	Federal Government; institutions supporting the beef production chain; slaughterhouses	Mid-term	High
	Assist smaller slaughterhouses in making voluntary commitments	Institutions supporting the beef production chain; slaughterhouses	Mid-term	Medium
	Support a national individual traceability policy, especially in municipalities with a high social and environmental risk	Federal Government; institutions supporting the beef production chain; slaughterhouses	Long-term	High
	Support adding value to individual traceability by reducing information asymmetries	Federal Government; institutions supporting the beef production chain; slaughterhouses	Long-term	High
	Disseminate individual traceability as a benefit, working as a management tool for the activity and property	Institutions supporting the beef production chain; cattle ranchers	Long-term	Medium

Challenge	Strategies	Players needed	Implementation time	Level of complexity
Deforestation command and control	Implement the Action Plan for the Prevention and Control of Deforestation in the Amazon	The federal government in partnership with state governments, local institutions, and the private sector	Short-term	High

Source: Study results. Development: Agroicone

10.1. Accelerating the attraction of producers to adopt GAPs

One of the challenges identified in the interviews was the need to mobilize cattle ranchers in initiatives that support the implementation of good agricultural practices, monitoring, and traceability. In addition, the diagnosis carried out revealed that the adoption of technologies and GAPs is diffuse and different between the production cycles of breeding, rearing, and/or fattening, and more widespread in the latter.

Understanding the dynamics of knowledge transmission in the field is essential to leverage actions alongside rural producers, both in the realm of adopting GAPs and in environmental regularization. That occurs because the aversion

to risk, less accessibility to the internet in the field, little access to technical assistance, and, mainly, cattle ranchers' budget constraint represent barriers to disseminate information and knowledge among producers.

Understanding the pain, knowing the local dynamics, identifying leaders in politics and among producers, collecting information from the properties, mapping the productive suitability and the appetite of rural producers to engage in new technologies compatible with their reality, mobilizing efforts around environmental regularization are tasks of high complexity and require direct involvement in the field. Often, producers are unaware of the public policy instruments, technologies, and incentives available.



Taking action in the territory is fundamental to reduce this information asymmetry. However, for such, capillarity and a history of access with producers are necessary. Therefore, public institutions should be involved in mobilization actions – Departments of Agriculture and Environment, public technical assistance and rural extension companies, research institutions. Furthermore, institutions supporting the beef production chain are fundamental for their striking actions in the territory.

The link with the initiatives of the states to mobilize efforts around sustainability in agriculture and livestock is also fundamental. These initiatives, such as the Produce, Conserve, Include Strategy (PCI), in Mato Grosso, or Sustainable Territories, in Pará, already have structured governance, mobilized technicians, and the necessary capillarity to support actions in the territory. Private initiatives such as the Green Offices are a good example of this interlocution between public and private structures.

All this local structure is necessary to facilitate the process of conveying knowledge in the field. Faced with the high transaction costs of disseminating information, rural producers often get information from their peers and neighbors. That is, adopting new practices and a new paradigm in agriculture and livestock depends on collective action (CHAUDHURI, et al., 2021; DE SOUZA ALMEIDA, et al., 2021). Thus, efforts aimed at disseminating GAPs and encouraging environmental regularization should not be aimed at all producers, but at those who have some local influence. By mobilizing these individuals, actions aimed at cattle ranchers tend to be cost-effective, since they are based on a process of information overflow between influential individuals and their influences.

Identifying successful cases and opportunities

to leverage or replicate them is essential for an optimal intervention design that considers local characteristics. Promoting integration and coordination between public agents, other links in the chain, and rural producers in forums that allow for the exchange of experiences can contribute to this process of scalability of actions to encourage the adoption of GAPs and social and environmental compliance.

10.2. Escalating productive sustainability initiatives and actions

From the diagnosis presented and the interviews conducted, the need for escalating or designing sustainable business models for cattle ranching was identified.

Adopting GAPs and other sustainable practices on a large scale in cattle ranching depends on two factors: the process of adopting technologies by rural producers and scalable business models, such as those based on the conveyance of the agricultural operation. The Pecsá model and, currently, Caaporã were based on this second factor.

Adopting sustainable practices and technologies by cattle ranchers faces a time challenge, once the dissemination and incorporation of good practices require technical assistance provision and direct support to producers via incentive instruments, which takes time. The low willingness of the other players in the chain to provide access to technical assistance and other incentives also makes the process even more lengthy. Conveyance models, on the other hand, attack risk aversion and have power to escalate, as long as the business is perennial, with interesting conditions for producers who own the land and the very managing company.



In terms of productivity, profitability, and sustainability, Pecsá's results were clear when saying that such models are economically viable (provided they are well managed). Thinking about such models incorporating integrated systems (with crops and/or forests), as is the case of Caaporã, can make this strategy even more attractive.

In the context of a positive and growing ecosystem of sustainable finance and private financing in general, reflecting on the potential of financial instruments aimed at financing such operations can be an alternative. How much could an Investment Fund in Agroindustrial Production Chains (FIAGRO), for example, be used for this purpose? Real estate funds are already available for the purchase of properties with degraded areas for subsequent recovery of productive vigor (from pastures or conversion to agriculture/grains) and environmental regularization. Perhaps it is possible to explore this type of instrument in the context of a business model based on management and production conveyance.

In addition, conveyance models can work in the

territory as a form of Demonstration Unit, offering knowledge and demonstrating in practice the potential of productive interventions that mitigate environmental externalities for producers in the surroundings, in addition to being a measure to circumvent risk aversion when adopting technologies in the field.

10.3. Access to subsidy and risk reduction in financing operations

Agricultural policy instruments such as rural credit and rural insurance play a key role in inducing the adoption of sustainable technology and practices in the field, but there is still a huge number of cattle ranchers who do not access and/or who have access restrictions.

Despite falling short in terms of the volume of resources needed for the technological transition in cattle ranching, agricultural policy, especially its main instrument – rural credit –, plays a significant role in this process.

Rural credit with economic subsidy currently has two main programs aimed at sustainability and resilience: the ABC+ Program and the PRONAF ABC+. In addition, the Crop Plan finances several products and purposes that are not labeled but have a clear potential to promote sustainable practices in agriculture and livestock activities.

The main challenge (in addition to the supply of resources, which depends on the government budget) is to expand access to the rural credit policy. Faced with risk aversion and information asymmetry, cattle ranchers are often unaware of available investment financing lines. To this end, training alongside local players, qualifying technical assistants to prepare good investment projects, and reducing transaction costs between producers and financial institutions are fundamental to leverage credit to cattle ranchers.

Contracting rural credit for investments can take a long time since it involves a bureaucratic process that requires collecting documents and developing a technical project. To this end, transaction costs are high when contracting credit, which limits its demand. Supporting technology-based initiatives that promote easier access to financing combined with perennial technical assistance is critical.

In addition, support for risk-reducing (de-risk) instruments, such as the creation of endowments and incentives for blended finance instruments, can reduce risk aversion either for producers or financial institutions. Models that combine public resources from the Crop Plan, philanthropic

resources such as climate funds, and resources from the very slaughterhouses can help leverage the demand for credit among cattle ranchers, as long as they are combined with the other actions presented herein.

Efforts must be focused on the better underwriting of the risks involved in credit operations already conducted. Identifying operations related to negative environmental externalities should be the first step before improving the ability to differentiate producers depending on the management strategy and social and environmental attributes of their activity. In the System of Rural Credit Operations and Proagro (SICOR), there are several fields to be filled in by the financial agent related to the production system and the characteristics of the activity, whose completion could be mandatory at least in rural credit operations with economic subsidy.

Another need for compliance is the credit for the purchase of cattle not considering the quality of the pasture in which they will be inserted. That is, it is not reasonable to finance the purchase of animals with the maintenance of low-productivity extensive activity. There is a wide engagement observed in Banco Central do Brasil (with the sustainable rural credit bureau, not yet implemented) and in the commitments of financial institutions in this process. These analyzes and proposals are detailed in Technical Notes with Proposals for the 2023-2024 Crop Plan⁽²³⁾ developed by Agroicone, discussed and delivered to the Ministry of Agriculture and Livestock, and other relevant institutions that work on and interfere in agricultural policies.

(23) Over the last six years, since the 2017/2018 Crop Plan, Agroicone has been debating and presenting proposals for the Crop Plan, based on evidence, to promote sustainability in the field, in credit operations, and for the integrated management of (climate, social and environmental) risks. The Technical Notes with Proposals for the 2023/2024 Crop Plan (Agroicone, 2023) are just one example, and brought three sets of proposals, endorsed by Coalizão Brasil Clima, Florestas e Agricultura: (i) Improve regulations for the sustainability of rural credit and prioritize resources for the ABC+ Program and PRONAF ABC+; (ii) Improve integrated risk management in agriculture and livestock; (iii) Prioritize the allocation of resources from the Constitutional Funds to smaller producers and sustainability (ABC+ Program and PRONAF ABC+). The full document can be accessed at: https://agroicone.com.br/wp-content/uploads/2023/04/Agroicone_Notas-tecnicas_Plano-Safra-2023-2024_final.pdf

Finally, the rural credit eligibility criteria exclude producers in non-compliance with land tenure and social and environmental issues. In view of the efforts of the beef production chain to include cattle ranchers currently blocked from the purchasing policy, especially in the Amazon biome, it is necessary to amend BCB Resolution n. 140, of September 15, 2021, to include exceptions, such as authorizing financing to those producers who have environmental embargoes, but who have signed a regularization commitment with the competent environmental agency and prove compliance. These exceptions could be granted for credit lines without economic subsidy, for example (such as those that use mandatory resources from demand deposits – MCR 6-2 and free resources), or even the creation of a specific credit line for such purpose, containing investment and costing resources.

10.4. Difficulty in measuring the environmental and climate contributions of adopting GAPs

For the instruments of Payment for Environmental Services and sustainability-oriented certifications, there is a need to develop methodologies for quantifying GHG emissions, especially those capable of differentiating production systems, soil management, and animal production.

Despite having technologies and practices consolidated as environmentally sustainable and that increase productivity, the ability to measure the impacts of these GAPs and the quantification of GHG emissions related to them are still limited in Brazil.



Expanding this research effort is essential to reposition Brazil in the agriculture and livestock and climate change agenda. Despite the country being one of the largest emitters of GHGs due to agriculture and livestock and land use changes, Brazil also has the greatest potential to reverse this situation only by using its factor endowments more efficiently. That is, more than part of the problem, Brazil currently stands out as one of the solutions to the climate issue.

Thus, improving the ability to justify this argument through scientific knowledge is essential for Brazil to be the protagonist of the agenda's narrative and the focus of actions aimed at Climate-smart agriculture (CSA). To this end, developing methodologies for quantifying the economic, social, and environmental impacts of a technological transition to a low-carbon standard also resilient to climate change is of great reputational importance.

In other words, to optimize efforts aimed at creating sustainable methodologies and technologies, a well-defined strategy for communicating the results of these efforts is needed to present the potential of Brazilian cattle ranching to the world, both in terms of production and the environment.

In addition, investing in emission factor methodologies adapted to Brazilian production systems would bring a great opportunity to assess the ecosystem services provided by cattle ranching and their respective pricing. To this end, the entire ecosystem of sustainable finance and PES would benefit once the ability to differ productive systems (and the pricing of these differences) would increase. These efforts can also grow the number of sustainable technologies and practices, reduce their implementation costs, and allow for greater access by cattle ranchers.

It is also important to point out that there

are initiatives aimed at this purpose, but they are scattered. It is necessary to combine efforts already being made by Imaflora, different Embrapa units and universities to catalyze and accelerate such process of building scientific knowledge. A highlight to the initiative of a calculator of emissions in cattle ranching financed by the BNDES, which is under development. Reflecting on ways to use this tool, as well as incorporating existing research or research being developed at the same time, can benefit the entire beef production chain.

10.5. Scale limitation of PES instruments and certifications

The scale limitation of PES and certifications in cattle ranching needs to be addressed. The highly complex challenges and expectations of the beef production chain need to be solved for PES and certifications to be implemented.

PES instruments as a tool to price ecosystem services in agriculture and livestock are still specific, with no gains in scale and, for the most part, aimed at forest assets (or restoration of native vegetation) and not at those arising from the production itself. This is precisely due to the (almost) absence of methodologies that allow for quantifying and measuring emissions from cattle ranching activity in Brazil, given its wide heterogeneity.

In addition to this methodological challenge, the high transaction costs and the difficulty of scale still make PES initiatives something ethereal from the perspective of rural producers. The same reasoning applies to the certification systems for social and environmental attributes.

The activity, economic factors such as land prices and profitability of the activity, the pattern of occupation and land use, and the availability of areas subject to clearing are factors that impact on the ability of PES instruments to compensate the rural producers' opportunity cost. Such difficulty has a direct impact on avoided deforestation, for example.

However, in this scenario of multiple voluntary commitments signed by slaughterhouses, they will have to take action to retain producers who adopt GAPs and, consequently, emit less. Therefore, it is expected that slaughterhouses, together with institutions supporting the beef production chain, take action to build instruments capable of differentiating producers by management strategy and rewarding them. This loyalty strategy may even have an impact on encouraging producers in the technological transition process.

10.6. Traceability and monitoring

One of the major bottlenecks in the chain is to ensure the sustainable origination of beef. Traceability and monitoring have been addressed since 2009 and, considering the limitations of the instruments implemented over the years and the market pressures to prove origination, the lessons learned must be considered, as well as the implementation of short- and medium-term actions and solutions.

It is worth noting that the diagnosis presented revealed a consensus among the players in the chain to solve, in the short term, the social and environmental monitoring of cattle ranching production cycles (breeding, rearing, and/or fattening) in a coordinated way (based on the GTA and the CAR), as well as the need for an

individual traceability policy in regions of greater social and environmental risk as a medium-term solution. Coordination between the different links in the chain is mandatory for the success of this implementation.

The traceability of the beef production chain gained urgency due to the voluntary commitments signed by slaughterhouses and because it was placed as part of the strategic actions to control deforestation in the Action Plan for the Prevention and Control of Deforestation in the Amazon (PPCDAm)⁽²⁴⁾, document made available for public consultation in April 2023. In addition to initiatives aimed at the traceability of production cycles, committed efforts also promote environmental regularization and homogenization of the regulatory environment. To ensure a non-excluding process, it is therefore necessary to combine the creation of traceability and monitoring instruments with incentives for environmental regularization, both at the producer level and in the spheres of government.

In this urgent scenario and in view of the impossibility of disseminating individual traceability instruments among the entire mass of cattle ranchers, the solution identified by the chain was the traceability of cattle ranching production cycles using the Animal Transit Guide (GTA) (batches of animals transacted for different productive purposes) as part of the social and environmental monitoring instrument of the properties with the Rural Environmental Registry (CAR). The implications of such use have already been explored throughout the diagnosis, which revealed that, although not preferable, these solutions based on monitoring the production cycle are identified as viable in the short term.

However, a high transaction cost still remains in these initiatives. The reason for such cost is the inability to manage information for some states, which still do it in an inefficient and even manual way.

(24) Available at: <https://www.gov.br/participamaisbrasil/consulta-publica-ppcdam>



Helping the GTA's information management process in a coordinated manner is imperative. Furthermore, the incorporation of the CAR into the GTA would also facilitate the process of monitoring deforestation in the chain, directly linking the property to the Animal Transit Guide, as long as it complies with the Brazilian General Data Protection Law (LGPD). All these points can be seen as part of the standardization process initiated by the Beef on Track initiative.

This transaction cost is also evident in the way in which the chain checks for compliance with environmental legislation. Each player checks with their own methodology, by means of geomonitoring companies. A pre-competitive alternative that would facilitate the participation of other slaughterhouses and retailers to the monitoring process would be developing a single platform to check for environmental compliance provided by the government in partnership with

the chain. That alternative would share costs and risks, promoting greater synergy between the players and a greater addition of slaughterhouses with social and environmental verification of their suppliers.

It is worth pointing out that previous issues must be addressed. The very exposure to moral hazard of instruments such as the CAR and the GTA, both self-reporting, and the slowness in validating the CAR are points to be addressed so that traceability and monitoring instruments based on production cycles are less subject to errors and fraud. To this end, the single platform managed by the government must share the risks and guarantee the minimum security for the beef production chain.

Including slaughterhouses in this network of social and environmental commitments also represents a window of opportunity.

In the coming years, depending on the evolution of market pressures and civil society, players who are still inert will have to take action. Thus, they will need direct technical support to make these commitments and direct actions to address the issue of deforestation.

Even so, the monitoring of cattle ranching production cycles poses a high moral hazard, and the individual traceability of animals is identified by the players in the chain as the permanent solution. Faced with the impossibility of incorporating this burden on the part of slaughterhouses, engaging in state policies in favor of individual traceability would be necessary. Such policies for the world's largest cattle herd would have immense challenges to overcome. Thus, identifying priority regions using social and environmental risk as a criterion can be a short-term alternative to the issue of individual traceability.

It is worth noting that maps have already been developed by Agroicone to mitigate social and environmental risks for the beef production chain by municipality for the Amazon, Cerrado, Pampa, Pantanal, and Atlantic Forest biomes. Today they are used by Marfrig as part of the origination strategy of the Marfrig Verde+ Program, but they can be used throughout the beef production chain to prioritize local actions and guide the traceability of beef cattle, starting in municipalities with the highest social and environmental risk associated with cattle ranching in the Amazon biome.

Public engagement does not mean that market solutions will not necessarily thrive. In a scenario where the information asymmetry between producers, slaughterhouses, retailers, and government is very high, adding value to information can be an alternative. To this end, a "ear tagging" system (or any other type of individual identification) that identifies not only the animal and where it came from but the social

and environmental and productive characteristics of the property can be an alternative. Therefore, a traced animal would also come with extra information, adding value to the transaction. This concept also has the potential to thrive and increase individual traceability.

Finally, individual traceability should be seen not only as part of the solution for monitoring deforestation and other social and environmental criteria but also as a value-adding step from the point of view of activity and property management. Monitoring zootechnical and productivity indicators has enormous potential in producers' production increases, thus reducing the pressure for deforestation. To this end, it is worth considering direct actions with rural producers, as previously explored.

10.7. Deforestation command and control

The Action Plan for the Prevention and Control of Deforestation in the Amazon (PPCDAm) has several strategic axes and objectives. In April 2023, the public consultation of the preliminary document that details Phase V of the Plan was completed (BRASIL, 2023). The document presented the recent dynamics of deforestation in the Brazilian Amazon, highlighting:

- Deforestation inland expansion with the invasion of public lands.
- Reconcentration of deforestation in large contiguous areas.
- Reduced governance capacity in protected areas and settlements.
- Illegal deforestation in production chains.
- Increased forest degradation.

Deforestation by land tenure category in the Brazilian Amazon in 2022 shows that 25% occurred in private areas or areas without information and highlights the need to restructure territorial governance in non-allocated public lands (32.4% of total deforestation), in rural settlements (29%), in Conservation Units (11.1%), and in Indigenous Territories (2.2%).

If strengthening the actions of command, control, and fight against deforestation by the public power, especially in areas that are in the public domain, and restructuring public territorial governance in the Brazilian Amazon do not occur, the strategies and actions presented above will have little effectiveness in controlling deforestation. It is worth noting that the beef production chain may be able to demonstrate that its products are free from deforestation, but will deforestation effectively be reduced without command and control actions?

That question always gets past the main objective – fight, avoid, and control deforestation at its source. It is desirable to have deforestation-free products, transparent and verifiable information, effective deforestation control, avoiding the exclusion of non-compliant producers, which, otherwise, could lead to the segregation of products that do not have the same social and environmental attributes. Based on the data presented by the Action Plan for the Prevention and Control of Deforestation in the Amazon (PPCDAm), this risk remains current, considering the weaknesses identified by the suggested monitoring and traceability instruments (CAR and GTA), highlighted in the preliminary document of Phase V of the Plan.

Finally, (public) command and control and (private) market instruments are complementary and inseparable when aiming at achieving deforestation-free chains.





11. Conclusions

Undeniably, the Brazilian cattle ranching industry has been going through a process of increased productivity. Such increase can be observed in the productivity indicators as well as in that of the support capacity of pastures. The combination of cattle herd growth and reduction of pasturelands (and recovery of degraded areas) was observed both in Brazil in general and in the

Midwest region (where the highest concentration of beef cattle in the country is located). The North region has also been registering increases in productivity and support capacity, however in an extensive way, that is, the cattle herd grows at a rate greater than that of pasturelands (in this case, where pastures advance on areas of native vegetation).

This observed growth is the result of two movements at least. The first is market pressure, especially from China, that requires an animal to be finished within 30 months, which forces producers to adapt to and invest in improving productivity. The second is the very dynamics of adopting good agricultural practices by producers, which includes interventions in diet, land use, the introduction of integrated systems, pasture management, genetics, and production cycles. However, this process is not adopted by all cattle ranching production cycles, whereas breeding producers are the most weakened and with less access to opportunities for modernizing production.

Given the conditions of comparative advantage that cattle ranching has (largest cattle herd in the world and extensive pasturelands, even if part of them somewhat degraded), the combination of these characteristics with the wide availability of management strategies and adoption of GAPs places Brazil in a unique position with regard to the potential for productivity increases in cattle ranching linked to social and environmental attributes.

For this potential to become reality, producers must be brought to the center of the issue. The decision on how to produce is made by producers, who evaluate their opportunity costs regarding investments in adopting GAPs in cattle ranching. Such decision goes through an analysis of land prices, availability of cleared areas, and existence of areas of excess native vegetation in Legal Reserves eligible for clearing, availability of resources for financing, and alternative occupation of such area – for example, the transition to other uses, such as soybean production, or the creation of integrated systems (ICLS).

Focusing efforts on developing incentives, both public and private, that change this decision-making process is essential. In the public sector,

the main agricultural policy instrument for sustainability purposes in cattle ranching is the ABC+ Plan, in particular its financing arm, the ABC+ Program and the PRONAF ABC+ financing lines. Despite being extremely important, even if they are not the only options of the National Rural Credit System aligned with the ABC+ Plan, these resources, towards investment financing for sustainability purposes and resilience in agriculture and livestock, are insufficient when compared to the volume of resources needed to make Brazilian cattle ranching more sustainable or even achieve the goals of the very ABC+ Plan.

Thus, private financing has been gaining prominence, especially in the field of sustainable finance. In addition to the broad effort of the Central Bank to incorporate the climate, social, and environmental agendas in credit granting and in the government's work on improving the institutional and regulatory environment, private financial institutions have been moving towards a better underwriting of climate risks and incorporating sustainability criteria in credit granting and development of financial instruments aimed at sustainable purposes.

This business environment favorable for sustainable finance must be preponderant in the production dynamics of Brazilian cattle ranching. In addition to the banks' own commitments to monitoring social and environmental compliance, these new resources can be directed towards fostering value-adding business models, such as those based on conveyance. They can also be fundamental in the process of differentiating producers, rewarding those who adopt better practices and are more sustainable with better financing conditions.

Other possibilities for differentiating producers by social and environmental characteristics and the possible payment for these characteristics are also in progress, such as certifications and PES.

Despite being seen as an alternative to facilitate the fulfillment of the commitments signed by slaughterhouses, which could be a loyalty strategy for more sustainable producers, these initiatives are still sparse and with a high transaction cost. Furthermore, the carbon market (main available PES route) is unable to pay for the opportunity cost of the producers' economic decisions (for example, the decision to advance on areas of excess native vegetation) and is considered ethereal and very distant from the reality of common producers.

However, none of these incentive instruments will prosper if the ability to quantify and measure sustainability attributes and GHG emissions is not improved. Efforts must be focused on creating robust and reliable methodologies not only to back up incentive instruments but for Brazil to improve its ability to communicate with civil society and the international community to the point of dominating the debate and not just being responsive to market pressures. Assertively communicating the nuances of Brazilian cattle ranching, its productive potential, and its ability to provide social and environmental solutions is fundamental to this process.

In other words, fostering GAPs for cattle ranching in Brazil depends on developing incentives that change the productive path of cattle ranchers. This whole context is still part of several disconnected initiatives in the pilot phase. However, it is important to emphasize the need to take action in the territory, bringing information to producers, reducing information asymmetries between them and the other links in the chain, as well as reducing the resistance and risk aversion of such audience.

Those actions in the territory are even more preponderant when it comes to traceability and monitoring. The big challenge lies in indirect suppliers, often small producers and linked

to a disorderly occupation in areas of native vegetation. Faced with the fragility of land tenure and environmental legislation, it is economically rational for these producers to adopt an extensive production strategy in which, when observing a loss of vigor in pastures, they can choose to clear a new area over native vegetation rather than recover the degraded area. That producer measures fictitious profits (understood as the perception of profit by cattle ranchers, resulting from the frequent non-incorporation of land and/or labor costs in their financial analyses, which distorts the actual results), feeding back this degradation and deforestation process.

Such process, linked to a context of high moral hazard, makes that producer in environmental and land non-compliance still be able to supply animals for the domestic market even though on the fringes of the formal market due to the voluntary commitments signed between slaughterhouses, the Federal Department of Justice, and civil society.

That is, to bring producers to legality and formality, an incisive action in the territory is necessary. This process is complex, as it requires convincing. But convincing can be done by means of incentives. This is what initiatives such as the Green Offices or the Reinsertion and Monitoring Program (PREM) are willing to do, offering incentives such as technical assistance, subsidies on regularization costs, and reducing the transaction costs of such process.

That integration must also take place among the other links in the chain. The entire regulatory and homogenization effort of processes, partnerships between slaughterhouses, retailers, and public authorities in building bridges and solutions for blocked producers and efforts to improve information management in the states is essential to overcome the challenge of deforestation associated with the beef production chain.



However, in order to fulfill its voluntary commitments, each slaughterhouse is running against time to provide solutions to the deforestation associated with its supply chain. To address this short-term challenge, discussions are directed towards the use of the Animal Transit Guide (GTA) as a traceability instrument associated with the Rural Environmental Registry (CAR) as part of the deforestation monitoring instrument. The possibility of greater exposure to moral hazard and, consequently, to health risk, in addition to the fact that the GTA corresponds to the batch of animals traded, imposes some limits on its use. However, it is the most feasible solution given the short time available.

This does not mean, however, that efforts and resources in monitoring solutions for the cattle ranching production cycles are discarded. It is necessary to understand the GTA use solution as a complement to individual traceability solutions, the only strategy capable of shedding light on the issue of monitoring deforestation. Adding value to the socioeconomic and productive information of each property in an individual traceability system could be a solution. That would be wrapped in a

national individual traceability policy, all of that coordinated and shared with the other links in the chain. The understanding of a national policy does not mean that it will be destined for the entire territory but for those regions at greater social and environmental risk.

P4F has been working decisively on all those fronts, mobilizing efforts around the promotion of integration between players in the chain, normative homogenization, support for value-adding business models, and creation of monitoring tools and GHG emission methodologies in cattle ranching.

With all those efforts, Brazilian cattle ranching can continue to evolve in productivity and efficiency, contributing to income generation, business development, and new sources of foreign currency. And it may yet emerge as part of the country's main strategies for reducing deforestation, preserving biodiversity, conserving water resources, and transitioning to a modern low-carbon economy. Finally, (public) command and control and (private) market instruments are complementary and inseparable when aiming at achieving deforestation-free production chains.

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Appendix A • Methodological strategy of active search for information

Understanding that the pace of innovations, projects, and initiatives in sustainable cattle ranching occurs at a different speed than that of science, a strategy of active search was chosen for these innovations, projects, and initiatives as a way to complement the processes of literature review and characterization of the activity over the past four years.

In order to carry out this active search, some sectoral news outlets were listed in order to cover the largest number of initiatives aimed at sustainable cattle ranching. So far, the following outlets have been explored: Canal Rural, Valor Econômico, Reset, Giro do Boi, and Planeta Campo. These outlets were chosen due to the relevance and diversity of related news.

When choosing the outlets, the process of extracting these pieces of news varied, depending on the outlet itself. Canal Rural, Valor Econômico, and Reset underwent an automated process to some degree to reduce the search cost and increase the accuracy of this process. As a way of validating the efficiency of the automated strategy, Giro do Boi and Planeta Campo were explored manually.

The searched news focuses on six major themes as follows: Sustainable finance; traceability and monitoring; agricultural policy; payment for environmental services (PES); good agricultural practices; certification. Table A1 summarizes these categories and presents the keywords used in the search processes, both automated and manual.

Table A1 - Categories, description, and search dictionary

Categories	Description	Dictionary
Sustainable finance	Financial instruments aimed at financing sustainable cattle ranching.	Green finance; sustainable finance; green bonds; sustainable bonds; green finance; green credit; green CRA; green CPR; Green LCA; ASG; ESG.
Traceability and monitoring	Actions to monitor the cattle herd and social and environmental aspects and trace the beef origin.	Traceability; monitoring; direct suppliers; indirect suppliers; cattle; HDI; GHG; sustainability; carbon; deforestation.
Agricultural policy	Public instruments of agricultural policies such as rural credit and insurance. Regulatory changes, laws, and regulatory frameworks.	Rural credit; rural insurance; parametric insurance; Crop Plan; BNDES, FNO, FNE, FCO.
Payment for Environmental Services (PES)	Instruments that compensate the environmental asset or good agricultural practices	Carbon credit; carbon; ecosystem services; PES; water resources; biodiversity; native vegetation; forests; avoided deforestation.

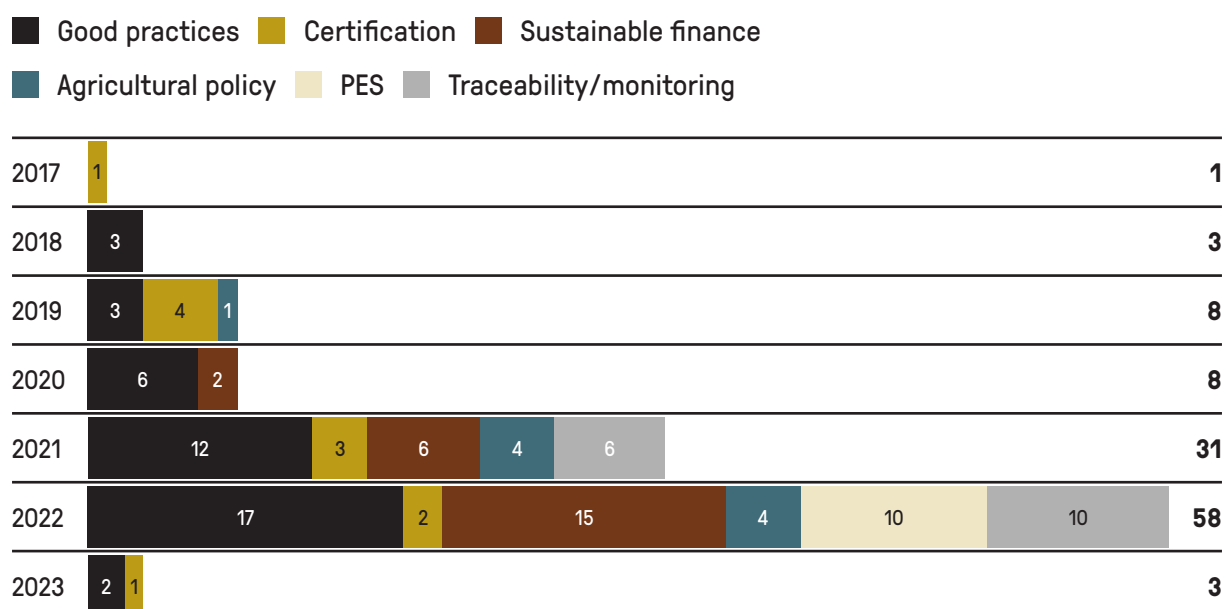
Categories	Description	Dictionary
Good agricultural practices	Set of efforts aimed at leveraging the use of good practices in cattle ranching. It encompasses research and incentives aimed at integrated systems, recovery of degraded pastures, intensive finishing, waste treatment, animal health, etc.	Management; degraded pastures; intensification; semi-intensive; intensive; coverage; fodder; integration; ICLFS; integrated systems; intensive finishing; confinement; semi-confinement; consortium; health; additive.
Certification	Labels and certificates that attest to production in line with the precepts of good practices, health, quality, and environmental compliance.	Label, certification, authentication, certificate, audit.

Source: Study results. Development: Agroicone

For each of the categories, the instruments⁽²⁵⁾ were divided into several subcategories. The institutions involved in each of the instruments were also classified. Other characteristics such as public or private nature of the intervention, target audience, and territorial scope were also considered. A total of 112 instruments were

mapped, involving 142 institutions. Of the total instruments, 64 of them (57.66%) are of a strictly private nature, while 42 (37.84%) are public initiatives and only 5 (4.5%) are public-private partnerships. Figure A1 shows how the dynamics of actions aimed at sustainable cattle ranching intensified, especially in 2021 and 2022.

Figure A1 - Evolution of the number of instruments by category between 2017 and 2023



Source: Study results. Development: Agroicone

(25) For simplification purposes, all projects, initiatives, actions, and instruments will be addressed exclusively as the term "instruments".

Instruments for promoting good livestock practices were the most common over time, recording their peak in 2022. Also noteworthy are the PES instruments, which also emerged more strongly in 2022, as well as sustainable finance instruments. Intended to highlight the main

instruments, the analysis was divided by category.

Institutions also went through a categorization process, depending on their field of activity. Table A2 summarizes the universal characteristics of each class, as well as the number of institutions per class.

Table A2 - Type of institution by description and number of institutions

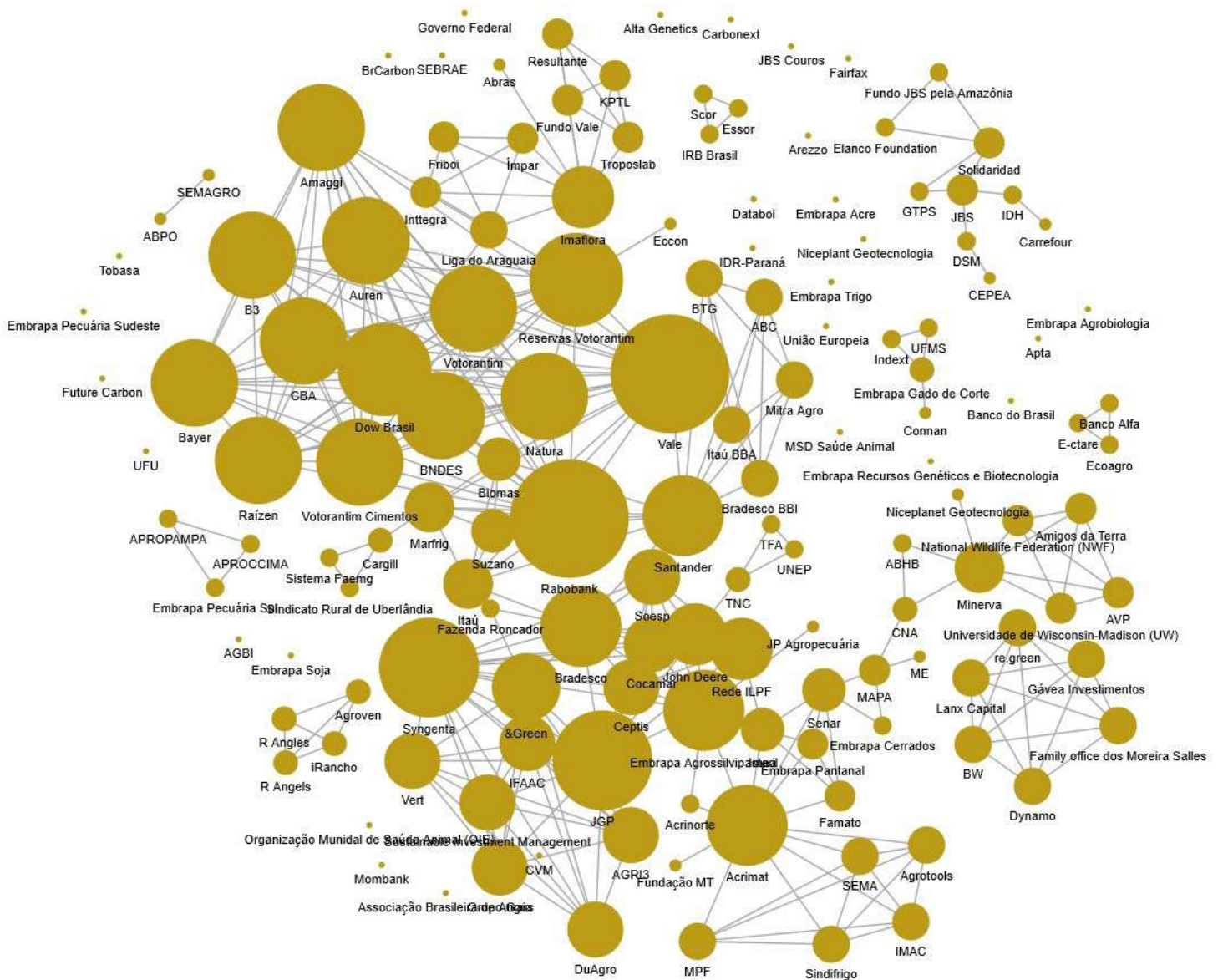
Type of institution	Description	Number of institutions
Financial institution	Banks, securitization companies, insurance companies, reinsurance companies, investment funds.	34
Research institution	Institutions that work in applied agricultural research. Institutions funding research initiatives are also included.	32
Associations/unions	All and any type of association, union, or class representative of the links in the beef production chain. That is, producers, slaughterhouses, retailers.	15
Inputs	Input reseller companies.	14
Technological solutions	Companies based on technological solutions for the field, such as geomonitoring.	10
Ecosystem services	Companies specialized in pricing and marketing of ecosystem services via PES instruments.	9
Governments	Federal, state, and municipal governments.	8
Infrastructure	Infrastructure and power companies.	6
Service provision	Companies providing services such as technical assistance and rural extension.	5
Retail	Retailers overall.	5
Slaughterhouse	Slaughterhouses overall.	3

Source: Study results. Development: Agroicone

In addition, social networks were produced by instrument category. These networks reflect how the interrelationships between companies take place in the respective instruments identified. The larger the circle, the greater the level of centrality,

that is, the greater the number of connections with other companies, indicating a potential for mobilization between companies. Figure A2 presents the social network of sustainable cattle farming in Brazil for the period of 2018-2023.

Figure A2 - Social network of sustainable cattle ranching in Brazil between 2018 and 2023



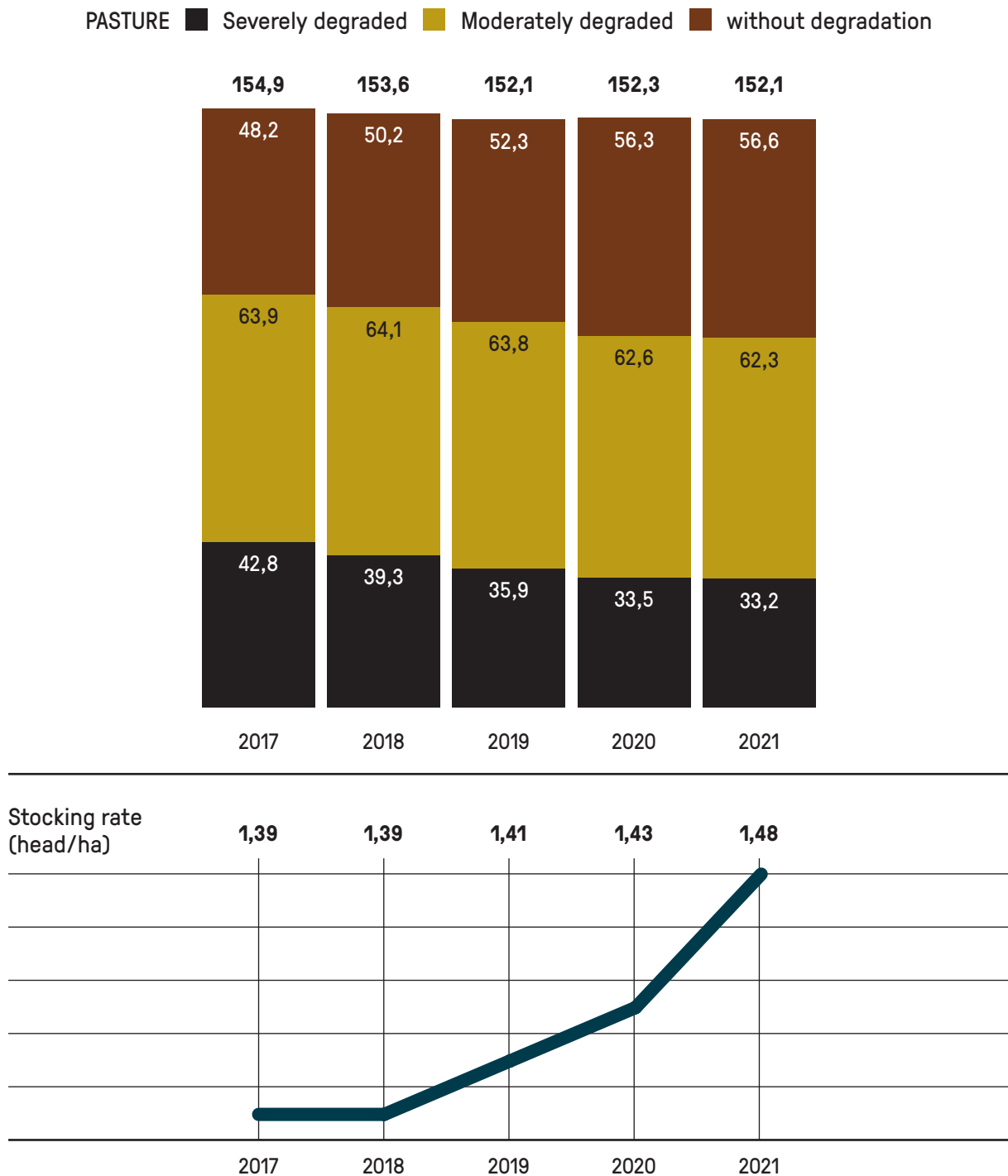
Source: Study results. Development: Agroicone

It is worth mentioning the weaknesses and limitations of the adopted methodology. The model considers only the news published in

communication vehicles. Therefore, the analysis is subject to the editorials of each of the outlets and conditioned to the previously defined dictionary.

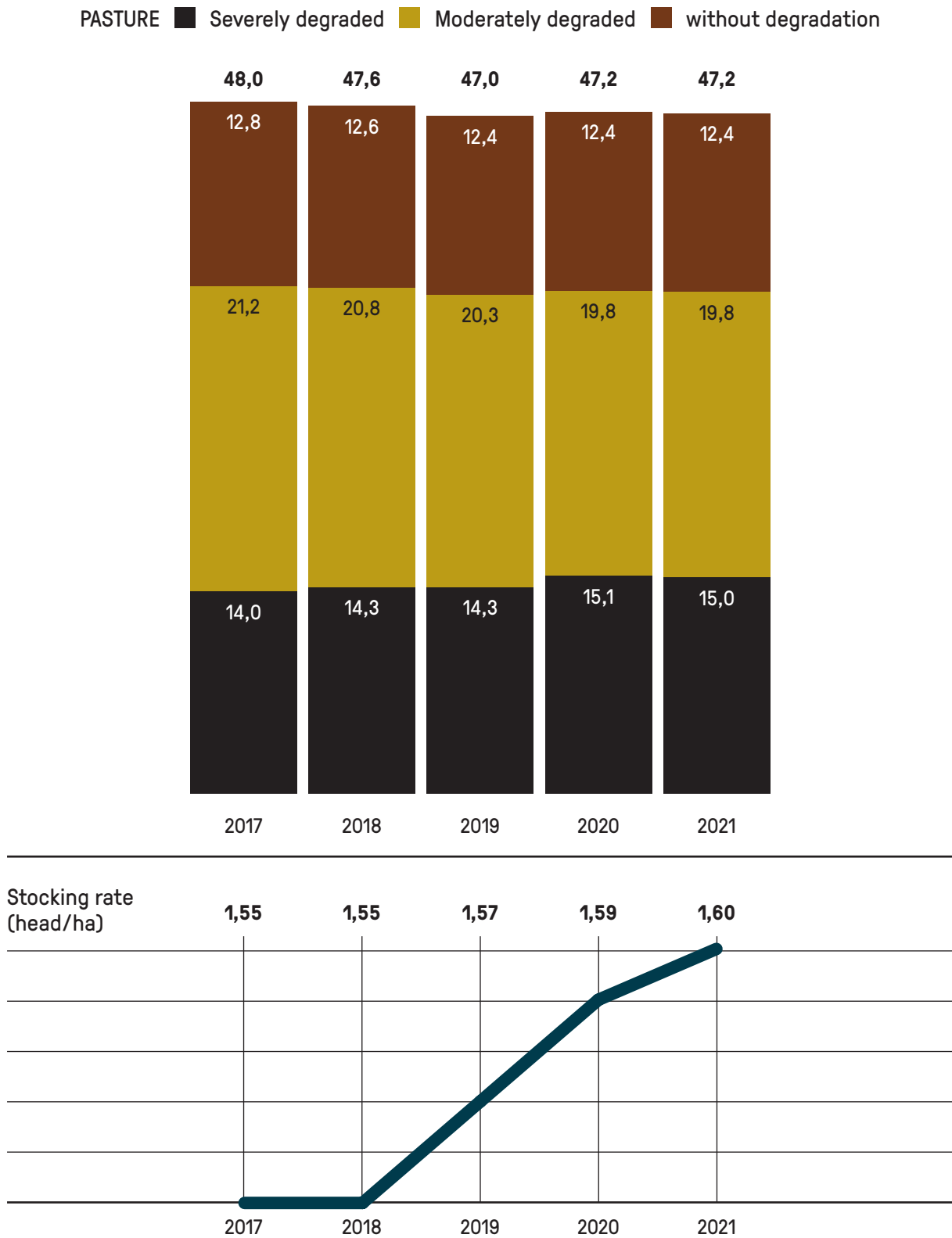
Appendix B • Auxiliary data on the Brazilian cattle ranching production

Figure B1 - Dynamics of pasturelands (ha) by quality of pastures and stocking rate (head/ha) in Brazil



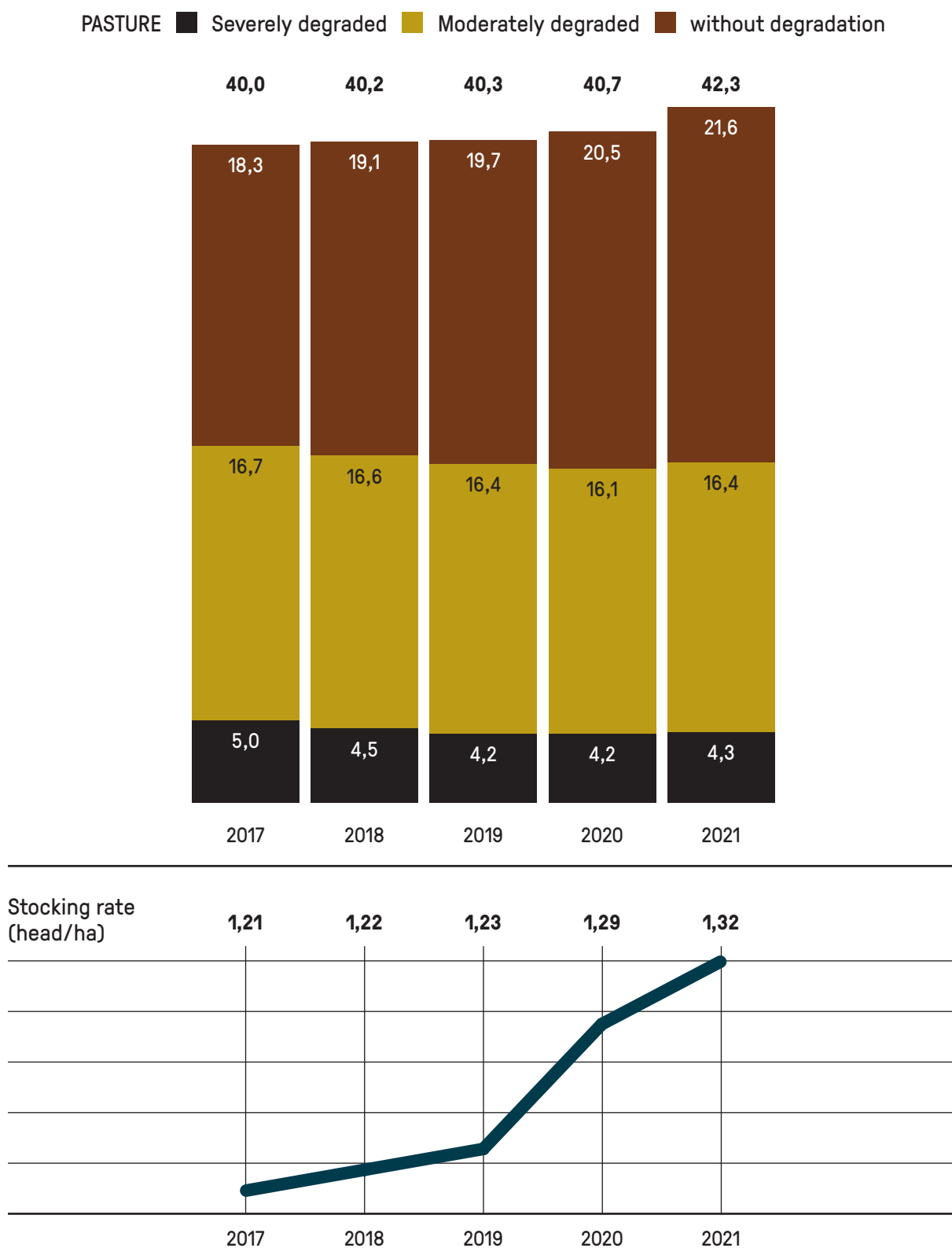
Sources: IBGE, Mapbiomas. Development: Agroicone

Figure B2 - Dynamics of pasturelands (ha) by quality of pastures and stocking rate (head/ha) in the Midwest region



Sources: IBGE, Mapbiomas. Development: Agroicone

Figure B3 - Dynamics of pasturelands (ha) by quality of pastures and stocking rate (head/ha) in the North region



Sources: IBGE, Mapbiomas. Development: Agroicone

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