STUDY

RESTORATION OF DEGRADED LANDS AND REHABILITATION OF SOILS IN THE BRAZILIAN CERRADO

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Introduction

According to The World Bank Group (2020), agriculture is an important sector of Brazil's economy that benefits from a variety of benign production conditions and the natural resources to scale production. The agribusiness sector has contributed to the expansion of the Brazilian economy over the past four decades and represents around one fifth of its GDP. Brazil is an important agricultural commodities' producer, for both national and international markets.

Historically, the production was concentrated in the Northeast, South and Southeast of the country, producing grains, sugarcane, beef, fruits, etc. With the food, fiber, fuel and feed demand growth in the last four decades, production expansion was driven to the Mid-West and North regions, displacing forests, savannahs and other types of native vegetation.

This expansion resulted on large areas of pasturelands (planted pasture) which, according to Mapbiomas - Collection 5 (2020) sum 167.5 million hectares in 2019 (65% of total area allocated to agricultural production), mostly used

for extensive cattle production. In addition, the lack of good agricultural practices and pastureland management resulted on degraded areas, with low productivity and income, also becoming a driver of deforestation. Other crops, mostly soy, has displacing pasture areas for their expansion, but also native vegetation mainly in the Cerrado biome.

Degraded pasture areas recovery represents the following benefits: higher yield for cattle production, higher income for farmer, increase on carbon stocks in the soil, avoid the need to additional areas for agricultural expansion (avoiding deforestation), among others.

The rationale behind the importance of addressing the recovery of degraded areas relates to the explicit need to use natural resources comprehensively. Despite the availability of native vegetation areas suitable for agriculture, it is quite important to drive the use of converted areas optimizing land use and maximizing production and conservation, in line with the Forest Code (Law n. 12,651/2012) regulation requirements.

In this sense, it is critical to discuss and create opportunities for conversion of degraded land into highly productive land, combining

technology adoption and development that presents economic returns for agriculture, forestry and livestock supply chains.

Having this scenario as a basis, the present paper aims to analyze and put into perspective the challenges and ways to recover degraded land in the Cerrado biome. Within the scope of the consultancy on restoration of degraded lands in the Brazilian Cerrado, Agroicone presents this document as a final report with the results of degraded pasturelands' zoning in the Cerrado, the financing available for degraded land recovery, an exploratory analysis about why farmers are not taking credit and/or implementing these practices and business cases based on cattle ranching activity in the Guariroba river basin (Mato Grosso do Sul), in Araguaçu (Tocantins) and Canarana (Mato Grosso).

The first section of this report gives a brief introduction about the Cerrado biome, showing land use and land cover data. It then presents the degraded pastures in the Cerrado and the potential that some agricultural supply chains have to recover these areas. Two types of production systems are also presented: integrated systems and agroforestry systems.

The second section introduces the rural credit in Brazil, the main public policy that has been used to foment agriculture in the country, and, through data from Central Bank of Brazil, it was evaluated the resources allocated to recover degraded lands in the Cerrado. Then, it was analyzed data from Agricultural Census to understand the number of farms that had access to rural credit recently.

The third section presents how soy farmers have been funding their operational costs, based on data for Mato Grosso state.

The fourth section explores rural producers' confidence in the Brazilian economy and in the agribusiness sector.

The fifth section explores the research on investment intention by cattle ranchers.

The sixth section presents the perceptions regarding the decision of producers to advance agricultural production over cleared areas.

The seventh section provides the results of the questionnaires and the assessment about why ranchers are not taking credit / implementing land recovery practices.

The eighth section presents business cases for pasture recovery in three regions: in Guariroba River basin (Mato Grosso do Sul state), in Araguaçu (Tocantins state) and in Canarana (state of Mato Grosso).

The last section presents final remarks of this study and recommendations to support WWF to address the degraded pasture areas recovery in the Cerrado biome.

CHAPTER 1

Zoning of degraded pastures

1.1 The Cerrado biome

The Brazilian Cerrado is characterized as a tropical savanna. It is the second largest biome in South America, with 200 million hectares, occupying 22% of the national territory and its continuous area covers (partially or totally) the states of Goiás, Tocantins, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Bahia, Maranhão, Piauí, Rondônia, Paraná, São Paulo and Distrito Federal.

Due to its geographical position and ecological characteristics, the Cerrado plays an important role for Brazilian society in terms of biodiversity and maintenance of natural resources, particularly water resources, as well as agricultural production developed in its territory. In this territorial space are the springs of the three largest river basins in South America (Amazon/Tocantins, San Francisco and Prata).

The most current and complete data on land use and land cover are from MapBiomas - Collection 5 (2020). According to this source, in 2019 the Cerrado had an

area of 89.2 million hectares (46.5%) with forest formation, which includes forests, savannas and mangroves. Agricultural activity occupied 86.9 million hectares (43.8%), of which 25.9 million are agriculture and 61 million are pasture. In ***Figure 1*** and ***Figure 2*** it is possible to observe in more detail the land use and land cover in the biome.

Figure 1.
Land Use and Land Cover in Cerrado in 2019

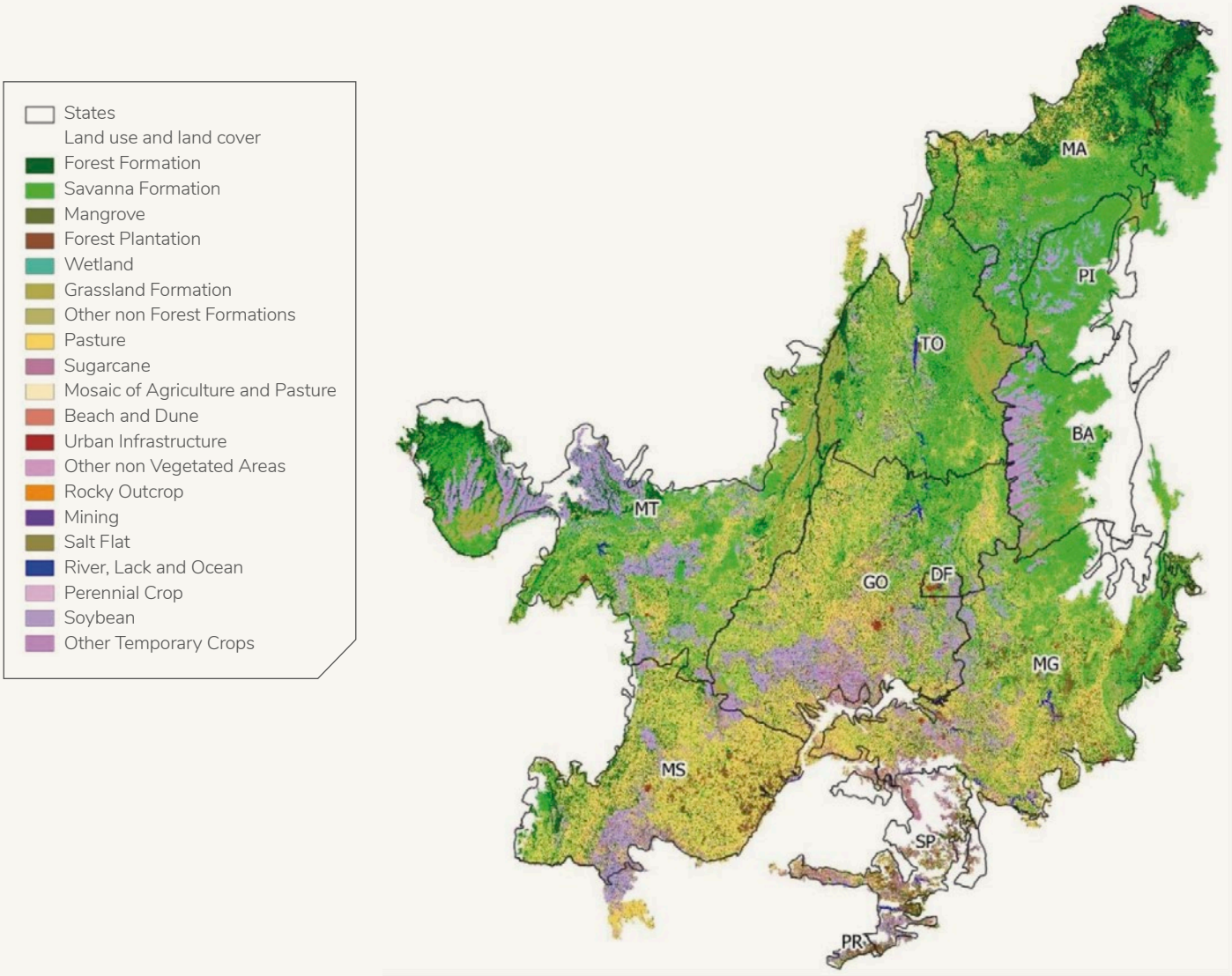
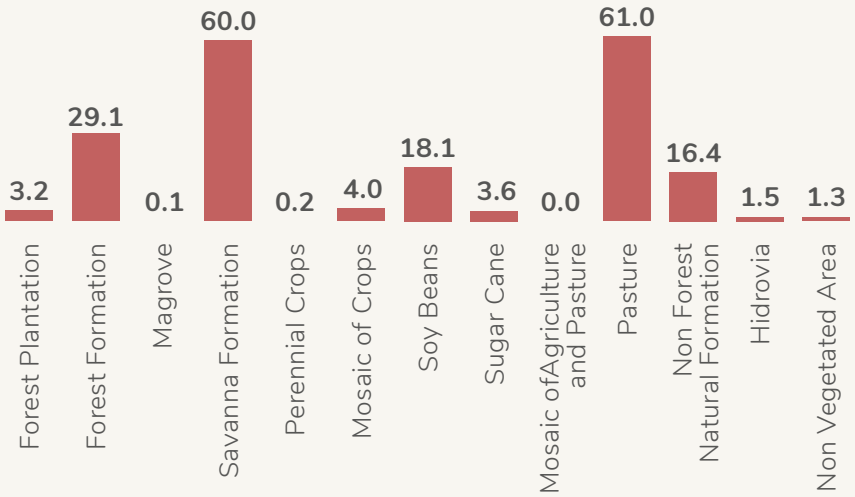


Figure 2.
Land Use and Land Cover in Cerrado - area by use in million hectares

Source: MapBiomas – Collection 5 (2020). Elaborated by Agroicone



From 2010 to 2019, the native vegetation of the Cerrado was removed to replace 5.5 million hectares (Mha) of pastureland and another 2.1 Mha of annual and perennial crops. Agricultural crops expanded 14 Mha in the same period, showing that the expansion has been occurring mainly over pasture areas (more details are in ***Annex 2*** - Transition of land use (net) from 2010 to 2019 in the Cerrado biome). According to MAPA (2020), the grain area should increase 11 Mha from 2019 to 2030 in Brazil, mainly in the Cerrado biome.

A study conducted by Agrosatélite (2018) indicated that the pattern of soybean expansion in the Cerrado has changed over the years. In the period from 2000 to 2007, 32% expanded over native vegetation and another 68% over cleared areas. Between 2007 and 2014, the scenario was similar, 25% of the expansion occurred over vegetation. Between 2014 and 2017, the expansion in vegetation area reached 8%.

Even with the change in the pattern of expansion, agriculture can still represent a risk for the conservation of the Cerrado (TNC, 2020). The use of technologies and good agricultural practices, such as recovery of degraded pasture and integrated systems, can play a significant role in promoting changes in land use and a more sustainable agriculture.

Related to that, it is estimated[1] that in Brazil, between 2010 and 2017, 10.44 million hectares of pastureland were recovered, which allowed to mitigate between 39.57 and 57.52 million Mg CO_2 equivalent. The integrated systems have achieved an area expansion from 2010 to 2016, of 5.83 million ha, allowing mitigation between 22.10 and 36.40 million Mg CO_2 equivalent.

The high stock of pasture and the intensification of cattle ranching (increasing cattle ranching while reducing pasture area) provides the opportunity to expand agriculture over or along with pasture. This intensification, for example, is fundamental to fill productivity gaps, allowing efficiency in livestock production and, at the same time, reducing land degradation and carbon emissions from cattle (as reduces the slaughter age of cattle).

[1] Source: MANZATTO, C. V. (et. al). Mitigação das emissões de Gases de Efeitos Estufa pela adoção das tecnologias do Plano ABC: estimativas parciais. Embrapa Meio Ambiente. Jaguariúna, SP. 2020; MAPA, Diagnóstico da expansão da adoção da tecnologia de Tratamento de Dejetos Animais (TDA) no território brasileiro entre 2010 e 2019.

1.2 Degraded pasture in the Cerrado

The pasture referred in this report consists of an area fenced and covered by planted forage plants, being the main ones of the genera Brachiaria, Panicum and Cynodon, which is used to food by animals directly. Macedo and Zimmer (1993, apud Zimmer et al., 2012), Macedo (1995, apud Kichel et al., 1999), Peron and Evangelista (2004), Townsend et al. (2012), Moreira and Assad (2000), Macedo et al. (2000), Macedo et al. (2013) and Ismar (2015), define pasture degradation as “an evolutionary process of the loss of vigor, productivity, the capacity of natural recovery of pastures to sustain the levels of production and the quality required by animals, as well as the to overcome the harmful effects of pests, diseases and invaders, culminating in the advanced degradation of natural resources due to inadequate management”.

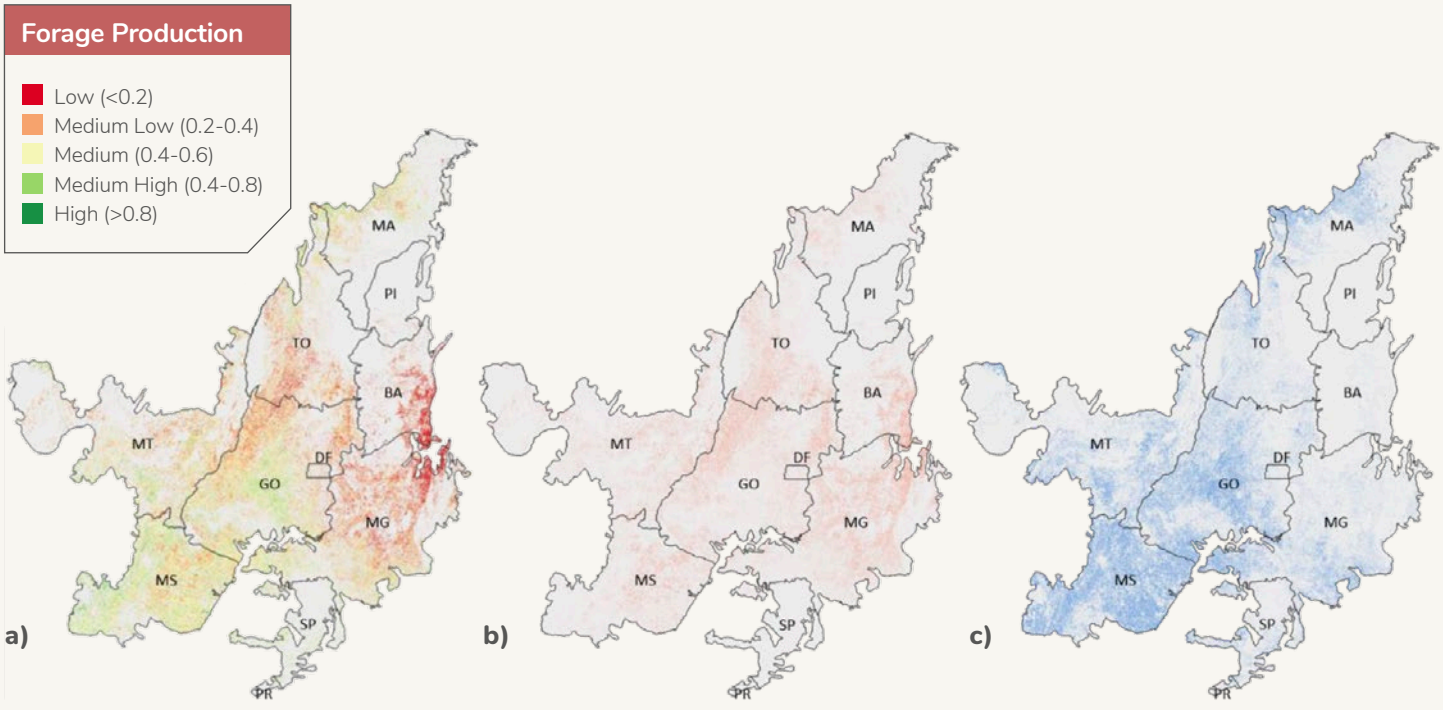
For Dias-Filho (2014a) the pasture can be considered degraded due to different conditions. The extremes of these conditions are called **agricultural degradation**, where there is a change in the botanical composition with an increase in the proportion of weeds in the pasture and a decrease in the carrying capacity, and **biological degradation**, when the soil loses its capacity to support plant production significantly, with drastic decrease in plant biomass.

The researchers of Image Processing and Geoprocessing Laboratory – LAPIG conducted a study about degraded pastures in 2019, classifying pasture areas for the year 2018. They analyzed the pasture by Normalized Difference Vegetation Index (NDVI) over the years, using images from Modis and Landsat satellites. From the index it was defined forage production classes, ranging from 0 to 1 ***(Figure 3a)***.

The low productive pastures (below 0.4) were classified as degraded. And the high productive pastures (above 0.4) were classified as undegraded. Approximately 62.8 million hectares of pasture were classified: 23.7 million of degraded pasture ***(Figure 3b)*** and 39.1 million of undegraded pasture ***(Figure 3c)***.

Figure 3.
a) Map of pasture quality in 2018;
b) Map of degraded pasture;
c) Map of undegraded pasture

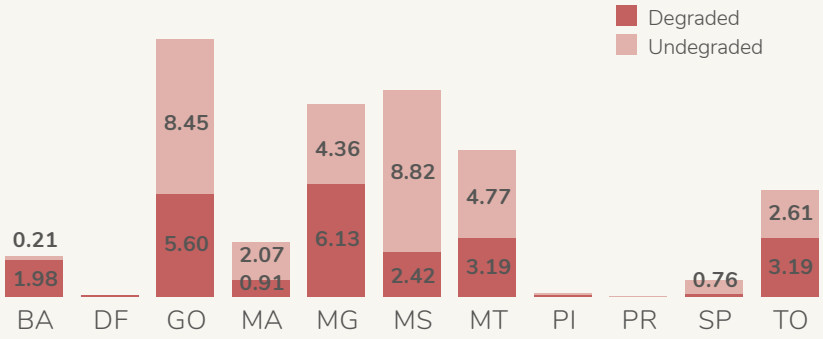
Source: LAPIG (2019).



The states with the largest areas of degraded pasture are Goiás, Mato Grosso do Sul, Mato Grosso e Minas Gerais ***(Figure 4)***.

Figure 4.
Pasture areas in the Cerrado in 2018 (million hectares)

Source: LAPIG (2019).
Elaborated by Agroicone.



The aim to restore pastures and turn it into productive areas is a challenge when it comes to optimizing land use and incorporating technology. Moreover, since 2011, the recovery of degraded pastures and integrated systems implementations was incorporated into the Low Carbon Agricultural Policy, as an effort that Brazil will pursue regarding climate change mitigation and adaptation targets presented at COP-15 in Copenhagen. In addition, the restoration of 15 million hectares (MH) of degraded pastures and implementing 5 MH of integrated crop-livestock-forestry systems are part of the contributions of Brazil to the Paris Agreement as key actions towards low carbon agriculture, together with deforestation reduction. Those practices are essential to recover the capacity of areas that were deforested, abandoned or inappropriately managed over time.

From a policy perspective, it is possible to say that while tackling deforestation will continue to be a target, especially ending illegal deforestation, Brazil has an enormous opportunity to use pastureland, degraded or not, in a strategic manner. The rationale is to reduce abruptly the deforestation, while cleared areas are recovered and managed, maximizing productivity and increasing technology adoption.

There are different agronomic techniques to improve degraded pastures, such as pasture recovery and renovation, or the implementation of integrated crop-livestock-forestry systems (ICLFS) and their combinations.

The recovery consists in the rehabilitation of the production of fodder, keeping the same species or cultivar. The renovation consists in re-establishing fodder production with the introduction of a new species or cultivar, replacing the degraded ones. Recovery and renewal may occur directly or indirectly: when the machinery and soil correctives are used, the recovery and renewal is classified as direct. In the indirect technique it is used other crops in rotation, as grain or green manure, to improve the soil aspects (MACEDO et al., 2000).

The technique to be used will depend on the purpose that this pasture will have (intensification

of cattle raising, soy expansion, planting of commercial forests) and on the degree of pasture degradation. Therefore, it is important to make the evaluation in the field and thus make the best decision for the land rehabilitation.

1.3 Agricultural supply chains

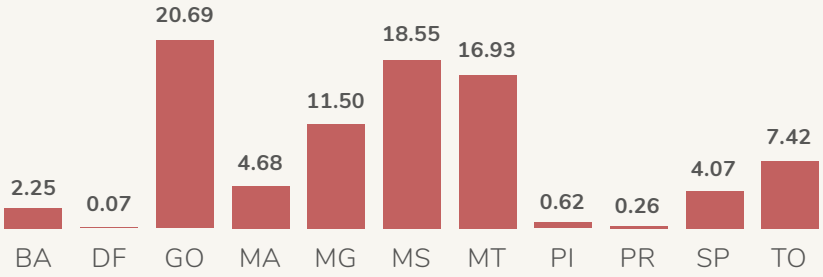
1.3.1 BEEF SECTOR

Brazilian cattle herd sum 213.4 million heads in 2018, according to data from the Municipal Livestock Research - Brazilian Institute of Geography and Statistics (PPM – IBGE, 2018). In the Cerrado this sum was 94 million heads, which represented 44% of the total in Brazil. The states with the largest cattle herd are Goiás, Mato Grosso do Sul, Mato Grosso, and Minas Gerais.

PPM-IBGE does not inform the number of cattle specifically for the beef sector. For this reason, this data was estimated from the difference between the total herd and the number of dairy cows, using other data from PPM-IBGE. The number of cattle herds in the beef sector reached 88.6 million in the Cerrado ***(Figure 5)***, which represents 94.3% of the total herd. About 84% of this herd is concentrated in media and large properties and 16% in family farms.

Figure 5.
Beef cattle herd estimated (million heads)

Source: Estimated data from PPM – IBGE (2018). Elaborated by Agroicone.

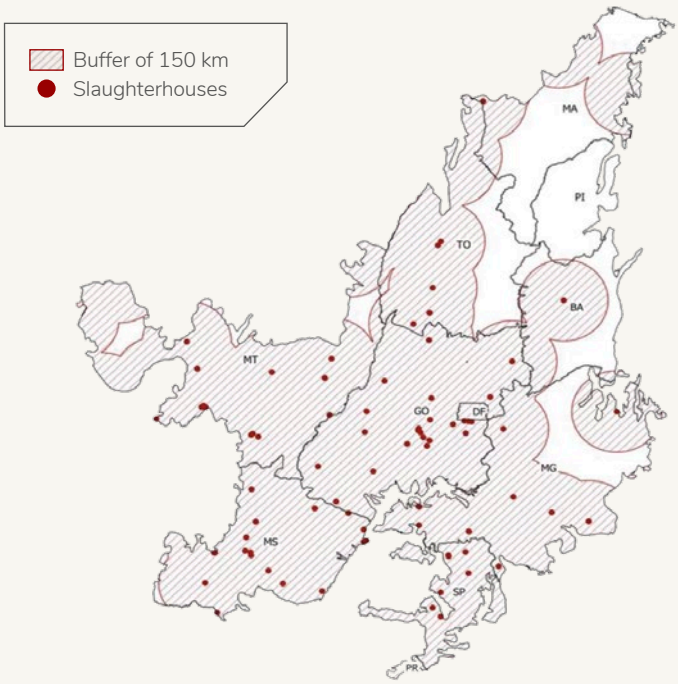


To identify the degraded pasture areas with potential for intensification of beef cattle, the following criteria were used:

Proximity to slaughterhouses - the Cerrado has 80 slaughterhouses according to the survey conducted by LAPIG. A radius of 150 km was generated from these slaughterhouses. This represents the economic radius of this industry; it was obtained from conversations with partners who work in the chain and studies conducted by Agroicone. Properties within this radius were selected ***(Figure 6)***.

Figure 6.
Slaughterhouses and radius of 150 km

Source: LAPIG (2017). Elaborated by Agroicone



Properties that have livestock as their main activity - properties that have at least 50% of their area with pasture.

In order to obtain the information by property size, the degraded pastureland was combined with the land tenure prepared by Imaflora (2018). After applying the criteria, the results show an area of 5.6 million hectares (Mha) of degraded pasture with potential for intensification of beef cattle production ***(Figure 7)***. Regarding the size of the farms, 3.1 Mha are in small properties, 1.4 Mha in medium and 1.1 Mha in large. The states with the largest potential areas are Goiás (2 Mha) and Mato Grosso do Sul (1.3 Mha).

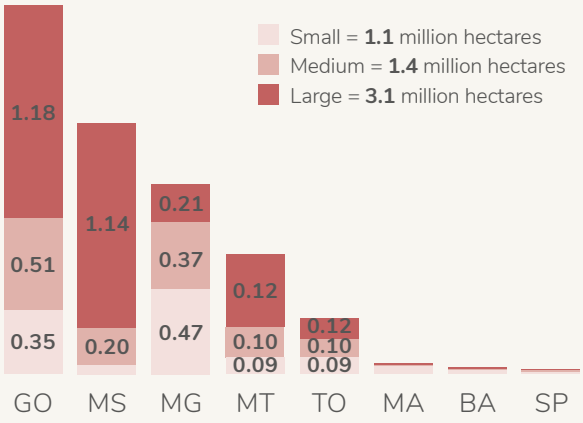
Figure 7.
Degraded pasture with potential for livestock intensification

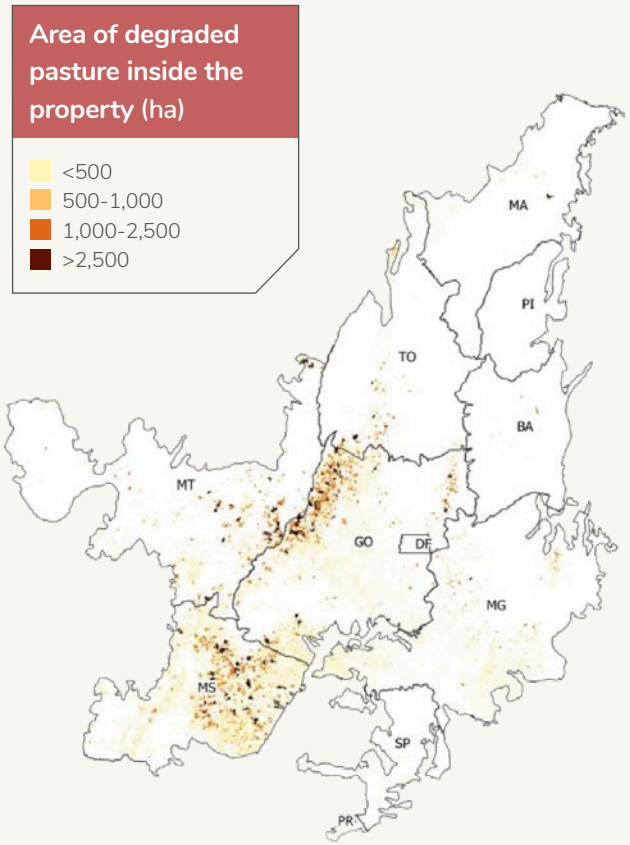
Source: Study results. Elaborated by Agroicone.

5.6 MILLION HECTARES

of degraded pasture for livestock intensification

Area of degraded pasture (million hectares)





1.3.2 DAIRY SECTOR

For the dairy sector, data from IBGE - Agricultural Census (2017) was used. According to this source, there was 3.7 million heads of dairy cows, being 1.6 million in medium/large properties and 2.1 million in family farming. Production reached 9.9 billion liters of milk for each type of property - family and medium/large – contributing with 50% of this production. Thus, it is important to mention that productivity in family farming is lower than in medium/large farms, 2,354 and 3,173 liters/cow/year, respectively.

The criteria to evaluate the degraded pasture with the potential of intensification for dairy sector were the proximity to dairy plants and properties that have livestock as their main activity. For the first criterion it was generated a radius of 100 km from the dairy plants (51 plants in the Cerrado). After the selection of the properties within this radius, it was selected those that have at least 50% of their area with pasture ***(Figure 8)***. As a result, an area of 4.3 million hectares (Mha) of degraded pasture with potential for intensification of dairy production was selected ***(Figure 9)***. About 1.2 Mha are in small properties, 1.3 Mha in medium and 1.8 Mha in large. The states with the largest potential areas are Minas Gerais (2 Mha) and Goiás (1.7 Mha).

Figure 8.
Dairy plants in Cerrado

Source: MAPA (2018).
Elaborated by Agroicone

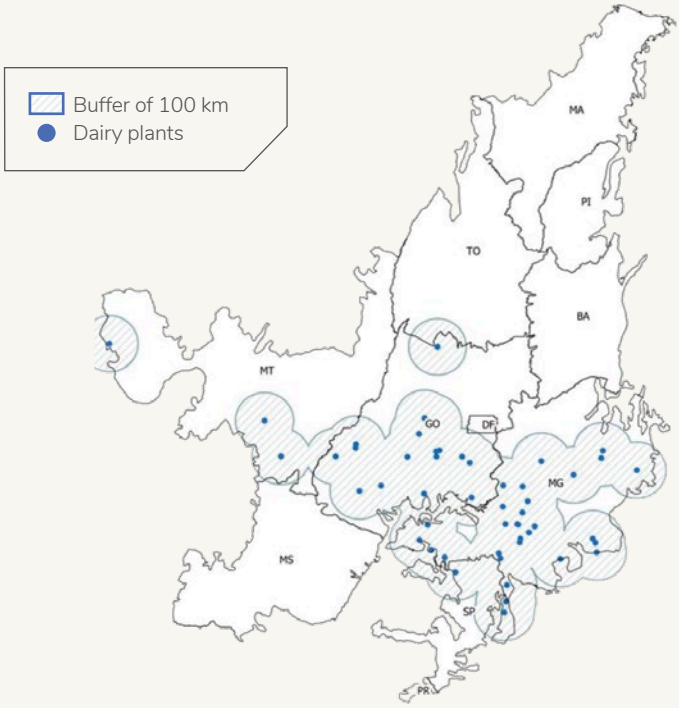


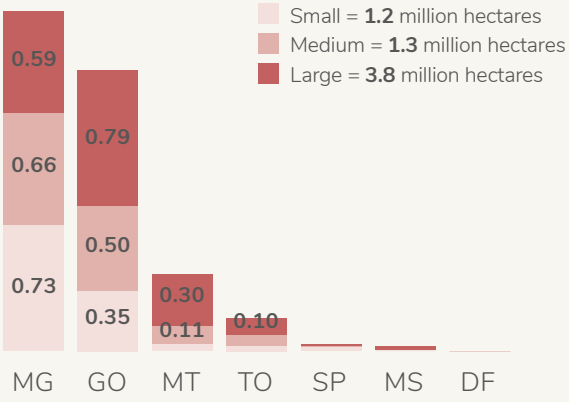
Figure 9.
Degraded pasture with potential for intensification of dairy farming

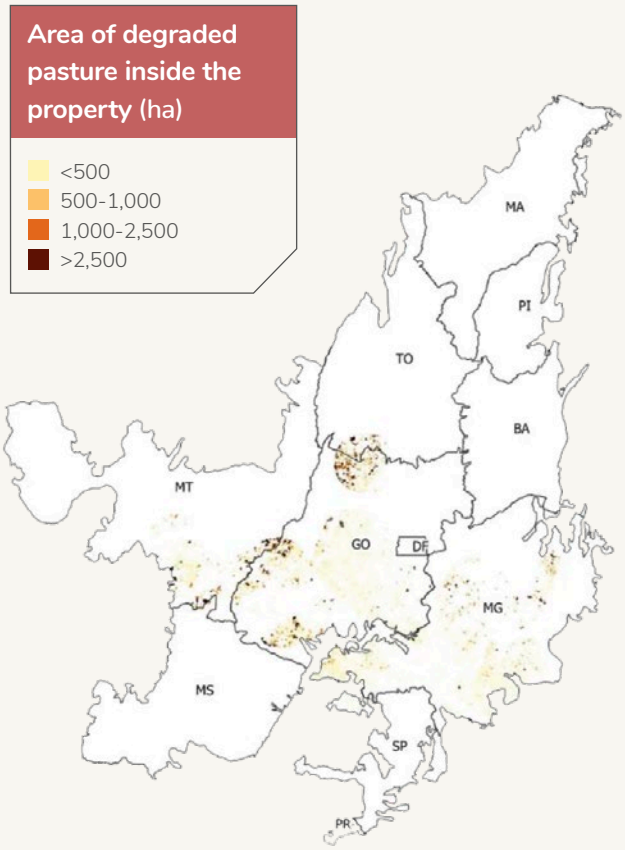
Source: Study results.
Elaborated by Agroicone.

4.3 MILLION HECTARES

of degraded pasture for intensification of milk production

Area of degraded pasture (million hectares)



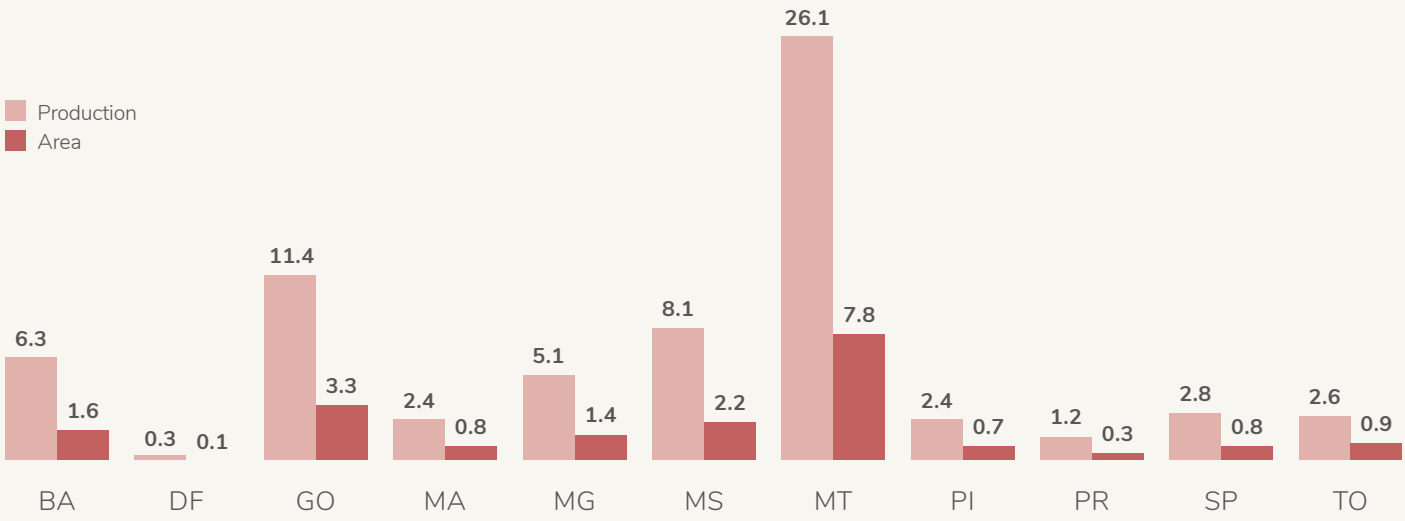


1.3.3 SOYBEAN SECTOR

Brazil is a major producer of soybeans, disputing the position of largest world production with the United States. In 2018, the soybean planted area in Brazil was 34.8 million hectares, and production reached 117.9 million tons. Cerrado biome has 59% share in production (69.3 million tons). This production is distributed over 20 million hectares (PAM-IBGE, 2018), 98% of which is concentrated in medium and large properties ***(Figure 10)***.

Figure 10.
Area (million hectares) and production (million tons) of soybean in the Cerrado

Source: PAM-IBGE (2018). Elaborated by Agroicone.

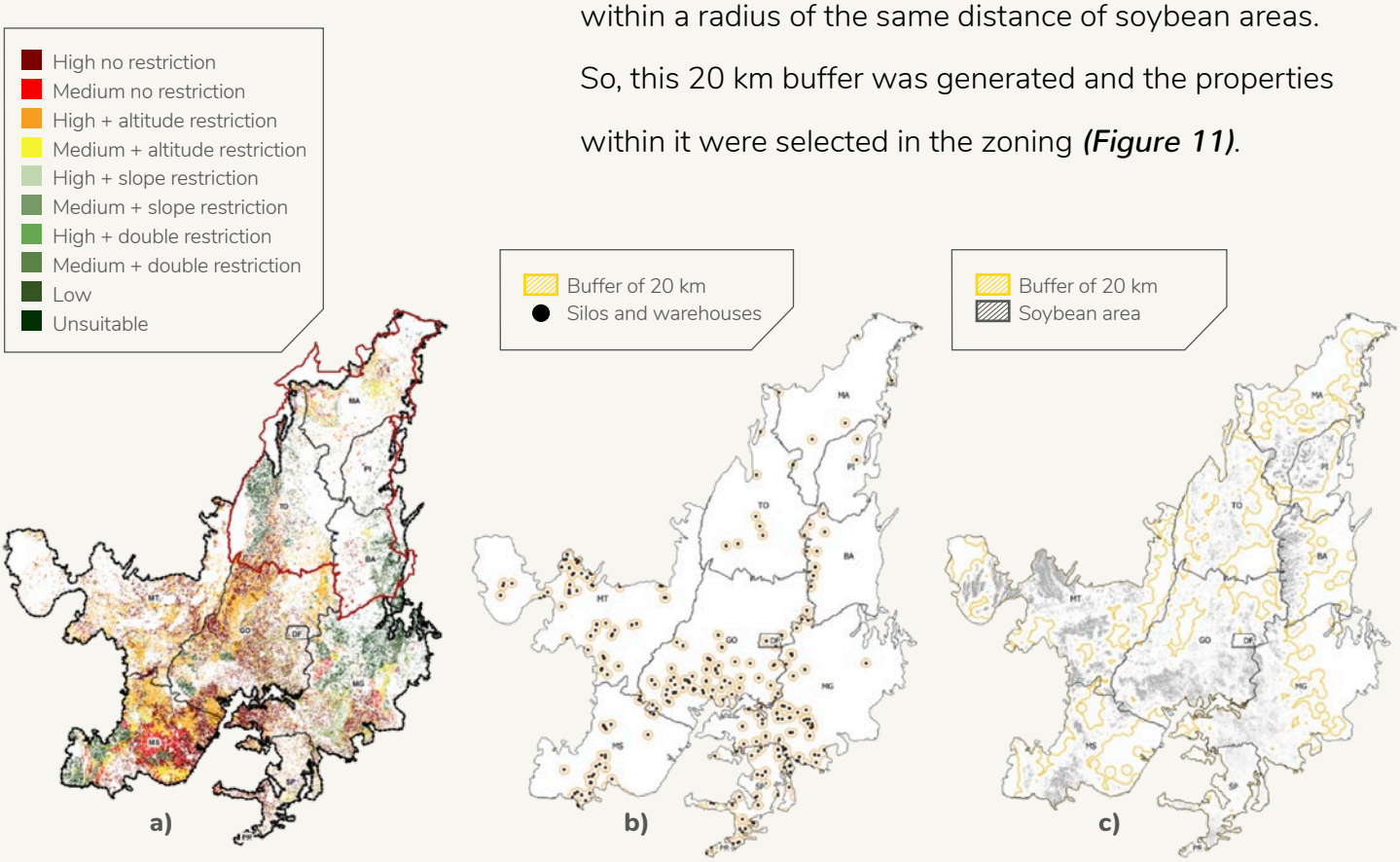


To identify degraded pastures with potential for soybean expansion, the criteria used were agricultural suitability, proximity to silos and warehouses, and proximity to soybean planted areas.

Agrosatélite (2017) was used for agricultural suitability[2]. The degraded pastures were combined with the high agricultural suitability categories, making it possible to select the pastures suitable for soy expansion. To assess the proximity of silos and warehouses, data from the National Supply Company (CONAB, 2019) was used. In total, the Cerrado has 5,550 silos and warehouses. And, for the proximity of the soybean area, was used the soybean map prepared by Agrosatélite (2018). According to the study conducted by Romeiro et. al (2018), more than 90% of the soybean area expands within a radius of 20 km of silos and warehouses, and within a radius of the same distance of soybean areas. So, this 20 km buffer was generated and the properties within it were selected in the zoning ***(Figure 11)***.

Figure 11.
Zoning criteria for soy expansion:
a) Agricultural suitability;
b) Silos and warehouses;
c) soybean area

Source: Agrosatélite (2017 and 2018) and CONAB (2019). Elaborated by Agroicone.



[2] Agrosatelite classifies suitability in 4 categories (high, medium, low, and not suitable) and 4 types of restriction (height, slope, both height and slope, and no restriction). For the zoning we used the category of high suitability only, considering the 4 restrictions (which can be overcome using technologies).

With this cutout were obtained the degraded pasture areas that have high agricultural aptitude for soybean and that are close to soybean infrastructure and markets. Additionally, another filter was applied to select the areas of degraded pasture suitable with more than 100 ha continuous, since soybeans in Brazil are predominantly in medium and large properties.

Applying the criteria described above, we obtained an area of 4.9 million hectares of degraded pasture with potential for soy expansion. This is enough area to increase the current soy area by 25%. The potential areas are almost all allocated in medium and large properties ***(Figure 12)***.

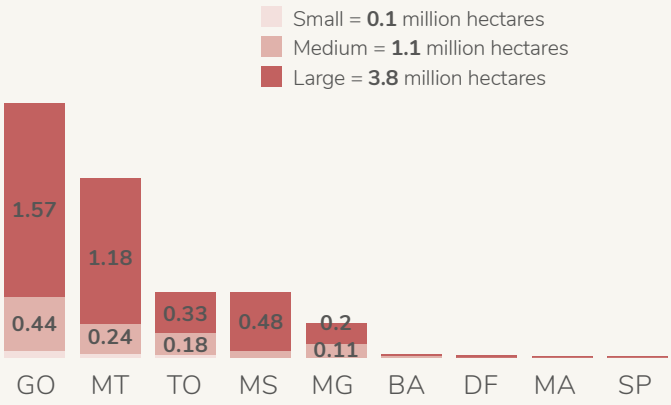
Figure 12.
Degraded pasture with potential for soybean expansion

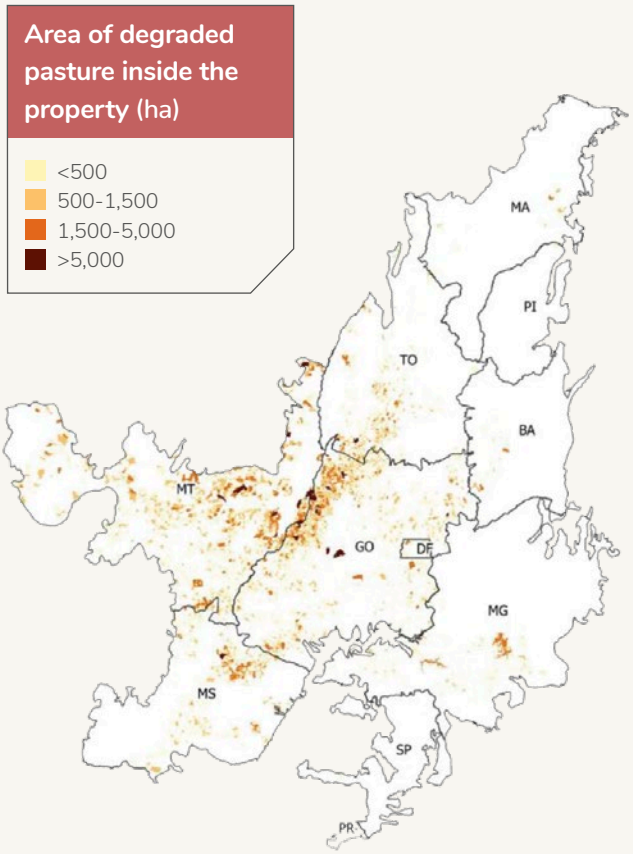
Source: Study results. Elaborated by Agroicone.

5 MILLION HECTARES

of degraded pasture for soybean expansion

Area of degraded pasture (million hectares)

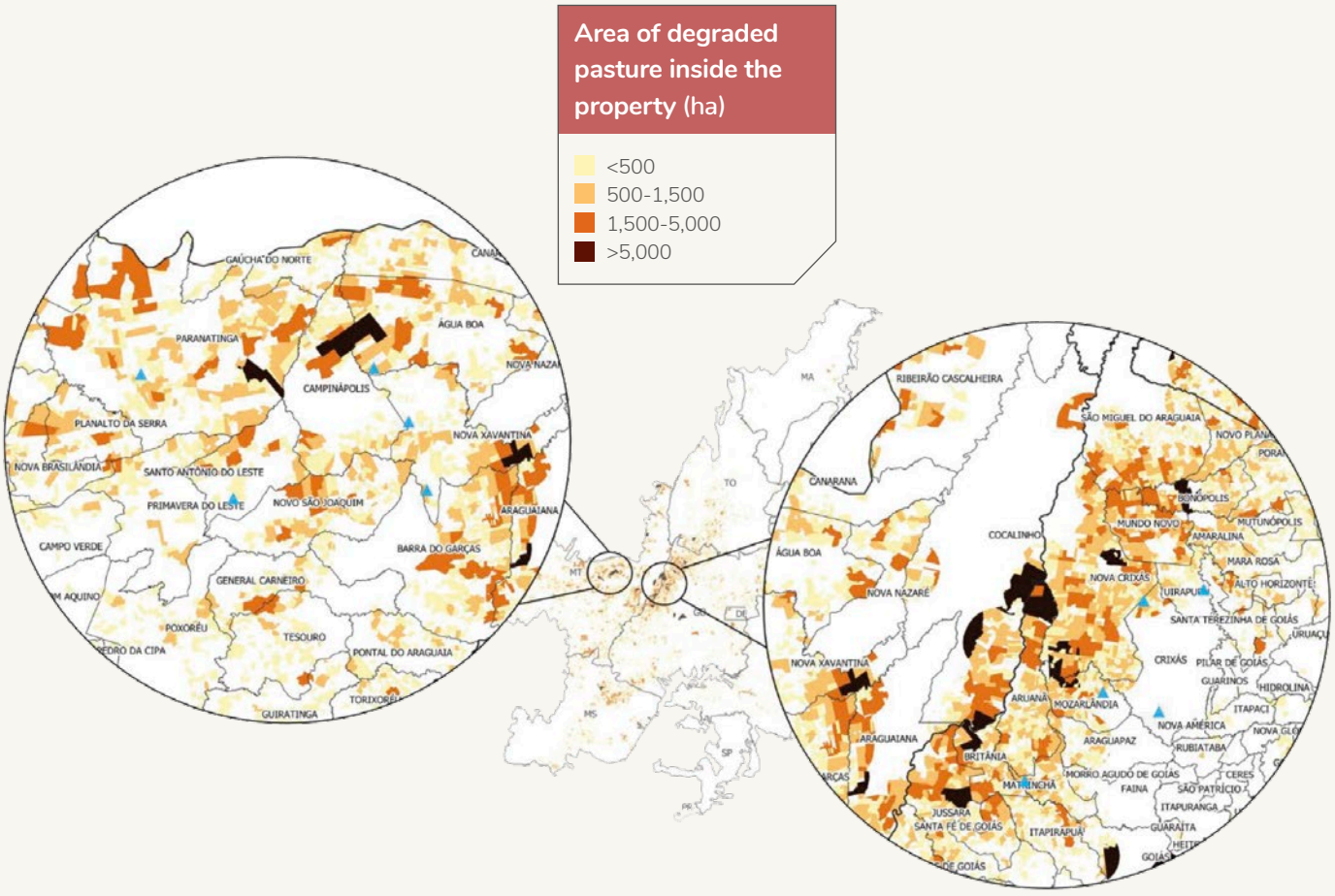




The potential areas are concentrated on the border between the states of Goiás, Mato Grosso and Tocantins. ***Figure 13*** shows a zoom of this region, so it is possible to know which are the municipalities with the best opportunities for soy expansion.

Figure 13.
Zoom of selected regions with potential areas for soy expansion on degraded pasturelands

Source: Study results.
Elaborated by Agroicone

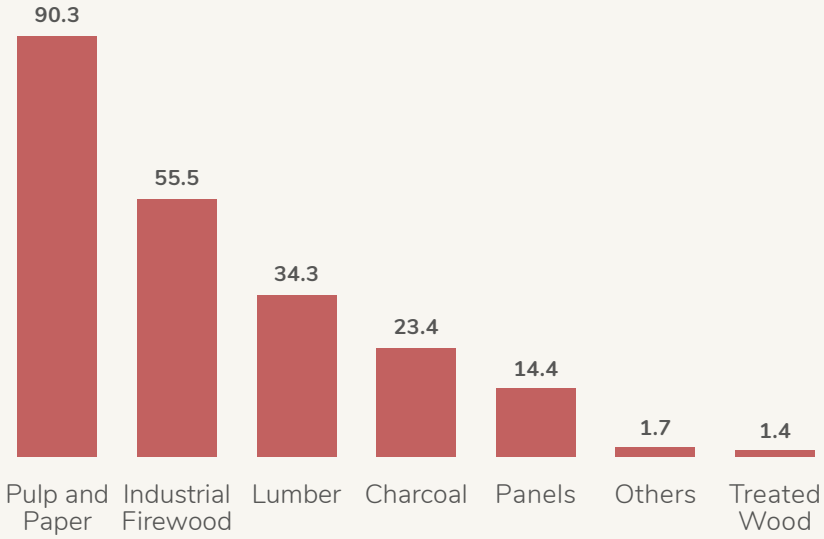


1.3.4 COMMERCIAL FOREST

Brazil has 8.6 million hectares of commercial forests, according to Mapbiomas (2019). Production reached 221 million m³, which was distributed among different types of industries, as shown in ***Figure 14*** (IBÁ, 2018).

Figure 14.
Wood consumption for industrial use (million m³)

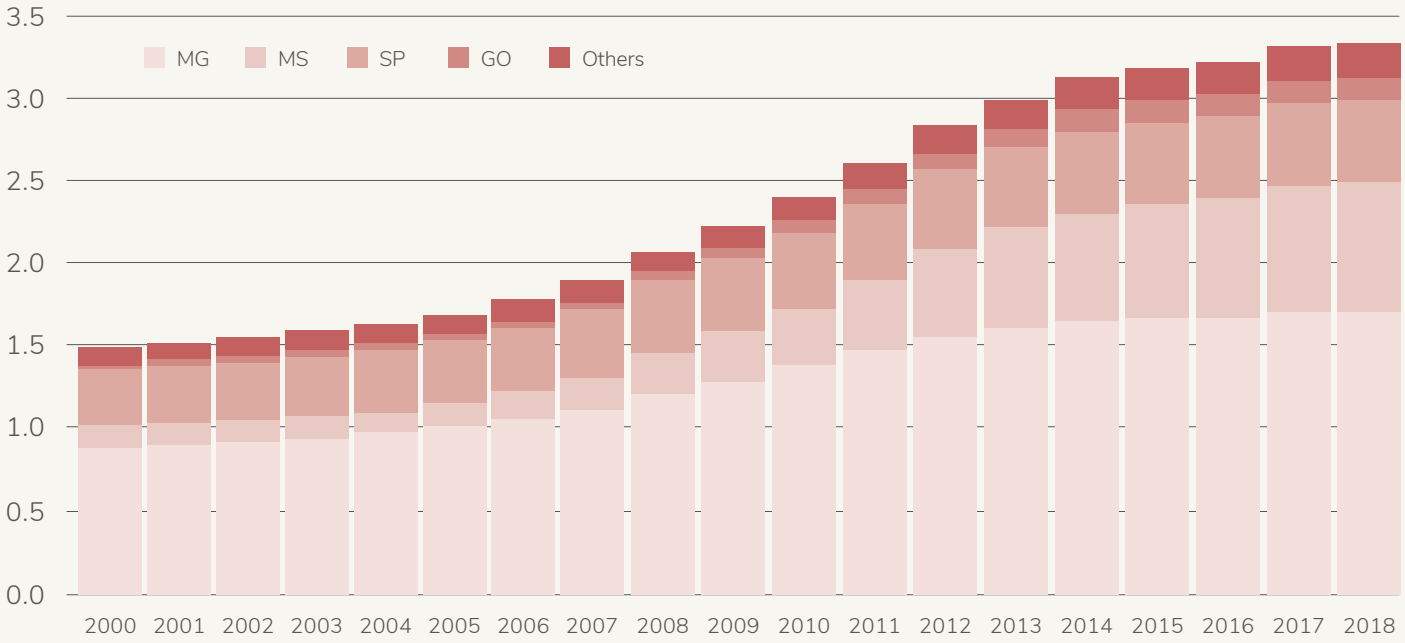
Source: Brazilian Tree Industry (IBÁ), 2018. Elaborated by Agroicone.



Between 2000 and 2018, the national area of commercial forests grew 1.8 million hectares, mainly in the states of Minas Gerais and Goiás ***(Figure 15)***, which are the states with the largest areas as well. In the Cerrado, the area of commercial forests was 3.3 million hectares in 2018, representing 38.6% share.

Figure 15.
Evolution of planted forest area between 2000 and 2018 (million hectares)

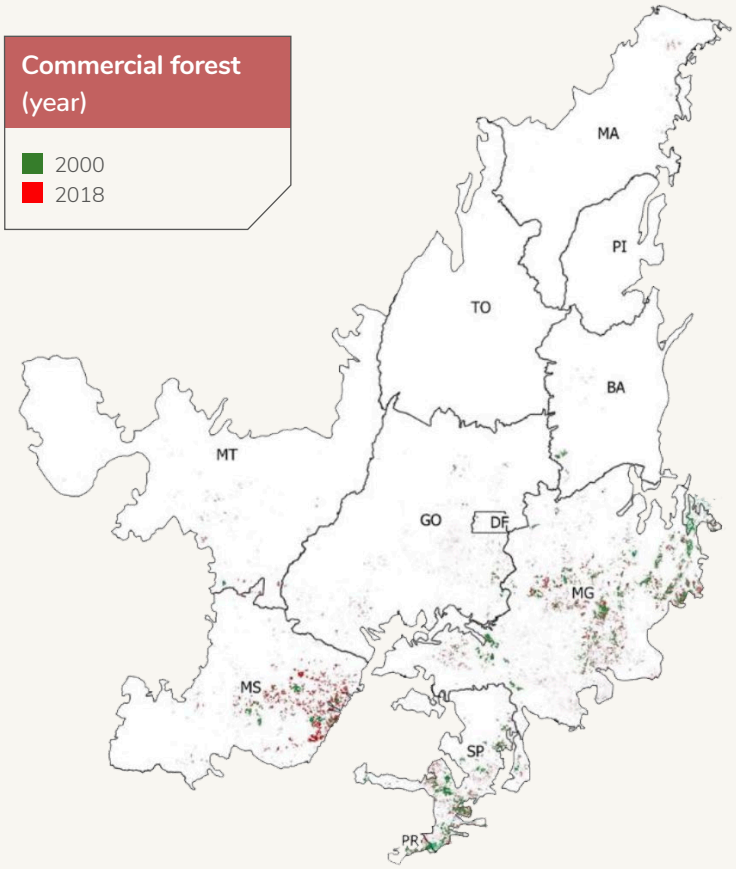
Source: Mapbiomas (2019). Elaborated by Agroicone.



When analyzing ***Figure 16***, it is possible to observe that the area that has expanded in these 18 years is concentrated near the areas already existing in 2000. In a brief analysis, it was verified that 95% of this expansion occurred within a 20 km radius of the consolidated commercial forest areas.

Figure 16.
Commercial forest areas

Source: Mapbiomas Collection 4 (2018).
Elaborated by Agroicone.



Based on this, it was defined as a criterion for selecting potential areas for commercial forest expansion, to be within a radius of 20 km from the consolidated areas of 2018. These would be the most propitious areas for the expansion of commercial forests, because they are close to consumer industries and that there are varieties of trees very adapted to these regions.

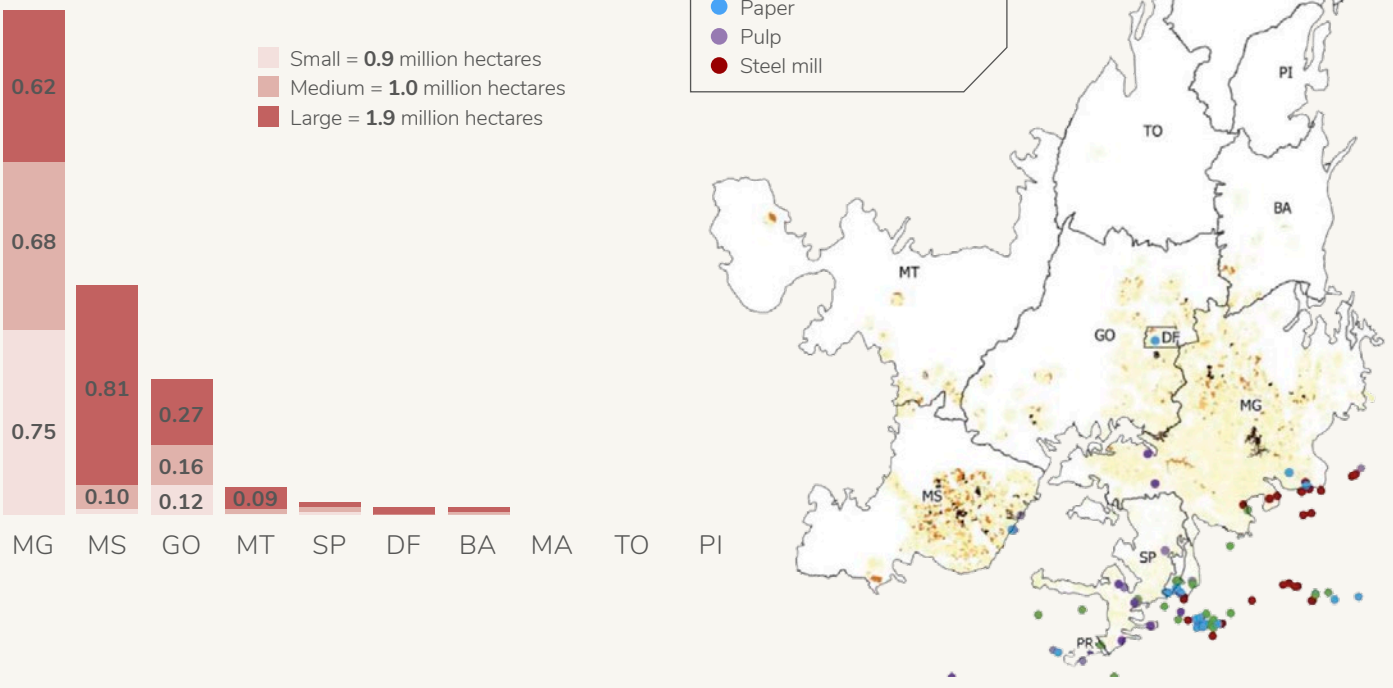
As a result, the zoning shows an area of 3.8 million hectares of degraded pastureland with potential for commercial forests expansion ***(Figure 17)***. This area is mainly concentrated in medium and large properties, around 2.9 Mha. The state with the greatest potential is Minas Gerais (2.1 Mha), followed by Mato Grosso do Sul (1.1 Mha), Goiás (0.9 Mha) and Mato Grosso (0.6 Mha).

Figure 17.
Degraded pasture with potential for commercial forest - most propitious (million hectares)

Source: Study results.
Elaborated by Agroicone.

3.8 MILLION HECTARES

of degraded pasture for commercial forest



industries in the agricultural sector, which have already been mentioned in the previous sections, such as slaughterhouses, dairy plants, silos, and warehouses.

These industries demand firewood to be able to generate energy and, according to data from the Production of Vegetable Extraction and Forestry (PEVS-IBGE, 2018), still 28% of the firewood used in the Cerrado comes from extractivism. Other industry that has the potential to be a firewood demander and was added in this analysis are the corn ethanol plants, located in Mato Grosso and Goiás. All degraded pasture with potential for soy expansion and intensification of livestock (including dairy), plus the area within the radius of 150 km of corn ethanol plants, was considered as the potential opportunity to grow commercial forests for firewood production ***(Figure 18)***.

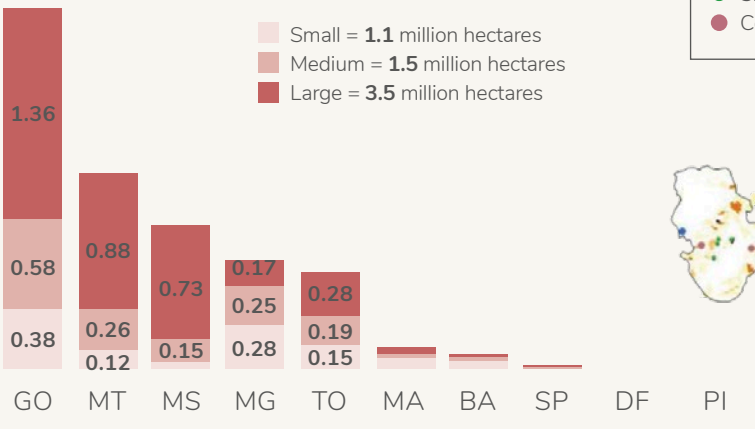
Figure 18.
Degraded pasture with potential for commercial forest - opportunities (million hectares)

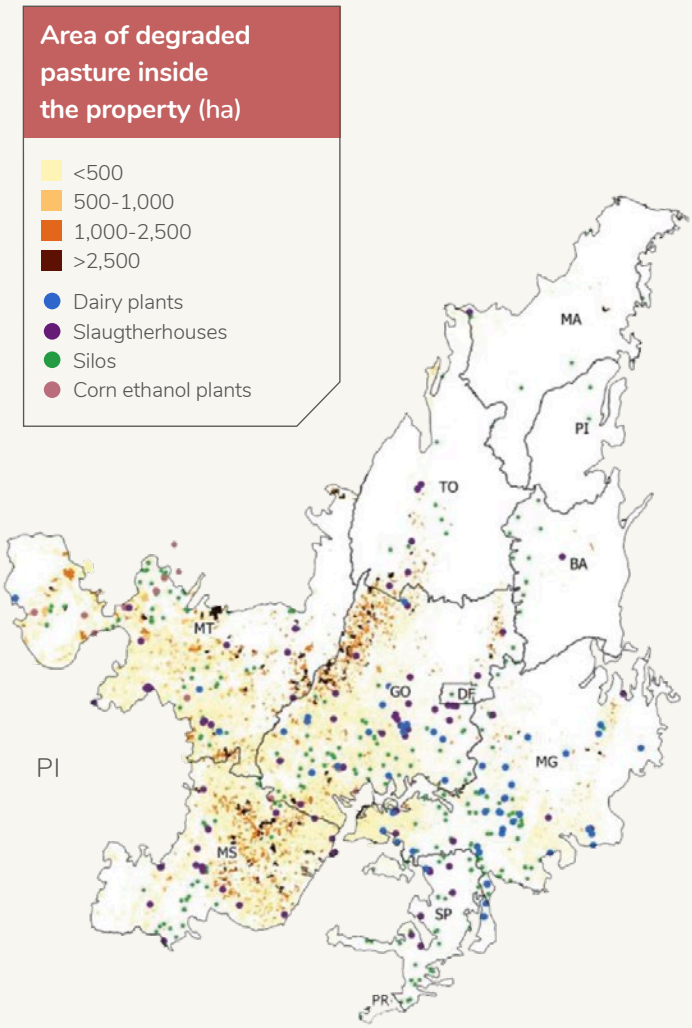
Source: Study results.
Elaborated by Agroicone.

6.1 MILLION HECTARES

of degraded pasture for commercial forest

Area of degraded pasture (million hectares)





The zoning shows 6.1 Mha of degraded pasture areas as opportunities to commercial forests production, near agricultural sector industries.

1.4 Integrated systems

According to the Brazilian Agricultural Research Corporation (EMBRAPA), the definition for integrated system is *"The crop-livestock-forestry integration system involves production of grain, fiber, wood, energy, milk or meat in the same area, in rotation, consortium and/or succession plantations"*. Those three types of agronomic practices are defined as:

ROTATION

Crop rotation consists in alternating, annually, plant species in the same agricultural area.
An example of crop rotation is the planting of soybeans in sugarcane areas for sugarcane renewal.

SUCCESSION

It is the repetitive sequence of crops grown in the same area and in the same crop year. The cultivation of corn in second crop after soy cultivation is an example of succession.

CONSORTIUM

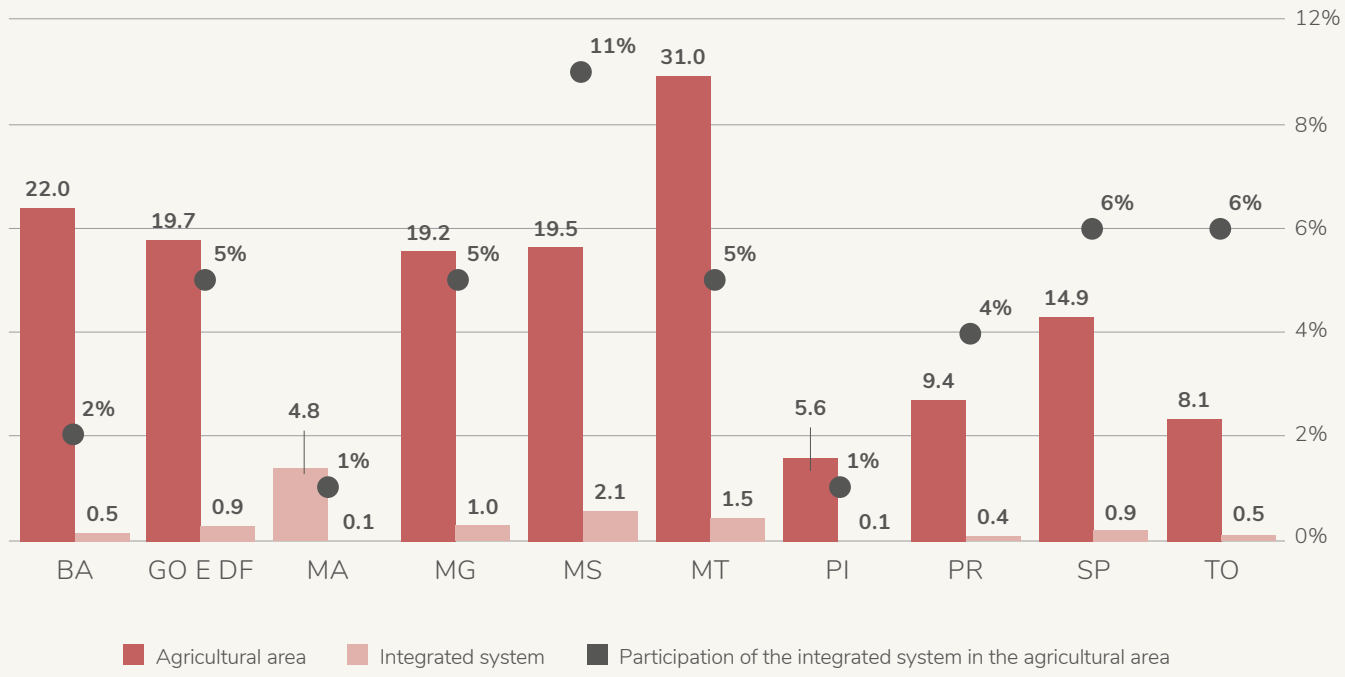
It consists of planting two or more crops in an area at the same time. The planting of corn intercalated with brachiaria, as in the Santa Fe system, is an example of a consortium of cultures.

The *Rede ILPF* network is formed and co-financed by different public and private organizations. EMBRAPA is the founder and one of the public organizations. It was initiated in 2012 and has the objective of accelerating a wide adoption of the technologies of integrated

crop-livestock-forestry (ILPF in Portuguese) by rural producers as part of an effort aimed at the sustainable intensification of Brazilian agriculture. According to this network, in 2018 the agricultural area with integration systems sum 11.5 million hectares in Brazil. This corresponds to 5.5% of the total agricultural area (Rede ILPF, 2018). Analyzing the states that are in the Cerrado biome, what stands out is Mato Grosso do Sul, with 2.1 million hectares ***(Figure 19)***.

Figure 19.
Area of agriculture and integrated systems (million hectares)

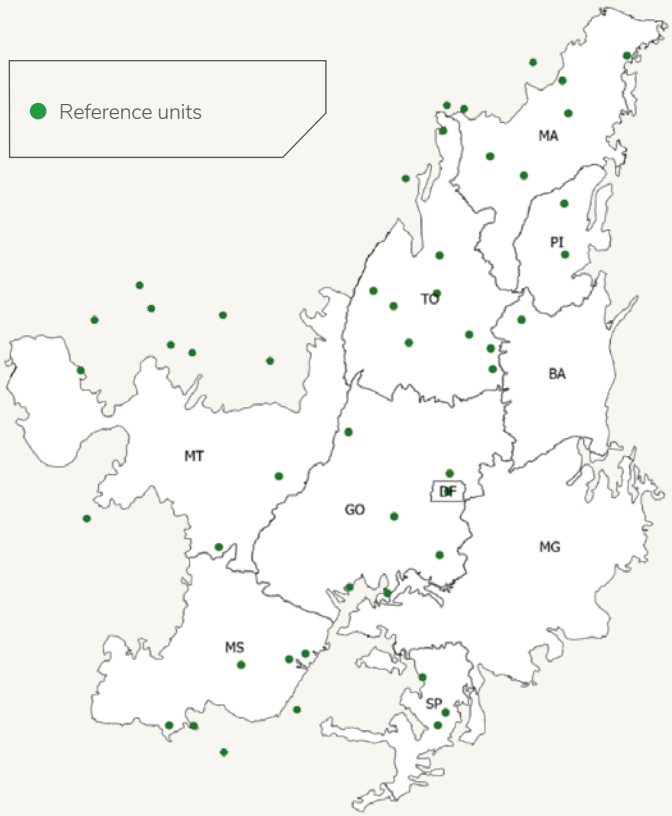
Source: REDE ILPF (2018). Elaborated by Agroicone.



In the Cerrado biome there are 32 reference units of the Rede ILPF, as shown in ***Figure 20***. Those units demonstrate different combinations of integrated systems, cultivars and agronomic practices implemented.

Figure 20.
Reference units of
Rede ILPF in Cerrado

Source: REDE ILPF (2018).
Elaborated by Agroicone.



From several studies on integrated systems, Embrapa identified the main benefits and challenges of this type of production system:

BENEFITS

- Reduction of implementation and pasture reform costs, product diversification and increase of the producer's net income
- Increase in fertility, increase in organic matter, decompaction and improvement of water infiltration in the soil. General improvement of soil quality and conservation
- It improves animal comfort with the planting of trees, increases the support capacity of pastures, increases the supply of fodder and increases animal productivity
- It can be applied to all producer profiles, property sizes and technological levels
- Reduces the pressure for new deforestation and climate risk

CHALLENGES AND BOTTLENECKS

- Lack of specialized tecnical assistance and rural extension to producers
- Lack of qualification of producers and difficulty in finding qualified labor in the different activities of the integration system: agriculture, livestock and forestry
- Lack of customized technological packages
- Lack of local infrastructure, difficulty in accessing the market and distance from consumer and agro-industrial centers
- Long term agronomic results, system management is adjusted with time and gain of experience
- High investment with machines and inputs
- Difficulty or restriction of access to credit lines
- Lack of knowledge of financial agents in relation to integrated systems, restricting the access of producers

Source: BALBINO et al. (2011). Elaborated by Agroicone.

There are four different types of integrated systems, detailed as following: integrated crop-livestock (ICLS); integrated crop-forestry (ICFS); integrated livestock-forestry (ILFS) and integrated crop-livestock-forestry (ICLFS).

1.4.1 Integrated Crop-Livestock System (ICLS)

Embrapa's definition for integrated crop-livestock: *"The System consists of the exploration of agricultural and livestock activities, in an integrated manner, in rotation or succession, in the same area and at different times, increasing the efficiency in the use of natural resources, with less impact on the environment, since the degradation processes are controlled by means of conservationist practices"*. This system can have different focuses:

- **Livestock -** the system with a focus on livestock has the objective of the annual crop planting to recover/improve pasture production. In addition, the sale of the annual crop helps in the payment of pasture improvement expenses.

- **Agriculture -** the system with a focus on agriculture has the objective to plant pastures in the areas of annual crops, to improve physical and biological aspects of the soil, besides producing a large amount of straw. The pasture can be used as cattle feed.

Agriculture and livestock - the system with a focus on both agriculture and cattle raising aims to diversify production in the area. Many times, it can be carried out in partnership between farmer and cattle rancher.

Integrated crop-livestock is the most disseminated system in Brazil, and the main technologies are:

Barreirão System (1991): It is a technology of recovery and renovation of pastures in consortium with annual crops. It consisted of upland rice, corn, sorghum, and millet with forage, such as *Andropogon gayanus*, *Panicum sp. Stylosanthes sp.*, *Calopogonio mucunoides* and *Arachis pintoe*.

Santa Fé System (2001): The Santa Fe System consists of a consortium of annual crops with fodder species, mainly brachiaria, implanted in partial or duly corrected soil. This system allows the production of grains, production of silage for animal feed, production of fodder and straw.

Santa Brígida System (2010): The Santa Brígida System consists of a consortium of corn with green manures, specifically the guandu-anão *(Cajanus cajan*) or crotalaria *(Crotalaria spectabilis)* species. The use of leguminous species as green manure brings nitrogen to the soil, benefiting the subsequent

crop and reducing the cost of mineral nitrogen fertilization. Moreover, this consortium increases the amount and diversity of the straw for the no-tillage system, adding organic matter and improving physical, chemical, and biological aspects of the soil.

São Mateus System (2013): The São Mateus System consists of rotation between soybean and pasture, is indicated for the South of Mato Grosso do Sul state. It is based on the use of crop-livestock integration with the anticipation of the chemical and physical correction of the soil and the cultivation of soy in no-till to amortize the costs of recovery of the pasture. Such system of production, provides the diversification of activities, diluting the risks of frustrations and increasing profitability.

Gravataí System (2018): The Gravataí System is one of the available technologies for crop-livestock integration, specifically in the "boi-safrinha" modality (cattle raising after soy production, having forage and livestock as the main activities in the second crop. It consists of the consortium of "feijão-caupi" *(Vigna unguiculata)* with grasses of the genus Brachiaria, such as *B. ruziziensis* and *B. brizantha* 'BRS Paiaguás' and 'BRS Piatã'.

São Francisco System (2013): The San Francisco System consists of the over-seeding of the Panicum genus forage over soybean or corn crops at the end

of the cycle. If handled correctly, the system assists in the recovery of degraded pastures, ensuring forage in quantity and quality for the cattle herds in the dry season of the year in Central Brazil and sufficient straw for the direct planting system of subsequent summer crops.

1.4.2 Integrated Crop-Forestry System (ICFS)

It is the production system that integrates the forestry and agricultural components by the consortium of tree and perennial agricultural species or the consortium of tree and agricultural (annual) species in rotation and/or succession.

1.4.3 Integrated Livestock-Forestry System (ILFS)

It is the intentional combination of trees, pasture, and cattle in the same area at the same time and managed in an integrated way, with the objective of increasing productivity per unit area.

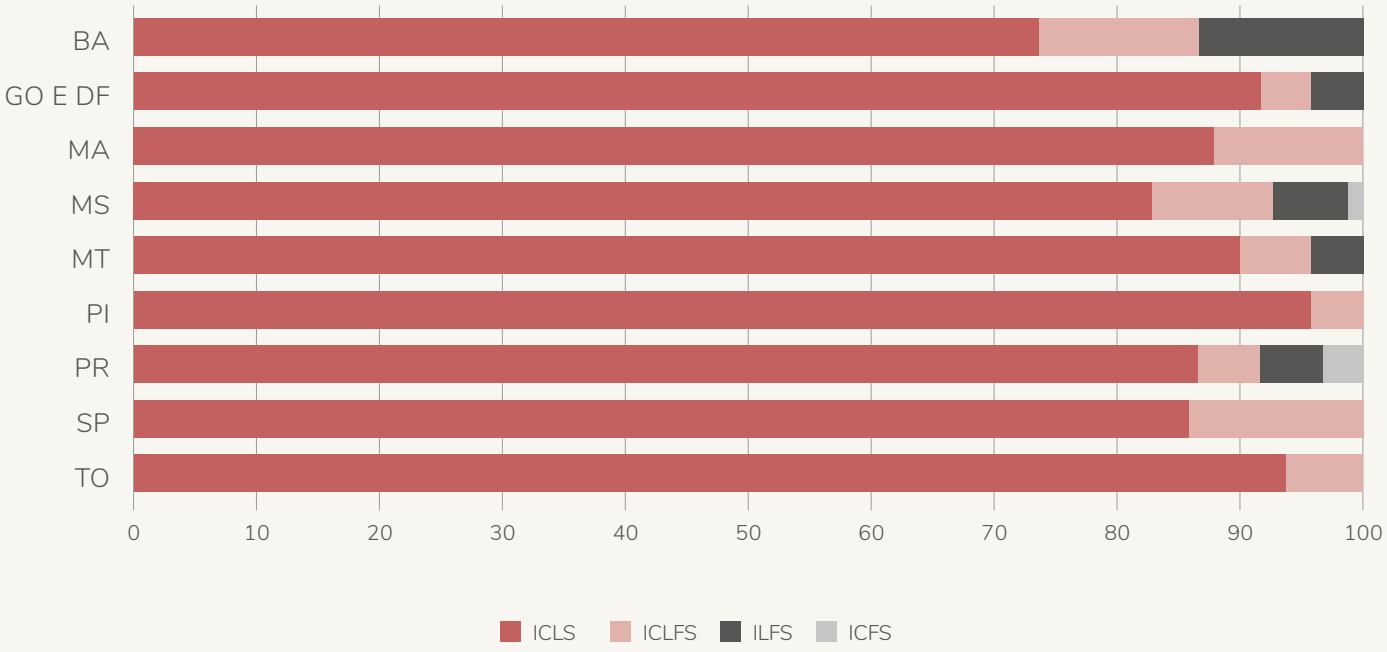
1.4.4 Integrated Crop-Livestock-Forestry System (ICLFS)

Crop-livestock-forestry integration is a production strategy that integrates different systems of production, agriculture, livestock, and forestry within the same area.

Figure 21.
Types of integrated systems adopted by state (share in % of total integrated system area in the state)

Source: Rede ILPF (2018).
Elaborated by Agroicone.

According to the Rede ILPF, the most adopted type of system in the Cerrado states is the ICLS, more details in ***Figure 21***.



The last 3 systems have as a common characteristic the inclusion of the forest component in the integration. In the case of the ICFS, the component crop is implemented before the forest component, the opposite occurs in the ILFS. The choice of the tree species to be cultivated depends on soil and climate factors (temperature, precipitation, soil type, altitude, among others) and what will be the purpose of its use.

The products generated with the forest component can be for the producer's own use or can be sold,

so it is important to analyze potential markets close to the property. The tree species can be exotic or native, the most common species is the eucalyptus. The ICLS described above can be transformed into integrated crop-livestock-forestry only with the addition of the forestry component.

The composition of the integrated systems may vary according to the region of the Cerrado that is being analyzed and according to the profile of the rural producer, as well as the local infrastructure for production flow, investment and costs of implementing the system and selling price of the products. The whole scenario should be evaluated.

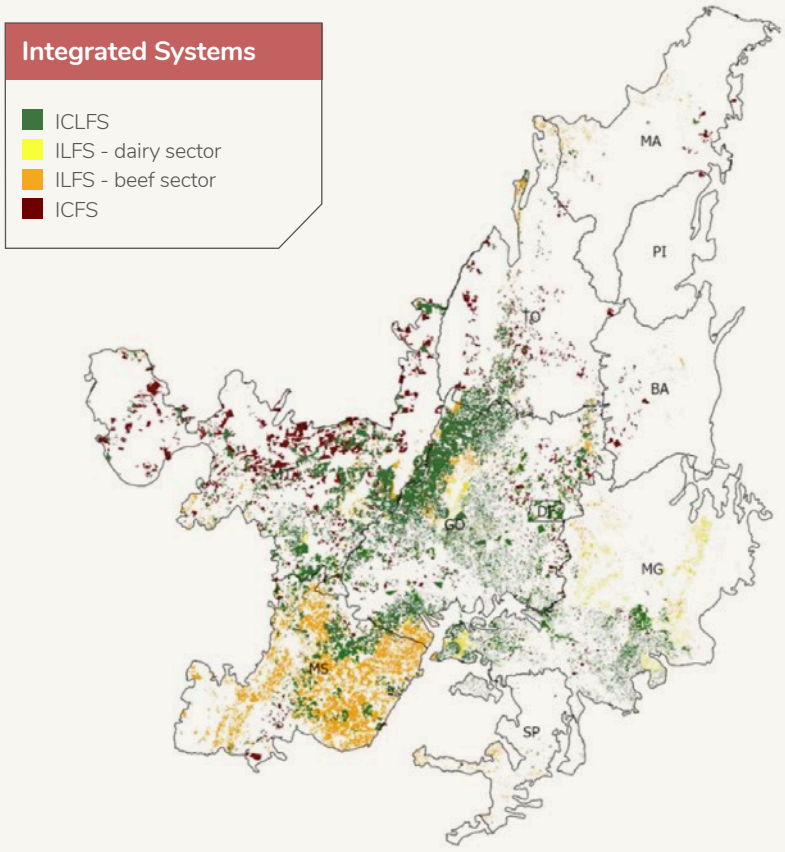
The practice of integrated systems has proved to be a great strategy for recovery/renewal, diversification and intensification, and proper management of pastures. From this idea, EMBRAPA developed the protocol for the neutralization of methane emissions and launched the seal "Carbon Neutral Brazilian Beef" (CCN – *Carne Carbono Neutro*, in Portuguese), which aims to attest the beef produced in an integrated system with the introduction of the arboreal component. *"The seal CCN is a concept brand that aims to attest the beef that presents its GHG emission volumes neutralized during the production process by the presence of trees in integrated systems ILFS or ICLFS, through production*

processes parameterized and audited" (EMBRAPA, 2015). To obtain the seal, the product must conform to the following requirements: commitment to adopt ILFS/ ICLFS system, technical evaluation of carbon emission, calculation of fixed carbon, calculation of neutralization of emissions and guarantee of carbon stock.

To identify potential degraded pastures for each type of integrated system, the zoning presented in section 1.2 for the agricultural supply chains were combined. The result is the map indicating the types of systems indicated for each region of the Cerrado[3] ***(Figure 22)***.

Figure 22.
Degraded pasture with potential for integrated systems

Source: Study results. Elaborated by Agroicone.

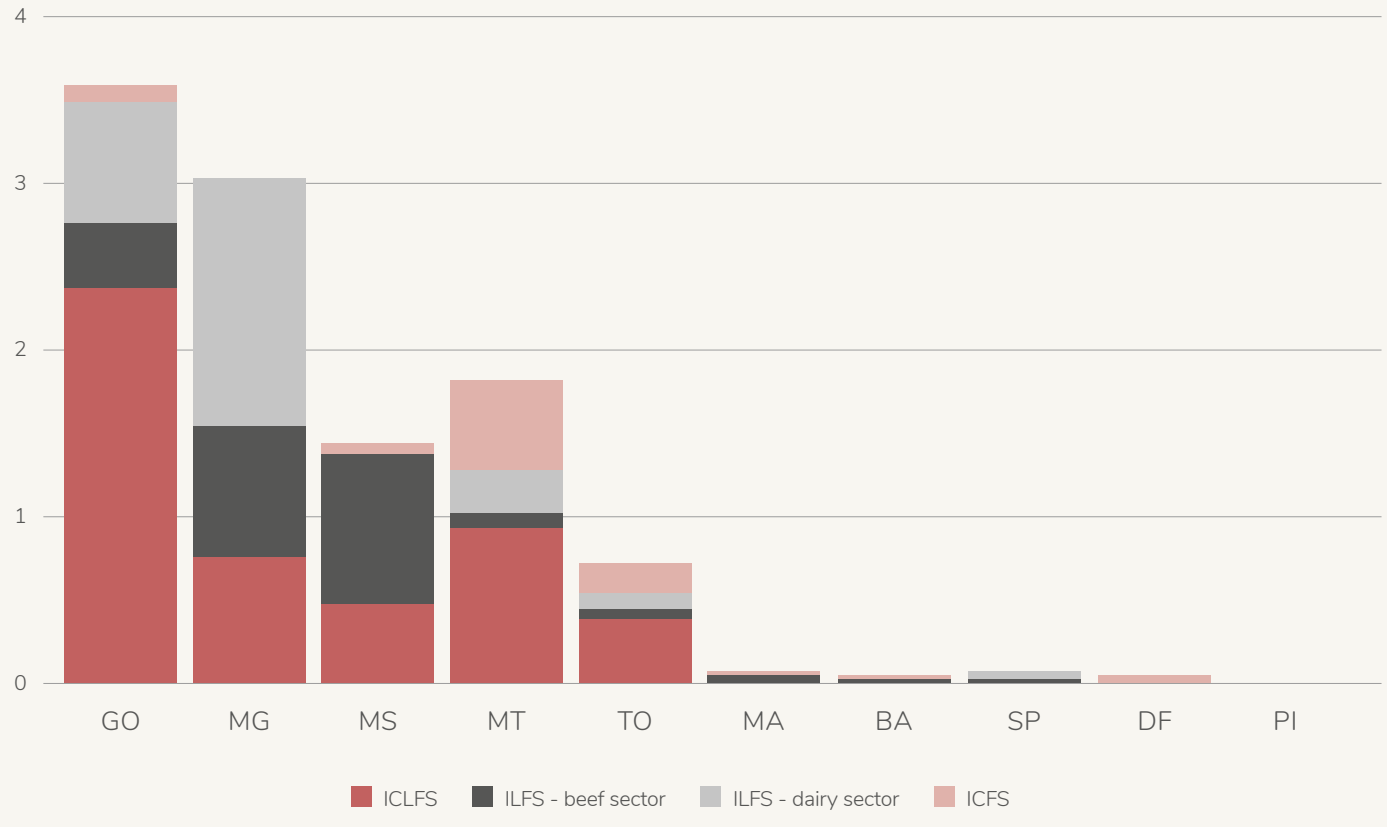


[3] We presented all opportunities for each integrated system separately in the report (in PPT) for WWF-Brasil and GTPastagens, but only the summary with all results was presented in this report.

In the Cerrado there are 10.8 million hectares of pasture with potential for integrated systems ***(Figure 23)***. The system with the largest potential to recover degraded pasture area is the integrated crop-livestock-forestry with 5.1 million hectares (which can also be used by any combination of integrated systems), followed by the integrated crop-livestock-forestry (dairy cattle) with 2.6 Mha. The integrated livestock-forestry (beef cattle) totaled 1.6 Mha and, finally, the integrated crop-forestry with 0.8 Mha. The states with the largest potential areas are Goiás, Minas Gerais, Mato Grosso and Mato Grosso do Sul, respectively.

Figure 23.
Area of degraded pasture with potential for integrated systems (million hectares)

Source: Study results.
Elaborated by Agroicone.



1.4.5 Agroforestry Systems

Embrapa's definition for agroforestry system (SAF, acronym in Portuguese): *"are productive systems that can be based on ecological succession, similar to natural ecosystems, in which exotic or native trees are consortium with agricultural crops, creepers, forage, shrubs, according to a pre-established spatial and temporal arrangement, with high diversity of species and interactions among them"*.

The types of elements found in an agroforestry system are:

PERENNIAL ELEMENTS

Arboreal or shrub species, fruit, wood or fertilizer.

E.g.: jatobá, copaíba, cedar, xixá, caju, mahogany, mango, jackfruit, cinamom.

SEMI-PERENNIAL ELEMENTS

Species that remain in the system for two to three years being deployed at the beginning of the system.

E.g.: Banana, feijão-guandu

SHORT-CYCLE ELEMENTS

Agricultural components.

E.g. sweet potato, pork bean, cabbage, pumpkin, bean, lettuce, corn, sweet potato, manioc).

EVENTUAL ELEMENT

Animal production.

E.g.: cattle, goats, pigs, among others.

The benefits, challenges and bottlenecks to implement agroforestry systems are:

BENEFITS

- Maintenance and increase of biodiversity
- Conservation and maintenance of doil fertility and nutrient cycling
- Conservation and maintenance of water resources
- Better use of the land
- Income diversity
- Reduces economic risk due to price and climate variations
- Improves the quality of life of the producer
- Strengthen social organizations in the countryside

CHALLENGES AND BOTTLENECKS

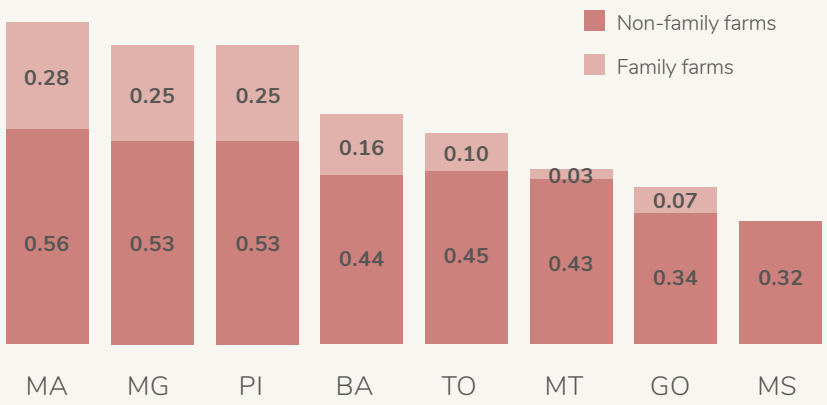
- Access to knowledge regarding the technology
- Availability of labor
- Limiting factors of the physical environment
- Access to inputs
- Lack of adequate agroforestry and economic planning

Source: MACEDO (2013) and Embrapa. Elaborated by Agroicone.

According to IBGE - Agricultural Census (2017), the properties' areas that have an agroforestry system sum 4.8 million hectares in the Cerrado. Non-family farms have the largest share with 3.6 million hectares, against 1.2 million for family farms ***(Figure 24)***.

Figure 24.
Agroforestry systems area (million hectares)

Source: IBGE - Agricultural Census (2017). Elaborated by Agroicone.



The agroforestry system can be a good option to recover degraded pasture in small properties (MACEDO, 2013). This is a way to diversify production, increase income and reduce risks for the small producer. It is important to get knowledge of the local markets, such as fairs, restaurants, small businesses to which this production can be sold, in order to choose which elements will compose the agroforestry system. ***Figure 25*** presents a map with the area of degraded pasture in small properties by municipality.

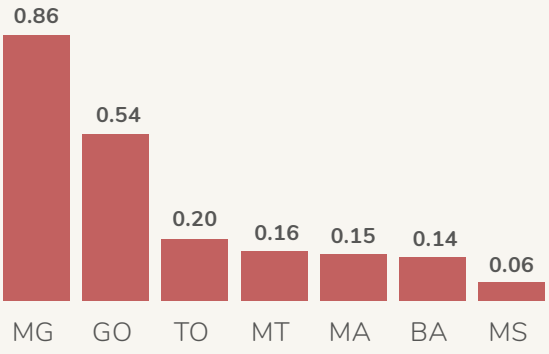
Figure 25.
Degraded pasture in small properties with potential for agroforestry systems' implementation

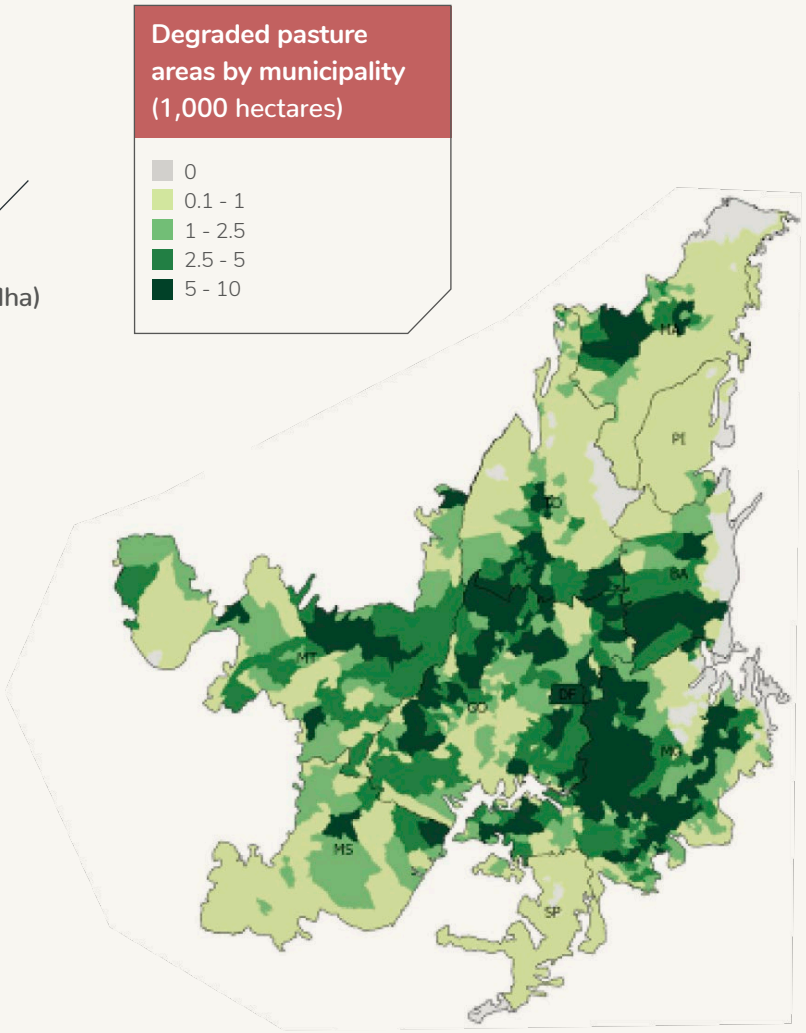
Source: Study results. Elaborated by Agroicone.

2.5 MILLION HECTARES

of degraded pasture areas in small properties which may have potential for agroforestry system implementation

Degraded pasture areas in small properties (Mha)





There are 2.5 million hectares of degraded pastures in small properties in the Cerrado that could be recovered with the implementation of Agroforestry System. The states with the largest areas are Minas Gerais and Goiás, although Tocantins, Mato Grosso, Maranhão, Bahia and Mato Grosso do Sul also have important potential.

CHAPTER 2

Rural credit in the Brazilian Cerrado

The agricultural policy in Brazil has three main components: market price policy[4], crop insurance subsidies[5] and rural credit policy. The rural credit policy is the major policy instrument for the sector and it is provided to both commercial and small-scale family farms. The National Rural Credit System (SNCR) directs credit to farmers at preferential interest rates and corresponds to 80% of all subsidies granted to the agricultural sector in 2019.

According to The World Bank (2020)[6], Brazilian "government support for the agriculture sector in Brazil has been focused mainly on rural credit as a policy tool. The overall level of public subsidies granted by Brazil to agriculture is lower than in peer countries. Overall, it

[4] The basic element of market price policy consists of regionally set minimum guaranteed prices, which cover a broad range of crops and a few livestock products. Given these minimum guaranteed prices, the government implements several price support mechanisms, including direct government purchases (AGF program); premiums to commercial buyers who pay minimum prices to producers; and public and private options contracts backed by a private risk premium option.

[5] There are four mains federal programs related to rural insurance in Brazil, providing support either in the form of insurance premium subsidies or by compensating farmers for production losses due to natural disasters.

[6] Agroicone was hired by The World Bank Group to support the development of this published agricultural policy note.

is estimated that the fiscal costs of the agriculture support programs stand at 0.35 percent of GDP (R$ 22.7 billion) in 2017. Agricultural subsidies account for slightly more than one quarter of all subsidies paid in 2017. The total is roughly equally split between direct and indirect subsidies. Direct agricultural subsidies of R$ 11.1 billion accounted for around 0.9 percent of total fiscal expenditures in 2017. Although modest as an overall agriculture support subsidy, it is a substantial financial sector subsidy. In previous decades, unstable macroeconomic conditions with high inflation and interest rates, led policymakers to pursue directed lending programs to support agriculture. However, market conditions have changed, questioning the efficiency, targeting, and effectiveness of the current programs." (adapted from The World Bank, 2020, p. 1).

Currently, the main form of financing the recovery of degraded areas has been made through agricultural policy, specifically the rural credit. The technologies are financed via rural credit programs, by the own resources of banks that operate rural credit and also by the own resources of rural producers. It has also been observed the creation of funds by large companies linked to agribusiness, which aim, among other objectives, to finance the recovery of degraded areas.

Considering the scenario presented, this section aims to analyze rural credit resources allocated to recover

degraded lands. It is presented an overview of total the resources borrowed in Brazil and how much is driven to municipalities in the Cerrado biome. In a second step, greater focus was given to resources allocated through investment purposes in that biome, where the funds for degraded land and pasture recovery were evaluated. Important to note that the data analysis for the Cerrado will be disaggregated into non-family farmers credit programs and family farmers credit program (Pronaf[7]), detailed as following.

2.1 Overview of the rural credit in Brazil

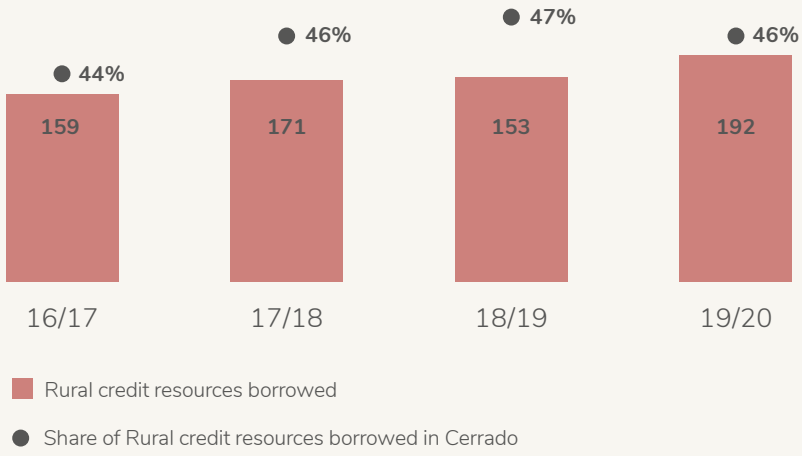
Official rural credit is significant for funding Brazilian agricultural production and represents one of the main instruments for incentivizing this sector of the national economy. In the last four crop-years, resources borrowed by producers increased 20%, from R$ 159 billion to R$ 192 billion, most part for costing the production and for investment. Both finalities represented, during the period, 56% and 24% of the total resources, respectively, while commercialization and industrialization were 15% and 4%.

[7] PRONAF - National Program for Strengthening Family Farming or “Programa Nacional de Fortalecimento da Agricultura Familiar” in Portuguese.

Municipalities in Cerrado biome play significant role in the rural credit market since, in average, 46% of the resources were allocated in there ***(Figure 26)***.

Figure 26.
Total rural credit resources borrowed in Brazil and participation of the municipalities in the Cerrado biome (Billion R$) – all programs by crop-year

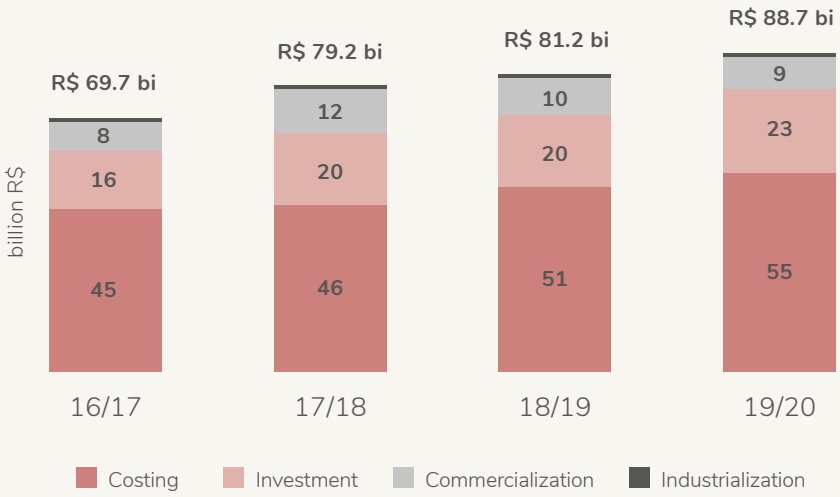
Source: Central Bank of Brazil – SICOR. Elaborated by Agroicone.



In the last four crop-years, borrowed resources in the Cerrado increased 27% (higher value when compared to Brazil scenario), mainly for industrialization (95%) and investment (44%) ***(Figure 27)***. Industrialization represented, in average, 2% of the total resources borrowed in that period, while investment represented 24%. Important to note that, in recent years, resources allocated for investments in agriculture increased substantially in Brazil, and even more in the Cerrado. However, resources for costing the production still is more significant, with a share of 61% of the total borrowed in the same period.

Figure 27.
Rural credit resources allocated in the Cerrado biome municipalities (Billion R$) by purpose – all programs by crop-year

Source: Central Bank of Brazil – SICOR. Elaborated by Agroicone.



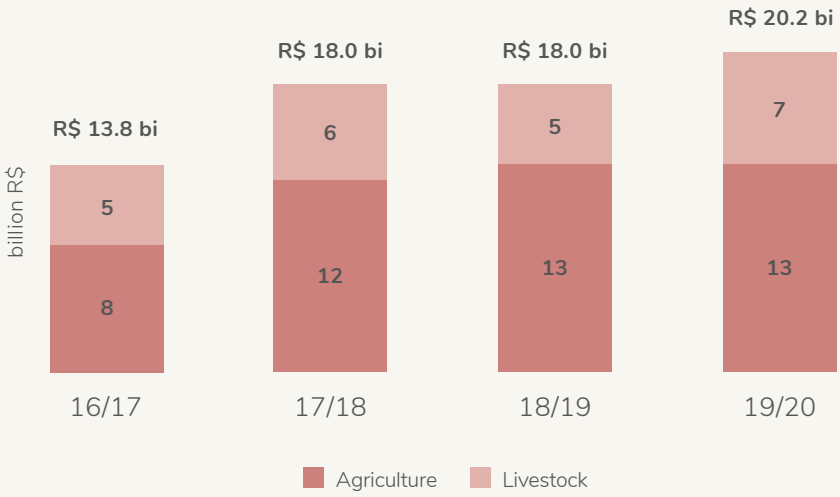
Resources are allocated through different credit programs, on various purposes and producers' profiles, which is mainly agricultural family farmers (Pronaf) and non-family farmers. During the period analyzed, in average, 14% of resources were borrowed trough Pronaf nationwide. In the Cerrado, it represented only 4%. For this reason, analysis conducted in the next section were focused on non-family farmers' credit programs.

2.2 ▸ Rural credit resources allocated for investments in general and in land recovery - non-family farmers programs

Considering a broader view of how the producers take credit for investment in the Cerrado biome, most of it has been borrowed by the agricultural activity, representing, in average, 65% of the total, while for livestock it represents 35% ***(Figure 28***).

Figure 28.
Total of rural credit resources allocated for investment in Cerrado - by activity

Source: Central Bank of Brazil – SICOR. Elaborated by Agroicone.
Note: Does not include Pronaf.



The largest share of those resources for investment has been oriented to the acquisition of cattle (animals' acquisition), harvesters, machinery, implements and tractors, which together represented 54% of the total resources for investment borrowed in 2019/2020 in the Cerrado[8] ***(Table 1)***.

Resources to recover degraded lands (soil recovery including improvements in pasture) summed up 14% (R$ 2.95 billion) of the total invested resources in 2019/2020, an increase of 91% since 2016/2017 (R$ 1.54 billion). Agriculture is the activity that accessed most part of these resources during the last four crop-years analyzed, in average, 60% of the total, and 40% for livestock.

Also, most part have been borrowed in the states of Mato Grosso, Goiás, Minas Gerais, Tocantins and Mato

[8] In general, the participation of these products in the total resources borrowed has not been changing in the last years.

Grosso do Sul, which concentrated 75% of the total resources for this purpose in 2019/2020 ***(Figure 29)***. Important to note that these states accommodate 89% of the total pasture area in the biome, and 87% of the degraded pasture area[9].

Table 1.
Distribution of rural credit resources for investments borrowed in Cerrado - by product

Source: Central Bank of Brazil – SICOR. Elaborated by Agroicone.
Note: Does not include Pronaf.

	Billion R$		Δ 16/17 – 19/20	Share in the total resources for investment in 19/20
	2016/2017	2019/2020		
Cattle (animals' acquisition)	3.46	3.57	3%	18%
Harvester machinery	1.58	2.77	76%	14%
Machinery and Implements	2.44	2.77	13%	14%
Tractor	1.43	1.89	32%	9%
Soil correction, protection and fertilization	0.98	1.91	96%	9%
Pasture	0.57	01.04	84%	5%
Sugarcane	0.42	0.85	103%	4%
Others	2.94	5.44	85%	27%
TOTAL	13.81	20.23	46%	100%

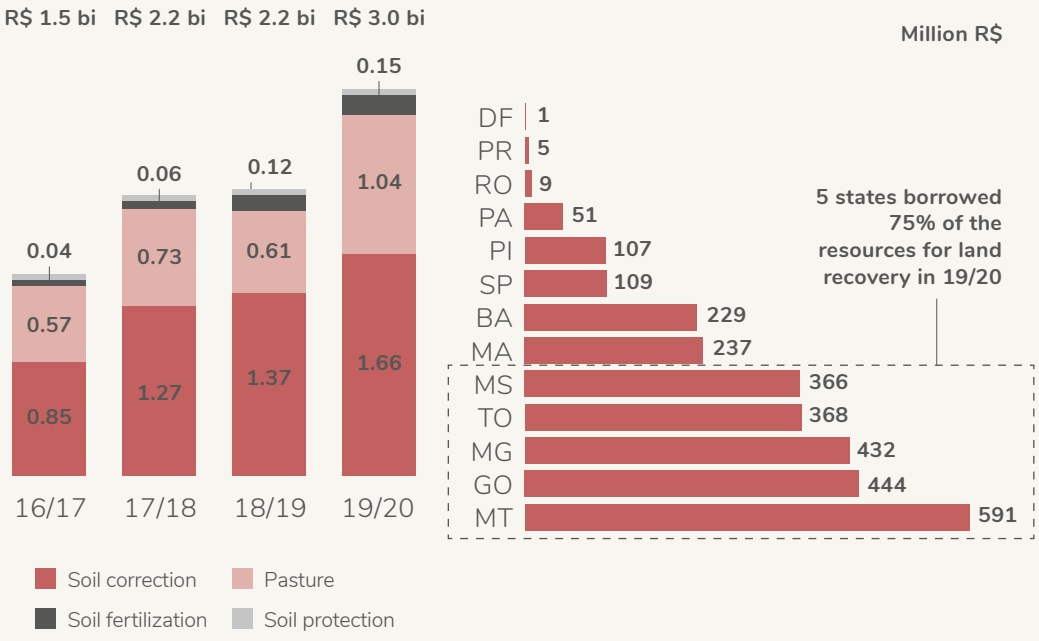


Figure 29.
Resources borrowed for investments in soil recovery in the Cerrado (left) and resources borrowed for investments in soil recovery by state in the Cerrado in 2019/2020 (right)

Source: Central Bank of Brazil – SICOR. Elaborated by Agroicone.
Note: Does not include Pronaf.

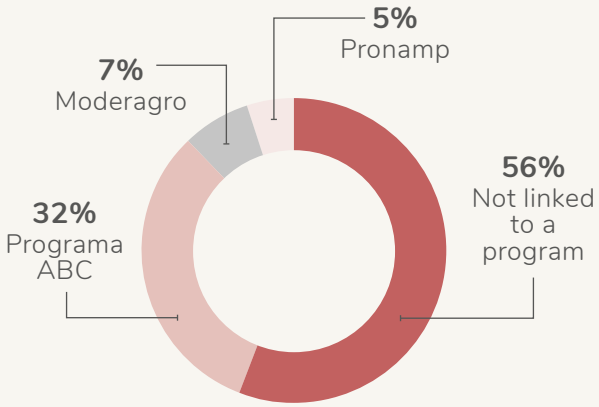
[9] Atlas Digital das Pastagens Brasileiras – Laboratório de Processamento de Imagens e Geoprocessamento (LAPIG). Available at: <https://pastagem.org/atlas/map>.

The resources for soil recovery purpose have been accessed by producers through different rural credit public programs[10], as Programa ABC (program to implement low carbon agriculture technologies, as pasture recovery, integrated agronomic systems, no-till, waste treatment, planted forests, among others), Moderagro (program for agriculture modernization and natural resources' conservation) and Pronamp (program oriented for medium producers, comprising costing, investments and commercialization). However, considerable value was borrowed without link to a specific credit program, which represented 56% of the total resources for in 2019/2020 ***(Figure 30)***. In addition, other programs have financed recovery of degraded land in this same year, as Inovagro (program to implement innovation, as green energy systems and improvements on cattle breeding) and Moderinfra (program to implement irrigation), however with a small share. On previous crop-years, Moderfrota, PCA (program for building warehouses) and PROCAP-AGRO (program for supporting cooperatives) also financed it.

[10] The Brazilian agricultural policy has historically been focused on subsidizing credit (interest rates) for farmers, for several purposes. For investments, there are around 8 programs for specific purposes (as Programa ABC, Moderagro, Inovagro, Moderfrota, Moderinfra, Procap-Agro, Prodecoop and PCA) and 2 for public-specific, as Pronaf - Brazilian Family Farming Strengthening Program and Pronamp – Brazilian Support for Medium Farmers. In parallel there are resources which are not linked to any of those programs and can finance costing, commercialization, industrialization and investments for several purposes including land recovery.

Figure 30.
Rural credit resources for investment borrowed for recovering degraded lands in 2019/2020 in Cerrado by program

Source: Central Bank of Brazil – SICOR. Elaborated by Agroicone.
Note: Does not include Pronaf.



In 2019/2020, R$3 billion were borrowed to invest in degraded lands' recovery into the Cerrado.

In the last 4 crop-years increase in resources borrowed through these programs was higher for "Not linked to a specific program" and for Pronamp, by 110% and 247%, respectively. However, Programa ABC represents an important investment program for low carbon agriculture and, in this case, resources oriented for degraded land recovery through it increased 74%.

2.2.1 Financing conditions for resources allocated to recover degraded lands in the Cerrado

Analyzing rural credit allocated for investment to recover degraded land in the Cerrado, it's possible to identify that the average interest rate paid over the loans is lower for livestock producers (6.4% py) compared to agriculture (7.2% py) in 2018/2019 crop-year[11]. The opposite is observed for average payment term, 8 years for livestock and 6.3 years for agriculture.

[11] For this analysis it was available microdata for 2018/2019 crop-year.

The lower interest rate for livestock can be explained by the fact that both, the average value financed and the average area financed by contract, are lower when compared to the same variables for agriculture. Also, federal government policies specific for technology adoption have lower interest rates for the livestock sector. Related to the payment term be larger for livestock, it can be linked, mainly to the cattle ranching, activity that presents higher payback, demanding larger payment terms over financing[12].

Regarding financial conditions by program, in general, average and maximum interest rate observed are closer to what was stipulated in the Agricultural and Livestock Plan ***(Table 2 and Figure 31)***. Lowest values were found in Pronamp, Moderagro and "Not linked to a specific program", which the last one is also an exception, presenting the highest maximum value. Analyzing the data, it's possible to verify that the highest interest rates allocated through "Not linked to a specific program", so over the average, refers to resources not subsidized, which the conditions (interest rate and payment term) were free agreed between financial institution and rural producer[13].

[12] Important to note that interest rate and payment term are evaluated by financial institution considering rural project investment presented by the rural producer.

[13] The Rural Credit Manual (1-6-3) refers to it as: "... rural credit operations carried out using free resources from financial institutions, contracted at freely agreed rates, not supported by the Union's economic subsidy in the form of equalization of interest rates and other financial charges."

Table 2.
Financial conditions from the rural credit resources allocated to recover degraded land in the Cerrado - 2018/2019 crop-year by program

Source: Central Bank of Brazil and MAPA (2018). Elaborated by Agroicone.

Note: Does not include Pronaf.

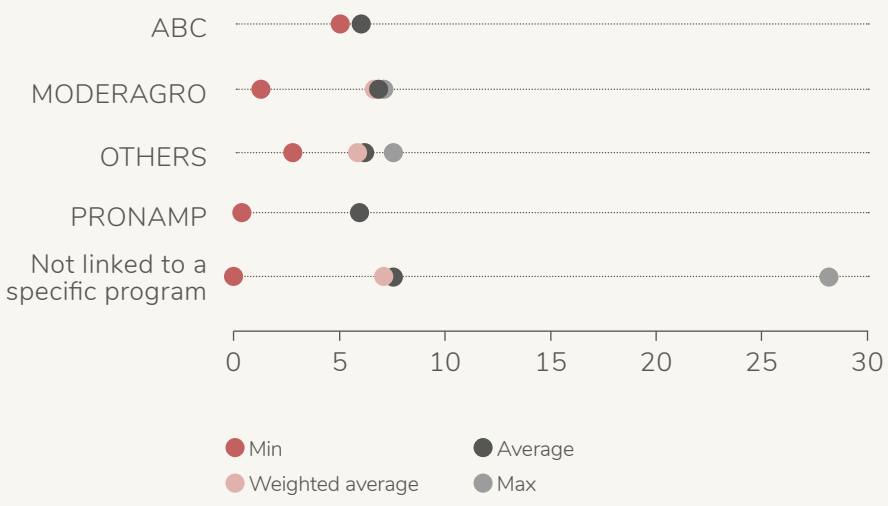
It shows that the private market (not subsidized resources) may represent an impediment to financing long-term investment, as degraded lands recovery.

Program	Interest rate (% py)			Payment term (years)			Agricultural and Livestock Plan 2018/2019	
	Min	Average	Max	Min	Average	Max	Interest rate (max % py)	Payment term (max years)
Not linked to a specific program	1.0	7.1	28.2	0.6	7.5	15.0	-	-
Programa ABC	5.0	6.0	6.0	2.0	7.5	11.0	6.0	12
Moderagro	1.3	6.9	7.0	2.8	6.9	10.1	7.0	10
Pronamp	0.3	6.0	6.0	1.8	6.9	8.1	6.0	8
Inovagro	6.0	6.0	6.0	4.9	8.2	10.1	6.0	10
Moderinfra	7.0	7.0	7.0	5.0	6.4	7.1	7.0	10
Moderfrota	7.5	7.5	7.5	5.0	6.4	7.1	7.5	7
PCA	5.3	5.5	6.0	7.0	9.1	10.1	6.0	15

Figure 31.
Interest rate analysis from the rural credit resources allocated to recover degraded lands in the Cerrado - 2018/2019 crop-year by program (% per year)

Source: Central Bank of Brazil and MAPA (2018). Elaborated by Agroicone.

Note: Does not include Pronaf.

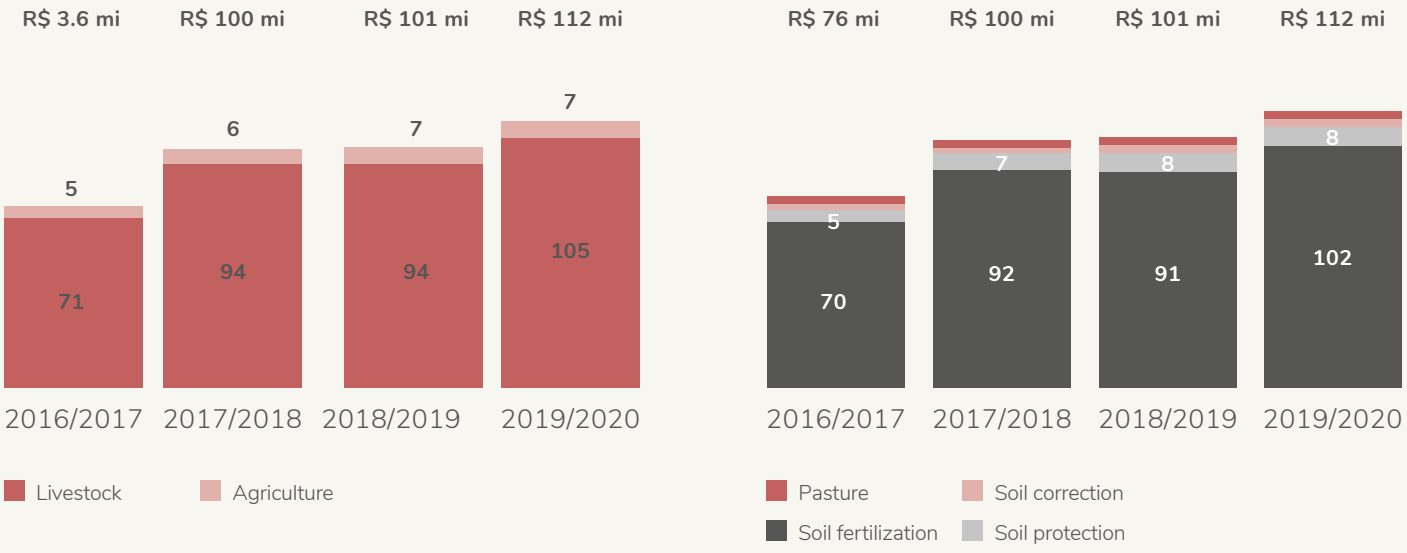


2.3 ▸ Rural credit resources allocated for investments in general and in land recovery - family farmers program (PRONAF)

Considering Pronaf data, resources borrowed to recover degraded land in the Cerrado increased 48% from 2016-2017 to 2019-2020 crop-years. In this last year, it represented R$ 112 million (23% of the total resources allocated for soil recovery through Pronaf in the country), which is most accessed by livestock activity, mainly to recover pasturelands ***(Figure 32)***.

Figure 32.
Rural credit resources for investment to recover soil in Cerrado through Pronaf - by activity (left) and by product (right)

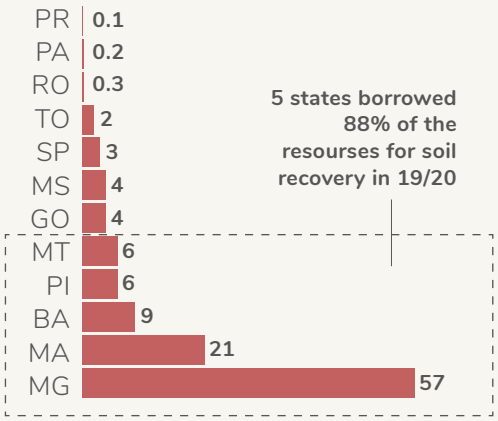
Source: Central Bank of Brazil – SICOR. Elaborated by Agroicone.



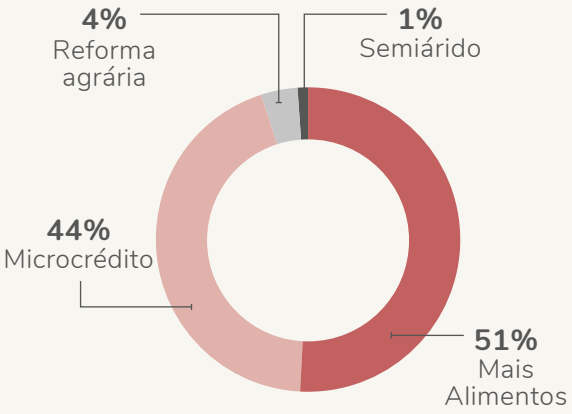
Important to note that, Minas Gerais, Maranhão, Bahia, Piauí and Mato Grosso states have been accessing most part of the resources for degraded land recovery. In 2019/2020, these states borrowed 88% of Pronaf resources in the Cerrado for this

Figure 33.
Rural credit resources for investment in soil recovery in Cerrado through Pronaf - by state in 2019/2020 (left) and by subprogram in 2019/2020 (right)

Source: Central Bank of Brazil – SICOR. Elaborated by Agroicone.



purpose, which represented R$ 98.6 million **(Figure 33)**. Also, Pronaf has an important role in the agricultural frontier region (MAPITOBA).



In 2019/2020, R$112 million were borrowed for investment to recover degraded lands in the Cerrado through Pronaf.

Regarding the interest rate charged over the resources allocated to recover degraded lands through Pronaf[14], it was possible to observe that the average rate charged for livestock (0.8% py) is lower than for agriculture (1.12% py), and the payment term is similar for both, 3.4 years and 3.7 years, respectively. As previously verified for the other rural credit programs, the average area and average value financed by contract for agriculture are greater than for livestock, which may reflect the difference in interest rates charged between the two activities.

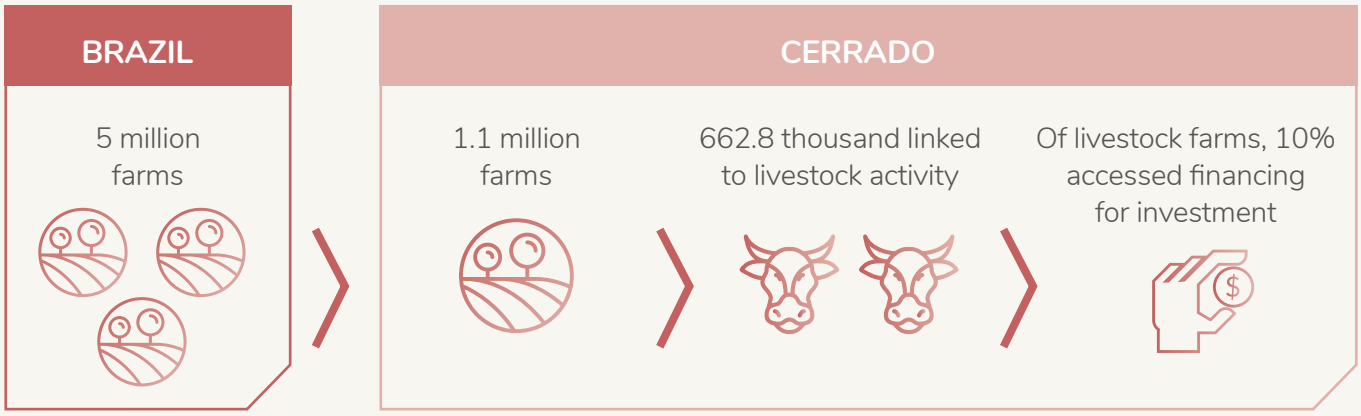
[14] Family Farming Haverst Plan 2017-2020 (Plano Safra da Agricultura Familiar) stablished maximum interest rate for investments according to Pronaf subprograms that may vary from 0,5% to 4,5%.

2.4 ▸ Access of Brazilian farms to rural credit

According to data from IBGE - Agricultural Census (2017), the number of agricultural properties that obtained financing in 2017 were analyzed. It was found that the country had 5 million properties, of which 1.1 million (21%) in the Cerrado biome. Of the total of properties in the country, only 15% (784.5 thousand) obtained financing, either to costing, investment or commercialization. Considering the total of 1.1 million properties in the Cerrado, 662.8 thousand (63% of the total in the biome) are linked to livestock activity. Within this activity, 98.2 thousand accessed financing, of which 67.9 thousand accessed financing for investment, which represents only 10% of the number of livestock properties in the Cerrado biome in 2017 ***(Figure 34)***.

Figure 34.
Access of livestock farms to rural credit for investments in Cerrado in 2017

Source: IBGE - Agricultural Census (2017). Elaborated by Agroicone.



Also, according to data from the Agricultural Census, livestock properties that accessed resources from rural credit for investment were financed, in large part, by banks, either through public or private resources. Other producers also financed investments by the government (federal, state or municipal) and also through credit cooperatives, which have an increasingly relevant role in financing national agricultural activity in recent years ***(Figure 35)***.

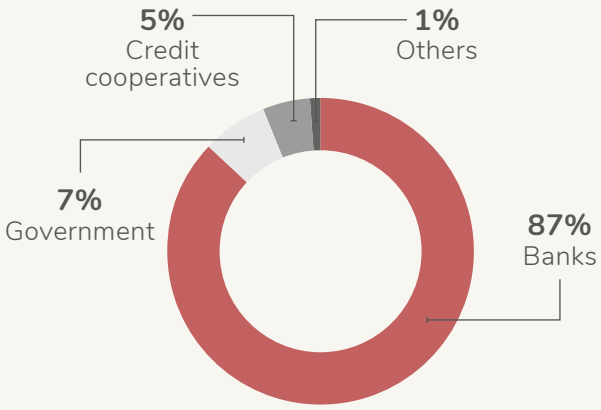


Figure 35.
Access of livestock farms to rural credit investment resources in 2017 - by financial agent

Source: IBGE – Agricultural Census (2017). Elaborated by Agroicone. Note: "Others" means input suppliers, other financial institutions (except banks and credit cooperatives), nonprofit organizations, relatives or friends, other agents

In this way, despite the increase in investments borrowed by producers in the Cerrado, a small percentage of farms in the biome obtained financing to invest in their activity. This scenario was not just found in the biome but, in general, in the whole country.

2.5 ▸ Determinants of credit demand by rural producers

A previous study carried out by Agroicone sought to evaluate the determinants of credit for investment taken by cattle ranchers in Mato Grosso[15]. The research used an econometric model to assess which variables (factors) are more significant and which determine the credit resources demand, mainly for investment.

The model was based on information from 141 municipalities in Mato Grosso (Cerrado, Amazon and Pantanal biomes) to ascertain the importance of issues such as technical assistance and environmental and land regularization on the volume financed for investment in the livestock activity in the state.

According to the results obtained, the number of financial institutions in the municipality has an important impact on the demand of investment credit in Mato Grosso, and for each additional financial institution, there is an increase of R$ 3.4 million in the amount financed for investment in the state. In turn, technical assistance was also of great importance, and for each additional property

[15] Study not yet published.

receiving technical assistance in Mato Grosso, there is an increase of R$ 207.7 thousand in the total financed by the property. Land and environmental regularization were also significant as determinants for borrowing. For each regularized property, there is an increase of R$ 45.6 thousand and R$ 30.3 thousand, respectively, in the total financed resources. Based on this information, this project will seek to validate through the questionnaires that will be applied to rural producers, producer associations and financial institutions what are the factors that these agents consider to be decisive for taking credit for investment, especially for pasture recovery. We expect to have those answers by the end of October 2020.

CHAPTER 3

Agricultural funding structure – the case of soybean in Mato Grosso

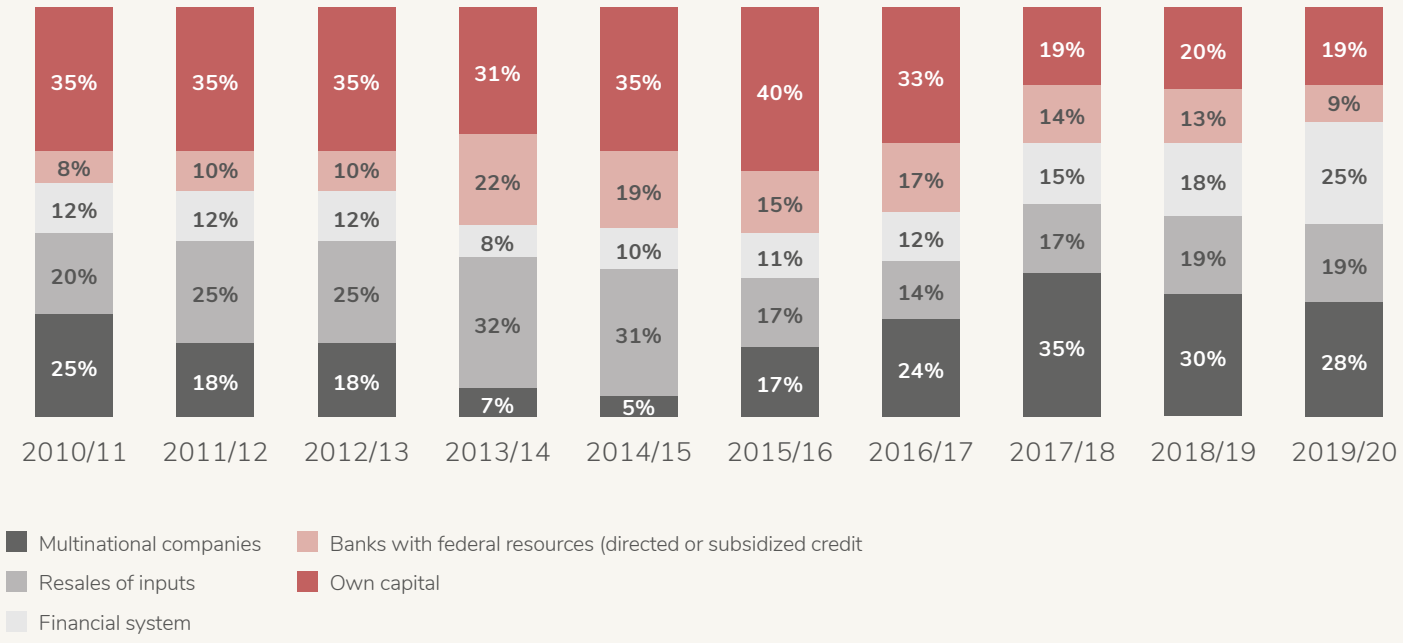
Although rural credit is the main public policy instrument for financing agriculture, rural producers, in this case the non-family farming producers, may have other ways to finance their agricultural activities and necessary investments. The case of soybeans is an example of other sources of financing accessed by producers for operational costs.

From 2010 to 2019, the subsidized rural credit's share in funding the soybean costing in Mato Grosso varied by 8% to 22% of the total soy cost ***(Figure 36)***. The multinationals' share in the soybean chain, producers' own capital and input resale have a significant role too. Soybean producers have a high degree of leverage with their own capital to cover costing - around 19% to 40% (in Mato Grosso). In general, in the last two crop-years, the financial system and banks with federal resources have been the largest financiers of soy costing in Mato Grosso.

It can be said that market (not subsidized) credit has funded costing for both production and agricultural expansion. It is worth mentioning that this differs according to producer profile, especially by property size, as well as by region. This does not apply, for example, in the South region, where producers are more dependent on official and subsidized rural credit, given the characteristics of producers (smaller properties than in Mato Grosso), and the preference for official credit over other mechanisms in that region's market. In Mato Grosso and in MATOPIBA region there are large companies producing grains (soy, cotton and corn) and taking credit directly from the financial market and from investors (investment funds).

Figure 36.
Funding structure for soybean production costing in Mato Grosso

Source: IMEA.
Elaborated by Agroicone.



Subsidized credit for costing can be covered by private credit market, mainly for large producers, since the national interest rate (SELIC interest rate) has been declining in the last years. However, this cannot be said when related to investment credit, which incurs in long term financing and higher risks from the financial institution perspective.

Currently, the Brazilian credit market is not able to offer long-term credit to the agricultural sector (individual producers) efficiently and with conditions that are consistent with the returns on the projects, especially considering the high risk and uncertainties regarding the funded project, as well as a result of the country's macroeconomic instabilities.

However, related to funding for investment for the livestock sector or in soil recovery, data availability is very restricted, emphasizing the importance of applying questionnaires to rural producers aiming to understand what are the sources of financing accessed for these purposes by them.

CHAPTER 4

Agribusiness sector confidence in national economy and in business environment

Investments made by producers are linked to several factors, but mainly to their perception of the economic scenario, which may be favorable or not. Based on this aspect, the ICAGRO (Agribusiness Confidence Index)[16] is analyzed in this section. The Index is released by FIESP (Federation of Industries of the State of São Paulo), and it presents information on the economic perception of Brazil and agribusiness by agricultural producers, cooperatives and industries connected to the segment. Additionally, the confidence indexes of agricultural and livestock producers, IC Agriculture[17] and IC Livestock, respectively, are evaluated.

[16] Calculated quarterly, the Agribusiness Confidence Index (ICAGRO) measures, through a set of variables, the expectations of the sector's agents related to their business and the economic environment in general. The Index has a scale ranging from 0 to 200 points, where 100 points indicate neutrality. Values below 100 points indicate dissatisfaction / pessimism and above 100 points, satisfaction / optimism of the sector with the business situation and with the general conditions of the economy. Other information regarding the methodology can be found at <http://icagro.fiesp.com.br/resources/download/2t20/metodologia_icagro.pdf>.

[17] In this context, "Agriculture" represents the crop producers and "Livestock" represents the cattle ranchers.

Since the beginning of the historical series, there have been fluctuations in the indexes analyzed, but a tendency for growth over time ***(Figure 37)***. In general, evaluating the periods of fall in the confidence indexes, the reports issued by FIESP for each quarter point to the negative perspective in relation to the Brazilian economy and political scenario, in addition to factors such as the increase in the price of agricultural inputs, low expectations regarding future prices of the commodities, reduced availability of credit to finance production and a disadvantaged business environment, factors that negatively impact the sector's confidence. Also, important to note that, in the 2020 first quarter the index had a drop due to Covid-19 pandemic crisis, which affected Brazilian economy and it created a strong feeling of uncertainty in the country, even in the agricultural sector.

On the other hand, greater confidence (periods of rising indexes) occurred when the sector's perception was of economic recovery, greater stability of the political scenario, positive expectations about commodity prices, better credit conditions together with lower interest rates and increasing in production productivity.

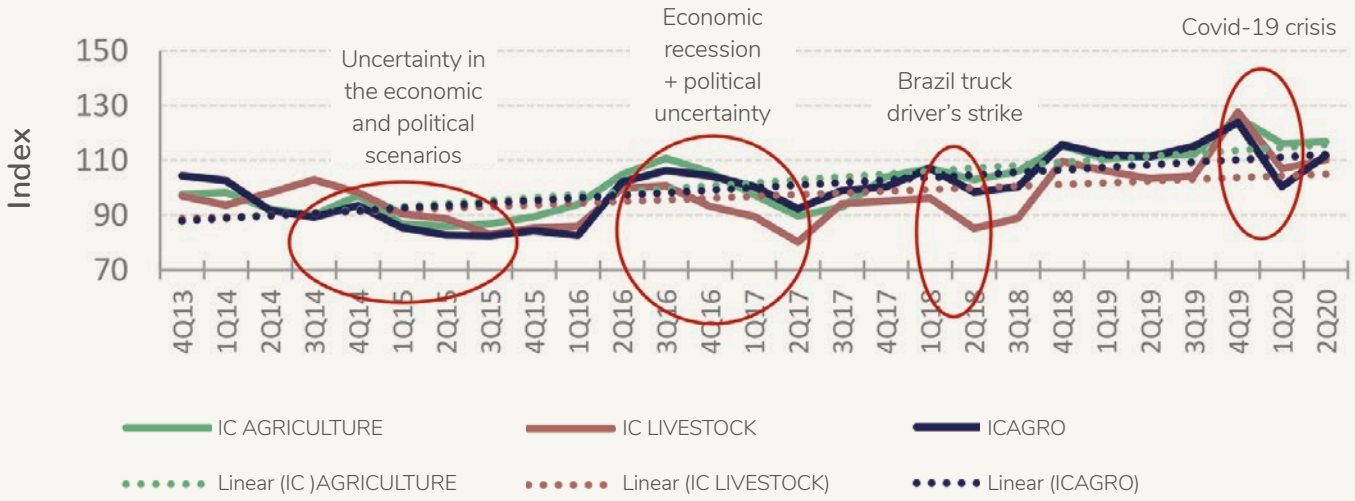


Figure 37.
Agribusiness confidence indexes

Source: FIESP.
Elaborated by Agroicone.

Comparatively, the IC Livestock has been, for much of the analyzed period, below the IC Agriculture, showing that the ranchers have less confidence and / or they are more pessimistic in comparison to agricultural farmers. In addition, a characteristic of ranchers linked to what was mentioned, is their greater risk aversion. In this sense, a lower level of confidence and greater risk aversion tend to lead to lower investment levels in the activity by such producers.

Another point is about the standard deviation[18] observed for the IC Agriculture and the IC Livestock. The first one presents a greater deviation (11.0) than the second (10.5), that is, the confidence of ranchers in relation to the economy and the business environment tends to oscillate less than agricultural farmers.

[18] Standard deviation is a statistic that measures the dispersion of a dataset relative to its mean. A low standard deviation indicates that the values tend to be close to the mean of the set, while a high standard deviation indicates that the values are spread out over a wider range.

CHAPTER 5

Investment intention by cattle ranchers

In addition to the confidence indexes analyzed previously, FIESP also releases the investment intention panel[19], a research developed in specific periods to monitor the producer's intention to invest in machinery, farm infrastructure, productivity, technology and people management.

The main question of the survey to producers is whether they intend to invest in a certain area. Regarding livestock producers, the panel identifies, among the investments in technology, whether they intend to allocate resources for pasture recovery.

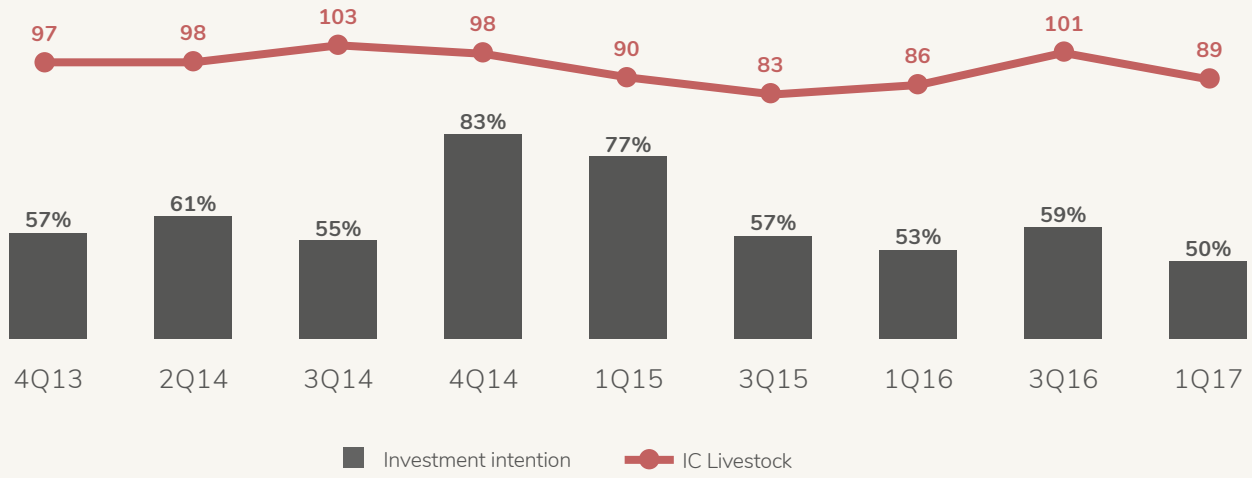
Figure 38 shows the percentage of ranchers interviewed and who stated they intended to invest in pasture recovery in that period, and also the IC Livestock, representing the confidence of ranchers in the economy and in the agribusiness sector.

[19] Important to note that Investment Intention data series is not continuous and it is available until the first quarter of 2017.

Especially from the fourth quarter of 2014 onwards, it is more evident that, if the ranchers have a positive outlook regarding the economic environment (IC Livestock increasing), the intention to invest in pasture recovery grows. The opposite is also observed when producers have a negative perspective leading to lower intention to invest.

Figure 38.
Investment intension by cattle ranchers - Percentage of ranchers interviewed that had the intention to invest in pasture

Source: FIESP.
Elaborated by Agroicone.



Thus, considering the information analyzed, the environment perceived by rural producers is important for their investment decision. In this case, political and economic scenarios that allow a positive business environment are prominent factors for agents' decision making.

CHAPTER 6

Initial perceptions about farmers' decision on expanding production over new areas including degraded lands

In studies previously developed by Agroicone, interviews were carried out with rural producers in the Cerrado region in order to understand the expansion of the agricultural area and also about the conversion of pastures (with low productivity) into areas for soybean cultivation.

The pattern of agricultural expansion is different between regions in the Cerrado and depends on the need for soil correction. In some cases, when correction is necessary, especially in the MATOPIBA region (sandy soils), the period for the crop to reach its ideal productivity level is longer.

Similar difficulty occurs in the expansion over pasture, especially if it presents degradation or little correction of limestone, plaster and other

inputs. The costs of conversion and correction of the soil are equivalent in relation to the expansion over the Cerrado (native vegetation), differing only by the fact that there is no need to clean (deforest) the area.

Historically, as for the financing of the expansion, this took place mainly with the producers' own capital, especially for the purchase of areas. Some investments in soil correction and purchase of machinery were financed by bank credit (official rural credit for individual producers and credit lines for companies). Today there is no official credit for financing for the purchase of areas, regardless of current use. The form of payment for the areas depends on each case, they can be paid linked to the price of the bag of soybeans, and the quantity of bags per hectare is fixed. In some cases, land is paid over an average of five years.

Until 2019, before COVID-19 pandemic, there was demand for areas that are suitable for cotton planting, due to the good results of this crop in recent years. Producers implement crop rotation between soy, corn and cotton, especially in Mato Grosso and MATOPIBA (in this region, mainly in irrigated areas).

Producers' decision to expand the area is related to different factors, such as increase of the productive scale and formation of patrimony, production

profitability and land valuation, and climate risk management, operating in different regions.

According to producers interviewed, the future expansion of agriculture should be based on already cleared areas, some with pastures (as in Tocantins), others with agricultural production (as in Bahia) and some areas of vegetation with aptitude for grains (especially in Maranhão and in Piauí).

In Mato Grosso, the main expansion model is land lease, whether agricultural or pasture for the production of soy and / or cotton. A similar model is found in the southern region of the Cerrado (as in Goiás state and Minas Gerais). For the expansion of soy in cleared areas (as pasture), the main bottlenecks identified were:

- High investments are necessary to convert pasture areas. In the case of leased areas, these investments may become unfeasible.

- Lack of pasture areas available in some regions, such as Bahia, Maranhão and Piauí.

- Traditionally livestock regions do not have infrastructure for grains, making expansion in these regions difficult or the need for higher investments (warehouses, silos, etc.). It was also identified the lack of qualified labor for

grain production, as operators of agricultural machinery in the case of conversion pasture into agriculture areas.

- Smaller gain on price of land when acquiring and converting pasturelands compared to native vegetation.

- Farms in need of environmental compliance to the Forest Code.

Among the incentives to expand agriculture over cleared areas, it can be divided between economic and financial incentives and those linked to the production system.

The main incentive to guide the expansion of agriculture would be to reduce bureaucracy and provide long-term credit to finance investments in conversion of cleared areas, with differentiated conditions (such as longer grace periods, payment, interest rates, etc.). In addition, financing the purchase of areas can also encourage expansion over cleared areas, since they do not exist today or has impeditive conditions.

Regarding incentives related to production and production systems, to expand over cleared areas (pastures), it is necessary to invest in infrastructure, technical assistance and qualification of labor, especially in traditional livestock production regions.

CHAPTER 7

Assessment about why ranchers are not taking credit / Implementing land recovery practices

As part of this study, between October and November/2020, we conducted meetings and application of a questionnaire to address the following:

- For all four agriculture practices, why farmers are not implementing practices to recover degraded pasturelands? What other barriers producers face to implement agronomic systems oriented to recover degraded pasture lands, such as technical assistance, input access, among others? What are the risks associated?

- Is it because the business model is not profitable/ practical? Are the financing terms not attractive? What are the barriers to access credit? What are the risks associated? What other credit barriers producers face to invest on degraded pasturelands recovery? Is the credit access, conditions and/or availability the main barriers?

- What mechanisms or incentives capable of changing producers' behavior in order to adopt agronomic systems to recover degraded pasture lands? What kind of supply chain arrangement is needed? What kind of arrangement among producers is needed?

Three groups were interviewed:

A)

- 11 producers in Mato Grosso do Sul;
- 1 Association from Guariroba river basin in the Cerrado biome

B)

- 4 Entities and Associations in Mato Grosso;
- 8 rural producers (1 from Mato Grosso – Cerrado and 7 from Mato Grosso – Amazônia);
- 35 technical assistants (acting in Mato Grosso, in both biomes)

C)

- 1 slaughterhouse (meatpacker);
- 2 financial institutions

We questioned the groups about conduction of cattle ranching activity in their region, adoption of technologies as pasture recovery, access to rural credit, compliance to the environmental legislation and perceived impact by Covid-19 on the farms/activity.

Regarding the associations, financial institutions and technical assistants, we questioned them about the main difficulties and limitations that the rancher faces to take credit and adopt sustainable systems and technologies in cattle ranching.

It is important to highlight that, due to the period of the year, we had difficulty contacting several producers (for the both groups above) because they were in high production demand, that is, they did not have enough time (or did not want) to answer the questionnaire or attend to meetings.

For the questionnaire applied to the Guariroba cattle ranchers, we could count on the Association for Recovery, Conservation and Preservation of the Guariroba Basin (ARCP) to access the producers. The information collected form this group (a), helped us to build a business case based on pasture recovery in Guariroba region (next section).

7.1 Group a: Interviews with Guariroba basin rural producers and association

7.1.1 Rural producers' interviews (in Mato Grosso do sul state)

We conducted interviews with 11 producers in Mato Grosso do Sul state, associated to Guariroba ARCP association or participated in the *Programa Nascentes* coordinated by WWF. In average, ranchers from group A have farms of 564 hectares, being 223 hectares of pasture and 895 cattle herd per farm. Most part of them have cattle ranching

as the main activity in the farm, conducting breeding or breeding and raising cattle productive cycles.

Extensive activity is the most common in the region, and only 3 producers answered that they do not have access to technical assistance. Among the agricultural practices, the most adopted in the region are soil correction with limestone, fertilization and use of paddock rotation on pasture, although there are still degraded pasture areas on the properties. However, as we were informed by ARCP association, many farmers still do the recovery and rotation of pasture incorrectly.

Among the producers who declared to have degraded areas on their properties (five of them), all stated that they intend to recover the soil by up to three years.

However, for pasture recovery, the difficulties encountered by them are, mainly, high investment required and lack of own financial resources. Other points still observed according to the responses obtained are the lack of public policies that encourage the producer to adopt pasture recovery, difficulty to access credit and difficulty in maintaining the quality of pasture after the recovery.

As for the difficulties encountered by producers to implement integrated systems, there is, especially, the

lack of own financial resources and the need for high investments to implement the system. Other difficulties mentioned, but less frequent, are the lack of technical assistance, lack of public policies that encourage producers to adopt the systems, deficient infrastructure in the region, lack of knowledge about such technologies and the region's low aptitude for crops. In general, only 3 producers stated that they are interested in implementing integrated systems in the property. Most of them are focused on pasture recovery and improving livestock activity itself.

As incentives for pasture recovery and the adoption of integrated systems, producers answered that is important a higher cattle sale's price, in order to have more financial resources for investment, since many do not access rural credit. Others mentioned the need for a greater offer of technical assistance and the possibility of arrangements with producers, slaughterhouses and the government.

Regarding access to rural credit, 5 producers stated that they access credit for costing and/or investment, and the financial institutions used are Sicredi and Banco do Brasil. Specifically, for investments, the rural credit programs accessed are Finame / BNDES, Pronamp, Programa ABC and Pronaf, for financing pasture recovery and improving the infrastructure

of the property. Of the total resources used for costing and/or investment in the cattle ranching activity, these producers have financed a maximum of 50% of the resources via rural credit, although very few have reached this limit. Thus, most of them still do not access rural credit mainly due to risk aversion, financing the activity with their own capital, as confirmed by ARCP association.

As the producers declared, the guarantee required by financial institutions for financing is part of the animals and/or the title of the property. In addition, they mentioned that the main difficulties in accessing credit are the lack of knowledge about credit lines, difficulty in presenting guarantees to the bank, interest rates charged and sales matched by the institutions. Regarding compliance with the environmental legislation, all the 11 producers reported that they have the Rural Environmental Registry (CAR), and all of them have Legal Reserve area on their properties, with only one having a Legal Reserve deficit. Still among the 11, 9 have a Permanent Preservation Area (APP), and only one has an APP deficit. Regarding the impacts of Covid-19 on livestock production, producers said that they did not perceive negative impacts of the pandemic in the region, and only one of them stated that the pandemic changed his decision to take investment financing.

7.1.2 Guariroba basin association (ARCP) interview

ARCP association was founded in 1996 and has been working to promote the restoration of Legal Reserves and of Permanent Preservation Areas in the Guariroba basin, Campo Grande region, capital of the state of Mato Grosso do Sul. The Association also started to support ranchers through technical assistance for pasture recovery and for better productive organization of their farms.

According to the Association, producers do not have knowledge / information on cost / revenue control (management) or herd productivity indexes about their farms. Most of the pastures in the Guariroba region are not completely degraded, but there is still a lack of incentives for producers to make investments and to incorporate best practices, with the adoption of new technologies, as integrated systems. In this sense, it is important to raise awareness among producers that it is important to recover, as a way of increasing livestock productivity.

In general, producers access credit for the purchase of animals (short term), but not for investment in pasture or for long term investments. Many of them are risk averse in taking credit, because they are afraid of not being able to pay the financing. One of

the reasons for this is due to the fact that, for many years, in the producers' perception, the selling price of the animals was low, which has changed in recent years (higher price), which may reflect in greater confidence of the producer in the market and, thus, may motivate them to take more credit.

Still in relation to credit, as informed by ARCP association, the first guarantee that the bank asks for granting financing is the animals on the property and / or the farmland.

7.2 ▸ Group b: Interviews with producers, associations, technical assistants and NGO in Mato Grosso state

7.2.1 Producers in Mato Grosso state

In general, out of the 8 producers in total, 3 are small producers with total area varying between 12 and 48 hectares and cattle herd between 30 and 170 heads, and 5 are medium/large producers with area between 2,114 hectares and 5,500 hectares and herd between 1,750 and 5,500 heads. Only one producer declared to have degraded pastures on his/her farm and most of the small producers do not receive technical assistance.

Main technology used for pasture maintenance is the rotation of grazing, followed by soil correction with liming, fertilization and machinery. All the producers interviewed made investments in the last years, to recover pasture, fences, cattle acquisition, genetic improvement and improvements in the farm.

Regarding access to rural credit, both medium and small producers said that environmental and land requirements are limiting factors to access credit. In addition, financial institutions own difficulties in offering credit were also mentioned.

High investments, lack of own resources and lack of technical assistance were also highlighted as difficulties in adopting technologies to recover pastures, some even reported a lack of knowledge of the technologies, especially integrated systems and agroforestry systems.

Related to Covid-19 impacts on cattle ranching, most producers reported that the pandemic generated little or no impact on the activity. Only two producers reported medium impact and only one reported that the pandemic changed his/her expectations regarding future investments.

7.2.2 Technical assistant agents

Regarding productive structure, technical assistants said that, in their perception, rural producers have been looking to recover pasture in their farms, and liming, fertilizing and of paddock rotation grazing are the main strategies adopted to recover pasture. However, high investment, lack of own resources and difficulty of access to credit are limiting factors to recover pastures.

According to the agents, main limitations for cattle ranchers accessing credit are: unproductive habits, lack of technical assistance, necessity of land and environmental regularization of the farm, financing conditions including guarantees. So, the main changes that are necessary to make credit access better are: improvements on financing conditions (interest, terms and guarantees) and reduction of bureaucracy.

On average, technical agents indicated that, in general, producers finance their investments via rural credit policy, especially Pronaf (small farmers), but also via their own resources.

Related to Covid-19 impacts on cattle ranching activity, agents believe that there have been small or no impact on livestock activity in the state.

7.2.3 Entities, associations and local NGO

Interviewed ranchers' association in the east of Mato Grosso state evaluates integrated systems with great expectation, but admits that there is a greater difficulty for cattle ranchers to work with crops than the opposite. In this way, land leasing strategies between ranchers and crop producer to recover pastures can be the solution. A guarantee mechanism, to guarantee liquidity to the system of financing (credit), needs to be combined with a strong approach of technical assistance and monitoring. Bureaucracy in credit analysis and lack of environmental regularization are the main challenges.

According to IMAC – Mato Grosso Meat Association, Integrated systems are increasingly important but still represents several challenges for producers whose not have a farm well managed.

Main challenges for accessing credit and adoption of technologies by producers are their risk aversion and resistance to new technologies, environmental and land requirements and the low family succession in livestock activity.

IMAC believes that its a favorable moment to foment investments in cattle ranching due to market conditions (high export demand of meat and advantageous prices).

IMEA observes an unprecedented change in cattle ranching activity in the state of MT, determined by high cattle prices and high demand for meat (exports to China). Integrated systems and cattle ranching intensification (better productivity condition in the activity) have been increasing recently.

Breeding is the most vulnerable activity, since presents low profitability, low support capacity in pasture and low investments. Solutions proposed: technical assistance and access to rural credit, but environmental requirements may have a negative impact.

The local NGO in Mato Grosso State, states that medium-scale producers access less rural credit in Alta Floresta region. Not all producers are able to take credit (for environmental regularization) and it is often quite simple to solve and would take many producers out of “illegality”. The main actions are in the field, with training producer in farm management, technical assistance for technology adoption and technology dissemination.

7.3 ▸ Group c: Interviews with meatpacker and financial institutions

7.3.1 Financial institutions

We interviewed two financial institutions which has important share on rural credit in the Cerrado biome: a commercial bank and a credit cooperative.

The commercial bank points out that producer resistance to new techniques and credit, coupled with low quality of technical assistance are the main problems for credit access.

Cattle ranchers seek more short-term investments, preferring to invest in cattle because income is present, while investments whose income is diluted over time (long-term) are less preferred.

For producers able (regularized) to take rural credit, there is no lack of financing and there is no difficulty in presenting guarantees (mortgage or guarantee). Eligibility assessment of the bank is behavioral (historical credit rating). The bank does not need efforts to allocate investment resources, as it has captive clients.

According to the interviewed credit cooperative, producers face difficulties in accessing credit, such as:

i. lack of adequate technical assistance,

ii. difficulties faced by the financial institutions themselves in dealing with more complex financing projects (such as integrated system),

iii. the requirement for land and environmental regularization,

iv. other bureaucracies

The credit cooperative understands that the producer who wants to take credit does not face difficulties with guarantees, but a guarantee instrument (in financial resources and not real assets) would be essential for financial institutions. The cooperative does not have own resources for funding investment credit in the rural sector, depending on the rural credit policy.

7.3.2 Meatpacker

The interviewed meatpacker believes that the marginalization of the producer who does not comply with the environmental and land requirements is a huge mistake and it is necessary to think on strategies to include him/her in the formal chain and in the financial system, subject to their compliance with the law.

The interviewed meatpacker is engaged in several actions and strategies to foment the cattle ranching sustainable intensification in Mato Grosso.
Promotion of credit is one of these possible strategies. The meatpacker intend to use its own resources for pilot projects, which are scalable, but understand that the company must not finance the producer.

However, it is necessary to define protocols, requirements and production standards that take into account productivity, sustainability and social aspects in a way that producers will have technological packages and pre-defined indicators. The meatpacker has been using those protocols for green financing cattle acquisition.

CHAPTER 8

Business cases for pasture recovery

8.1 Business case for cattle intensification in Guariroba Basin region

The Guariroba hydrological basin is located in the municipality of Campo Grande, capital of Mato Grosso do Sul (MS) state, 40 km away from the city center, being the main source of water supply in this city. Part of the Paraná Basin, the Guariroba basin is located in the Cerrado biome.

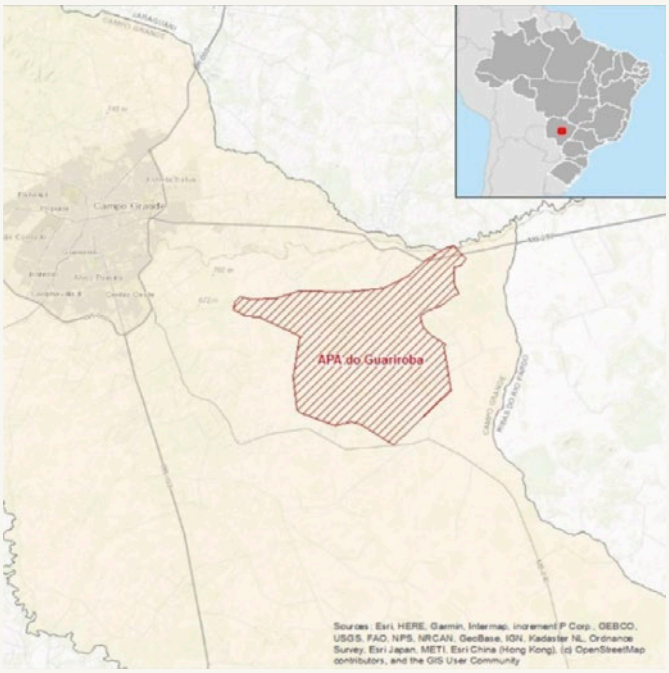


Figure 39.
Location of Guariroba basin region

Source: IBGE (2019).

With approximately 36,194 hectares, the predominant productive activity in the basin's properties is extensive beef cattle. With 65 rural properties, the predominant land tenure characteristic of the basin is of small, medium and large properties (mostly the last two profiles), with sizes between 48 and 5,480 hectares.

In this region, the Association for Recovery, Conservation and Preservation of the Guariroba Basin (ARCP) operates, which works with rural producers to promote compliance with environmental legislation, raise joint solutions to environmental degradation problems and claim technical support from environmental agencies. Since 2010, WWF-Brasil has been an ARCP partner through the Água Brasil Program, seeking to disseminate and encourage good agricultural practices, such as soil conservation, pasture recovery and environmental compliance, in order to ensure the hydrological basin's safety.

The business case aims to assess the financial performance of cattle ranching producers according to the source of their returns: productive activity and land appreciation. The financial models were built based on a real case and with the perspectives of livestock production in the Guariroba region.

It was considered different scenarios from the perspective of the producer and according to the conclusions perceived from the questionnaires applied. The main objective was to evaluate financial indicators of these scenarios and understand the profitability when the producer adopts pasture recovery on his property.

Figure 40.
Business case for pasture recovery in Guariroba Region Basin

Source: Study results.

HYPOTHESES

- Cattle ranching production models that adopt pasture recovery have higher productivity and thus have better financial returns
- Financing costing and investment in cattle ranching permit rural producers to have an improved cash flow
- Real price of land increases by 2.5% py

ASSUMPTIONS

- Breeding cycle of beef cattle ranching (medium farm size)
- Project period: 15 years
- There is no purchase of area, nor expansion of productive area
- Financing costing (working capital) annually only in the scenario B: 70% with own capital (6% py nominal) and 30% through rural credit (8% py nominal)
- Financing investment for pasture recovery and property improvements (B): 29% with own capital (6% py) and 71% through rural credit (ABC Program) (6% py)
- Financing investment for machinery purchase (B): 15% with own capital (6% py) and 85% through rural credit (similar to Moderfrota) (8% py)

	Scenario	Productive area	Stocking rate	Description
BAU	**Business As Usual**	Pasture area (242 ha)	1.49 heads/ha in year 1 1.49 heads/ha in year 5 1.49 heads/ha in year 15	Degraded pasture in farm that are not recovered. Cattle ranching presenting low stocking rate and low productivity. Producer does not invest in the activity and continues to produce as usually. Producer does not access rural credit.
A	**Recovery of degraded pastures – no access to credit**	Pasture area (242 ha)	1.49 heads/ha in year 1 3.58 heads/ha in year 5 3.58 heads/ha in year 15	There are investments to recover degraded pasture and to improve farm infrastructure during the first 5 years. Cattle ranching presenting growth in stocking rate until year 5, from which remains constant with higher productivity. Producer does not access credit to finance costing and investments in cattle ranching activity. 100% of own capital to finance the activity and investments.
B	**Recovery of degraded pastures – with access to credit**	Pasture area (242 ha)	1.49 heads/ha in year 1 3.58 heads/ha in year 5 3.58 heads/ha in year 15	There are investments to recover degraded pasture and to improve farm infrastructure during the first 5 years. Cattle ranching presenting growth in stocking rate until year 5, from which remains constant with higher productivity. Producer access credit to finance annually costing and investments in cattle ranching activity.

Table 3.
Scenarios considered (with and without land price appreciation)

Source: Study results.

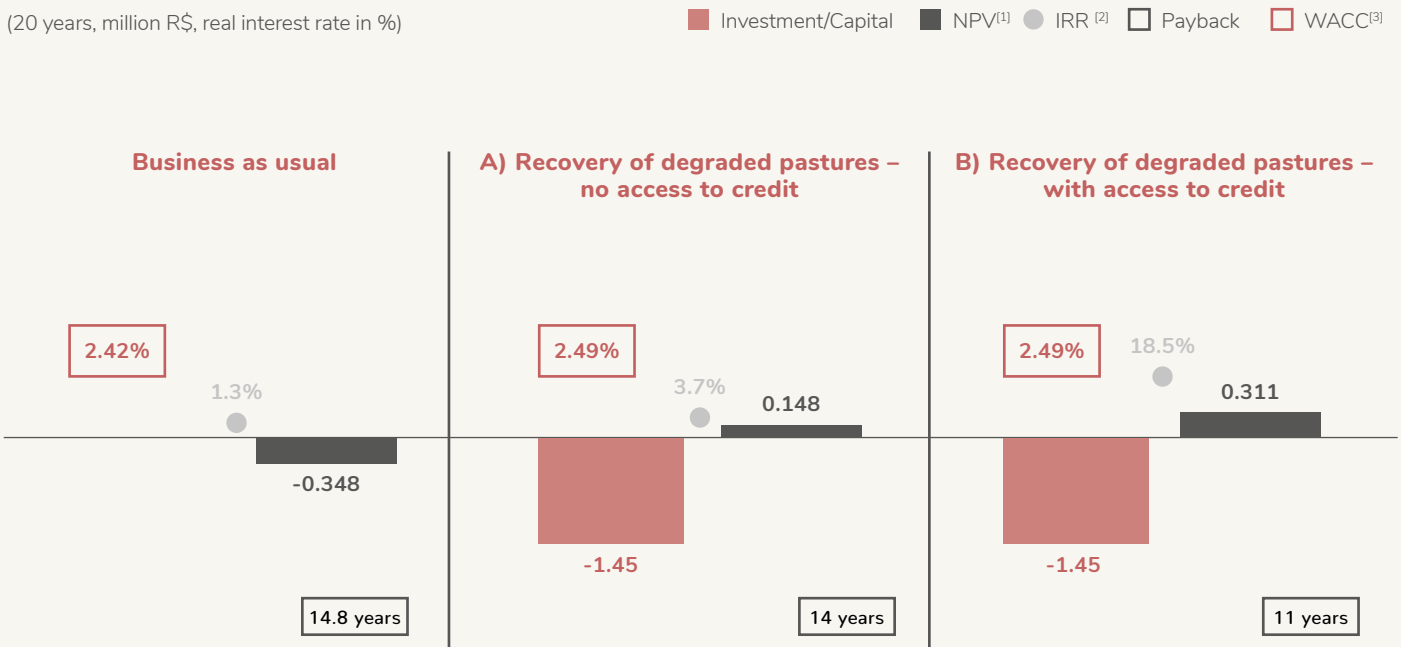
The results presented in the ***Figure 41*** show that extensive cattle ranching activity, with low productivity and pasture quality is not profitable. However, if the rancher invests on recovering pasture areas, the financial results are positive, especially when he/she access credit for investments.

Figure 41.
Business cases results for pasture recovery and cattle intensification (without land appreciation) - Guariroba basin region

Source: Study results.

CATTLE RANCHING IN GUARIROBA REGION | NO LAND APPRECIATION

(20 years, million R$, real interest rate in %)



Lower-productivity (1.49 head/ha) cattle breeding (not considering land appreciation) **presents negative returns**. This is due to the low return of the activity (extensive livestock) that generates insufficient returns, not being enough to remunerate the fixed assets in the activity.

The recovery of pastures and the improvement of productivity generate positive returns to the rancher and make the activity feasible. It is important to amphasize that, even to achieve greater productivity (3.58 heads/ha), the rancher needs to be capitalized.

Leveraging cash flow through by financing working capital and investments trough **rural credit can further increase the return on livestock activity** that included recovery of pastures and increased productivity,

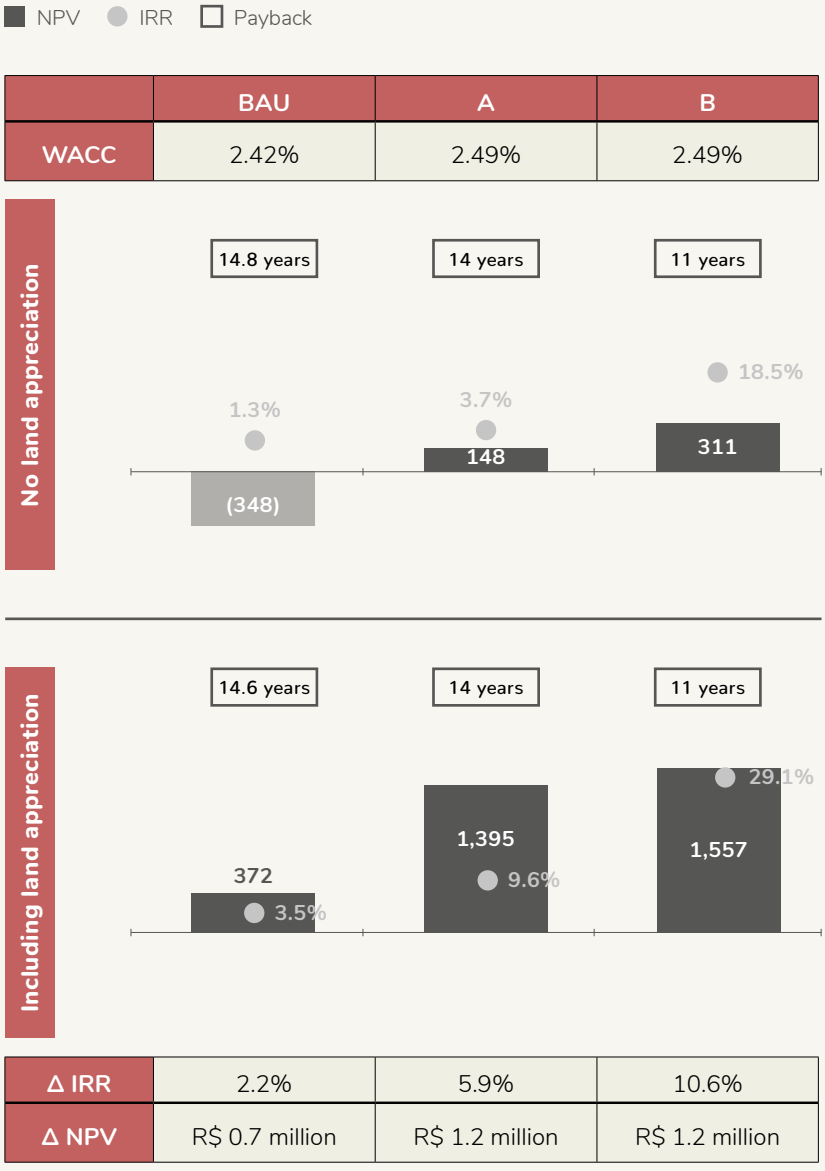
[1] NPV - Net Present Value
[2] IRR - Internal Rate of Return
[3] WACC - Weighted Average Cost of Capital

Figure 42.
Business case results for Guariroba region, with and without land price appreciation

Source: Study results

Note: The scenario without land appreciation refers to land prices in constant Reais throughout the project, while the scenario with land appreciation considers growth of 2.5% per year above the inflation rate and the effects of change in land use.

(15 years, thousand R$, real interest rate in %)



	BAU	A	B
WACC	2.42%	2.49%	2.49%

Δ IRR	2.2%	5.9%	10.6%
Δ NPV	R$ 0.7 million	R$ 1.2 million	R$ 1.2 million

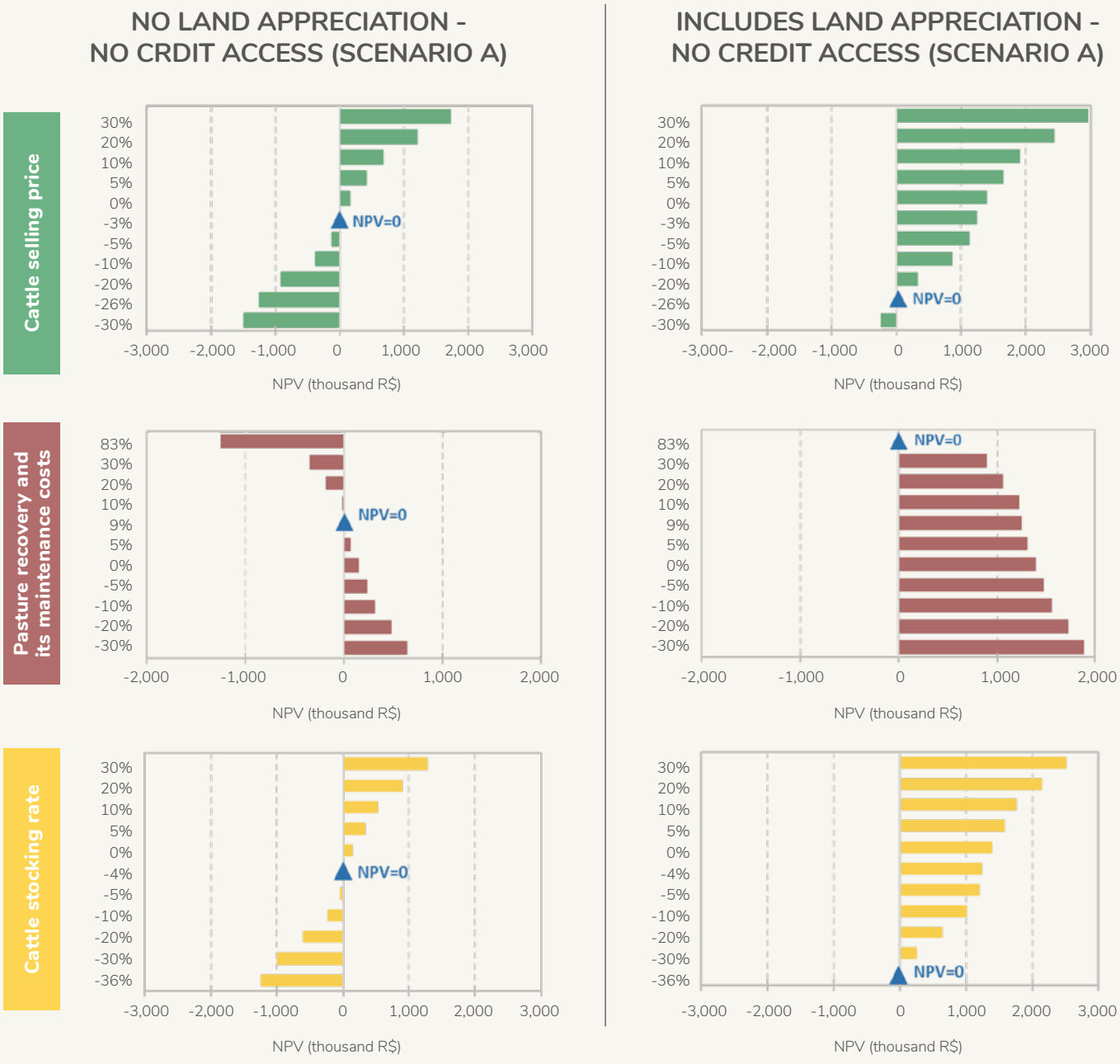
Traditional activity of beef cattle of breeding cycle, where there is no investment for improving pasture (BAU) and productivity, shows negative NPV (IRR <WACC). Only including the land appreciation provides the activity to become profitable, despite being very low (IRR = 3.5%).

The recovery of pasture allows the producer greater productivity, and consequently greater profitability, since it will produce more animals for sale (scenarios A and B), whether or not including land appreciation. In other words, activity by itself becomes more profitable than the traditional model (BAU) (in scenarios A and B, IRR>WACC).

Access to credit allows the producer to leverage the cash flow (scenario B), financing the cost of livestock activity and the investments necessary to recover pasture, to improve the farm's infrastructure and to purchase machinery. The result shows higher profitability of livestock activity, whether or not it considers land appreciation. Currently, the rural credit interest rate in Brazil is in lower levels, although higher than the Selic rate (general interest rate of the economy), favoring the contracting of credit for costing and investment.

Figure 43.
Business case sensitive analyses results – Guariroba basin region

Source: Study results



Cattle selling price has an expressive impact on cattle ranching activity return. A drop of more than 3% in the price means a negative NPV and a negative return in the model (no land appreciation)

A positive variation higher than 9% in **costs of pasture recovery and its maintenance** can compromise cash flow, making the activity unfeasible (no land appreciation).

Reduction in the **stocking rate** creates an expressive negative impact in cattle ranching activity return, since fewer animals would be produced for sale. The opposite for an increase in stocking rate.

8.2 ▸ Business case for cattle intensification in Araguaçu

Araguaçu is a municipality located in the south of the state of Tocantins. It is characterized by cattle ranching activity, focused on the breeding system. According to data from LAPIG, the municipality has approximately 199 thousand hectares of degraded pasture.

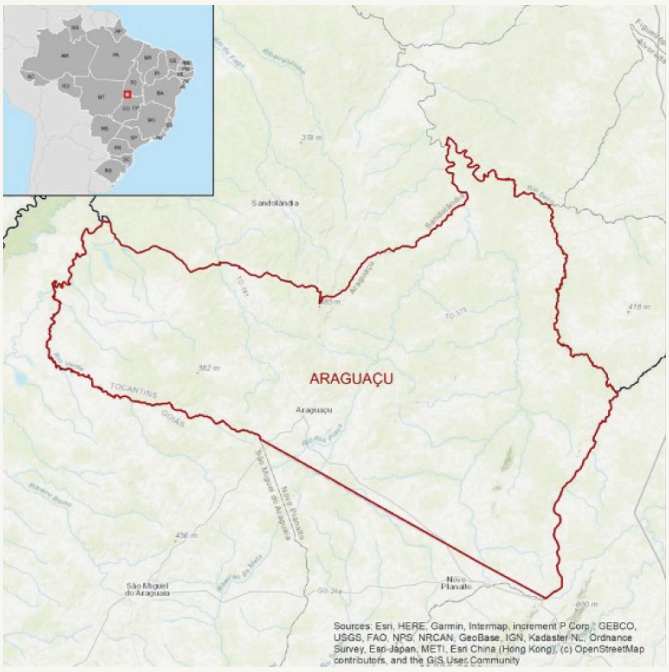


Figure 43.
Location of Araguaçu

Source: IBGE (2019).

Based on this information and in consonance with the purpose of this study, it was developed:

a) business case in reference to cattle ranching producers in the region of Araguaçu according to the source of their returns: productive activity and land appreciation. It was evaluated financial

indicators of these scenarios and understood the profitability when the producers adopt pasture recovery on their properties, or when they lease part of their pasture area for soybean expansion.

b) business case for soybean producers in the region of Araguaçu, according to the source of their returns: productive activity and land appreciation. It was evaluated financial indicators of these scenarios, observing the profitability when the producers expand soy production over new areas.

Figure 44.
Hypotheses and assumptions based on cattle ranching activity in the Araguaçu region.

Source: Study results.

HYPOTHESES

- Cattle ranching production models that adopt pasture recovery have higher productivity and thus have better financial returns
- Financing costing and investment in cattle ranching allows rural producers to have an improved cash flow
- Leasing part of pasture area for soybean production can increase financial return of the farm
- Real price of land increases by 2.5% py

ASSUMPTIONS

- Breeding cycle of beef cattle ranching (medium farm size)
- Project period: 15 years
- There is no purchase of area, nor expansion of productive area
- Own cattle ranchers capital for costing the activity in the scenarios BAU, A1 and B1.
- Own cattle ranchers capital for investments in pasture recovery and infrastructure in the scenarios A1 and B1.
- Financing costing (working capital) annually only in the scenarios A2 and B2: 70% with own capital (6% py nominal) and 30% through rural credit (6% py nominal).
- Financing investment for pasture recovery and property improvements (A2 and B2): 29% with own capital (6% py) and 71% through rural credit (ABC Program with 4 years of grace period) (6% py)
- There is no investment for machinery acquisition in all scenarios, since producers already have it in their farms.

Table 4.
Scenarios considered – Cattle ranching in Araguaçu region

Source: Study results.

	Scenario	Productive area	Stocking rate in pasture area	Description
BAU	**Business As Usual**	Pasture area (250 ha)	1.24 heads/ha in year 1 1.24 heads/ha in year 5 1.24 heads/ha in year 15	Degraded pasture areas in the farm are not recovered. Cattle ranching presenting low stocking rate and low productivity. Producer does not invest in the activity and continues to produce as usually. Producer does not access rural credit.
A1	**Recovery of degraded pastures – no credit access**	Pasture area (250 ha)	1.24 heads/ha in year 1 3.58 heads/ha in year 5 3.58 heads/ha in year 15	There are investments to recover degraded pasture and to improve farm infrastructure during the first 5 years. Cattle ranching presenting growth in stocking rate until year 5, from which remains constant with higher productivity. Producer does not access rural credit to finance costing and investments in cattle ranching activity. 100% of own capital to finance the activity and investments.
B1	**Recovery of degraded pastures and leasing are for soybean – no credit access**	Pasture area (125 ha) Leased area for agriculture (125 ha)	1.24 heads/ha in year 1 3.58 heads/ha in year 5 3.58 heads/ha in year 15	Cattle rancher leases 50% of his/her pasture area (125 ha) for soybean producer over the total period of the project. 50% pasture remaining, cattle rancher invests to recover degraded pasture and to improve farm infrastructure during the first 5 years. Cattle ranching presenting growth in stocking rate until year 5, from which remains constant with higher productivity. Producer does not access rural credit to finance costing and investments in cattle ranching activity. 100% of own capital to finance the activity and investments.
A2	**Recovery of degraded pastures – including rural credit access**	Pasture area (250 ha)	1.24 heads/ha in year 1 3.58 heads/ha in year 5 3.58 heads/ha in year 15	There are investments to recover degraded pasture and to improve farm infrastructure during the first 5 years. Cattle ranching presenting growth in stocking rate until year 5, from which remains constant with higher productivity. Producer access rural credit to finance costing and investments in cattle ranching activity.
B2	**Recovery of degraded pastures and leasing are for soybean – including rural credit access**	Pasture area (125 ha) Leased area for agriculture (125 ha)	1.24 heads/ha in year 1 3.58 heads/ha in year 5 3.58 heads/ha in year 15	Cattle rancher leases 50% of his/her pasture area (125 ha) for soybean producer over the total period of the project. 50% pasture remaining, cattle rancher invests to recover degraded pasture and to improve farm infrastructure during the first 5 years. Cattle ranching presenting growth in stocking rate until year 5, from which remains constant with higher productivity. Producer access rural credit to finance costing and investments in cattle ranching activity.

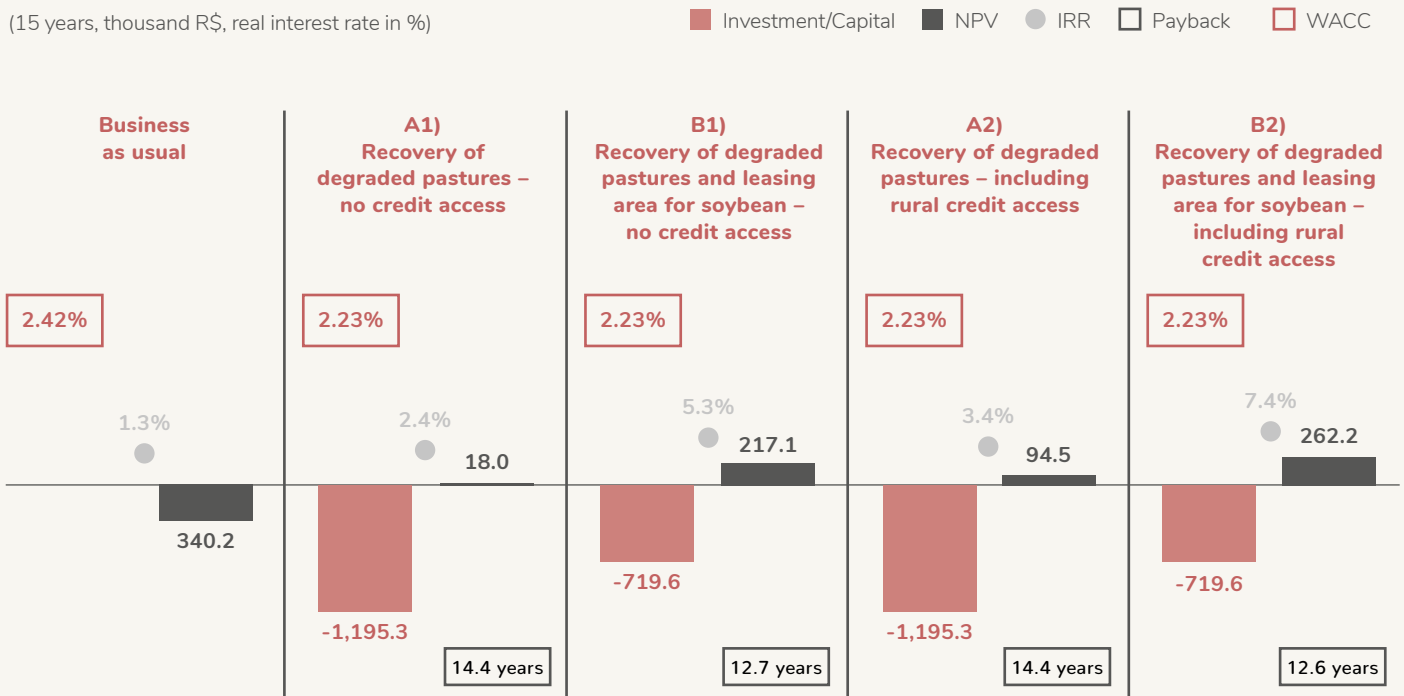
The results presented in the Figure below show that investing in pasture recovery is a way to the producer obtain higher productivity and better financial returns. When leasing pasture area, IRR is even higher due to the revenue obtained, which can be allocated to support investments in the farm.

Figure 45.
Business cases results for cattle ranching in Araguaçu region

Source: Study results.

CATTLE RANCHING IN ARAGUAÇU REGION | NO LAND APPRECIATION

(15 years, thousand R$, real interest rate in %)



Lower-productivity (1.24 head/ha) cattle breeding (not considering land appreciation) **presents negative returns**. Extensive livestock that generates insufficient returns, not being enough to remunerate the fixed assets in the activity.

The recovery of pastures and the improvement of productivity generate positive returns to the rancher and make the activity feasible. Even to achieve greater productivity (3.58 heads/ha), the rancher needs to be capitalized.

Leasing area for soybean expansion is a way to get revenue that can be allocated to support investments in the farm using own capital. In this case, financial return is higher then in scenario A1.

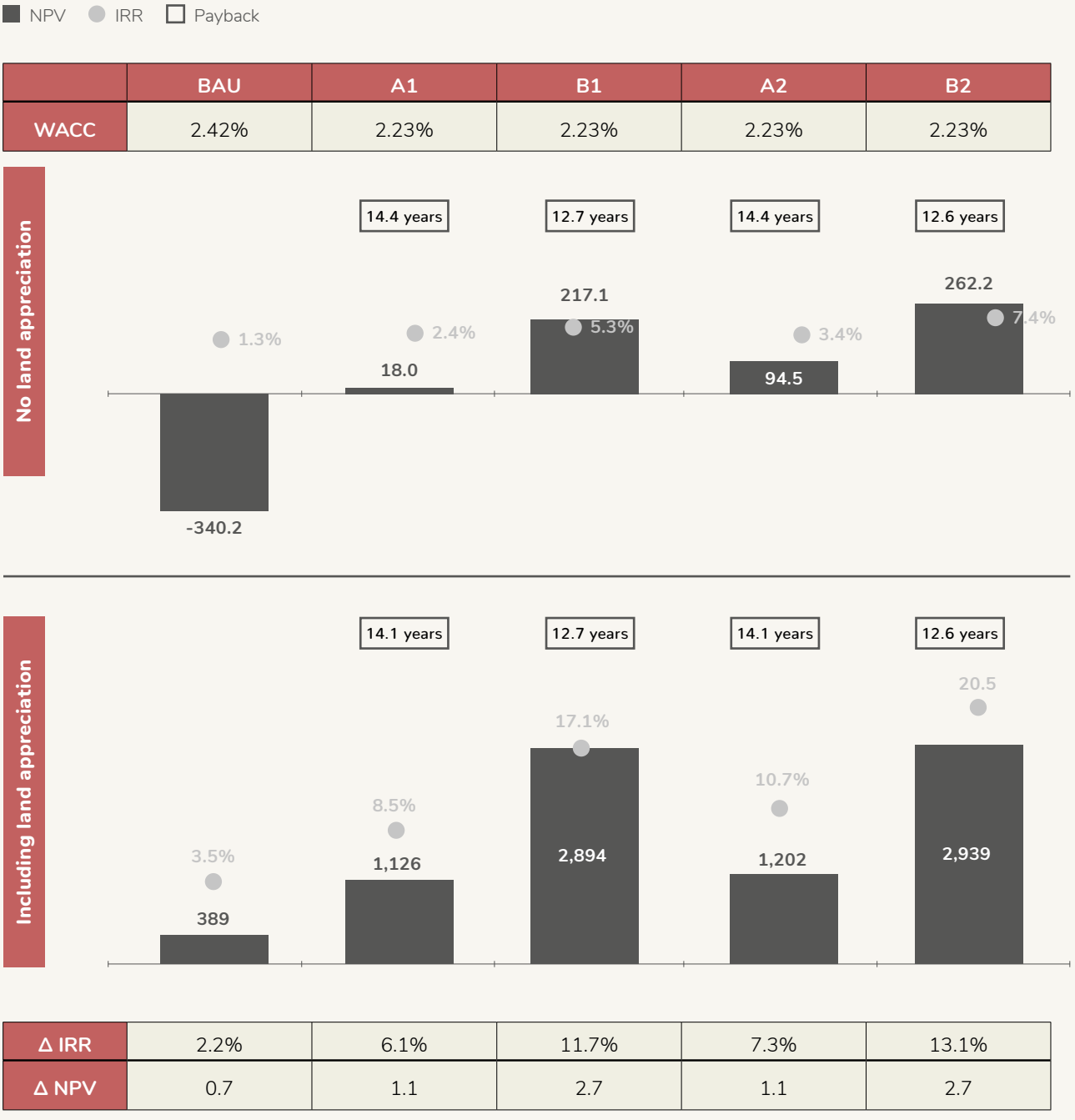
Leveraging cash flow by financing working capital and investments trough **rural credit can further increase the financial return of cattle ranch activity compared to scenario A1**. Thi is the best option for the producers that do not intend to lease areas for agriculture.

Besides the revenue obtained from leasing areas for soybean expansion, **leveraging cash flow can present financial return higher than scenario B1**, in wich rural credit is not accessed.

Figure 46.
Business case results for Araguaçu region – Cattle ranching

Source: Study results.
Note: The scenario without land appreciation refers to land prices in constant Reais throughout the project, while the scenario with land appreciation considers growth of 2.5% per year above the inflation rate and the effects of change in land use.

(15 years, thousand R$, real interest rate in %)



	BAU	A1	B1	A2	B2
WACC	2.42%	2.23%	2.23%	2.23%	2.23%
Δ IRR	2.2%	6.1%	11.7%	7.3%	13.1%
Δ NPV	0.7	1.1	2.7	1.1	2.7

Land appreciation is an important factor that impacts on financial returns of the business model and on producers' decision to invest in their farms. Ranchers achieve higher return when lease part of pasture for agriculture.

Extensive activity of beef cattle (breeding cycle) shows negative NPV (IRR <WACC), mainly due to low productivity and inefficient use of capital. When land appreciation is included, the scenario become profitable, despite the low return.

Pasture recovery and improvement in productive conditions with higher productivity generate a positive return of the cattle ranching (A1) (IRR = 2.4%), since the activity is carried out more intensively with greater use of the capital. In the case of the producer leasing part of the pasture area for soybean expansion (B1), his/her return is greater in relation to the previous scenario (A1), this is because the revenue obtained from the lease can be allocated to finance part of the investments to recover pasture.

Access to credit allows the producer to leverage the cash flow (scenarios A2 and B2), financing the cost of livestock activity and the investments necessary to improve the farm's infrastructure, resulting in even higher profitability of cattle

ranching activity, whether or not it considers land appreciation, with a lower payback period. Also, land appreciation impacts significantly on the financial returns, especially on scenarios B1 and B2, where there is conversion of pasture into crop land, which has higher price than pastureland, and hence land appreciation is higher.

Important to note that financial returns are different for other beef cattle productive systems and for different pasture area/stocking rate due to the production scale obtained. Also, costs incurred in the activity are distinct between Brazilian regions. By these reasons, solutions to recover degraded pasture must be evaluated regionally.

Based on scenario A, cattle price and cattle stocking rate are the variables that most impact on return **(Figure 47**). When land appreciation is considered, the impact on cash flow is substantially lower for all variables considered. **Figure 48** shows the hypothesis and assumptions for the soybean producer business case.

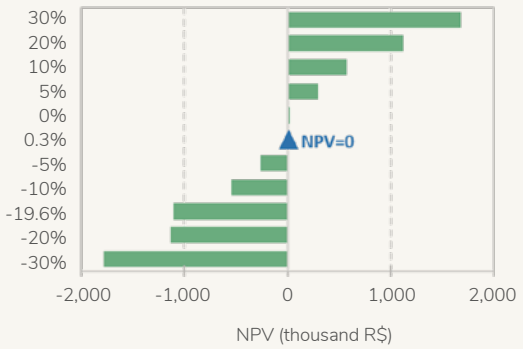
Figure 47.
Business case sensitive analyses results – Cattle ranching in Araguaçu region

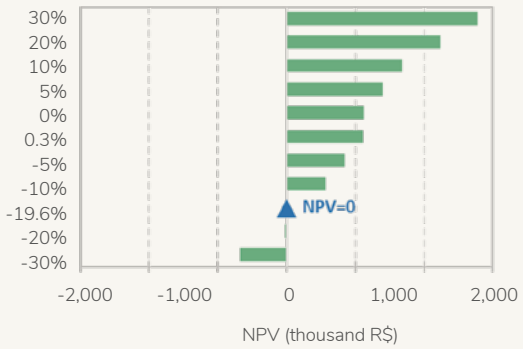
Source: Study results

NO LAND APPRECIATION - NO CRDIT ACCESS (SCENARIO A)

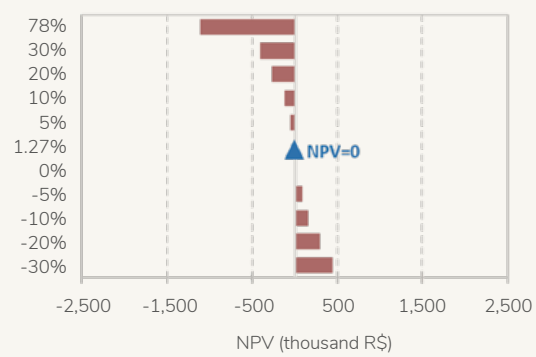
INCLUDES LAND APPRECIATION - NO CRDIT ACCESS (SCENARIO A)

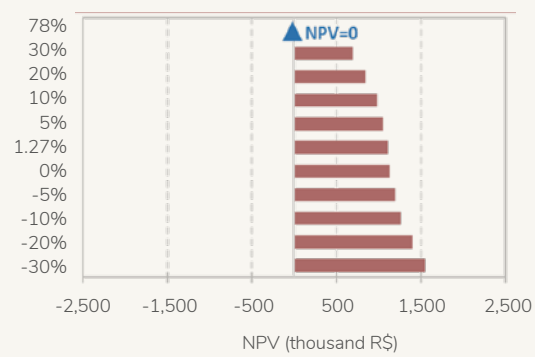
Cattle selling price



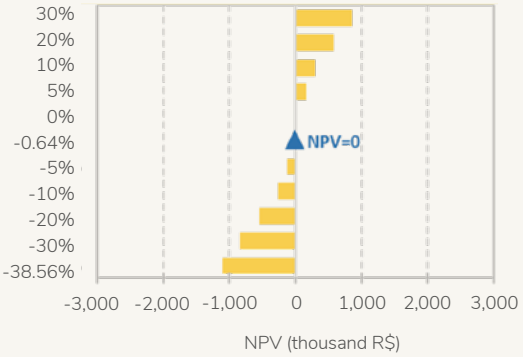


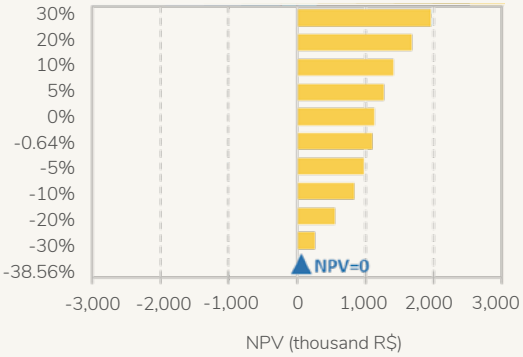
Pasture recovery and its maintenance costs





Cattle stocking rate





Cattle selling price has an expressive impact on cattle ranching activity return. A drop of more than 0.3% in the price means a negative NPV and a negative return in the model (no land appreciation). This risk reduces significantly when land appreciation is considered in the model.

A positive variation higher than 1.27% in **costs of pasture recovery and its maintenance** can compromise cash flow, making the activity unfeasible (no land appreciation). It does not affect when land price is included.

A drop in the **stocking rate** creates a negative impact in cattle ranching activity return, since fewer animals would be produced for sale (lower revenue). The opposite for an increase in stocking rate.

Figure 48.
Hypotheses and assumptions based on soy expansion over the last years in the Cerrado biome

Source: Study results.

HYPOTHESES

- The models of agricultural activity with soy have good profitability, showing returns higher than other activities, such as livestock. Reason why it has been losing area to soybeans.
- Land appreciation is a factor that drives agricultural expansion.
- Occupation of pasture areas is a way to direct the expansion of soy in the Cerrado, avoiding native vegetation conversion.

ASSUMPTIONS

- Project period: 15 years
- Financial sources for funding annual costing (all scenarios):
  - 32% official rural credit (6% py nominal)
  - 24% barter (12% py nominal)
  - 44% own capital/equity (6% py nominal)
- Financing investment for conversion area into agriculture:
  - scenarios D, F and G (pasture into agriculture): 71% official rural credit (ABC Program with 4 years of grace period / 6% py nominal) and 29% own capital/equity (6% py nominal)
  - scenarios C and E: there is no conversion of area
  - scenarios A and B (native vegetation into agriculture): own capital/equity (6% py nominal)
- Financing machinery investments in scenarios A to G
- 85% official rural credit (Moderforta with 1 year of grace period / 7.5% py nominal)
- 15% own capital/equity (6% py nominal)
- No investments in machinery on BAU scenario
- Payment term of the acquired area
- 5 years on scenarios B to F: 20% own capital/equity (6% py nominal) and 80% financed by the previous land owner/vendor (7.5% py nominal)
- no acquisition of area on scenarios BAU, A and G
- Leasing area: own capital/equity (6% py nominal) and amount paid annually corresponding to 12 months of land use
- Prices paid for:
  - Leasing area: R$ 738/ha
  - Native Vegetation land: R$ 3,000/ha
  - Pasture land: R$ 3,750/ha
  - Agriculture land: R$ 12,000/ha

Table 5.
Scenarios evaluated - Soy expansion in Araguaçu region

Source: Study results.

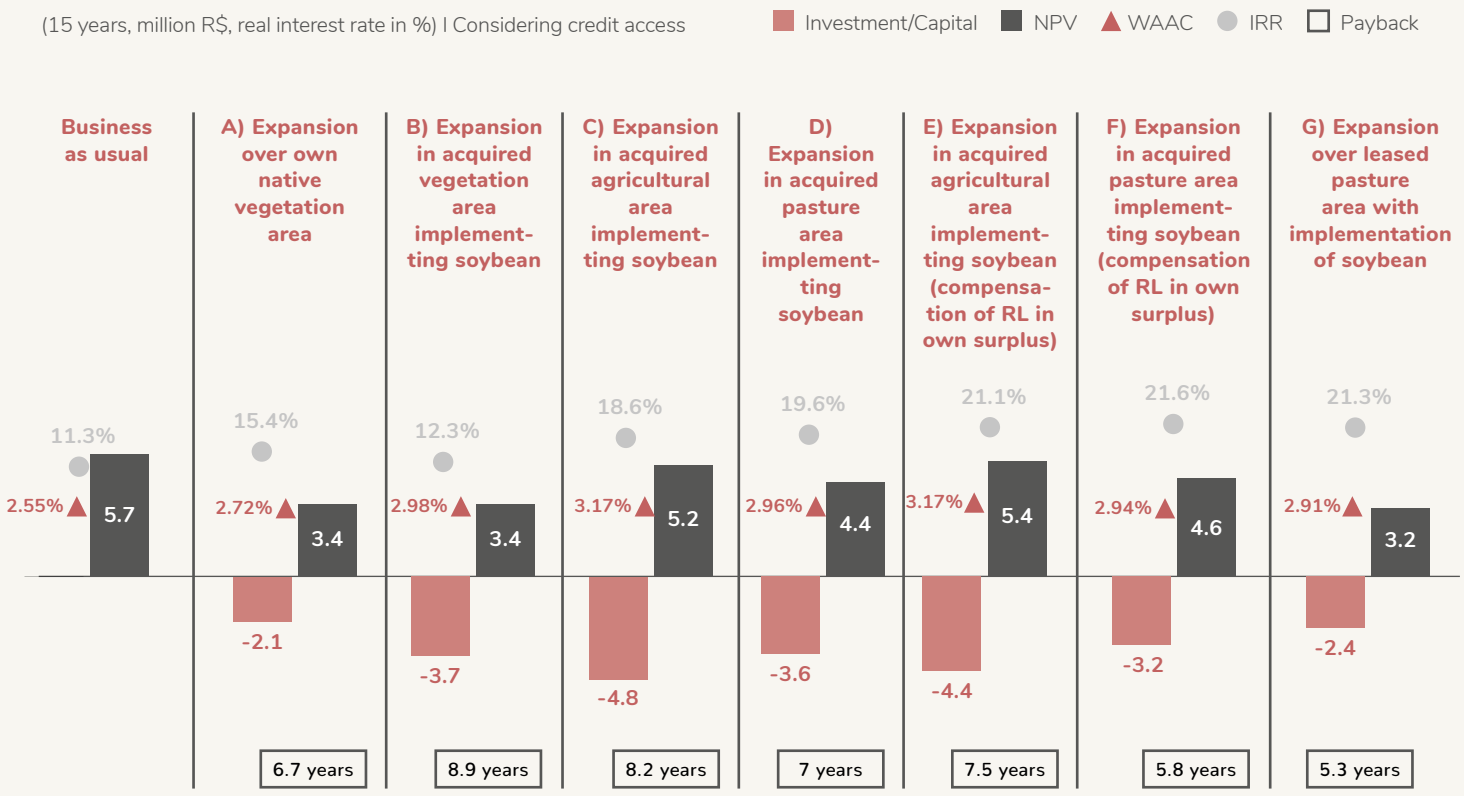
	Scenario	Total area	Productive area	Productivity	Description
BAU	**Business As Usual**	Consolidated area (250 ha) + Surplus of Legal Reserve - LR (463 ha) = 713 ha	Consolida-ted area (250 ha)	3.32 ton/ha. Growth rate: 0.53% py	Producer already have necessary infrastructure and machinery to conduct soybean activity. Consolidated area with full productivity. Costing is financed annually through official rural credit and *barter*.
A	**Expansion over own native vegetation area**	Own LR area = 329 ha (214 ha of productive and 115 ha of LR)	Expansion area (214 ha)	Initial of 1.66 ton/ha and reach BAU rate at year 6. Growth rate: 0.53% py after year 6	Producer expands over own native vegetation area (LR surplus), but being in compliance with the Forest Code. There are investments in machinery and in land conversion. Costing is financed annually through official rural credit and *barter*.
B	**Expansion in acquired vegetation area implement-ting soybean**	Acquisition of area with native vegetation = 385 ha	Expansion area (250 ha)	Initial of 1.66 ton/ha and reach BAU rate at year 6. Growth rate: 0.53% py after year 6	Producer expands soybean production acquiring an area with native vegetation. There are investments in machinery and in land conversion. Costing is financed annually through official rural credit and *barter*.
C	**Expansion in acquired agricultural area implement-ting soybean**	Acquisition of agriculture area (250 ha) + LR (135 ha) = 385 ha	Expansion area (250 ha)	3.32 ton/ha. Growth rate: 0.53% py	Producer expands soybean production acquiring a crop area, not being necessary land conversion. There are investments in machinery. Costing is financed annually through official rural credit and *barter*.
D	**Expansion in acquired pasture area implement-ting soybean**	Acquisition of pasture area (250 ha) + LR (135 ha) = 385 ha	Expansion area (250 ha)	Initial of 1.66 ton/ha and reach BAU rate at year 4. Growth rate: 0.53% py after year 4	Producer expands soybean production acquiring a pasture area. There are investments in machinery and in land conversion. Costing is financed annually through official rural credit and *barter*.
E	**Expansion in acquired agricultural area implement-ting soybean (compensa-tion of RL in own surplus)**	Acquisition of agriculture area = 250 ha (does not include Legal Reserve)	Expansion area (250 ha)	3.32 ton/ha. Growth rate: 0.53% py	Producer expands soybean production acquiring a crop area, which not includes Legal Reserve, so there is compensation of LR in own consolidated area (BAU). Land conversion is not necessary. There are investments in machinery. Costing is financed annually though official rural credit and *barter*.

	Scenario	Total area	Productive area	Productivity	Description
F	**Expansion in acquired pasture area implement-ting soybean (compensation of RL in own surplus)**	Acquisition of pasture area = 250 ha (does not include Legal Reserve)	Expansion area (250 ha)	Initial of 1.66 ton/ha and reach BAU rate at year 4. Growth rate: 0.53% py after year 4	Producer expands soybean production acquiring a pasture area, which not includes Legal Reserve, so there is compensation of LR in own consolidated area (BAU). There are investments in machinery and in land conversion. Costing is financed annually through official rural credit and *barter.*
G	**Expansion over leased pasture area with implementation of soybean**	Leasing of pasture area (250 ha)	Leased area (250 ha)	Initial of 1.66 ton/ha and reach BAU rate at year 4. Growth rate: 0.53% py after year 4	Producer expands soybean production leasing a pasture area. There are investments in machinery and in land conversion. Costing is financed annually through official rural credit and *barter.*

Not considering land appreciation, soybean expansion over pasture and over agriculture are the most profitable scenarios ***(Figure 49)***. ***Figure 50*** shows the results comparing the scenarios with and without land price appreciation.

Figure 49.
Business cases results for soy expansion in Araguaçu region

Source: Study results.



BAU) The soybean activity shows **a positive return**, with NPV of R$ 5.7 million, remunerating the fixed capital. This explains the expansion of soy activity in recent years.

A) **Expansion over own native vegetation presents the lowest investment necessary with a positive return.** Financial return is limited due to the lower productivity in the area during years.

B) **Expansion over acquired native vegetation area shows the lowest IRR**, since productivity is lower in the first six years, reducing the gains compared to the other scenarios (no land appreciation considered).

C) Although the highest investment (R$ 4.8 million), **expansion over crop area (conversion not necessary) allows higher financial return** when compared to expansion over acquired native vegetation (B) due to high productivity over all project period.

D) **Expansion over acquired pasture area presents a lower payback than expansion over acquired agriculture area (C),** due to lower necessary investments (lower price of land for acquisition and conversion costs).

E) **Expansion over acquired crop land with compensation of RL achieves the higher financial return**, since only productive area is acquired, not being necessary to buy the portion of RL.

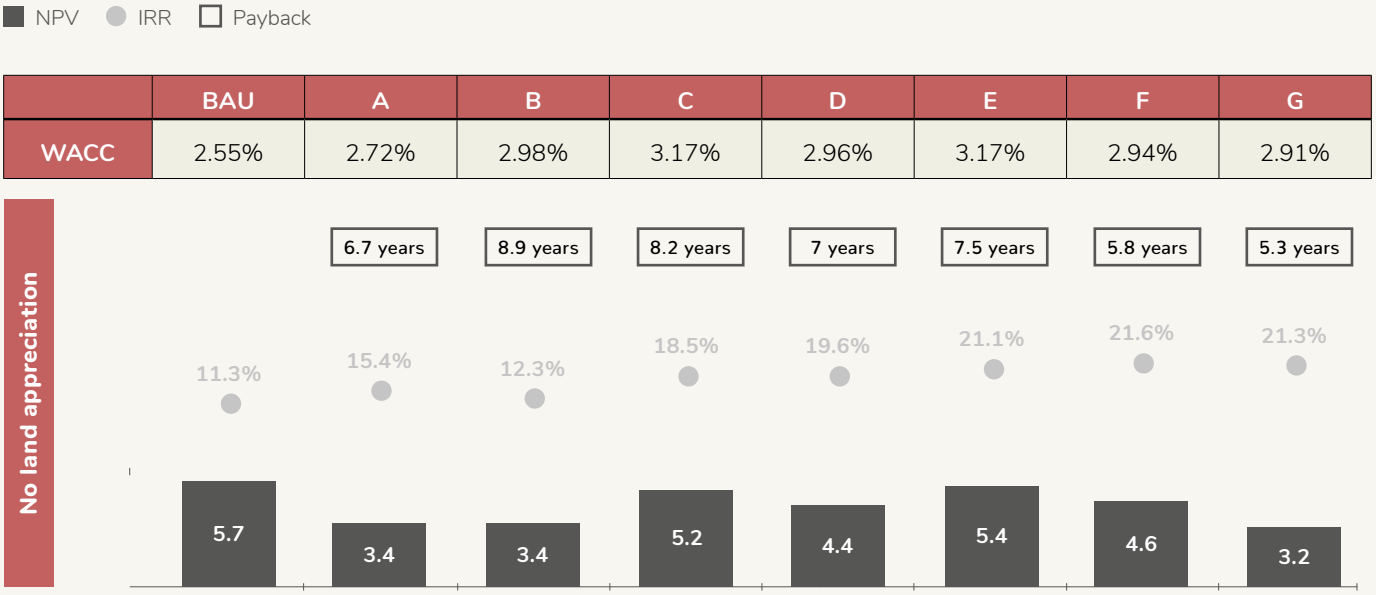
F) **Expansion over acquired pasture area with compensation of RL also presents high financial return.** In this case, lower investment is needed compared to scenario E.

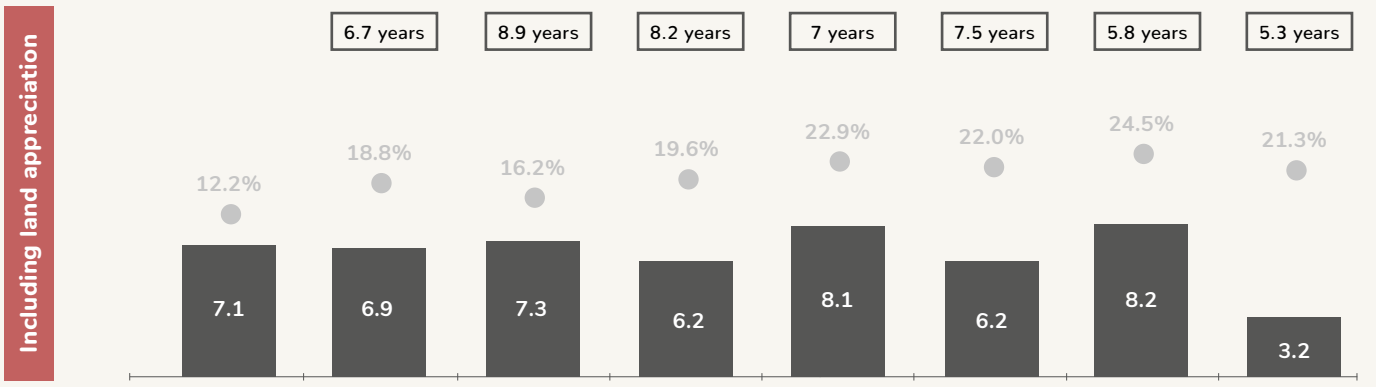
G) **Soy is profitable enough to pay for the lease of the area and for the necessary investments to convert it into agriculture.** Soy producer does not appropriate the difference on land prices after conversion.

Figure 50.
Business case results for Araguaçu region – Soybean expansion

Source: Study results.

(15 years, million R$, real interest rate in %) I Considering credit access





	BAU	A	B	C	D	E	F	G
WACC	2.55%	2.72%	2.98%	3.17%	2.96%	3.17%	2.94%	2.91%
Δ IRR	1.0%	3.4%	3.9%	1.0%	3.3%	0.8%	2.8%	0.0%
Δ NPV (million)	1.3	3.4	3.9	1.0	3.7	0.8	3.5	0.0

Positive return from soybeans activity makes expansion viable in all scenarios, with or without land appreciation. The appreciation of the land brings significant incremental gains, except for the cases of leasing, where the producer does not appropriate it.

Expanding over acquired native vegetation (B) showed the lowest IRR (without land appreciation), since investments in acquisition and area conversion are needed and the time to reach maximum productivity is slower than other expansion models. In this case, expansion over own LR surplus (A) presents higher financial return.

Comparing IRR, expansion over acquired crop area (C and E) or pasture area (D and F) present the high returns for soybean activity.

Leasing pasture area (G) has positive return and also it is a profitable option to the soy producer (important to note that this conclusion was observed when producer access credit), however rural producer does not appropriate gains over land appreciation.

The land appreciation has a relevant impact on the return of the scenarios, mainly those of expansion over native vegetation (A and B) (IRR with variation of 3.4 percentage points for the A and 3.9 percentage points for scenario B)

and over pasture (IRR varies by 3.7 percentage points in scenario D and by 3.5 points in scenario F), since in these there is conversion of area into agriculture, which does not occur in the other scenarios (C and E, and in scenario G when there is lease and no purchase of area).

Thus, considering the availability of degraded pasture in the region of Araguaçu, and looking to the return of soy activity (both NPV and IRR reached), to the land prices and to the gain with appreciation of the land, the expansion of soy over acquired pasture is the most profitable option for the soybean producer (scenarios D and F). This can also be explained by the fact that pasture land prices in the Araguaçu region are much lower compared to crop land prices and not so higher when compared to native vegetation land prices, and soybean productivity can be reached faster than when expansion occurs over native vegetation area.

8.3 ▸ Business cases - Integrated system in Canarana region

Canarana is a municipality located in the east of the state of Mato Grosso, characterized by agriculture and cattle ranching activities, where there are degraded pasture areas that can be recovered and/or converted for soy expansion.

Figure 51.
Location of Canarana region

Source: IBGE (2019).

Based on this information and in consonance with the purpose of this study, it was developed a business case in reference to cattle ranching and soy activities in the same area, composing a crop-livestock integrated system (ICLS). It was evaluated financial indicators and understood the profitability when the producers adopt ICLS to recover pasture in their properties, which composes the producer's perspective.

We conducted this analysis aligned with a land development company in Brazil, which the main business is to acquire areas, lease it for soil recovery and crop production and, then, sell the land in a long-term period, obtaining land appreciation gains. During this period, the company leases the area to a rural producer or to other companies

linked to agriculture production. For this business case, the area evaluated in Canarana represents a potential business for the company. For this reason, we also developed scenarios to explore the gains obtained by the company on land appreciation, which composes the land owner perspective.

Figure 52.
Hypotheses and assumptions based on adoption of an integrated systems (cattle ranching and soy) to recover degraded pasture in the Cerrado biome

Source: Study results.

HYPOTHESES

- Pasture recovery with adoption of integrated systems can be feasible, presenting positive financial returns.
- Land price and Land appreciation are factors that drive agricultural expansion in the Cerrado, through the acquisition of areas or leasing them.
- Occupation of pasture areas is a way to direct the expansion of soy in the Cerrado, avoiding native vegetation conversion.

ASSUMPTIONS

PRODUCER'S PERSPECTIVE SCENARIOS

- Project period: 15 years
- Financial sources for funding annual costing (all scenarios): 100% own capital, 6.5 py nominal
- Financing investment for pasture recovery, for conversion area into agriculture (scenarios A and B) and beginning cattle stock (scenario A): 6.5 py nominal with a payment term of 7 years including 1 year of grace period
- Leasing area (all scenarios): own capital/equity (6.5% py nominal) and amount paid annually corresponding to 12 months of land use
- Price paid for leasing area when achieving full yields (all scenarios): R$ 841/ha/year

LANDOWNER'S PERSPECTIVE SCENARIOS

- Project period: 15 years
- Financing investment for area acquisition (all scenarios): 100% own capital, 6.5 py nominal, paying for it over 4 years
- Price paid for acquiring agriculture area: R$ 21,538/productive hectare
- Price paid for acquiring pasture area: R$ 11,538/productive hectare
- Price received for leasing the area when achieving full yields (all scenarios): R$ 841/ha/year
- Land appreciation: it considers growth rate of 2.5% per year above the inflation rate (scenario BAU, A and B) the effects of change in land use (scenario A and B)

Table 6.
Scenarios evaluated - Integrated systems in Canarana

Source: Study results.

Perspective		Scenario	Total area	Productive area	Productivity	Period	Description
Rural producer / tenant	BAU	**Leasing crop area for soy expansion**	8,264 ha, being 2,892 of Legal Reserve	5,372 ha (soy area)	Soy: 57 bags/ha and reaches 64 bags at year 6. Growth rate: 2% per year	15 years	Producer leases a cropland to soy expansion. There is no investment in area conversion since it is already in good conditions for soy production. There is no access to credit line/financing. The main goal is to identify the feasibility to lease a land exclusively for soy production, since this activity is the main competitor for land in the region of Canarana.
	A	**Leasing pasture area for implementation of integrated system (ICL – cattle ranching + soy) including pasture recovery**	8,264 ha, being 2,892 of Legal Reserve	3,872 ha of ILP + 1,500 ha of pasture exclusive for cattle ranching	Soy: Initial of 0 ton/ha and reaches 65 bags/ha at year 6. Growth rate: 2% per year Cattle: initial of 0.9 unit animals (UA)/ha and reaches 1.5 UA/ha at year 4.	15 years	Producer leases a degraded pasture, invests in pasture recovery for cattle ranching exclusively (1,500 ha), invest to convert part of pasture area (3,872 ha) into cropland/ICL and invest to acquire the initial cattle stock. Investments are financed by a credit line which charges 6.5 py nominal with a payment term of 7 years including 1 year of grace period. Annual Costing is financed through own capital. The main goal is to identify the feasibility of the productive system designed in this scenario over a 15 years-project from the perspective of the agricultural producer (land operator).
	B	**Leasing pasture area for soy expansion**	8,264 ha, being 2,892 of Legal Reserve	5,372 ha	Soy: Initial of 0 ton/ha and reach 65 bags/ha at year 6. Growth rate: 2% per year	15 years	Producer leases a degraded pasture area, invests on conversion of all pasture area (5,372 ha) into cropland for soy expansion. Investments are financed by a credit line which charges 6.5 py nominal with a payment term of 7 years including 1 year of grace period. Annual Costing is financed through own capital. The main goal is to identify the feasibility of soy in this scenario over a 15 years-project from the perspective of the agricultural producer (land operator).

Perspective		Scenario	Total area	Productive area	Productivity	Period	Description
Land owner	BAU	**Acquisition of crop area by the company/ land owner and leasing it**	8,264 ha, being 2,892 of Legal Reserve	5,372 ha (leased soy area)	n/a	15 years	Land owner acquires a crop area with own capital, leasing it to a rural producer, what composes its revenue over the project period. In the year 15, the company sells the area, having land appreciation gains. The main purpose of this scenario is to evaluate the financial return obtained by the land owner while buying, leasing and selling the land.
	A	**Acquisition of pasture area by company/ landowner and leasing it**	8,264 ha, being 2,892 of Legal Reserve	5,372 ha (leased area for ICL)	n/a	15 years	Land owner acquires a degraded pasture area with own capital, leasing it to a rural producer, what composes its revenue over the project period. The rural producer will make investments to convert pasture area into agriculture and to recovery the remaining area of pasture (as in scenario A and B from the perspective of the rural producer). In the year 15, the company sells the area, facing the land appreciation. The main purpose of this scenario is to evaluate the financial return obtained by the land owner while buying, leasing and selling the land.

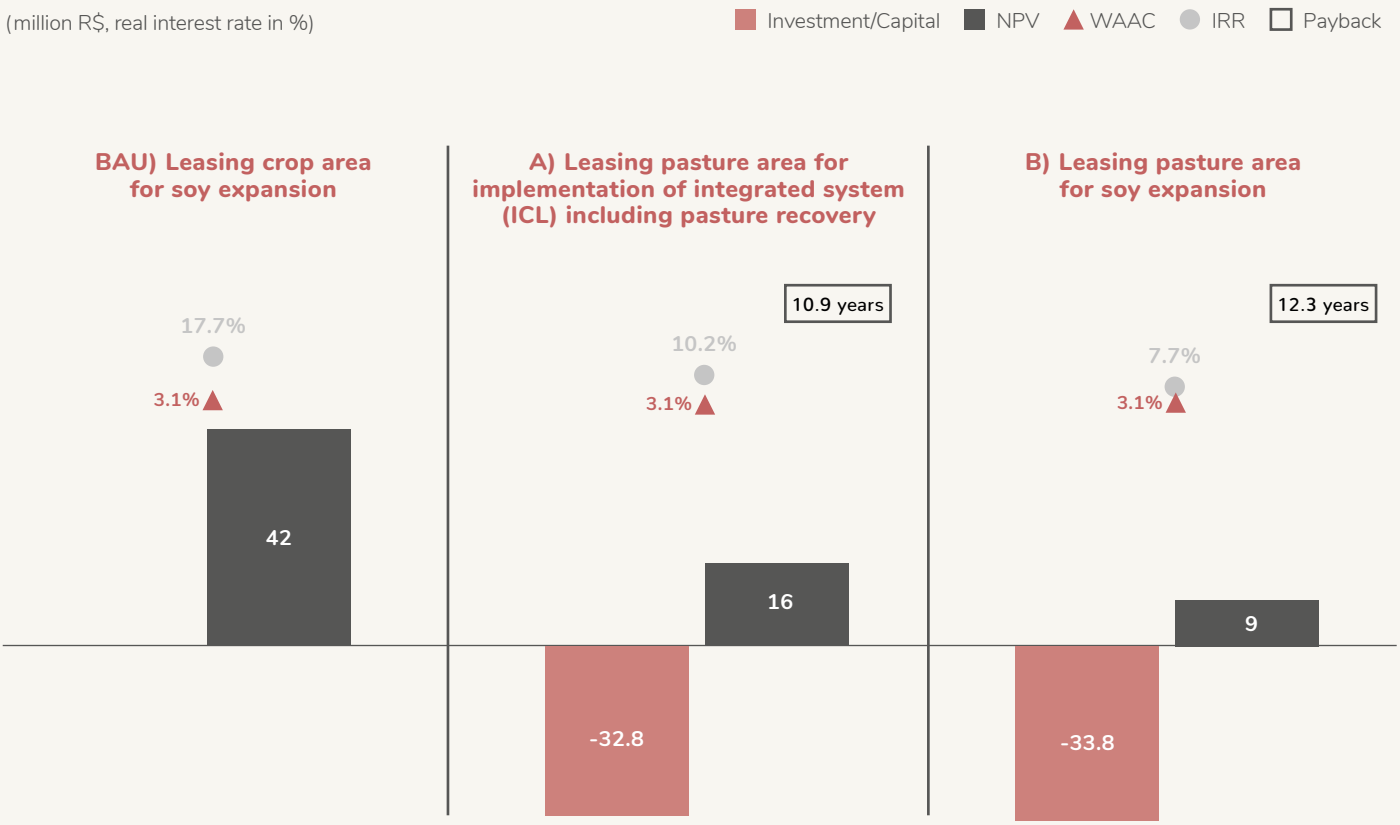
From the perspective of the rural producer, leasing a crop area for soy expansion (BAU) is the most profitable scenario, since it is not necessary to make investments to convert area, once the land is already in appropriate conditions for soy cultivation (no land use transition and investment needed). In this case, it is possible to reach an IRR about 17.7% ***(Figure 53)***.

Regarding leasing a pasture area (scenarios A and B), the most profitable option for the producer is to implement an integrated system, which achieves an IRR of 10.2%. In this circumstance, it is estimated an investment about R$ 32.9 million to recover part of pasture, convert the remaining pasture into agriculture (soy) and to acquire an initial cattle stock for cattle ranching activity. Combining cattle ranching with soy activity (ICL) generates higher NPV and IRR compared to scenario B, where soy activity is conducted exclusively in the area. Besides that, investments are higher in scenario B.

In summary, all scenarios present positive returns. However, the necessity of investments to convert and recover area is a point that impact on producers' decision to only expand soy or to implement integrated system. The importance of these systems for the producer is not only due to the recovery of the area, but also to the diversification of the productive activity.

Figure 53.
Business case results - Integrated system in Canarana region – Rural producer perspective

Source: Study results.



Analyzing the landowner perspective, acquire a pasture area (scenario A), lease it to a rural producer (agricultural operator) and sell it in a long-term period is more profitable than acquiring a crop area (BAU), since, in this case, the investment paid for cropland acquisition (R$ 116 million) is much higher than a pastureland (R$ 62 million), generating lower NPV

and IRR. Additionally, land appreciation when area is converted from pasture to agriculture is greater, what makes scenario A more profitable, since the IRR achieves 11.6% (Figure 54).

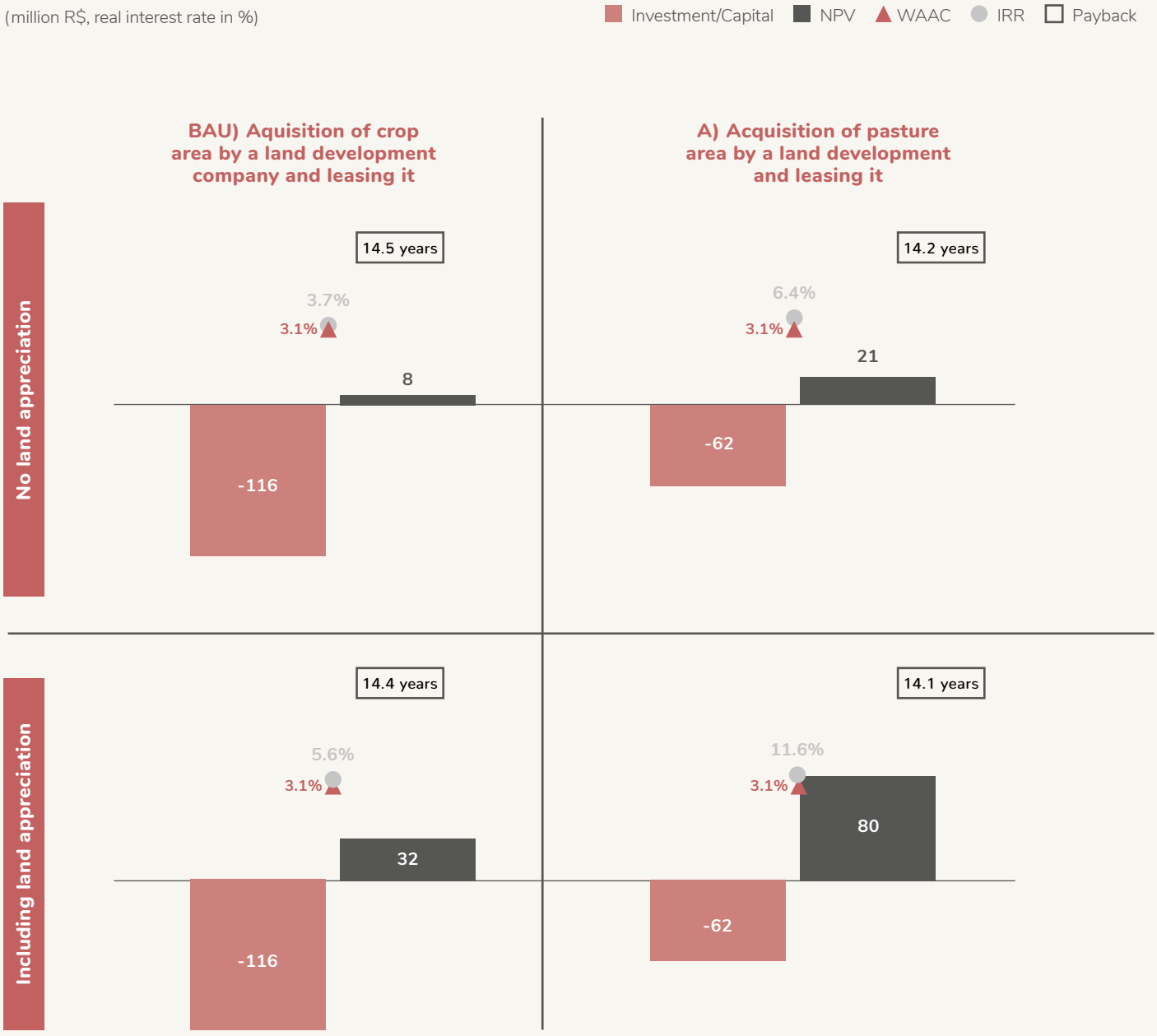
Important to note that earnings from leasing the area are not so different between the scenarios. For scenario A it is slightly lower because in the first years the rural producer makes investment in soil recovery, what is, partially, discounted on the price paid to the landowner for leasing in those years. Although the lower earnings from leasing area in scenario A compared to BAU, the difference in CAPEX needed and in land price appreciation are key decision-factors.

Besides the feasibility of both scenarios, their financial return may be not interesting enough to convince a land development company to invest in this business. It will depend on its strategies and desired gains' objectives to be achieved in short, medium and long term.

Figure 54.
Business case results - Integrated system in Canarana region – Land owner perspective

Source: Study results.

Note: The scenario without land appreciation refers to land prices in constant Reais throughout the project, while the scenario with land appreciation considers growth of 2.5% per year above the inflation rate and the effects of change in land use.



CHAPTER 9

Final remarks and recommendations

This study showed that **territorial analyzes** combined **with economic** is important to **drive actions** in the Brazilian Cerrado towards deforestation-free and sustainable production.

There are 23.7 million ha (Mha) degraded pastures and/or with low productivity in the Cerrado biome, representing 38% of total pasture area.

There are at least 10 million ha (out of almost 24 million ha) of degraded pastures that can be recovered for important supply chains' expansion, combined and/or isolate in the short term (near industrial plants and near current land use).

The zoning developed in this study presented the areas with the best opportunities to recover those degraded areas. Different production systems can be implemented to recover these pasture areas, with **monoculture, intensifying livestock production and/or implementing integrated or**

agroforestry systems. In summary, there are:

- **5.6 Mha** of degraded pasture areas can be intensified for beef cattle raising, near slaughterhouses and 4.3 Mha potential for dairy production near dairy plants.

- For soy there are **5 Mha** of degraded pasture with high suitability, near silos, warehouses, current soy area and with minimum 100 ha of continuous degraded pasture area.

- There are **3.8 Mha** of degraded pasture to supply the commercial forests industries and **6.1 Mha** to supply other agricultural industries.

- **10.8 Mha** of degraded pasture areas potential to implement integrated systems.

- **2.5 Mha** of degraded pasture areas to implement agroforestry systems in small properties.

To take advantage of the opportunities that the recovery of degraded pasture offers, it is **necessary that all stakeholders** (academia, public and private sectors, civil society) are organized and collaborate with each other.

The integrated and agroforestry systems are very interesting options for degraded pasture areas recovery,

with agronomic, environmental and, possibly, economic benefits. However, technical assistance and rural extension are key for the success of the implementation.

The forestry component brings additional challenges to the rural producer: the need to deal with perennial crops of medium- and long-term returns, requiring greater property management and a systemic view of it.

Together with technical assistance, long-term financing is needed to implement agronomic systems to recover degraded pasture areas, **requiring public policies and incentives.**

Brazilian agricultural policy was built having the rural credit as the main instrument for the development of the national agricultural sector. Evaluating the last four crop years, both in Brazil and in the Cerrado biome, there was an increase in the contracted value of credit resources, mostly oriented towards costing and investments.

Specifically, credit contracted for investment in the Cerrado has been allocated to purchase of animals and for the acquisition of machinery. **Investments to recover degraded areas and pasturelands have grown in recent years, but still represents a small share of total credit** (14% in the last crop-year).

Despite the growth in credit contracting, it was observed by data from the Agricultural Census that **the number of livestock properties that have accessed financing for investment in the Cerrado recently is still small.** Going deeper into this point, **the factors that determine the credit are the access to technical assistance and land and environmental regularization of the rural properties**, both determinants confirmed in the interviews. As known, in certain regions of Brazil (smaller share in the Cerrado biome), many farmers have difficulties to access financing since they do not have land tenure, what represents a lack of guarantee for financial institutions conceive credit resources to them.

Based on the presented analyzes, **the producer's confidence in the economic scenario and in the agribusiness' sector are relevant to guide their investment decision.** Perceptions regarding economic retraction and instability in the political field are factors that negatively impact the rural producer investment decision. Other issues such as expectations of future prices, availability of credit in the market and variation in the price of inputs also influence the willingness to invest.

According to the interviews conducted, there are important factors that impact producers' decision on degraded land recovery. Mainly, **to expand**

agriculture o**ver pasture areas, there is still a lack of infrastructure** necessary to accommodate agricultural production in these areas and also **a lack of rural extension and technical assistance to support producers in the conversion and degraded areas recovery. Producers' risk aversion for technology adoption and/or financing** (mainly for cattle ranchers) sustain the low productivity of pasture areas, improving degradation and native vegetation land conversion.

The business cases analyzed for **pasture recovered showed that both pasture recovery for cattle intensification and/or for soybean production has positive returns**, although expanding over native vegetation is also profitable, mainly due to land price appreciation after conversion.

Specifically, for the Canarana case, analyzed in partnership with a land development company, the objective was to evaluate the implementation of an integrated system for soil recovery. It was found that the need for investments to convert the area is an important factor that drives decision on expanding agriculture over cropland (non-conversion needed) or over pasture. For the rural producers, the most profitable scenario when they intend to expand soy is to rent a cropland. In the case of expansion over leased pasture, the greatest return is made with the

adoption of an integrated system. For the land company, besides its a feasible business, the financial return obtained may not be so high as its expectation.

In all models simulated, based on real data, **investments to recover pasture areas is high and has long payback**, in all cases (more than 6 years for soy and up to 14 years for cattle ranching intensification). **Long term credit with differentiated financing conditions** (as grace period, interest rates and payment terms) **is essential**, not only to increase projects' returns, but also to allow that the necessary investments be effectively implemented.

In order to address them and accelerate pasture recovery in the Cerrado, a set of actions are needed, with different complexity levels. Starting with **public policies, direct rural credit to degraded pasture recovery and include producers that are not taking credit for this purpose are key. Solutions for environmental legislation compliance** are also needed, and, in most cases, not complex to address (as lack of CAR registry of smallholders). **Private sector can also incentivize pasture recovery or conversion for soy**, but since there is no long-term contracts in most of the supply chains (except planted forests), economic incentives are harder to address.

Differentiating producers at least in compliance with **environmental legislation** and, also, with **private protocols for sustainable** sourcing are important. Addressing the **lack of technical assistance** is also key, and could be incentivized by private and public sectors and civil society. However, it is also a more complex solution in large scale.

Credit and/or financial mechanisms per se will not conserve the Brazilian Cerrado. They need to be combined with **technical assistance, environmental compliance implementation, sustainable sourcing protocols and long-term land use monitoring.**

Finally, **land development companies can be large-scale drivers of soil recovery in Cerrado**, however it may be aligned with their strategies and business goals. In addition, other companies as meatpackers or tradings can create protocols or programs to foment or, at least, advise producers linked to them about the importance of soil recovery and adequate pasture maintenance, once these organizations achieve a large number of farmers in Brazil.

Recommendations on how to increase farmer uptake of credit / adoption of practices

Considering all the analyzes developed and interviews conducted, the following actions are necessary in order to change landscape in the Cerrado, aiming at reducing native vegetation conversion and land degradation:

1. Greater dissemination of pasture recovery and integrated systems, pointing out benefits, necessary investments, how to implement and create a greater number of pilot projects that can raise awareness of producers regarding these technologies on a regional basis.

It is important that the rural producer has access to the necessary information for decision-making, as to the adoption of the technologies to be implemented, as well as their real gains in relation to this. Many rural producers, especially cattle ranchers, have a certain aversion to adopting technologies and making investments, and in this case access to the correct information on how to produce is a crucial factor for changing the mindset of these producers.

Also, it's important to disseminate the feasibility of pasture recovery and implementation of integrated systems. As seen in the business cases developed,

these technologies present positive financial returns for rural producers, offsetting the investment made for its adoption. Conclusions like this must be disclosed in order to support producers' decision to invest in their farm, especially in soil recovery.

The support of agricultural research organizations (Embrapa) and others that have leadership in the implementation of pasture recovery projects and integrated systems are relevant to achieve this objective, which can also help in the implementation of pilot projects.

Pilot projects, which are characterized by the implementation of pasture recovery and/or integrated systems in a portion of a farm area, called technological demonstration units, are of great value in disseminating information and convincing the rural producer of the benefits and gains that can be obtained with the adoption of such technologies.

2. Technical assistance and rural extension to producers are essential to increase productivity and improve cattle ranching activity. In addition, it may help producers to: a) employ property management techniques; b) learn more about rural credit financing; c) correctly adopt new technologies in their farm.

Since cattle ranchers are more risk averse than crop producers and, for this reason, they mostly apply traditional production techniques even with low or negative returns, it is necessary to work on changing his/her mindset showing the economic benefits of recovering degraded pasture areas (as mentioned in the first recommendation). Producers are not convinced only by environmental issues, but mainly on learning new techniques and financial results in practice.

There are already implemented pilot projects for this purpose. Technological demonstration units in real farms is a step for field days and training producers. After convincing producers regarding the technology, technical assistance is key for its effective implementation in the farm and for credit access. Including environmental compliance is also key to address, together with farm management solutions, since the farm needs to be considered in a systemic view in order to have long term results.

Examples of those projects are: Programa Novo Campo (in Alta Floresta region, Mato Grosso state, in the Amazon biome), Liga do Araguaia (in the Araguaia region, Mato Grosso state, Cerrado biome), several demonstration units of Embrapa for integrated crop-livestock-forestry systems along the Cerrado biome), Rural Sustentável Project (already

implemented in the Amazon and Mata Atlantica biomes, starting in the Cerrado biome), among others.

The key challenge of those pilots is the short term of their implementation, since interventions needs time to have financial returns and, mainly, high quality technical assistant needs to be constantly offered to producers.

3. Improve investment resources through rural credit. As seen in the business cases developed, high investments are necessary for conduction of recovering pasture and to implement degraded systems. As larger is the area, larger is the necessary capital to invest.
It is important that sufficient resources for investment purpose are made available through rural credit, since official rural credit (subsidized by government) has more attractive conditions for contracting.
An example is given by the ABC Program credit line, which aims to encourage the adoption of low carbon technologies in agriculture, which in recent years has had a rapid depletion of resources released in each crop year.
It is important to mention that in this period where the Brazilian economic scenario has lower levels of interest rate, it can be an encouraging factor to producers' access credit at attractive costs, that is, boosting investments in good agricultural practices. In alternative to public credit is green financing with private investors, but

it needs to be oriented to pasture recovery and have the correct instrument to achieve rural producers.

4. Reduce legal uncertainty regarding environmental and productive issues. It includes effectively implementing the rules of the Forest Code, ensuring environmental legislation compliance by rural producers and that it is not constantly reevaluated, which may cause some uncertainty about the Forest Code[20].

Also, it is important to ensure the right to property (reducing land insecurity), since in many situations it is necessary to regularize rural properties in terms of land ownership by the producer, which is often associated with legal bureaucracies and slowness of government agencies to analyze and deliberate on such cases. Moreover, it is difficult to regularize land ownership because, in some regions, there has been disorganized occupation of areas of agricultural expansion.

Others issues as bureaucracy to produce (such as a license or authorization to produce) are important to be reduced in order to create appropriate conditions to agricultural production.

[20] Native Vegetation Protection Law n. 12.651/2012. Available at: http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm

5. Support to associations and cooperatives: conducting actions with associations, cooperatives and rural unions is a way to have a communication channel with rural producers, and thus disseminate knowledge about recovery of pastures and integrated systems, hold lectures and field days on the subject with them. In general, rural producers have greater acceptance of information received through this associations and producers' cooperatives.

6. Divide producers into three distinct groups in order to establish how the financial mechanisms will affect each group:

i. the **marginalized (no credit access)**: a group that imposes greater risks and costs, should be seen from the perspective of inclusion, promoting their land and environmental regularization. However, these should have a greater counterpart in the financial mechanism.

ii. apt non-borrowers: they must also be viewed from the perspective of inclusion. The challenge with these producers is to convince and provide technical assistance to them in order to reduce their aversion to new technologies and to reduce their risk aversion for credit (debt, management and market). This group represents a moderate risk since it does not have a well-defined credit profile. As such, they must also pay a premium for the risk sharing of the financial mechanism.

iii. apt borrowers: it must be seen as an enhancer of the best technologies. Since they represent less risk to the credit operation, and, by hypothesis, they are the least risk averse and with a greater appetite for new practices, they should be provided with resources and guarantees for those projects with the greatest productive and environmental impact. Consequently, the counterpart in the financial mechanism must be the smallest among the groups.

As a result of all analyzes presented in this study, we conclude that there is a clear **trade-off between the insertion of new producers into the credit system** (with greater risks and less chances of successful ventures) **and promotion of credit taking for sustainable technologies for those who are already inserted in the system** (and who represents lower risks and greater chances successful ventures).

However, in order to have higher impact in terms of deforestation reduction and degraded land recovery, the suggestion is to work with the three groups, with different approaches.

The “marginalized” group and the “apt non-borrowers” should be the main focus of the technical assistance and convincing / dissemination / communication strategies, in addition to the need of a guarantee mechanism

(lack of collateral to offer to banks and/or higher risks for not having credit rating). It is suggested that they implement less complex technologies (and consequently cheaper), whose participation in a guarantee mechanism is greater in these ventures, but which includes a counterpart from the producer in the mechanism.

The group of producers “apt borrowers”, on the other hand, demand less need for the risk-sharing. As they already have a credit history, the risks involved in the operations are lower, which would allow using a guarantee mechanism to improve the conditions for financing the technologies. Based on the assumption that these producers are less risk averse and with a greater appetite for innovation, it is suggested that this group be prioritized with regards to more ambitious technical projects, possibly with higher costs but with greater impacts, both in productive and in environmental issues.

Projects with integrated systems would be the most interesting for the latter group. Still under the assumption above, implementing more complex technologies may attract the supply chain attention (especially slaughterhouses) with regard to the adoption of specific technological packages in these ventures. With clear protocols for good agricultural practices, productivity, sustainability and business predictability, the slaughterhouse may give preference to purchase

cattle from those suppliers (as Carbon Neutral Beef). The slaughterhouse (and also its clients) can access green financing for this sourcing, as already is in place the Marfrig's "Green CPR" (CPR – Agroindustry Product Note), which also has a brand for the Carbon Neutral Beef.

A possible strategy is to implement projects with incentives and actions for degraded pasture recovery, after having a structure governance with all interested stakeholders (producers, cooperatives, associations, financial institutions, NGO, technical assistants, etc.), it is necessary to define eligibility criteria for producers to participate, clear technical and environmental indicators and technological packages.

If the "marginalized" group of producers are considered, the eligibility criteria need to be soft, since they might need environmental compliance (such as CAR registry) and face problems with land tenure. If only the "apt-borrowers" group of producers is included, eligibility criteria can be strengthened, and technological packages more complex. The "apt-non borrowers" group can have eligibility criteria less soft than marginalized, but still may need environmental compliance. And it represents the majority of producers in the Cerrado biome.

Finally, financial mechanisms need to be adapted for each of those groups, providing de-risking, collateral, and financing, together with long-term technical assistance and monitoring.

References

AGROSATÉLITE GEOTECNOLOGIA APLICADA LTDA. Análise Geoespacial da Dinâmica das Culturas Anuais no Bioma Cerrado: 2000 a 2014 / Rudorff, B.; Risso, J. et al., 2015 Florianópolis, Santa Catarina, Brasil, 2015.

AGROSATÉLITE GEOTECNOLOGIA APLICADA LTDA. Mapeamento das Áreas de Soja do Bioma Cerrado em 2016/17. Florianópolis, Santa Catarina, Brasil, 2018.

BALBINO, L. C.; KICHEL, A. N.; BUGENSTAB, D. J., ALMEIDA, R. G. de. Sistemas de integração: que são, suas vantagens e limitações. Embrapa, 2011. Available at: <https://ainfo.cnptia.embrapa.br/digital/bitstream/item/159845/1/Sistemas-de-integracao-o-que-sao-suas-vantagens-e-limitacoes.pdf>.

CENTRAL BANK OF BRAZIL. Sistema de Operação do Crédito Rural – SICOR. Available at: <https://dadosabertos.bcb.gov.br/dataset/matrizdadoscreditorural>.

CENTRAL BANK OF BRAZIL. Rural Credit Manual. Available at: <https://www3.bcb.gov.br/mcr>.

COMPANHA NACIONAL DE ABASTECIMENTO (CONAB). Armazenagem. Available at: < conab.gov.br/armazenagem>.

DIAS-FILHO, M. B. Degradação de pastagens: processos, causas e estratégias de recuperação. 4. ed. rev., atual. e ampl. Belém, PA, 2011a.

DIAS-FILHO, M.B. Diagnóstico das Pastagens no Brasil. Belém: Embrapa, 2014a. 36 p. Disponível em: <https://www.infoteca.cnptia.embrapa.br/bitstream/doc/986147/1/DOC402.pdf>.

DIAS-FILHO, M.B. Estratégia de recuperação de pastagens na Amazônia. In: Intensificação da produção animal em pastagens: Anais do 1º Simpósio de Pecuária Integrada, 2014b, Brasília. Anais... 1º Simpósio de Pecuária Integrada, 2014. Available at: <https://ainfo.cnptia.embrapa.br/digital/bitstream/item/123926/1/p9-23.pdf>.

DIAS-FILHO, M.B. Diagnóstico das pastagens no Brasil e perspectivas de intensificação. In: Mapeamento e Monitoramento das Pastagens Brasileiras, 2017b, Brasília. Anais... Brasília: Laboratório de Processamento de Imagens e Geoprocessamento (Lapig), 2017. Available at: <https://www.lapig.iesa.ufg.br/drive/index.php/s/p5blijnaPKGAUQb?path=%2F02_produtividade#pdfviewer>.

EMBRAPA – EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA. Tecnologias: Sistemas Agroflorestais. Embrapa, 2013. Available at: https://www.embrapa.br/agrossilvipastoril/sitio-tecnologico/trilha-tecnologica/tecnologias/sistema-de-producao/sistema-agroflorestal

EMBRAPA – EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA. Carne Carbono Neutro: um novo conceito para carne sustentável produzida nos trópicos. Embrapa, 2015. Available at: https://ainfo.cnptia.embrapa.br/digital/bitstream/item/203141/1/Carne-carbono-neutro-1.pdf

FIESP - FEDERAÇÃO DAS INDÚSTRIAS DO ESTADO DE SÃO PAULO. Índice de Confiança do Agronegócio (ICAGRO). Available at: <http://icagro.fiesp.com.br/>.

FIESP - FEDERAÇÃO DAS INDÚSTRIAS DO ESTADO DE SÃO PAULO. Intenções de Investimento. Available at: <http://icagro.fiesp.com.br/investimentos.asp>.

IBÁ - INDÚSTRIA BRASILEIRA DE ÁRVORES. Report 2019. Available < https://iba.org/datafiles/publicacoes/relatorios/relatorioiba2019-final.pdf>.

IBGE - INSTITUTO BRASILEIRO DE GEOGRAIA E ESTATÍSTICA. Agricultural Census 2017. Available at: <https://sidra.ibge.gov.br/tabela/6896>.

IBGE - INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. Pesquisa da Pecuária Municipal (PPM) – 2018. Available at: <https://sidra.ibge.gov.br/>.

IBGE - INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. Produção Agrícola Municipal (PAM) – 2018. Available at: <https://sidra.ibge.gov.br/>.

IBGE - INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. Produção da Extração Vegetal e da Silvicultura (PEVS) – 2018. Available at: < https://sidra.ibge.gov.br/pesquisa/pevs/quadros/brasil/2018>.

IBGE – INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. Malha Municipal 2019. Available at: https://www.ibge.gov.br/geociencias/organizacao-do-territorio/15774-malhas.html?=&t=downloads

IMEA - INSTITUTO MATOGROSSENSE DE ECONOMIA AGROPECUÁRIA. IMEA, 2019. Available at: <http://www.imea.com.br/imea-site/relatorios-mercado-detalhe?c=4&s=21>.

IMAFLORA. Atlas Agropecuário 2018. Available at: <https://www.dropbox.com/sh/cvtrj35w6hzehhb/AAA3qEtmgwmQ1IN5bY2e5zYla?dl=0>.

ISMAR, M.G. A bovinocultura em municípios goianos e os fatores de degradação das pastagens. Dissertação (Mestrado em Zootecnia) – Universidade Federal de Goiás, Goiânia, 2015. Available at: <https://repositorio.bc.ufg.br/tede/handle/tede/5036>.

KICHEL, A. N.; MIRANDA, C. H. B.; ZIMMER, A. H. Degradação de pastagens e produção de bovinos de corte com a integração agricultura x pecuária. In: SIMPOSIO DE PRODUÇÃO DE GADO DE CORTE, 1., 1999, Viçosa. Anais... Viçosa: UFV, 1999. p. 201-234. Available at: <http://www.fcav.unesp.br/Home/departamentos/zootecnia/anaclaudiaruggieri/1.-degradacao-de-pastagens-e-ilp.pdf>.

LAPIG - LABORATÓRIO DE PROCESSAMENTO DE IMAGENS E GEOPROCESSAMENTO. Atlas Digital das Pastagens Brasileiras. Available at: <https://pastagem.org/atlas/map>.

MACEDO, J. L. V. de. Sistemas Agroflorestais: princípios básicos. Embrapa, 2013. Available at: https://www.embrapa.br/busca-de-publicacoes/-/publicacao/669177/sistemas-agroflorestais-principios-basicos

MACEDO, M. C. M.; ZIMMER, A. H.; KICHEL, A. N. Degradação e alternativas de recuperação e renovação de pastagens. 2000. Campo Grande: Embrapa Gado de Corte. Comunicado Técnico, 62, Embrapa Gado de Corte, 4 p.

MACEDO, M.C.M.; ZIMMER, A.H.; KICHEL, A.N.; ALMEIDA, R.G.; ARAÚJO, A.R. Degradação de pastagens, alternativas de recuperação e renovação, e formas de mitigação. In: Encontro de Adubação de Pastagens da Scot Consultoria, 2013, Ribeirão Preto. Anais. Bebedouro: Scot Consultoria, 2013. Available at: <http://www.alice.cnptia.embrapa.br/alice/handle/doc/976514>.

MAPA - MINISTRY OF AGRICULTURE, LIVESTOCK AND FOOD SUPPLY. Projeções do Agronegócio 2019-20 a 2029-30. MAPA, 2020. Available at: https://www.gov.br/agricultura/pt-br/assuntos/politica-agricola/todas-publicacoes-de-politica-agricola/projecoes-do-agronegocio/projecoes-do-agronegocio_2019_20-a-2029_30.pdf/view

MAPA - MINISTRY OF AGRICULTURE, LIVESTOCK AND FOOD SUPPLY. Family Farming Haverst Plan 2017-2020. MAPA, 2017. Available at: <https://issuu.com/sead19/docs/28_06_bb_20x20_baixa>.

MAPA - MINISTRY OF AGRICULTURE, LIVESTOCK AND FOOD SUPPLY. Agricultural and Livestock Plan 2018/2019. MAPA, 2018. Available at: <https://www.gov.br/agricultura/pt-br/assuntos/politica-agricola/plano-agricola-e-pecuario>.

MAPBIOMAS – Coleção 4 da Série Anual de Mapas de Cobertura e Uso de Solo do Brasil. Available at: <https://mapbiomas.org/>.

MAPBIOMAS – Coleção 5 da Série Anual de Mapas de Cobertura e Uso de Solo do Brasil. Available at: <https://mapbiomas.org/>.

MOREIRA, L.; ASSAD, E.D. Segmentação e classificação supervisionada para identificar pastagens degradadas. In: II Workshop Brasileiro de Geoinformática. São Paulo-SP: SBC; 2000. Available at: <http://webserver2.tecgraf.puc-rio.br/~lhf/geoinfo2000/anais/008.pdf>.

PERON, A.J.; EVANGELISTA, A.R. Degradação de pastagens em regiões de Cerrado. Lavras: Ciência e Agrotecnologia, v.28, n.3, p. 655-661, 2004. Available at: <http://www.fcav.unesp.br/Home/departamentos/zootecnia/anaclaudiaruggieri/12.-degradacao-de-pastagens-na-regiao-de-cerrado.pdf>.

REDE ILPF. ILPF em números. Available at: https://www.redeilpf.org.br/index.php/rede-ilpf/ilpf-em-numeros.

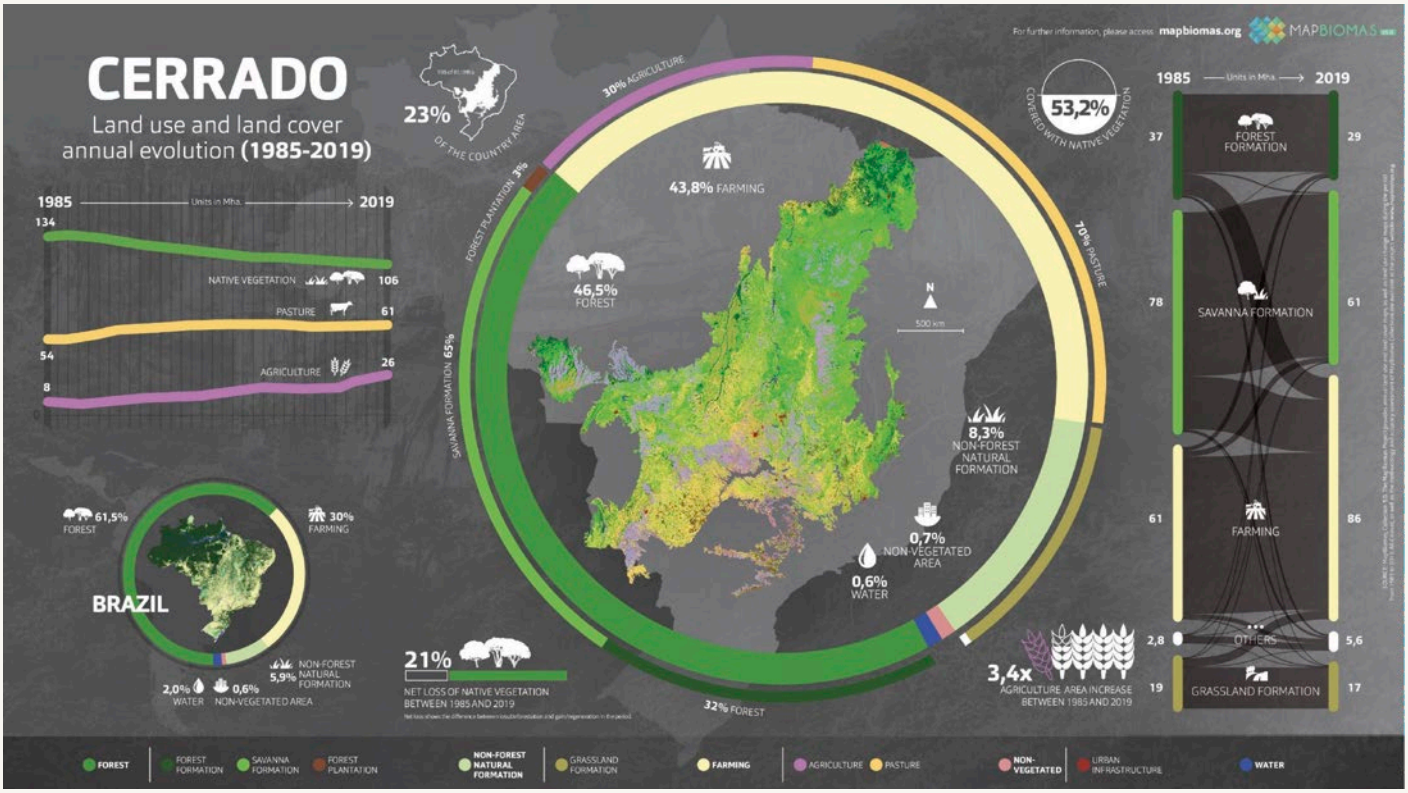
TNC - THE NATURE CONSERVANCY. Incentives for Sustainable Soy in the Cerrado. TNC, November 2019. Available at: https://www.nature.org/en-us/what-we-do/our-insights/perspectives/business-case-for-sustainable-soy-brazil-cerrado/

THE WORLD BANK GROUP. Brazil Rural Finance Policy Note. World Bank Group, July 2020. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/34195/Brazil-Rural-Finance-Policy-Note.pdf?sequence=4&isAllowed=y

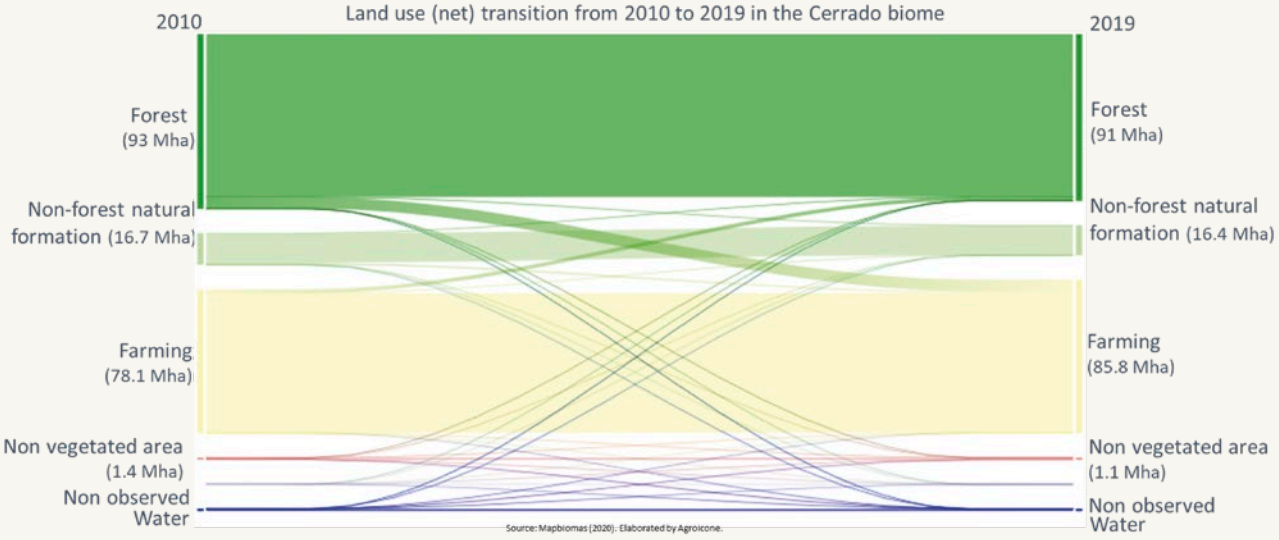
TOWNSEND, C.R.; COSTA, N.L.; PEREIRA, R.G.A. Recuperação e práticas sustentáveis de manejo de pastagens na Amazônia. Porto Velho: Embrapa, 2012. Available at: <https://www.infoteca.cnptia.embrapa.br/bitstream/doc/999525/1/doc148pastagens.pdf>.

ZIMMER, A.H.; ALMEIDA, R.G.; BUNGENSTAB, D.J.; KICHEL, A.N. Integração lavoura-pecuária-floresta no Brasil: histórico e perspectivas para o desenvolvimento sustentável. In: VII Congresso Latinoamericano de Sistemas Agroflorestais para a Produção Pecuária Sustentável, 2012, Belém. Available at: https://ainfo.cnptia.embrapa.br/digital/bitstream/item/74335/1/ZIMMER-0000003112-p833-Zimmer.pdf>

Annex 1 - Land use and land cover in the Cerrado



Annex 2 - Land use (net) transition from 2010 to 2019 in the Cerrado biome



Annex 3 - General information about agricultural policy credit lines which finance investment in land recovery

Producer profile	Credit Line / Program	Interest rate (py)	Payment term	Grace period	Funding limit	Description
Family farmer	Pronaf	2.75% to 4%	10 years	3 years	R$ 330 thousand	Pronaf, the National Program for the Strengthening of Family Farming, aims to stimulate income generation and strengthen the activities developed by the family producer through the financing of its agricultural activities and services, being considered as the main national public policy for the promotion of family units. Established in the 1990s, it meant an advance in terms of public policy directed at this category. In general, the beneficiaries of Pronaf are farmers and rural producers with an annual gross family income of up to R$ 415 thousand, with at least 50% of this income coming from agricultural activities. In addition, the property must have up to 4 area tax modules. The Program has subprograms that are aimed at specific financing objectives. For recovering degraded lands, the subprograms that finance it are: Pronaf Mais Alimentos, Pronaf Semiárido, Pronaf Mulher, Pronaf Jovem, Pronaf Microcrédito, Pronaf Reforma Agrária and Pronaf Eco. Important to note that Pronaf shows the lower interest rate for financing rural producers in Brazil.

Producer profile	Credit Line / Program	Interest rate (py)	Payment term	Grace period	Funding limit	Description
Non family farmer	Programa ABC	4.5% to 6%	12 years	8 years	R$ 5 million	The ABC Program offers credit to rural producers and cooperatives in order to reduce deforestation and GHG emissions in agriculture. It is divided into subprograms: pasture recovery, no-tillage, integrated systems (ILPF), organic production, environmental suitability, planted forest, nitrogen fixation and waste treatment. Each subprogram finances a set of items that make up the production system: increasing productivity, productive resilience and adopting sustainable practices, including the mitigation of greenhouse gases. Although the ABC Program is directed to finance technologies that reduce GHG emissions in agricultural production, some of these technologies are also financed in other programs in an undirected manner. The restoration of pastures, for example, is also financed by the lines of Pronaf (family farming), Pronamp (medium producers) and by the own resources of the banks that operate rural credit.
	Moderagro	6%	10 years	3 years	R$ 880 thousand	Moderagro (Program for the Modernization of Agriculture and Conservation of Natural Resources) aims to support and encourage the sectors of production, processing, industrialization, packaging and storage of agricultural products. The Program supports soil recovery through financing for the acquisition, transport, application, incorporation of agricultural corrective agents, soil conditioners.
	Pronamp	6%	8 years	3 years	R$ 430 thousand	Pronamp is focused on medium size producers, who must have up to R$ 2 million as annual Gross Production Value in the property to access the credit line. Pronamp's financing elements include the cost of agricultural crops and cattle ranching, as well as investment in the formation or recovery of pastures and soil, forestry, reforestation, improvements in infrastructure in the farms and purchase of machinery and equipment. There are no subprograms within Pronamp, allowing the allocation of resources more broadly between different purposes, and not necessarily between sub-items of the credit line.

Producer profile	Credit Line / Program	Interest rate (py)	Payment term	Grace period	Funding limit	Description
Non family farmer	Inovagro	6%	10 years	3 years	R$ 1.3 million	Inovagro (Incentive Program for Technological Innovation in Agricultural Production) is a credit line designed to support investments necessary for the incorporation of technological innovation in rural properties, aiming at increasing productivity, the adoption of good agricultural practices and the management of rural properties, and the competitive insertion of rural producers in different consumer markets.
	Moderinfra	6%	10 years	3 years	R$ 3.3 million	Moderinfra (Incentive Program for Irrigation and Production in a Protected Environment) aims to offer credit to support the development of sustainable, economically and environmentally irrigated agriculture, to promote the use of structures for production in a protected environment and to protect fruit production in temperate regions against the incidence of hail.

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This material is part of a three-study collection developed by GTPastagens and shows that it is possible to intensify and scale up the rehabilitation of degraded pastures in the Cerrado, boost their economic performance, and reduce the impact of production, and at the same time reduce the pressure for more deforestation.

Study by
Agroicone
WWF Brazil

Managing partner at Agroicone and project coordinator
Leila Harfuch

Researcher at Agroicone, geoprocessing and territorial intelligence
Mariane Romeiro

Researcher at Agroicone, economic-financial analyses
Gustavo Palauro

WWF-BRAZIL

Executive Director of the WWF-Brazil
Maurício Voivodic

Director of Conservation and Rehabilitation
Edegar de Oliveira Rocha

Project Coordinator
Carolina Siqueira

Conservation Analyst
Laís Ernesto Cunha

Engagement Analyst
Daniely Lima

Copywriting, Editing, Graphic Design, and Editorial Design
Laboota

ABOUT GTPASTAGENS

A multi-stakeholder working group composed of academics and members of the civil society and private sector with a single focus: rehabilitate degraded pastures in the Cerrado.

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