STUDY

QUALITY AND AGRICULTURAL SUITABILITY OF PASTURES IN THE CERRADO

1

GTPastagens

Summary

Executive summary

Spanning nearly a quarter of the Cerrado, pastures are deeply connected to the biome's land cover and use changes. If we take into account that the Brazilian bovine cattle is mostly grass-fed and the average yield is low – an approximate 1.0 head/ha stocking rate –, boosting pastureland efficiency is necessary to balance out a wide range of industry demands, such as increased production, zero illegal deforestation, and conversion of areas for grain crops. Therefore, identifying low-yield lands suitable for grain crops is essential for making assertive decisions.

This study, specifically, set out to assess the Cerrado's pastures between 2010 and 2018, using referencing maps devised by LAPIG under the MapBiomas initiative. In this period, pastures remained stable at around 54 million hectares, albeit with more intense dynamics of expansion and contraction.

Between 2010 and 2018, the quality of pastures improved, which goes along with an increased stocking rate observed in the same period. Still, pastures with signs of severe degradation,

and therefore unproductive or low-yield lands, accounted for 13.6 million hectares in 2018, while areas with signs of slight or moderate degradation, which can be improved, accounted for 19.2 million hectares, which further confirms there's an opportunity and need for a more efficient and productive use of pastures in the Cerrado.

Roughly 20% of the total area of pastures in the biome (~11 million hectares) are highly suitable for agriculture, with no limitation factors to grain crops. Around 70% of that area shows some signs of degradation (severe, moderate, or slight). These figures suggest it is necessary to continually explore the full potential of pastures in the Cerrado to contribute towards sustainable food production, as well as mitigating/reducing environmental damages that may compromise this sustainable production.

Introduction

pastures and grasslands cover 67% of farming areas worldwide – spanning 3.2 billion hectares in 2018 (FAO, 2020). Currently, 21% of the Brazilian territory is covered by pastures, a sharp increase in recent years. In 1985, pastures covered 120.3 million hectares in the country.
In 2018 [1], this area reached 183.1 hectares, a steep 52.2% increase over the past three decades.

Over that same period, the beef cattle grew from 97.5 million units in 1985 to 156.5 million in 2018 (pastagem.org/atlas). Proportionally speaking, the growth of the beef cattle (~ 60%) is comparable to the area covered by pastures – with an 8.1% difference. That shows that the growth of the cattle ranching activity was enabled by the expansion over new areas, rather than efficiency gains – this is known as horizontal production growth. In fact, the average stocking rate growth was a mere 0.12 heads/HA (heads per hectare), reaching an average 0.92 heads/HA in 2018 (IBGE, 2019). While horizontal production growth is viable in the short term, it is inefficient and economically unfeasible in the long term.

[1] pastagem.org/atlas

The Cerrado, Brazil's second largest biome, is home to 32.8% of the country's pastures and 34% of the beef cattle, spanning 29.4% [2] of the biome. There was a drop in the horizontal expansion of cattle ranching in this biome, with no substantial increase of pastures over the past two decades. Furthermore, its stocking rate is above the national average, which might show production increases through efficiency and productivity gains – known as vertical production growth – made possible through intensification and technological upgrades. This momentum offers an opportunity to transform pastures in the biome to boost efficiency and sustainability by rehabilitating unproductive lands and making better use of low-yield lands.

Pasture degradation is one of the main causes of low yield in cattle ranching in tropical regions and a massive challenge this industry faces today. Degradation, which is usually linked to inadequate management practices, is characterized by biomass productivity losses, whereby there is a reduced amount of food available for the cattle (DIAS-FILHO, 2015). Rehabilitating unproductive or low-yield pastures, whether by restoring pastures, converting them into other uses, or restoring native vegetation, can potentially boost the cattle ranching system's efficiency and mitigate the environmental impacts associated with this industry.

[2] pastagem.org/atlas

To rehabilitate degraded pastures, it is paramount to know the land. It is essential to survey the quality of pastures, identifying productive lands, low-yield lands – degrading pastures – and unproductive lands – degraded pastures. Based on an integrated pastures' quality analysis and knowledge about the local potential for productivity, it is possible to transform the cattle ranching industry, making it more productive and sustainable, as well as contributing to other industries by reducing the area covered by pastures and, consequently, “freeing land” for other uses and covers.

In this study, we have mapped out the quality of pastures in the Cerrado over the past decade and identified low-yield or unproductive lands with potential to be intensified or converted into a more efficient use.

CHAPTER 1

Data and analyses

1.1 Study area

The study area comprehends pastures in the Cerrado biome between 2010 and 2018. As a reference for the areas covered by pastures, we used a series of maps devised by LAPIG (under their MapBiomas initiative), available in the Atlas Digital das Pastagens Brasileiras[3] (Digital Atlas of Brazilian pastures). The method employed to devise this series of maps, which covers the period between 1985 and 2019, is based on Machine Learning algorithms – namely, the Random Forest
– covered in more detail in Parente et al. (2019).

In 2010, the start of the focus period, pastures spanned 54.4 million hectares in the Cerrado. At the end of the focus period, 2018, pastures reached 53.1 million hectares. This ~1% difference is within the accuracy of confidence interval for the mapping and shows the area has not changed over the past decade.

[3] pastagem.org/atlas

However, its spatial dynamics have intensified, and expansions and contractions have been observed. It can be noted that 20.4% of the area mapped out in 2010 has left the cattle ranching system throughout the focus period, whereas 18.4% of the area mapped out in 2018 was added over that same period ***(Table 1 and Figure 1)***.

It should be pointed out that, to calculate areas in this study, the images were projected in Albers "*+proj=aea +lat_1=-2 +lat_2=-22 +lat_0=-12 +lon_0=-54 +x_0=0 +y_0=0 +ellps=aust_SA +units=m +no_defs*", with pixel size "x=29.127 and y=29.128", and the calculation was based on pixel counts for each class.

Table 1.
Area (ha) and pasture dynamics in the Cerrado (according to the intersection with state limits that interact with the biome) between 2010 and 2018.

State	Pastures - 2010 (ha)	Pastures - 2018 (ha)	Abandoned or converted pastures between 2010 and 2018 (ha)	pastures added between 2010 and 2018 (ha)
BA	439,809	554,218	124,968	268,835
DF	99,133	101,140	29,404	31,412
GO	14,827,158	13,957,721	2,636,884	1,767,446
MA	2,163,198	3,052,923	420,468	1,310,192
MG	10,207,423	9,009,891	2,761,548	1,564,015
MS	12,978,474	11,572,098	2,156,275	749,899
MT	7,179,724	7,479,097	1,538,854	1,838,227
PA	303,460	386,644	45,831	129,015
PI	236,604	294,587	120,132	178,116
PR	30,258	19,147	16,508	5,397
RO	16,937	23,242	6,822	13,126
SP	826,981	508,819	411,519	93,358
TO	4,993,187	5,895,323	894,647	1,796,783

Pastures in the Cerrado

2010 - 2018

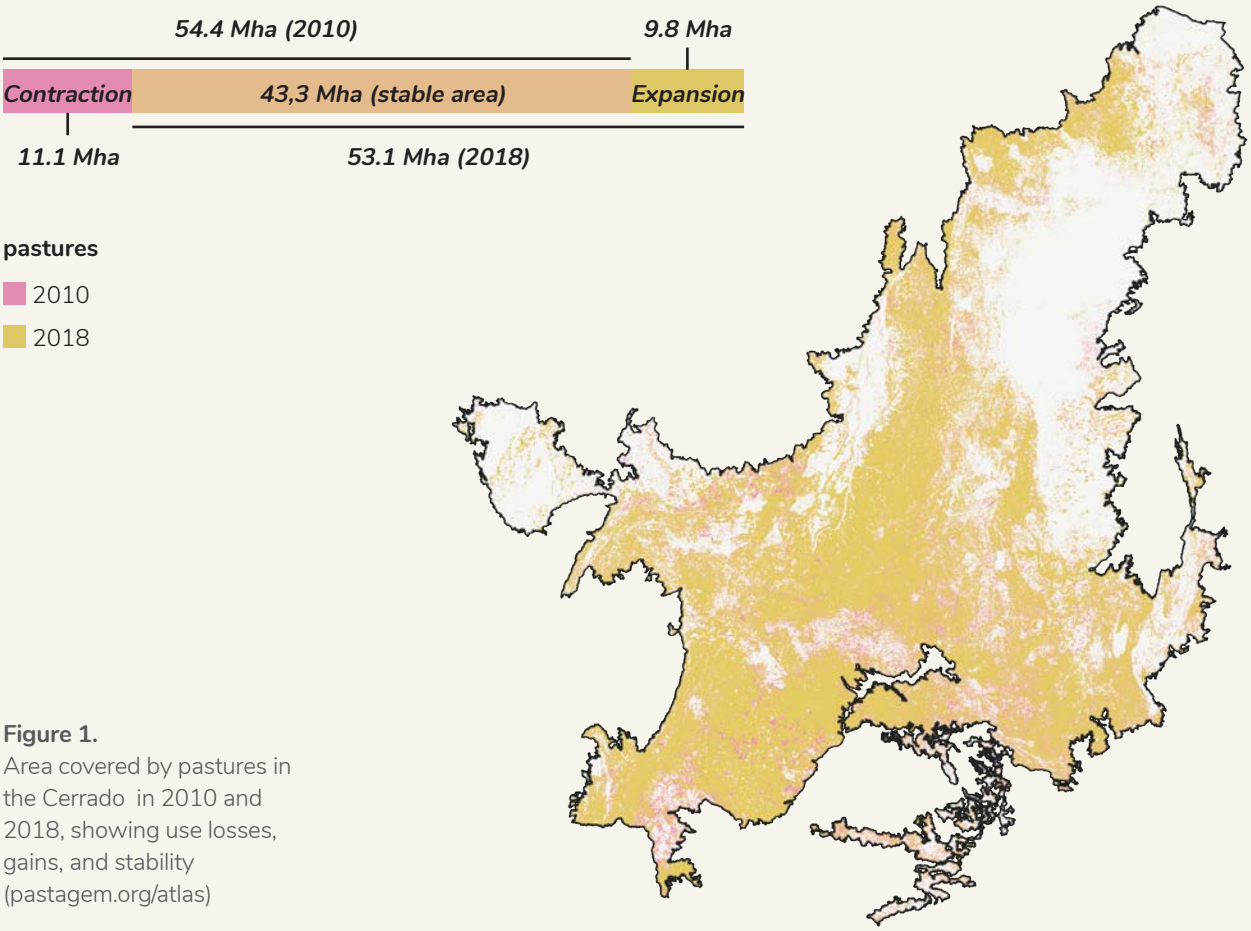


Figure 1.
Area covered by pastures in the Cerrado in 2010 and 2018, showing use losses, gains, and stability (pastagem.org/atlas)

1.2 Pastures' quality mapping method

Our approach to mapping the quality of pastures in the Cerrado and classify them with regards to productivity is based on the method proposed by Gao et al.
(2006), adapted to the Brazilian reality (Andrade et al., 2013; Gosch et al., 2020).

In this analytical approach, we used NDVI (Normalized Difference Vegetation Index) median images obtained from surface reflectance values provided by the Landsat 5 and Landsat 8 satellites, for the start and end of the focus period (that is, 2010 and 2018), respectively. To obtain the median images, we considered a 24-month temporal window – second half of the previous year, focus year, and first half of the subsequent year (e.g. July 2009 to June 2011). To make them equivalent and comparable, the following steps were considered: a) correcting the spectral characteristics of the TM sensor (Landsat 5) in relation to the characteristics of the OLI sensor (Landsat 8), simulating their spectral bands from information obtained in the field using a handheld spectroradiometer; b) applying a filter to remove clouds and shadows; c) removing outliers (that is, negative NDVI values); and d) equalizing pixel by pixel the availability of images so that only one pixel was considered in the analysis in case the observations for a certain month (that is, monthly median) were available for both periods and sensors (that is, 2010 / TM and 2018 / OLI).

For the boundaries of the Cerrado, the median NDVI images were normalized using the following equation:

$$NDVIq = \frac{NDVIi - NDVImin}{DVImax - NDVImin}$$

Where:
NDVIi = Value of each pixel;
NDVImin is the average 1% of pixels with the lowest NDVI values – considering 2010 and 2018;
NDVImax is the average 1% of pixels with the highest NDVI values – considering 2010 and 2018;
NDVIq is the normalized value of each pixel.

This normalization provides a pasture quality index ranging from 0 to 1, where 0 means unproductive and 1 means high-yield. We have stratified this index into four classes by pasture condition:

NO DEGRADATION	[NDVIq > 0.6]
SLIGHT DEGRADATION	[0.5 < NDVIq < 0.6]
MODERATE DEGRADATION	[0.4 < NDVIq < 0.5]
SEVERE DEGRADATION	[NDVIq < 0.4]

1.3 Agricultural suitability of pastures in the Cerrado

Suitability for and physical limitation to grain growing – agricultural suitability – in the areas covered by pastures were analyzed based on a study and mapping of agricultural suitability in the Cerrado, carried out by Agrosatélite (RUDORFF,2015). This analysis considered the intersection area between agricultural suitability data and pastureland quality according to the Cerrado's current boundaries published by IBGE in 2019.

The intersection area between the two databases – pastures' quality and agricultural suitability – was 30.2 million hectares, of which 78.7% were highly suitable for grain growing, 14.7% were moderately suitable on average, and 6.6% were marginally suitable (***Figure 2***). Of this area, 46.6% had no limitation to grain crops, 45.3% had slope steepness limitation, and 8.1% had elevation or double limitation – slope steepness and elevation. For the purposes of the integrated pastureland quality and agricultural suitability analysis, we've only considered areas highly suitable for grain crops. In this class, which amounts to 23.8 million hectares, 46.5% have no limitation to grain crops; the other areas had slope steepness, elevation, or double limitation.

Agricultural suitability of pastures in the Cerrado

2010

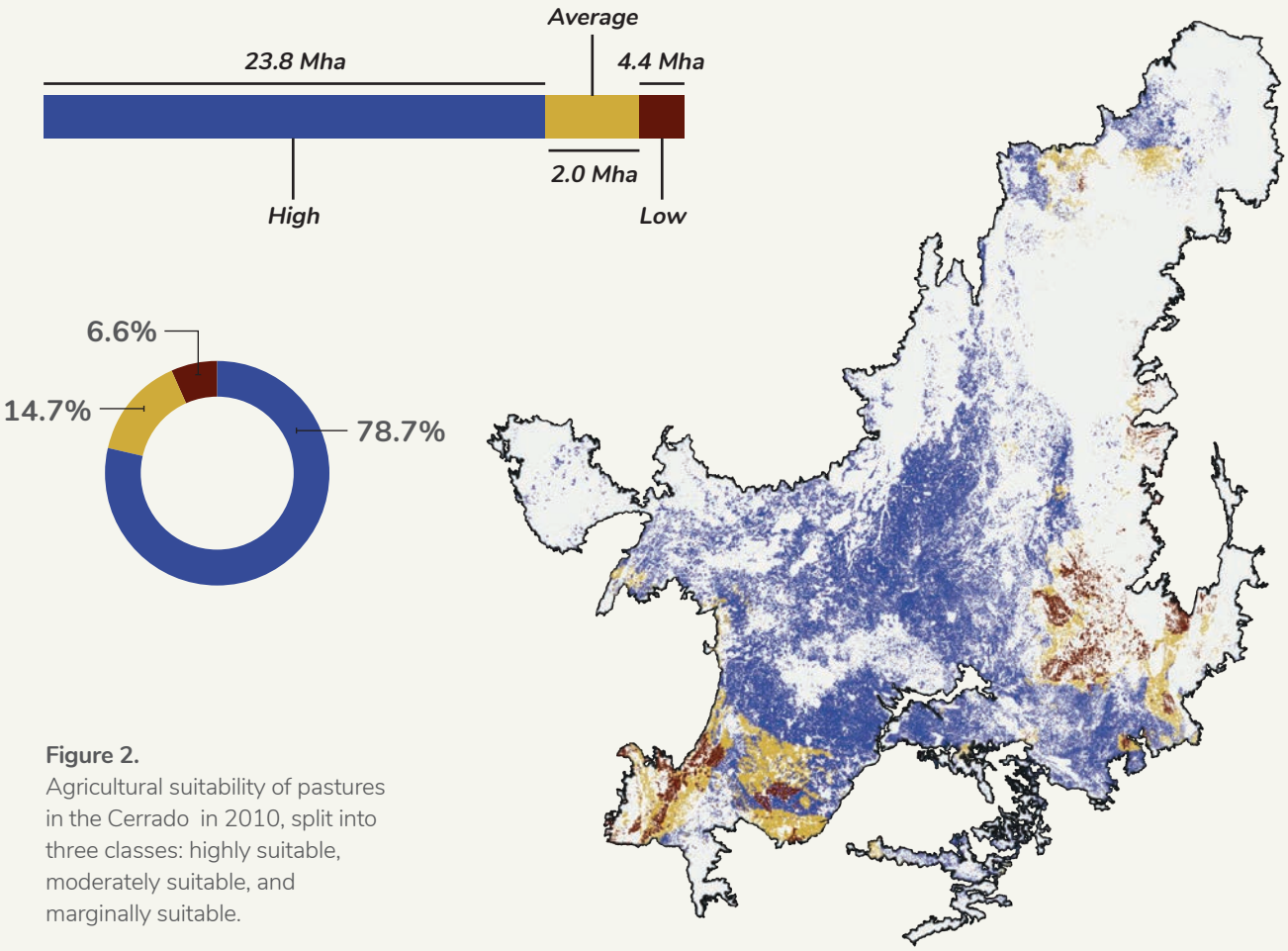


Figure 2.
Agricultural suitability of pastures in the Cerrado in 2010, split into three classes: highly suitable, moderately suitable, and marginally suitable.

CHAPTER 2

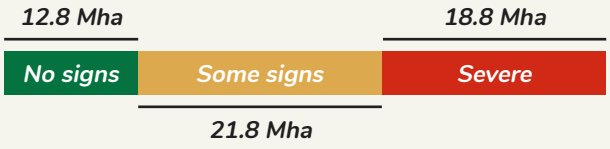
Results and discussion

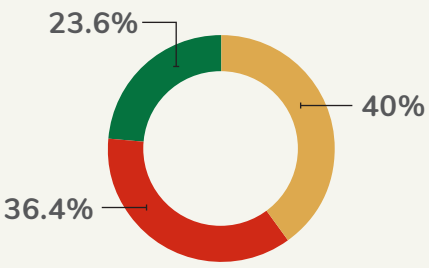
2.1 Pastures' quality in the Cerrado

In 2010, 23.6% of the 54.4 million hectares covered by pastures showed no signs of degradation, 40% showed signs of slight or moderate degradation, and 36.4% showed signs of severe degradation ***(Figure 3)***.

Signs of pastures degradation in the Cerrado biome

2010





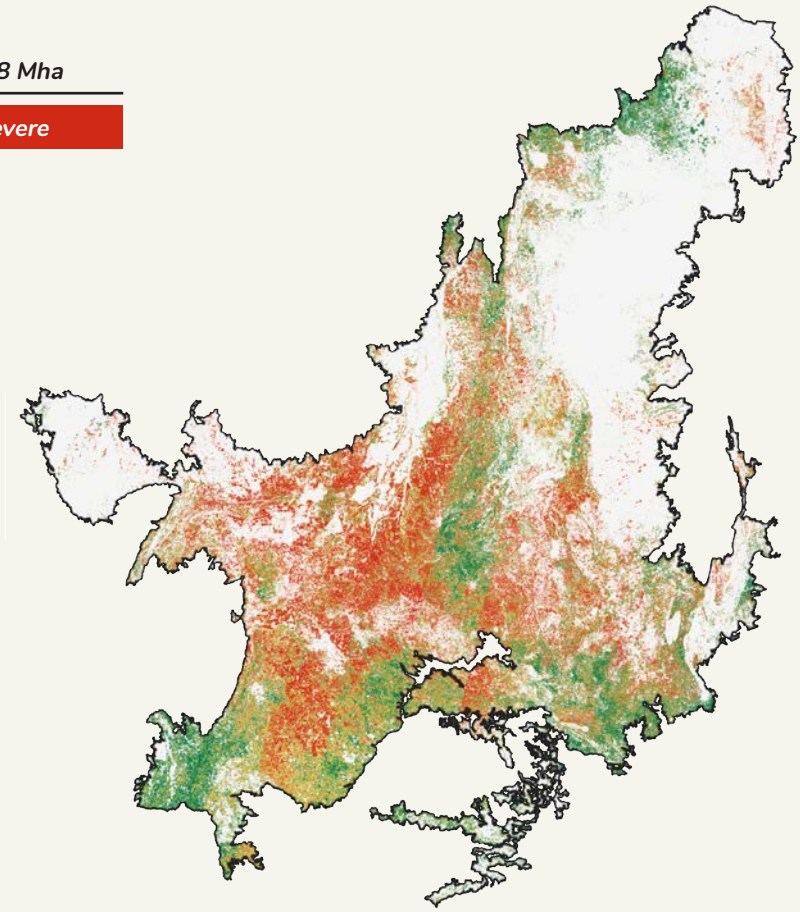


Figure 3.
Pastures in the Cerrado biome in 2010, classified in terms of degradation signs: **No signs** – no signs of degradation; **Some signs** – some signs of slight or moderate degradation; **Severe** – signs of severe degradation.

Between 2010 and 2018, there was a sharp rise in the percentage of areas with no signs of degradation (38.2%), a small drop in the percentage of areas with signs of slight and moderate degradation (down to 36.2%), and a considerable reduction in the proportion of areas with signs of severe degradation (down to 25.6%) ***(Table 2 and Figure 4)***. These results indicate pastures' quality has improved and are consistent with the information observed for the beef cattle, which shows rising stocking rates over the past few decades. Despite a marked improvement, pastures with signs of severe degradation, which are unproductive or have very low productivity levels, amounted to 13.6 million hectares in 2018, and areas with signs of slight or moderate degradation, which can be upgraded, came to 19.2 million hectares, confirming that there's an opportunity and need to make a more efficient and productive use of pastures in the Cerrado.

Table 2.
Area (ha) and dynamics of pastures in the Cerrado (according to degradation levels and intersection with state boundaries in the biome) between 2010 and 2018.

	2010			2018		
State	Non-degraded	Moderately degraded	Severely degraded	Non-degraded	Moderately degraded	Severely degraded
BA	82,528	182,315	174,967	88,821	208,086	257,312
DF	6,162	31,845	61,125	15,749	35,146	50,245
GO	2,524,118	5,358,875	6,944,165	5,175,983	4,738,538	4,043,201
MA	1,269,162	642,835	251,201	1,811,660	803,155	438,108
MG	3,158,712	4,225,134	2,823,577	3,120,819	3,143,910	2,745,162
MS	3,453,866	6,207,530	3,317,078	5,138,159	4,773,522	1,660,418

State	2010			2018		
	Non-degraded	Moderately degraded	Severely degraded	Non-degraded	Moderately degraded	Severely degraded
MT	573,662	2,382,278	4,223,785	2,146,565	2,868,831	2,463,700
PA	138,659	102,358	62,443	191,983	113,716	80,945
PI	21,470	91,520	123,614	45,155	80,648	168,784
PR	17,521	12,451	286	16,622	2,470	55
RO	8,983	5,442	2,513	12,612	5,624	5,006
SP	431,030	347,326	48,624	308,529	163,780	36,510
TO	1,120,356	2,127,000	1,745,831	2,144,733	2,116,282	1,634,308

Signs of pastures degradation in the Cerrado

2018

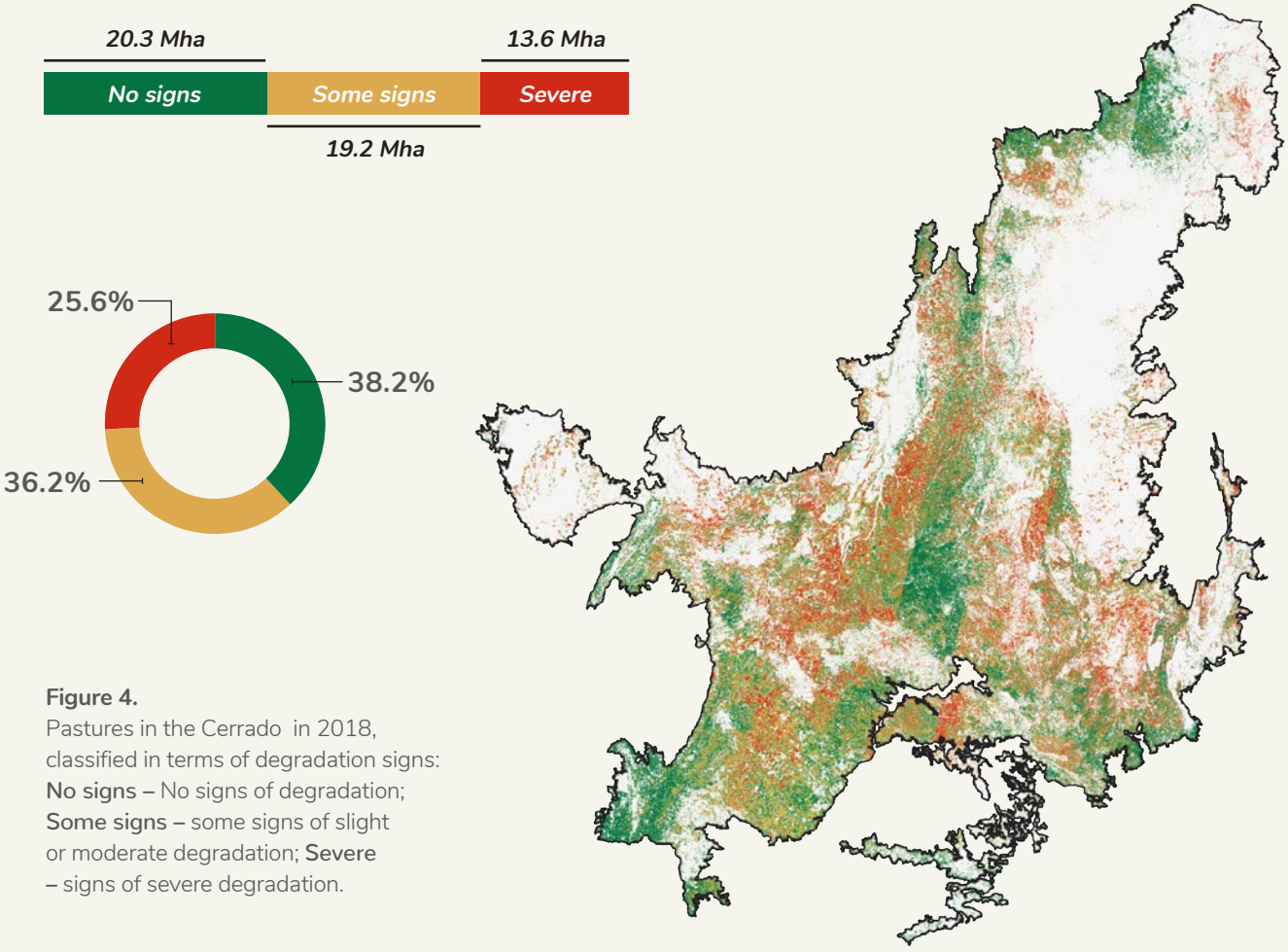


Figure 4.
Pastures in the Cerrado in 2018, classified in terms of degradation signs: **No signs –** No signs of degradation; **Some signs –** some signs of slight or moderate degradation; **Severe –** signs of severe degradation.

We've analyzed the pastures with regards to:

1. STABILITY

Areas that did not change between 2010 and 2018 in terms of whether there are signs of degradation or not

2. CHANGES OR DYNAMICS

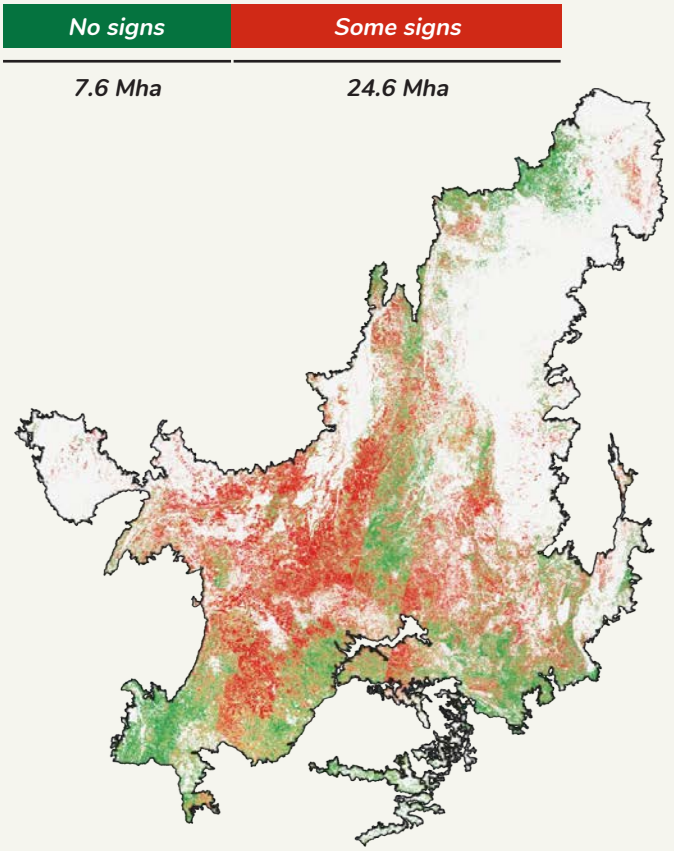
Areas that changed in terms of whether there are signs of degradation or not between 2010 e 2018

3. EXPANSION OR CONTRACTION

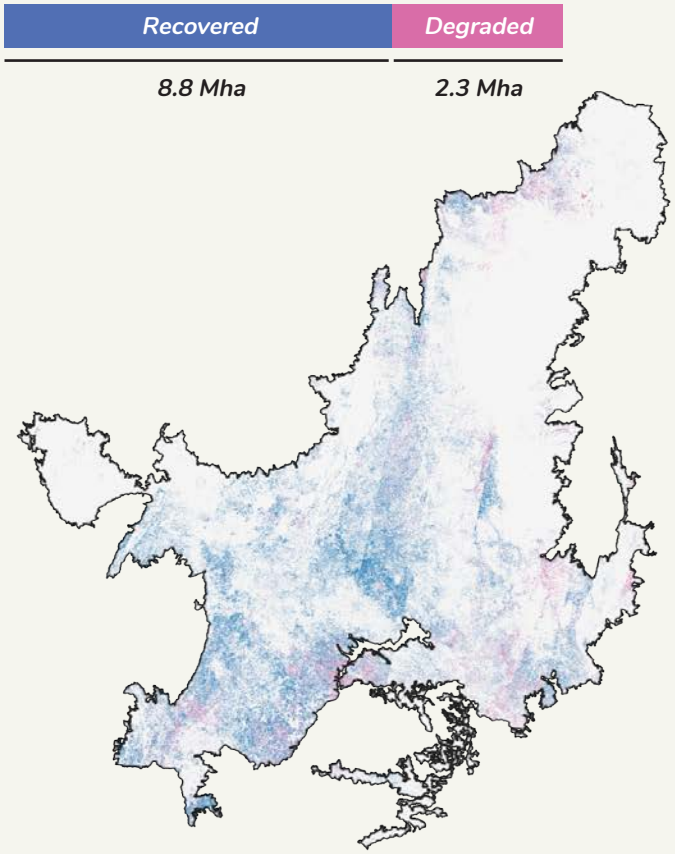
Area loss or gain. Stable areas amounted to 32.1 million hectares, and the areas that changed equated to 11.1 million hectares, of which 8.8 improved and 2.3 worsened

The area added to the cattle ranching system – expansion area – amounted to 9.8 million hectares, and the contraction area was 1.1 million. These results confirm the signs of improved in the Cerrado's pastures, contracting more than expanding, and the area where there was improvement was 3.8 times as large as the area that worsened. However, nearly 24.6 million hectares that showed signs of degradation in 2010 still show those signs in 2018, proving that there is still a large area covered by pastures that could be used more efficiently.

Stable areas



Dynamic areas



Contraction and expansion areas

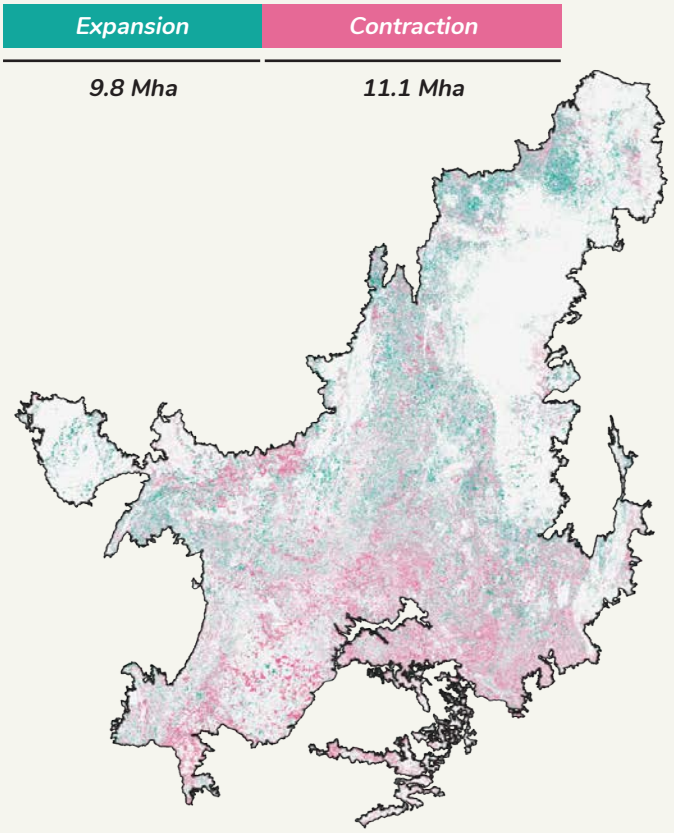


Figure 5.
Dynamic of pastures in the Cerrado between 2010 and 2018, namely: (A) Stable areas in terms of whether there are signs of degradation or not: No signs – no signs in 2010 and 2018; Some signs – some signs in 2010 and 2018; (B) Areas that changed: Degraded – no signs in 2010 and some signs in 2018; Recovered – some signs in 2010 and no signs in 2018; (C) Expansion and contraction areas: Expansion –areas not mapped as pastures in 2010 and mapped in 2018; Contraction – areas mapped as pastures in 2010 and not mapped in 2018. * To make viewing easier, the images have been spatially highlighted.

2.2 Integrated analysis of pasture quality and agricultural suitability of pasturelands in the Cerrado biome

The area of the Cerrado with high agricultural suitability covered by pastures amounted to 23.87 million hectares. We've analyzed this area with regards to limitations to grain crops and signs of degradation. We have found that 46.5% of this area – 11.1 million hectares – have no limitation to grain crops, whereas 44.7% had slope steepness limitation and 8.8% had elevation limitation or double limitation ***(Figure 6 and Table 3)***.

Limitations to farming in highly suitable pastures

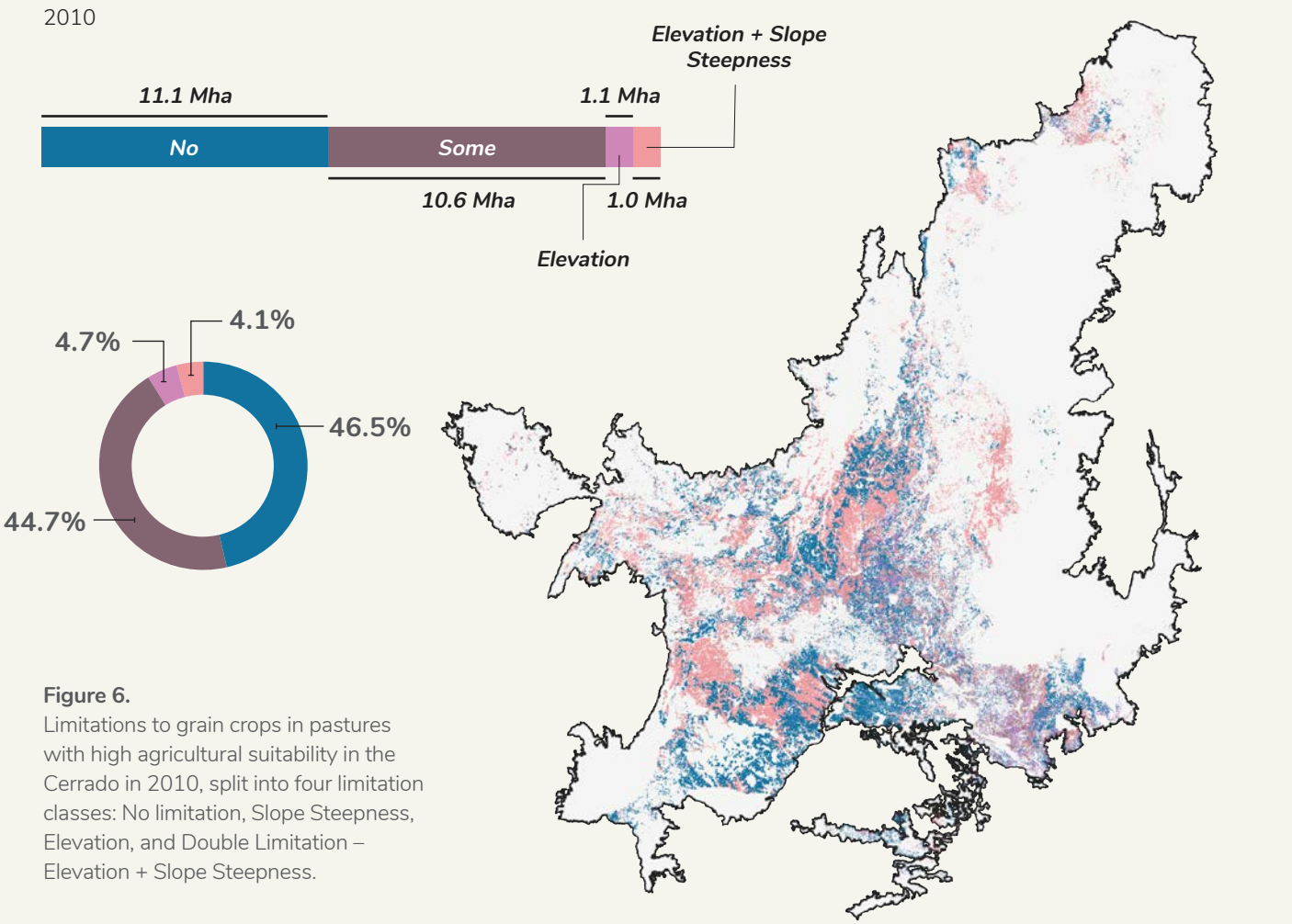


Figure 6.
Limitations to grain crops in pastures with high agricultural suitability in the Cerrado in 2010, split into four limitation classes: No limitation, Slope Steepness, Elevation, and Double Limitation – Elevation + Slope Steepness.

Nearly 3.4 million hectares of pastures in the Cerrado have true potential to rehabilitate its productivity. This area has shown signs of severe degradation, high agricultural suitability, and no limitation to grain crops. By including areas with signs of degradation (severe, moderate, or slight), the area that's shown these characteristics – high suitability and no limitation to grain crops – amounted to 7.7 million hectares, and area that also has potential for a more efficient, productive use.

Table 3.
Area (ha) of pastures in the Cerrado(2018) with high agricultural suitability and no limitation to crop growing (according to degradation levels and intersection with state boundaries in the biome).

State	Non-degraded	Moderately degraded	Severely degraded	Total
BA	1,693,17	14,372,10	5,909,90	21,975
DF	2,838,38	18,655,01	4,813,81	26,307
GO	1,344,406,31	2,024,215,02	703,051,62	4,071,673
MA	102,936,90	47,797,89	19,787,16	170,522
MG	539,329,96	839,159,58	322,270,54	1,700,760
MS	904,125,54	1,259,504,70	588,186,58	2,751,817
MT	300,715,49	1,029,346,25	355,605,24	1,685,667
PA	0,00	0,00	0,00	0
PI	278,16	703,33	281,21	1,263
PR	0,00	0,00	0,00	0
RO	0,00	0,00	0,00	0
SP	87,712,82	40,756,28	14,470,59	142,940
TO	247,305,97	434,807,79	163,168,91	845,283

CHAPTER 3

Final thoughts

The total area covered by pastures in the Cerrado has been stable – no expansion – over the past two decades. However, there has been an ongoing contraction/expansion process, whereby pastures are replaced by other land uses and expanding over new areas, mainly native vegetation areas.

Pastures with signs of degradation have contracted over two times faster than the area whose quality has been worsening. However, nearly 50% of the area covered by pastures in the Cerrado still shows some signs of degradation, so there is a massive opportunity and need to change pastures in this biome, boosting efficiency and yield.

A large pasture area – 7.7 million hectares – that shows signs of degradation, high agricultural suitability and no limitation to grain cultivation.

These areas are more likely to yield immediate productivity gains, and making them a priority in pastureland rehabilitation actions taken in the biome is a compelling strategy.

The results show that pastures in the Cerrado have been improving and becoming more productive. At the same time, our findings also point to the need for ongoing efforts to tap into these areas' full potential to contribute towards sustainable food production, as well as mitigating/reducing environmental impacts that compromise said sustainable production.

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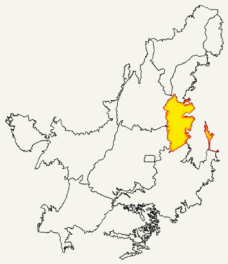
ANNEX 1

Quality and agricultural suitability of pastures in the Cerrado

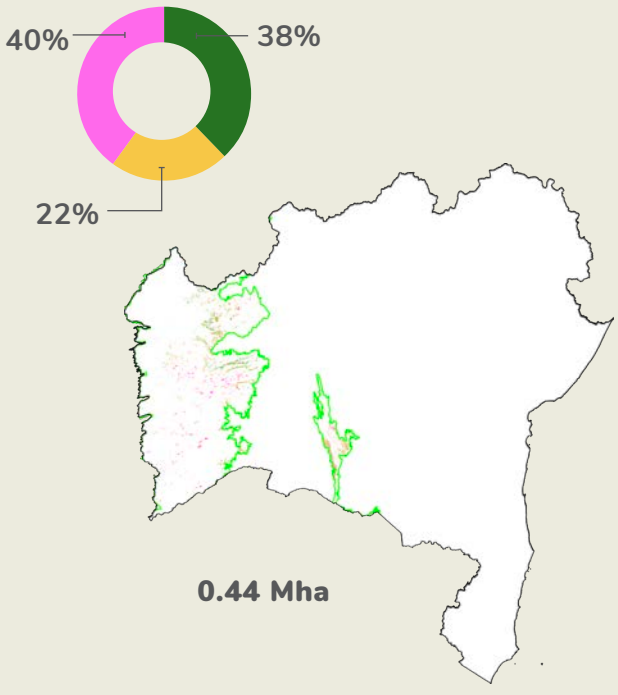
Analysis per state

Quality of pastures in Bahia

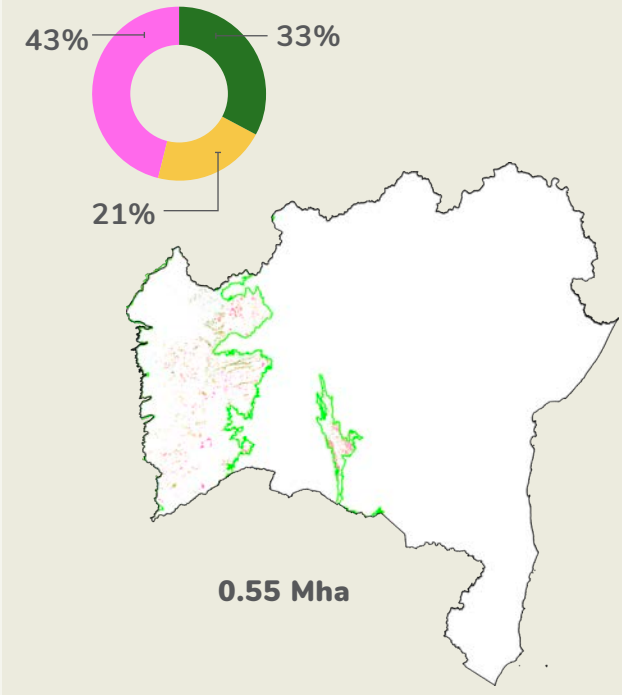


Severely degraded Moderately degraded Non-degraded

2010



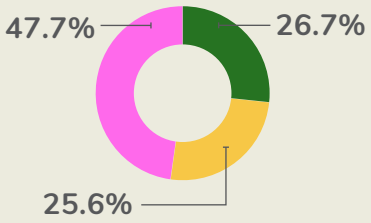
2018



Source: LAPIG/MapBiomas

Severely degraded Moderately degraded Non-degraded

Abandoned or converted pastures

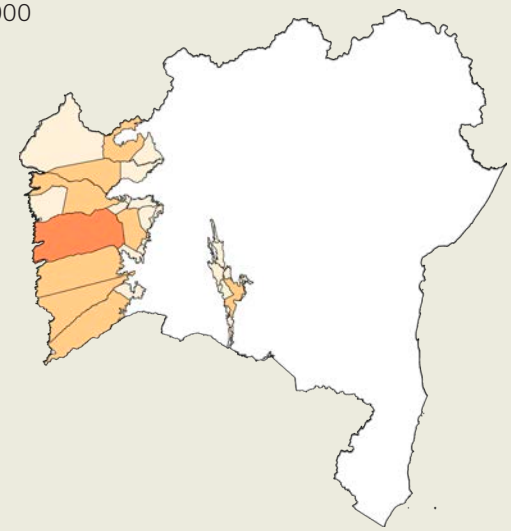


0.12 Mha

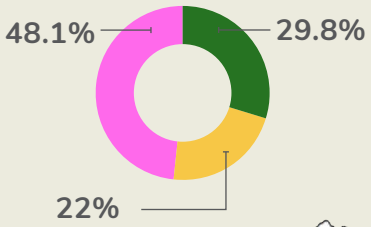
Pastures in the municipality

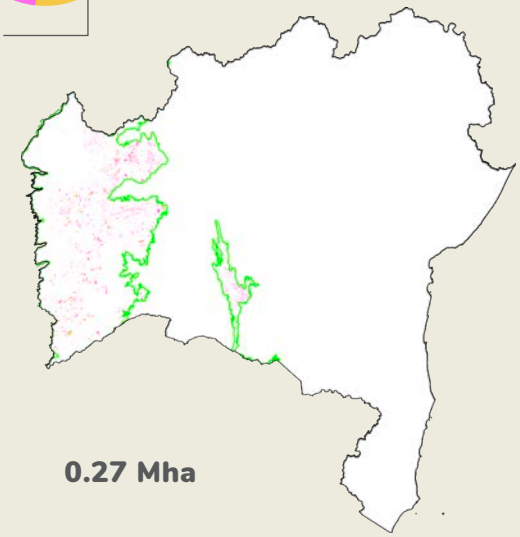
2018 (Mha)

- < 25,000
- 25,000 - 50,000
- 50,000 - 100,000
- 100,000 - 250,000
- > 250,000



New pastures





0.27 Mha

Percentage of area covered by pastures in the municipality

2018 (%)

- < 10
- 10 - 20
- 20 - 40
- 40 - 60
- > 60

Source: LAPIG/MapBiomas

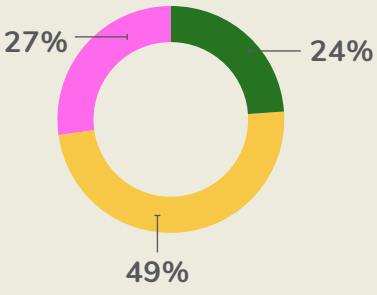
Dynamics of pastures' quality

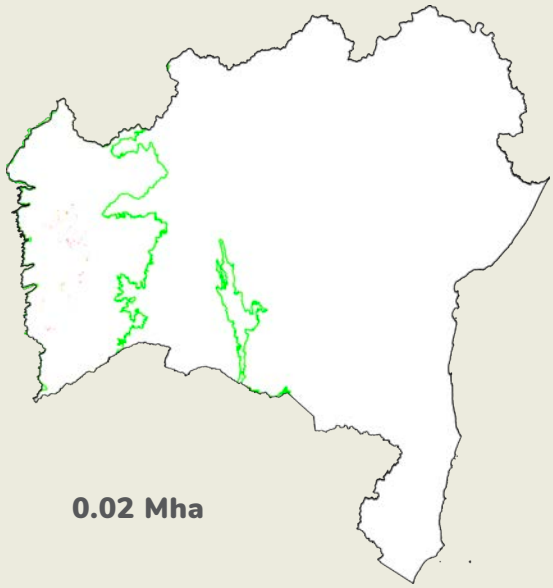
Continued non-degraded (0.06 Mha)
Continued degraded (0.14 Mha)
Recovered pasture (0.08 Mha)
Pasture with signs of degradation (0.08 Mha)

Severely degraded
Moderately degraded
Non-degraded

Pastures with high agricultural suitability per quality class

2018 (%)



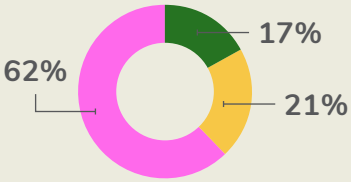


Source: LAPIG/MapBiomas

Quality of pastures in the Federal District

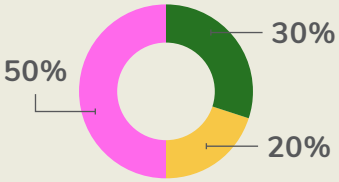
Severely degraded Moderately degraded Non-degraded

2010



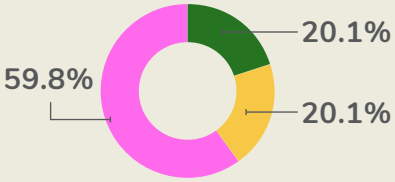
0.1 Mha

2018



0.1 Mha

Abandoned or converted pastures



0.03 Mha

Pastures in the municipality

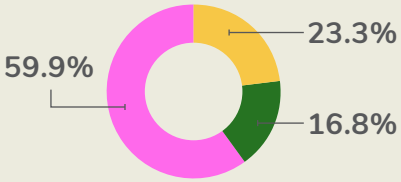
2018 (Mha)

- < 25,000
- 25,000 - 50,000
- 50,000 - 100,000
- 100,000 - 250,000
- > 250,000

Source: LAPIG/MapBiomas

Severely degraded Moderately degraded Non-degraded

New pastures



0.03 Mha

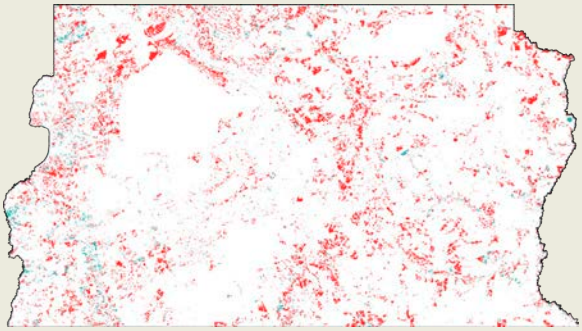
Percentage of area covered by pastures in the municipality

2018 (%)

- < 10
- 10 - 20
- 20 - 40
- 40 - 60
- > 60

Dynamics of pastures' quality

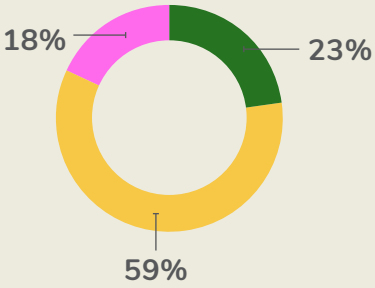
- Continued non-degraded (0.01 Mha)
- Continued degraded (0.04 Mha)
- Recovered pasture (0.03 Mha)
- Pasture with signs of degradation (0.01 Mha)



Severely degraded Moderately degraded Non-degraded

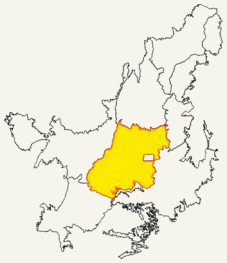
Pastures with high agricultural suitability per quality class

2018 (%)



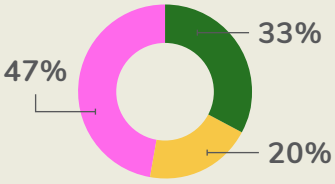
0.02 Mha

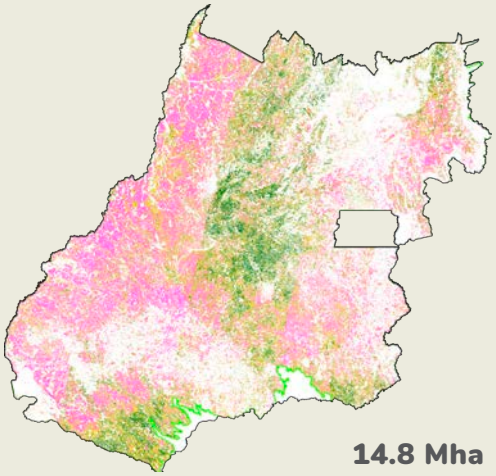
Quality of pastures in Goiás



Severely degraded Moderately degraded Non-degraded

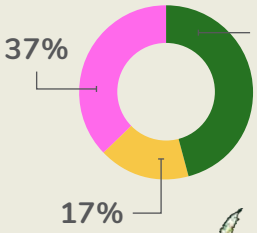
2010

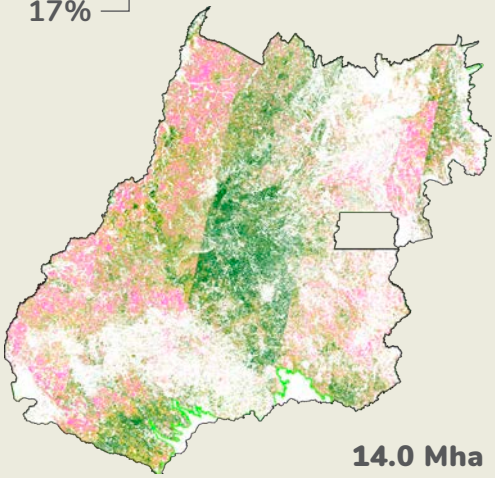




14.8 Mha

2018



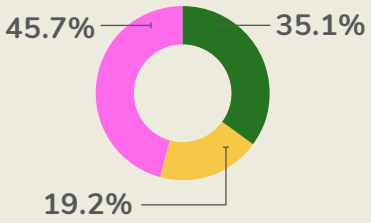


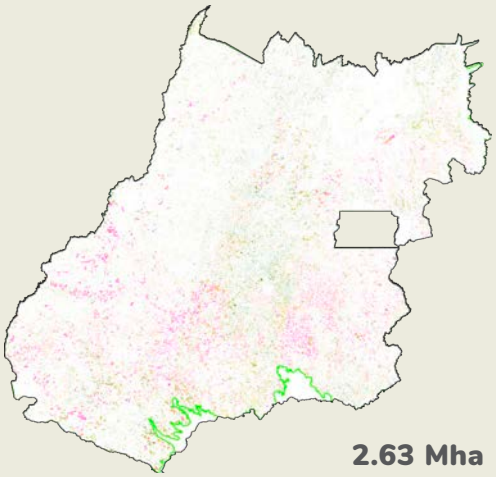
14.0 Mha

Source: LAPIG/MapBiomas

Severely degraded Moderately degraded Non-degraded

Abandoned or converted pastures

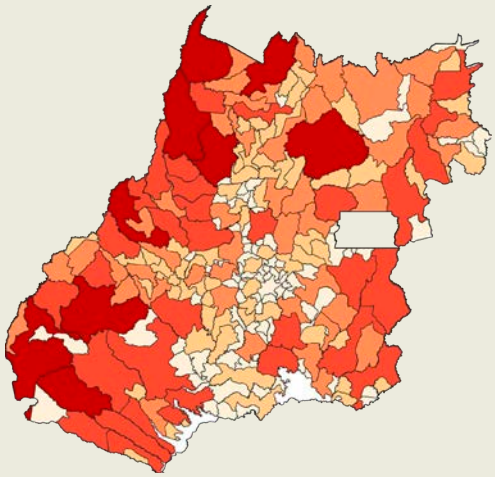




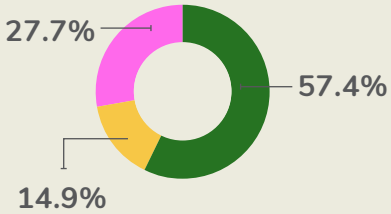
Pastures in the municipality

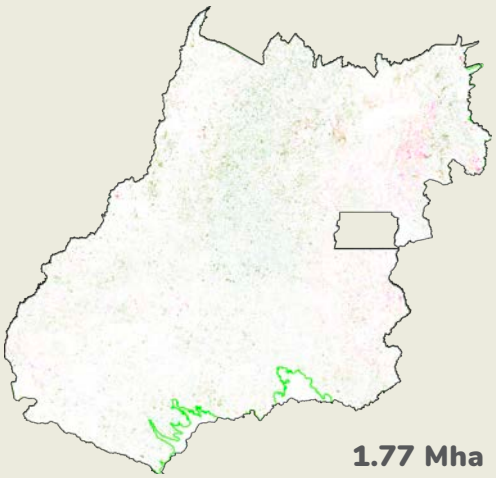
2018 (Mha)

- < 25,000
- 25,000 - 50,000
- 50,000 - 100,000
- 100,000 - 250,000
- > 250,000



New pastures

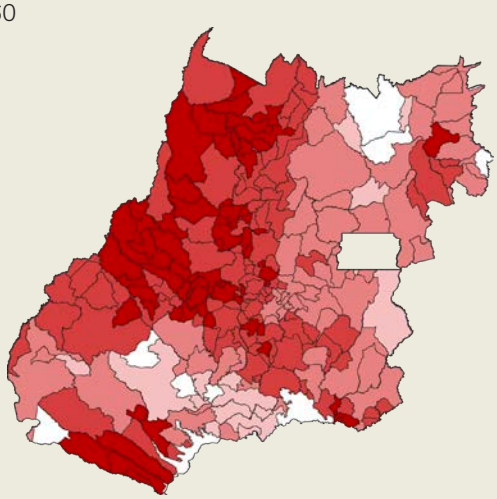




Percentage of area covered by pastures in the municipality

2018 (%)

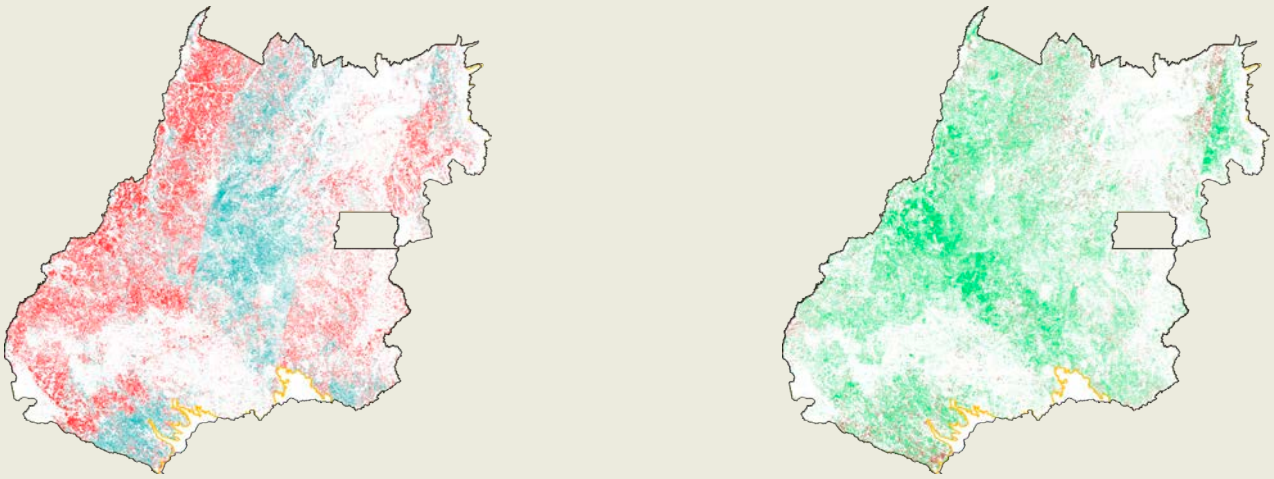
- < 10
- 10 - 20
- 20 - 40
- 40 - 60
- > 60



Source: LAPIG/MapBiomas

Dynamics of pastures' quality

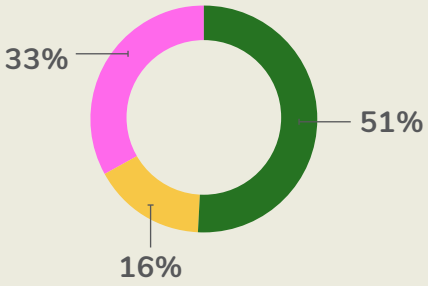
Continued non-degraded (3.5 Mha)
Continued degraded (5.1 Mha)
Recovered pasture (5.6 Mha)
Pasture with signs of degradation (1.1 Mha)

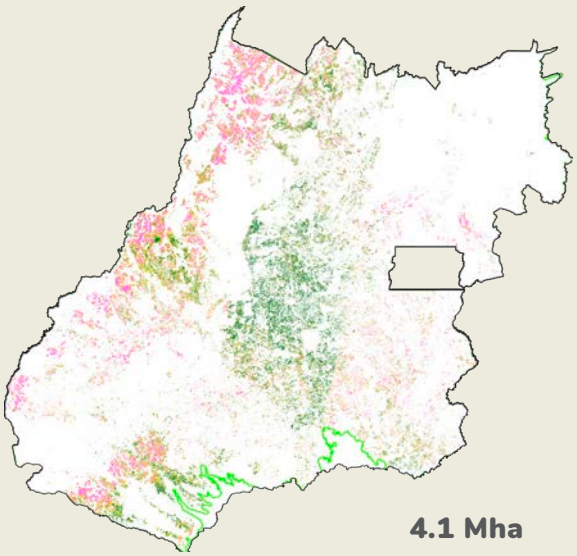


Severely degraded
Moderately degraded
Non-degraded

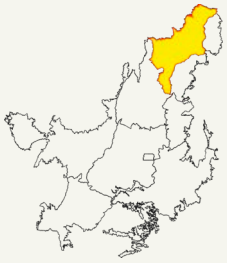
Pastures with high agricultural suitability per quality class

2018 (%)





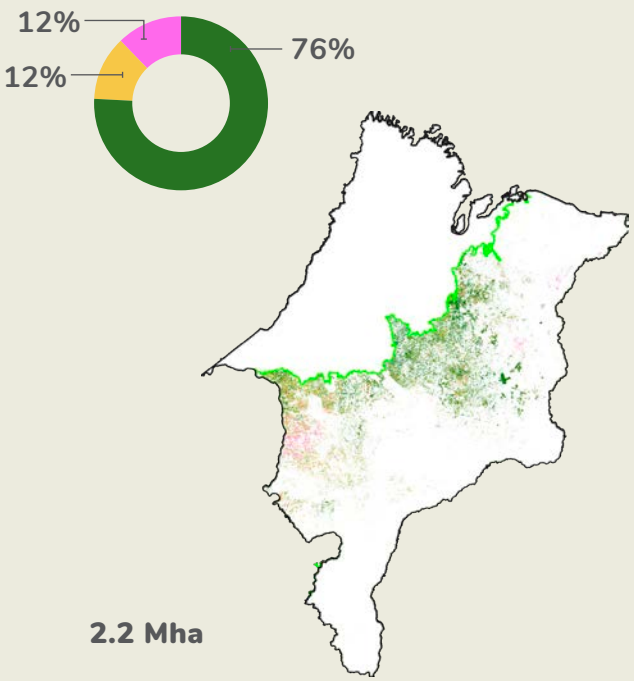
Source: LAPIG/MapBiomas



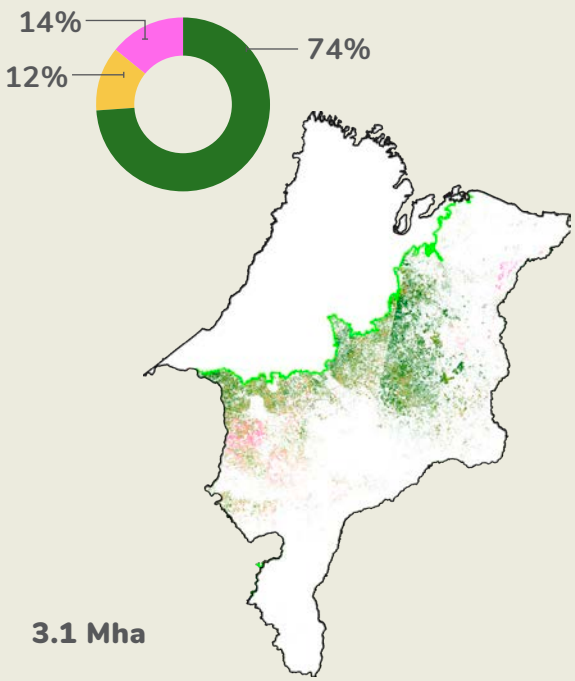
Quality of pastures in Maranhão

Severely degraded Moderately degraded Non-degraded

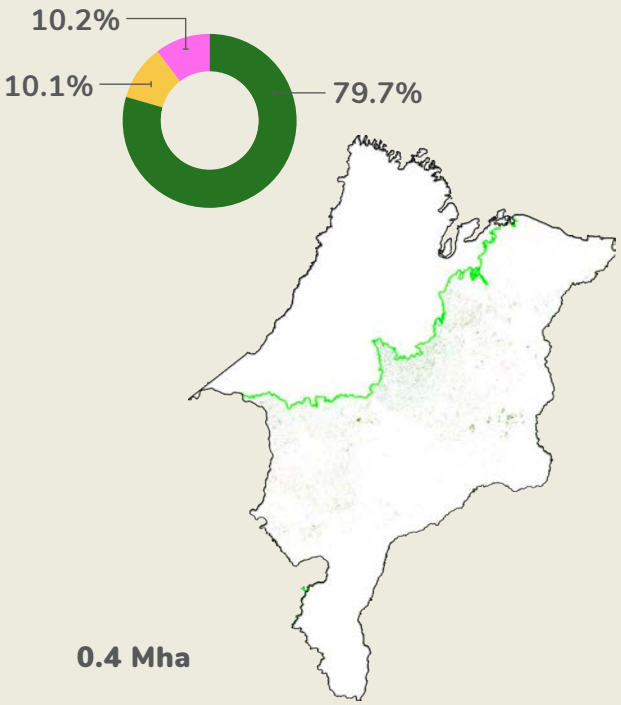
2010



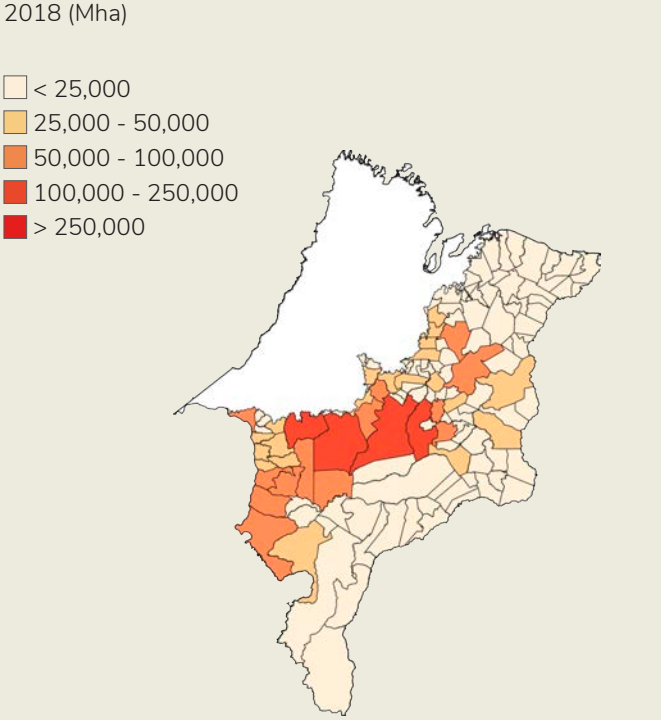
2018



Abandoned or converted pastures



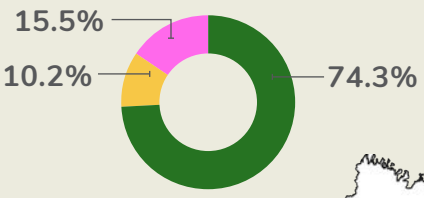
Pastures in the municipality

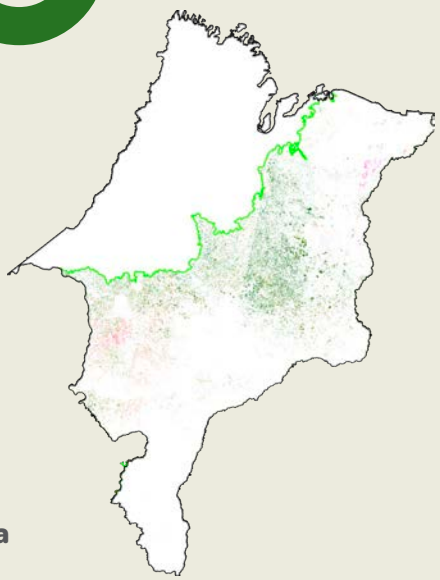


Fonte: LAPIG/MapBiomas

Severely degraded Moderately degraded Non-degraded

New pastures



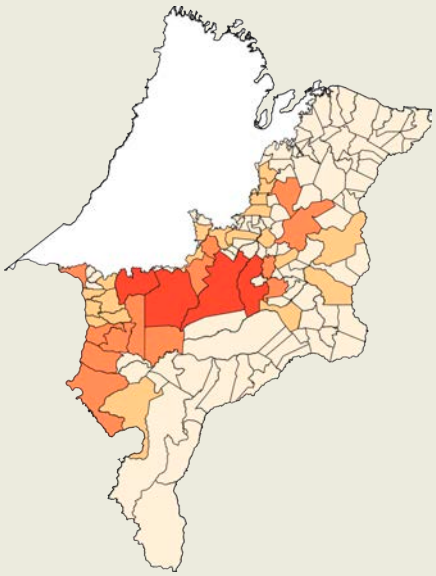


1.3 Mha

Percentage of area covered by pastures in the municipality

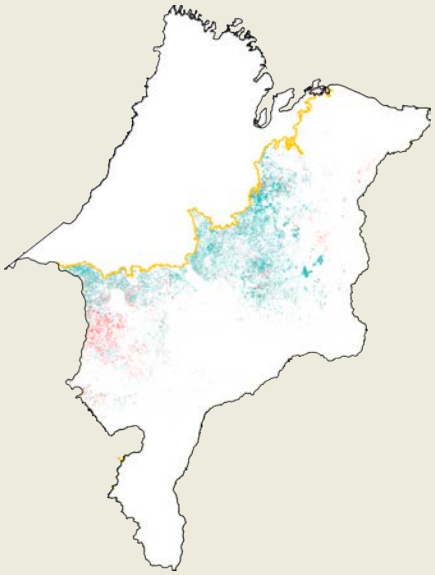
2018 (%)

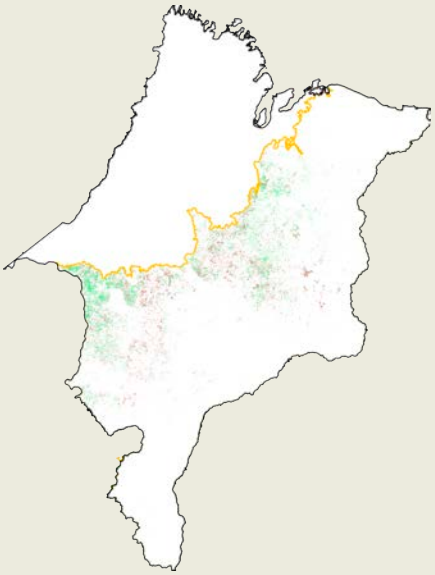
< 10
10 - 20
20 - 40
40 - 60
> 60



Dynamics of pastures' quality

Continued non-degraded (1.1 Mha)
Continued degraded (0.25 Mha)
Recovered pasture (0.38 Mha)
Pasture with signs of degradation (0.39 Mha)

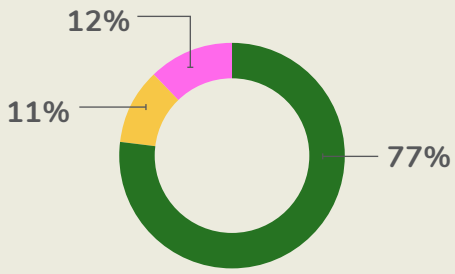




Severely degraded Moderately degraded Non-degraded

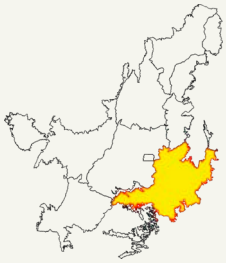
Pastures with high agricultural suitability per quality class

2018 (%)



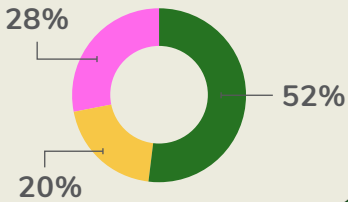
0.17 Mha

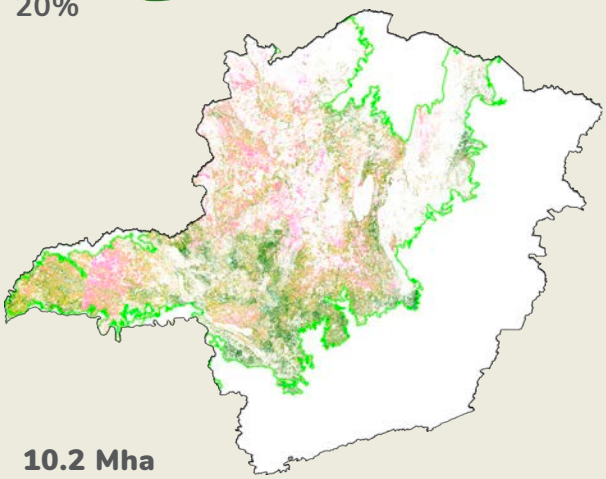
Quality of pastures in Minas Gerais



Severely degraded Moderately degraded Non-degraded

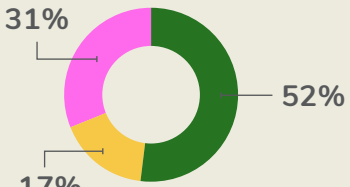
2010

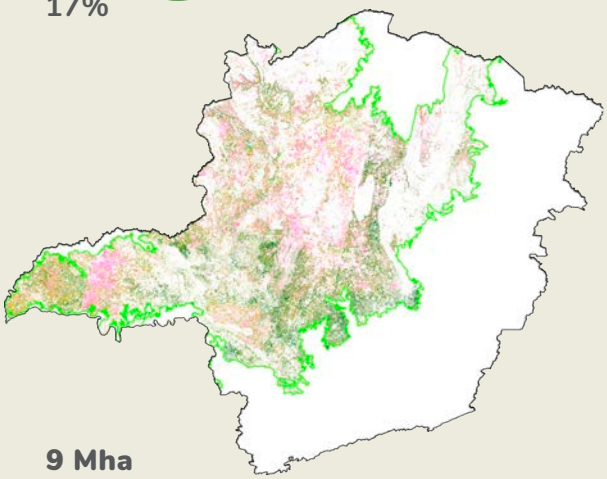




10.2 Mha

2018



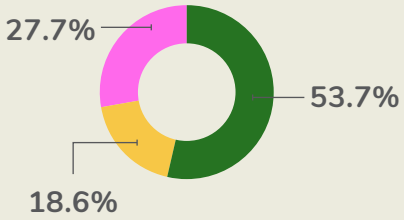


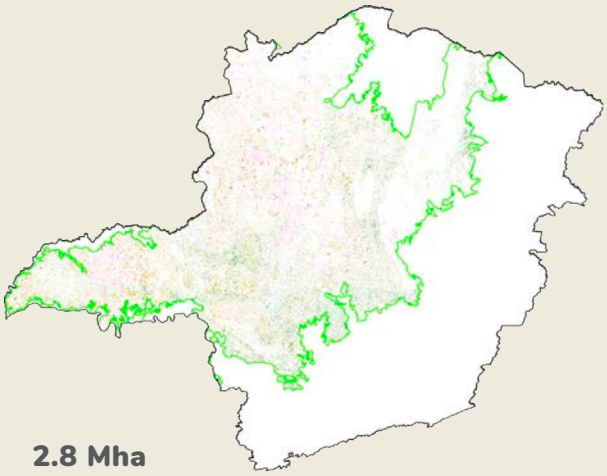
9 Mha

Source: LAPIG/MapBiomas

Severely degraded Moderately degraded Non-degraded

Abandoned or converted pastures



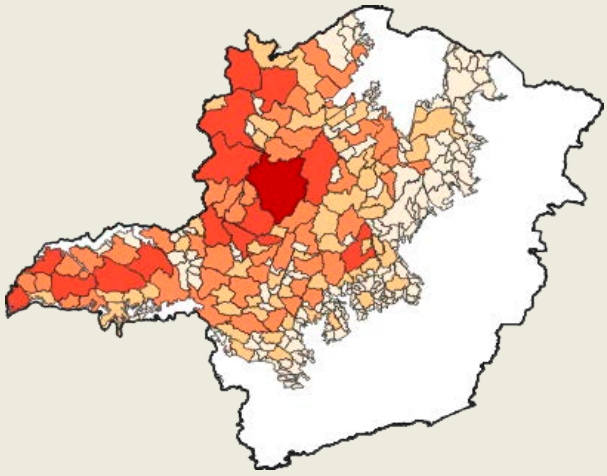


2.8 Mha

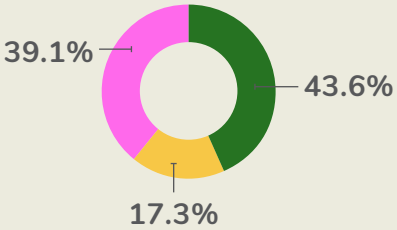
Pastures in the municipality

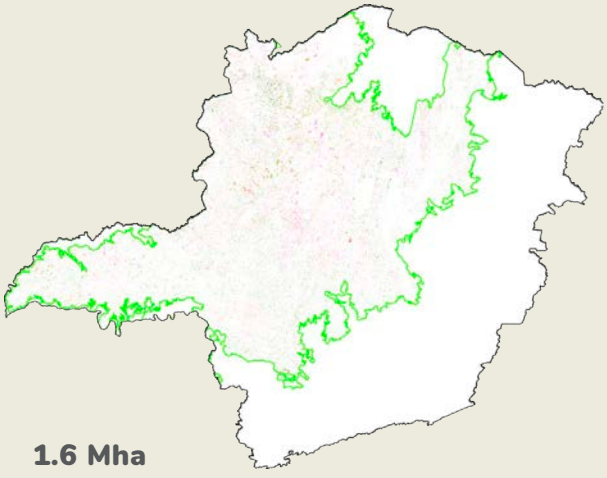
2018 (Mha)

- < 25,000
- 25,000 - 50,000
- 50,000 - 100,000
- 100,000 - 250,000
- > 250,000



New pastures



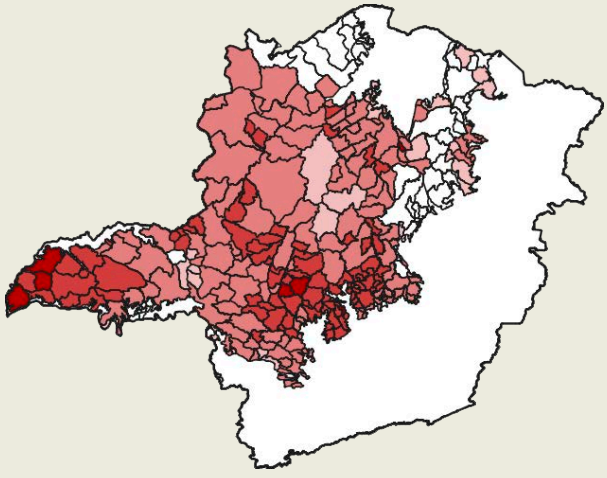


1.6 Mha

Percentage of area covered by pastures in the municipality

2018 (%)

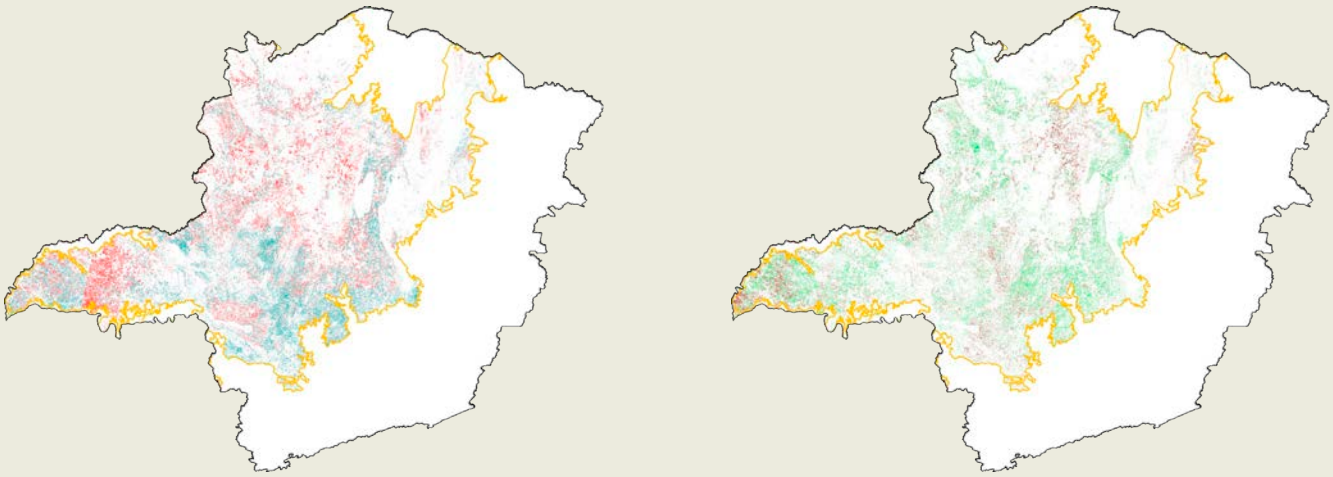
- < 10
- 10 - 20
- 20 - 40
- 40 - 60
- > 60



Source: LAPIG/MapBiomas

Dynamics of pastures' quality

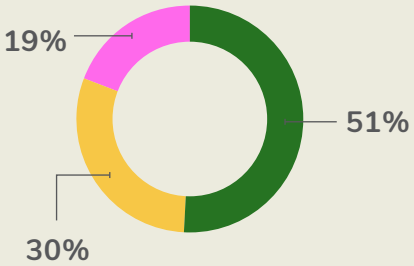
Continued non-degraded (2.98 Mha)
Continued degraded (2.55 Mha)
Recovered pasture (2.11 Mha)
Pasture with signs of degradation (1.66 Mha)

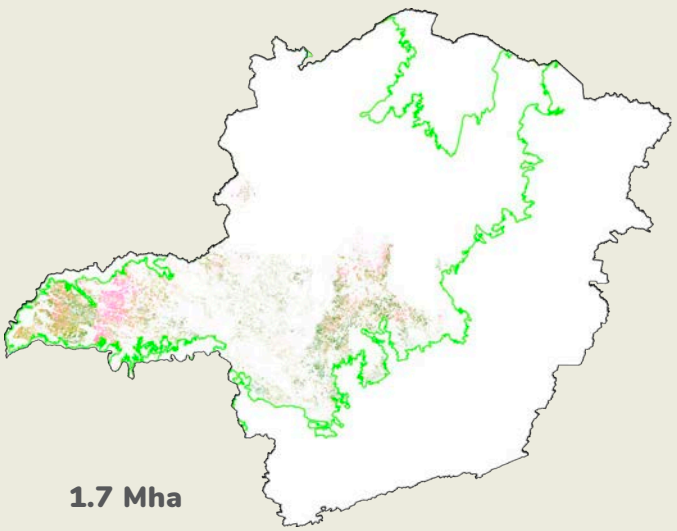


Severely degraded
Moderately degraded
Non-degraded

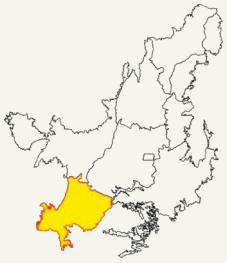
Pastures with high agricultural suitability per quality class

2018 (%)





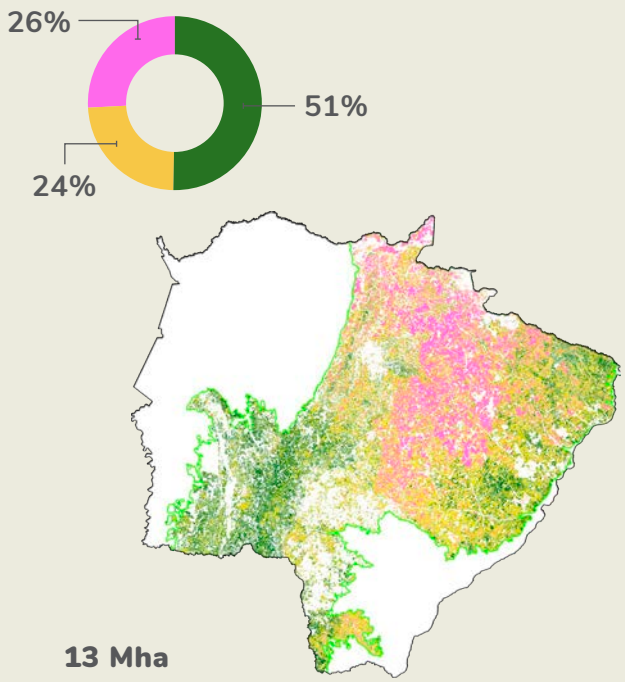
Source: LAPIG/MapBiomas



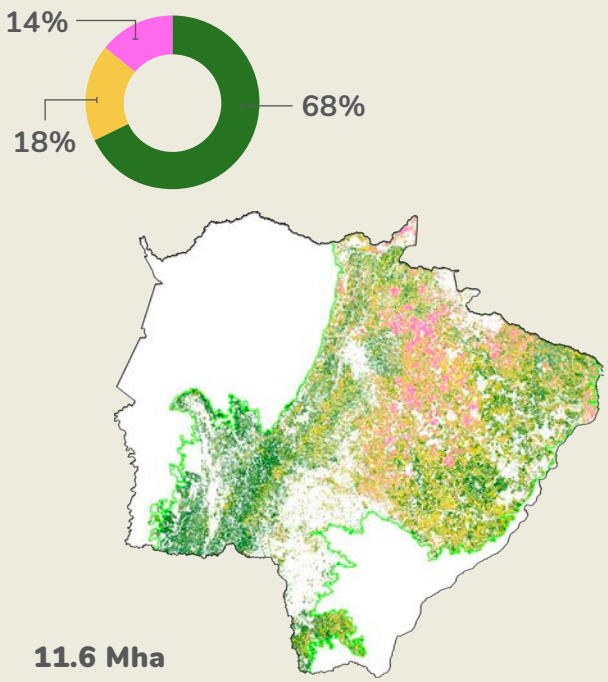
Quality of pastures in Mato Grosso do Sul

Severely degraded Moderately degraded Non-degraded

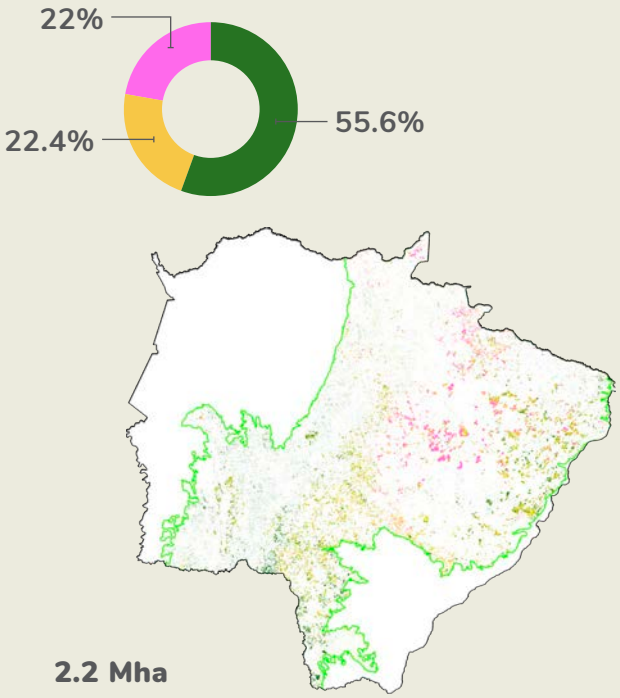
2010



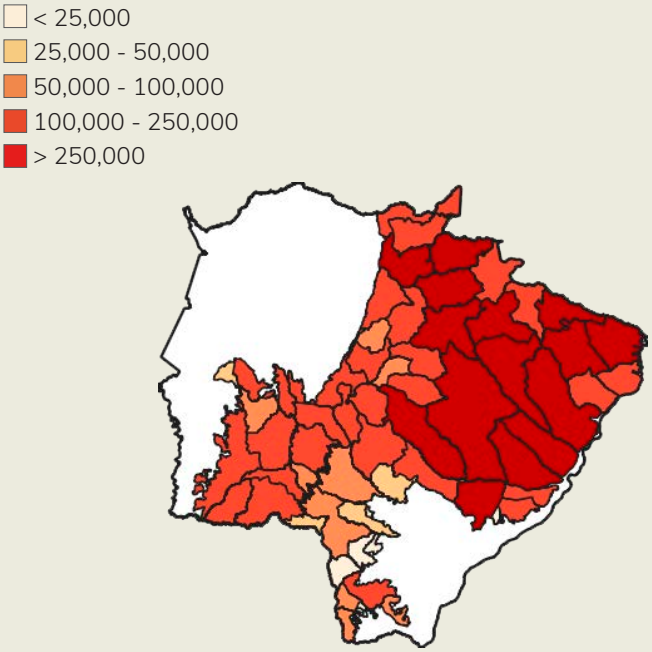
2018



Abandoned or converted pastures



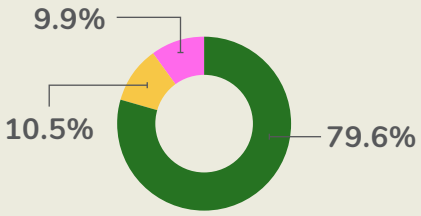
Pastures in the municipality



Source: LAPIG/MapBiomas

Severely degraded Moderately degraded Non-degraded

New pastures

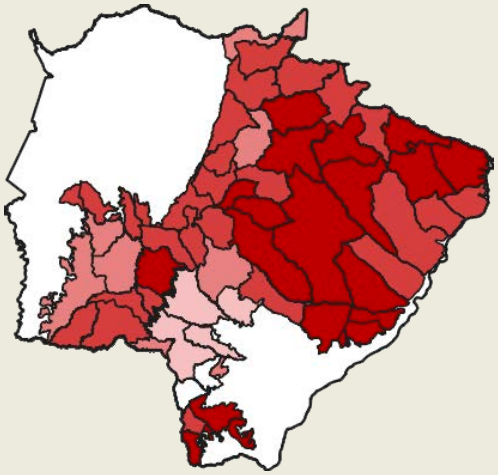


0.7 Mha

Percentage of area covered by pastures in the municipality

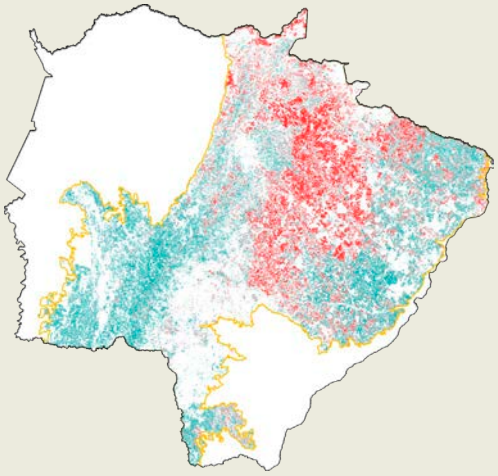
2018 (%)

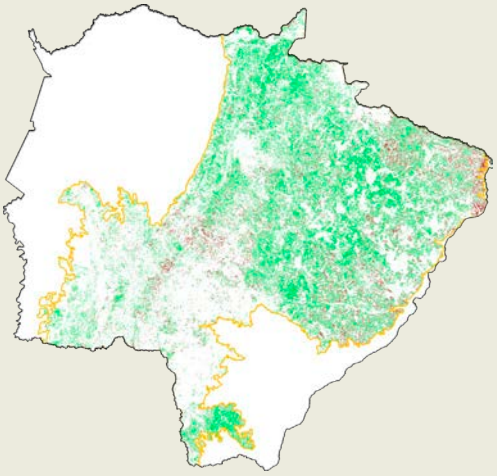
< 10
10 - 20
20 - 40
40 - 60
> 60



Dynamics of pastures' quality

Continued non-degraded (4.7 Mha)
Continued degraded (2.9 Mha)
Recovered pasture (4.8 Mha)
Pasture with signs of degradation (1.4 Mha)

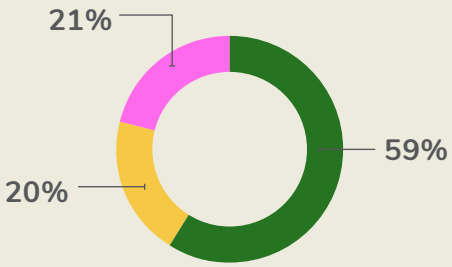


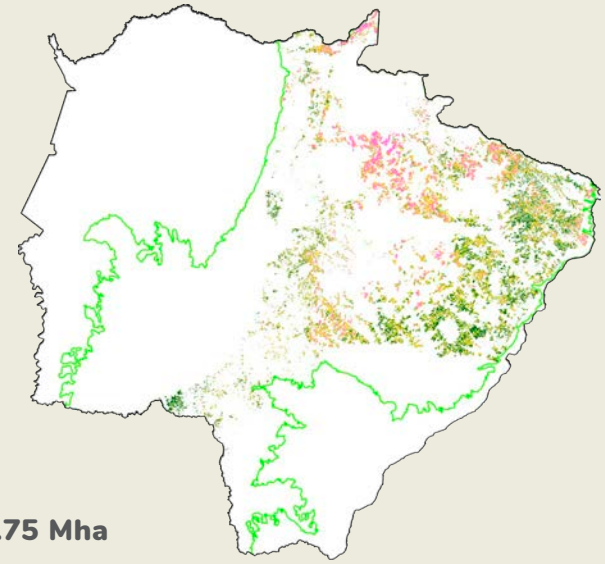


Severely degraded Moderately degraded Non-degraded

Pastures with high agricultural suitability per quality class

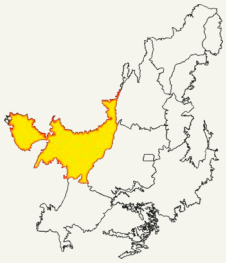
2018 (%)





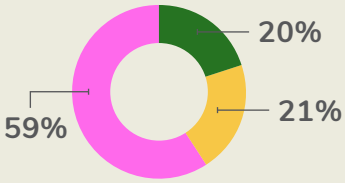
2.75 Mha

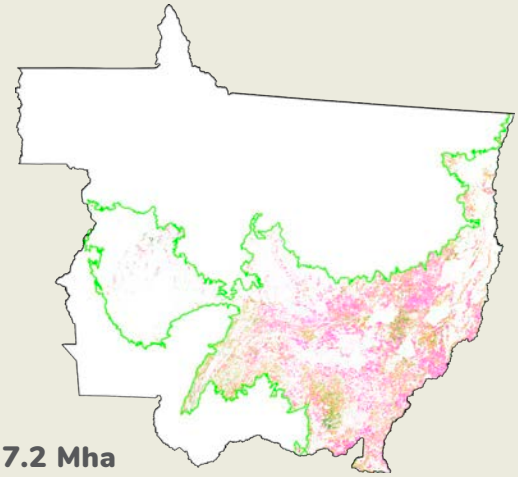
Quality of pastures in Mato Grosso



Severely degraded Moderately degraded Non-degraded

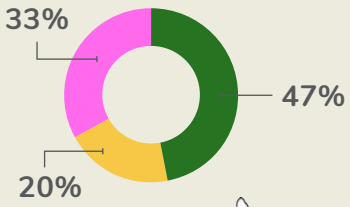
2010

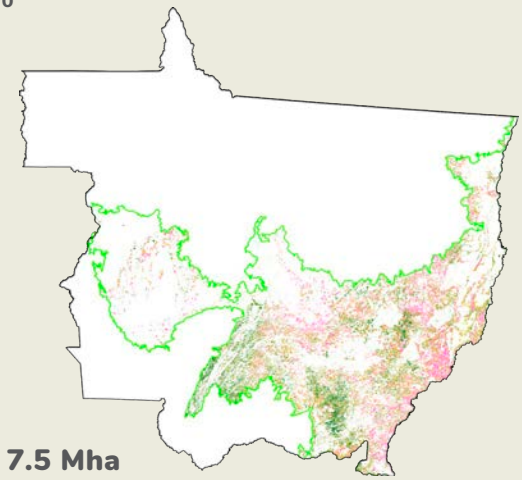




7.2 Mha

2018



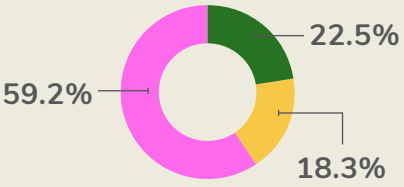


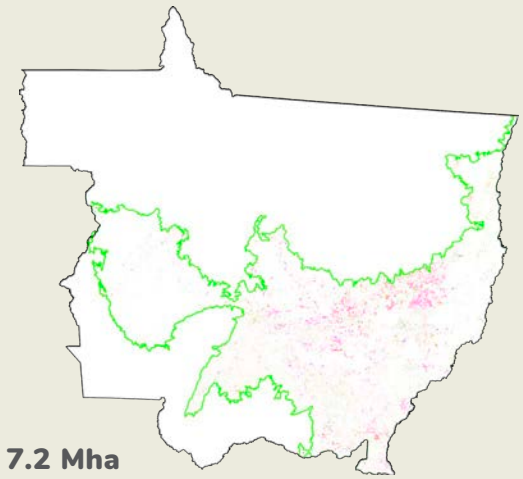
7.5 Mha

Source: LAPIG/MapBiomas

Severely degraded Moderately degraded Non-degraded

Abandoned or converted pastures



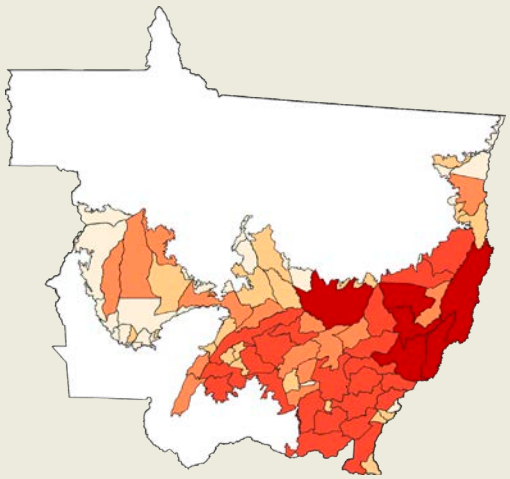


7.2 Mha

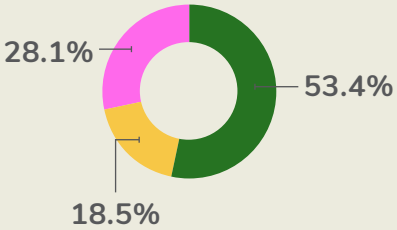
Pastures in the municipality

2018 (Mha)

- < 25,000
- 25,000 - 50,000
- 50,000 - 100,000
- 100,000 - 250,000
- > 250,000



New pastures

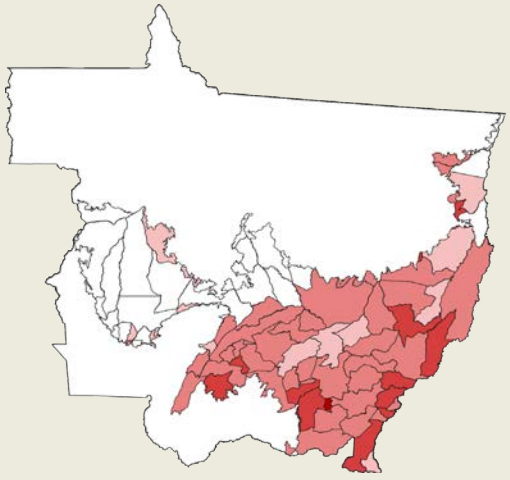


1.8 Mha

Percentage of area covered by pastures in the municipality

2018 (%)

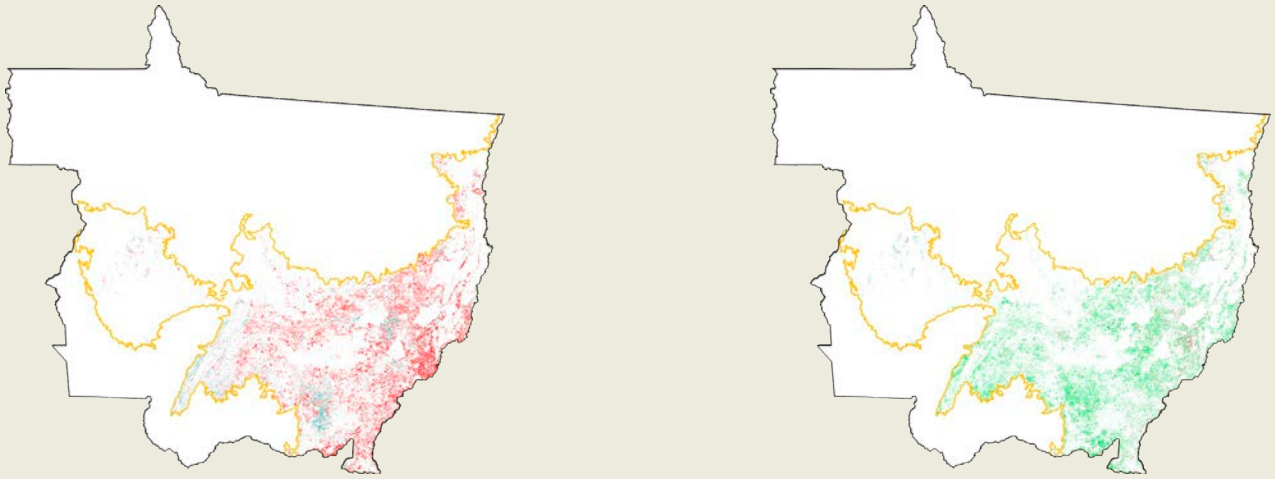
- < 10
- 10 - 20
- 20 - 40
- 40 - 60
- > 60



Source: LAPIG/MapBiomas

Dynamics of pastures' quality

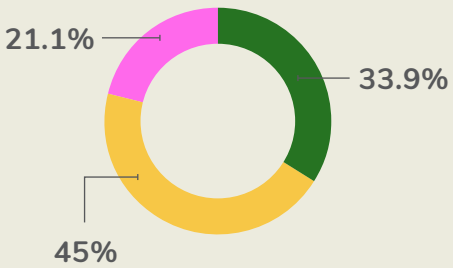
Continued non-degraded (0.9 Mha)
Continued degraded (2.88 Mha)
Recovered pasture (2.8 Mha)
Pasture with signs of degradation (0.5 Mha)

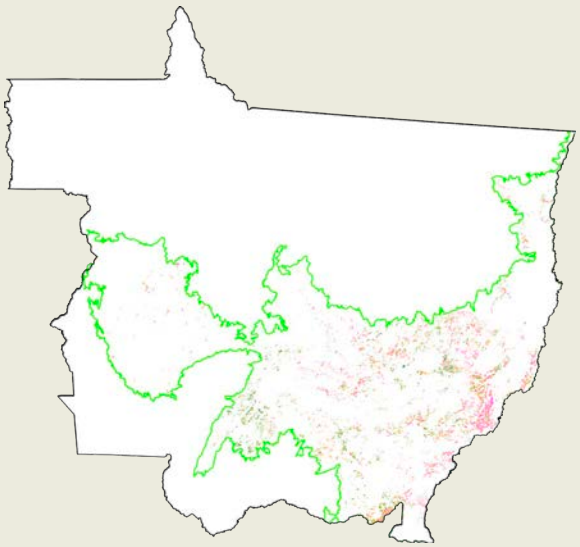


Severely degraded
Moderately degraded
Non-degraded

Pastures with high agricultural suitability per quality class

2018 (%)





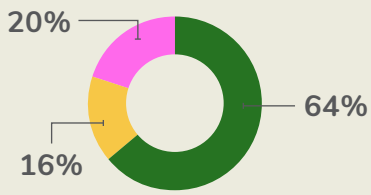
1.7 Mha

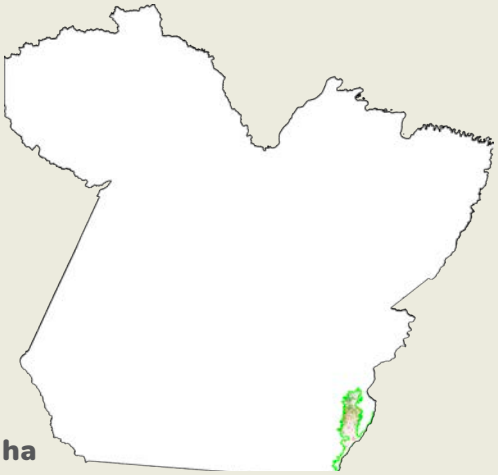
Source: LAPIG/MapBiomas

Quality of pastures in Pará

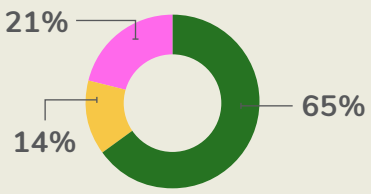
Severely degraded Moderately degraded Non-degraded

2010

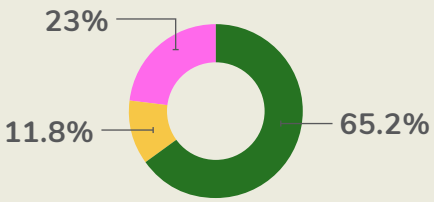




2018



Abandoned or converted pastures



Pastures in the municipality

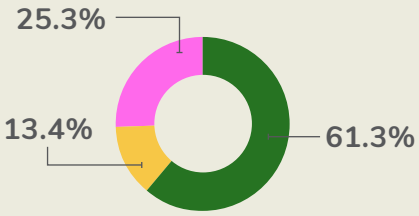
2018 (Mha)

- < 25,000
- 25,000 - 50,000
- 50,000 - 100,000
- 100,000 - 250,000
- > 250,000

Source: LAPIG/MapBiomas

Severely degraded Moderately degraded Non-degraded

New pastures



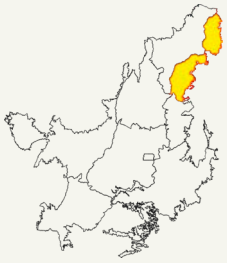
Percentage of area covered by pastures in the municipality

2018 (%)

< 10
10 - 20
20 - 40
40 - 60
> 60

Dynamics of pastures' quality

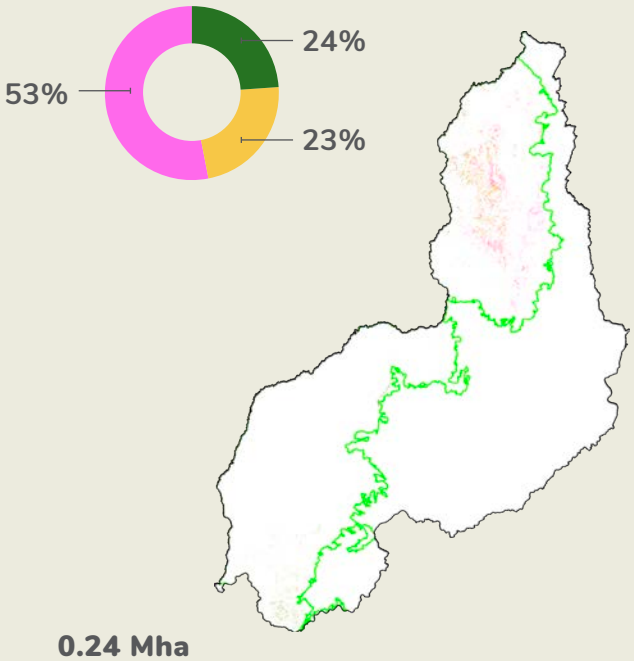
Continued non-degraded (0.14 Mha)
Continued degraded (0.06 Mha)
Recovered pasture (0.07 Mha)
Pasture with signs of degradation (0.01 Mha)



Quality of pastures in Piauí

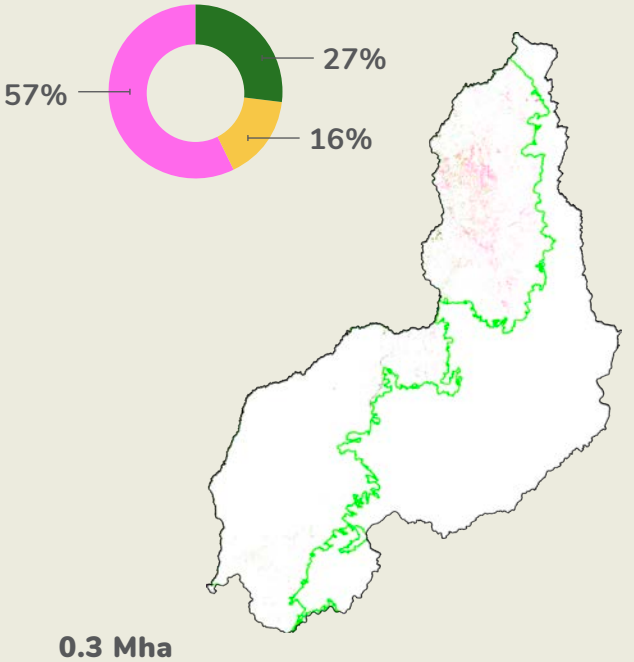
Severely degraded Moderately degraded Non-degraded

2010



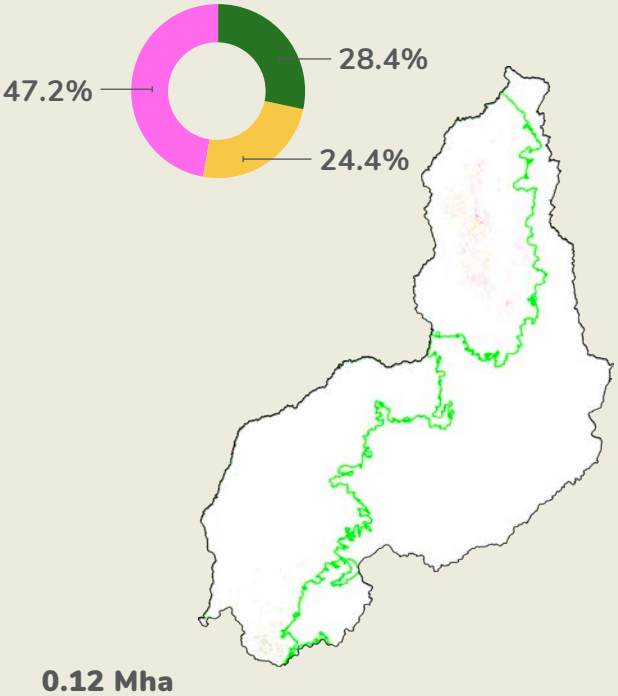
0.24 Mha

2018



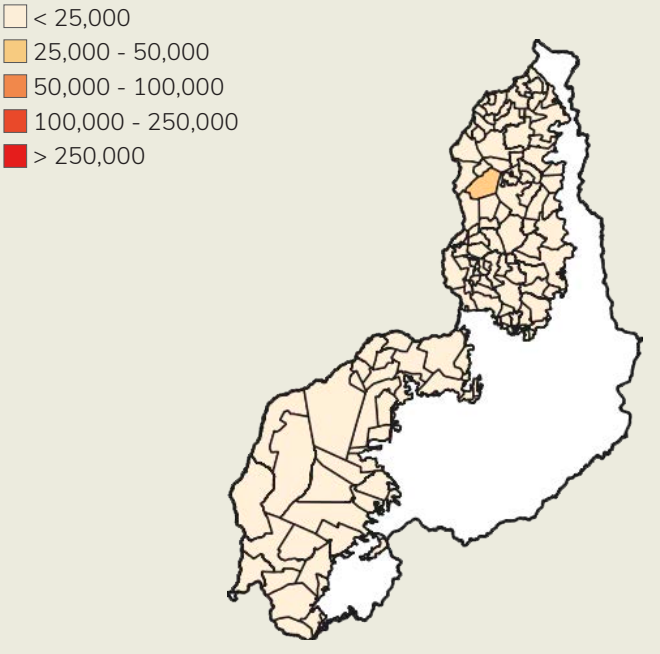
0.3 Mha

Abandoned or converted pastures



0.12 Mha

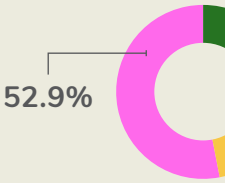
Pastures in the municipality

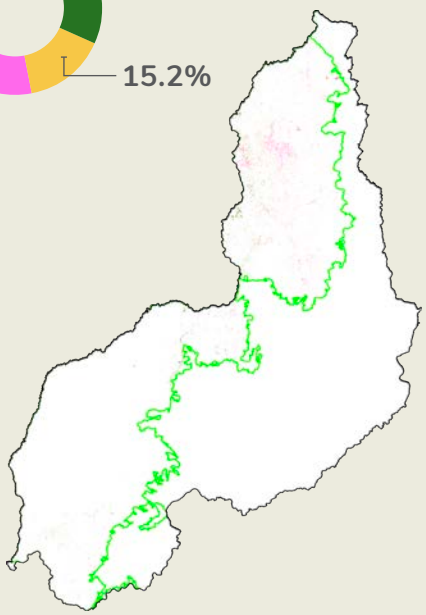


Source: LAPIG/MapBiomas

Severely degraded Moderately degraded Non-degraded

New pastures



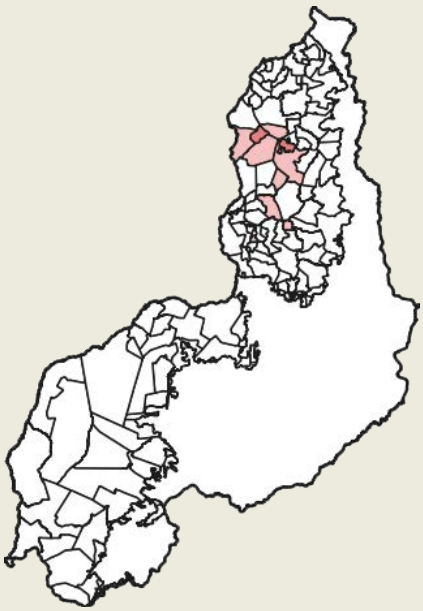


0.18 Mha

Percentage of area covered by pastures in the municipality

2018 (%)

< 10
10 - 20
20 - 40
40 - 60
> 60



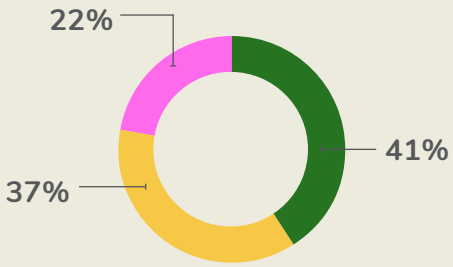
Dynamics of pastures' quality

Continued non-degraded (0.01 Mha)
Continued degraded (0.08 Mha)
Recovered pasture (0.02 Mha)
Pasture with signs of degradation (0.02 Mha)

Severely degraded Moderately degraded Non-degraded

Pastures with high agricultural suitability per quality class

2018 (%)

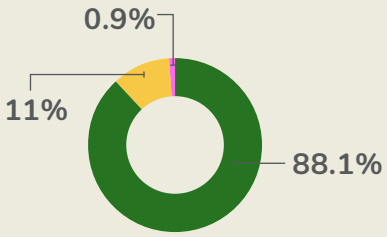


0.01 Mha

Quality of pastures in Paraná

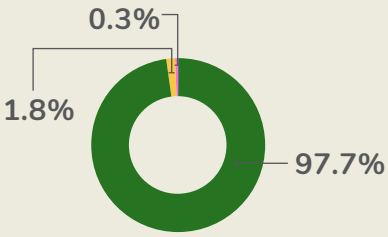
Severely degraded Moderately degraded Non-degraded

2010



0.03 Mha

2018

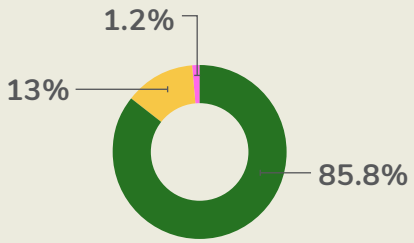


0.02 Mha

Source: LAPIG/MapBiomas

Severely degraded Moderately degraded Non-degraded

Abandoned or converted pastures



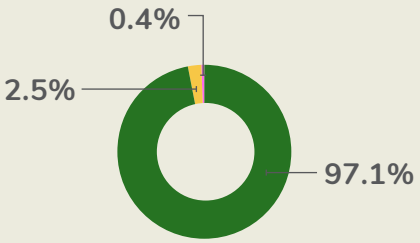
0.02 Mha

Pastures in the municipality

2018 (Mha)

- < 25,000
- 25,000 - 50,000
- 50,000 - 100,000
- 100,000 - 250,000
- > 250,000

New pastures



0.01 Mha

Percentage of area covered by pastures in the municipality

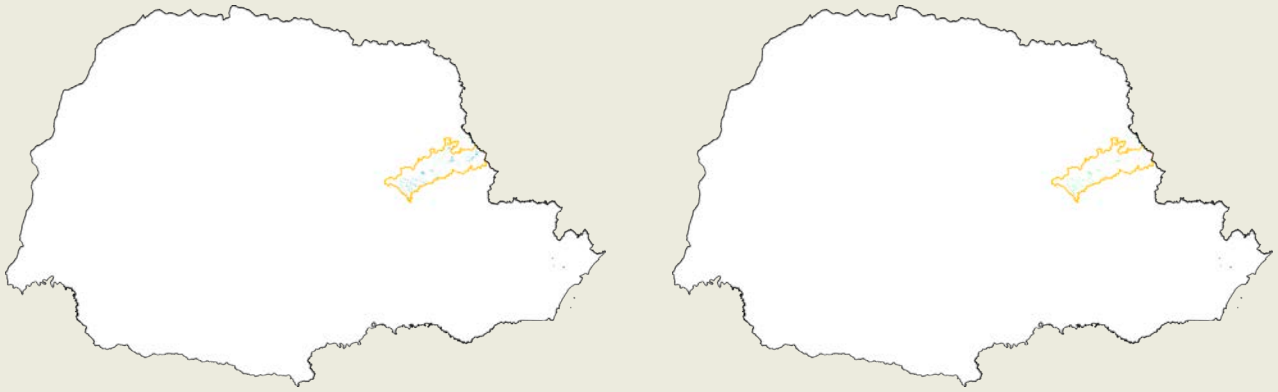
2018 (%)

- < 10
- 10 - 20
- 20 - 40
- 40 - 60
- > 60

Source: LAPIG/MapBiomas

Dynamics of pastures' quality

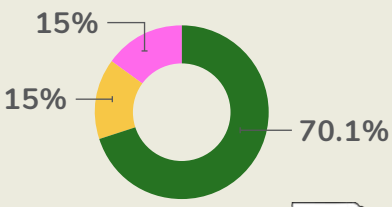
Continued non-degraded (0.01 Mha)
Continued degraded (>0.01 Mha)
Recovered pasture (>0.01 Mha)
Pasture with signs of degradation (>0.01 Mha)

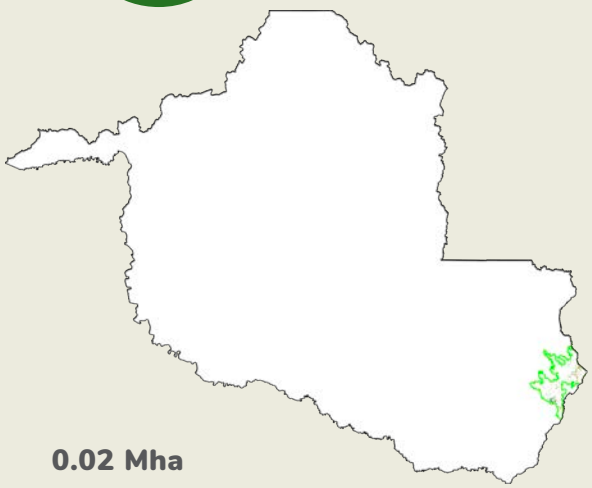


Quality of pastures in Rondônia

Severely degraded
Moderately degraded
Non-degraded

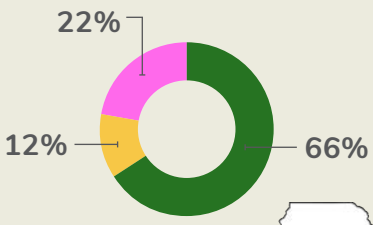
2010

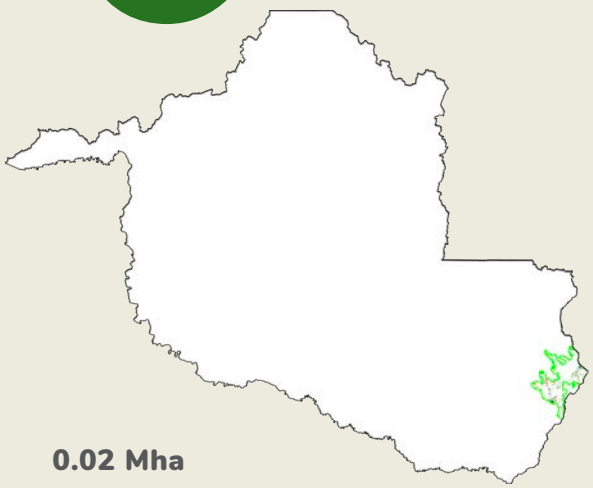




0.02 Mha

2018



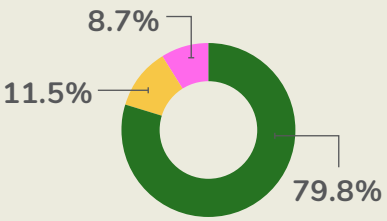


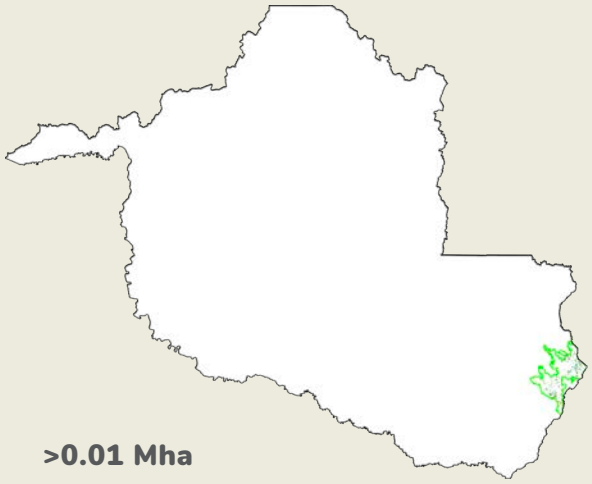
0.02 Mha

Source: LAPIG/MapBiomas

Severely degraded Moderately degraded Non-degraded

Abandoned or converted pastures



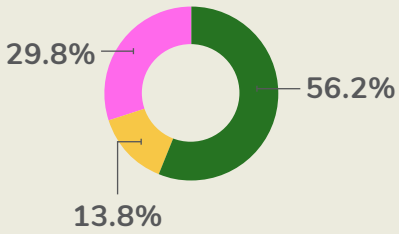


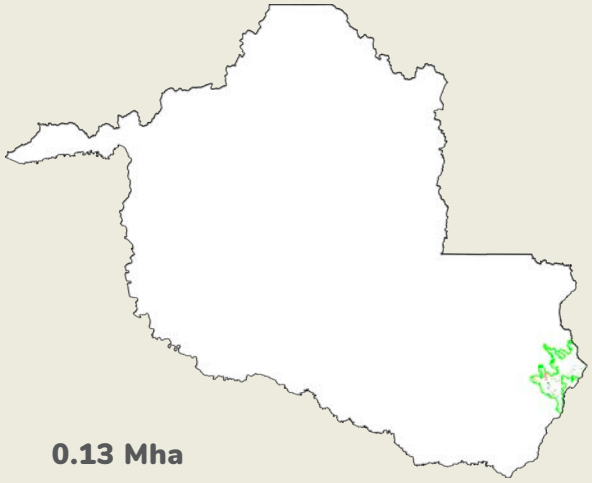
Pastures in the municipality

2018 (Mha)

- < 25,000
- 25,000 - 50,000
- 50,000 - 100,000
- 100,000 - 250,000
- > 250,000

New pastures





Percentage of area covered by pastures in the municipality

2018 (%)

- < 10
- 10 - 20
- 20 - 40
- 40 - 60
- > 60

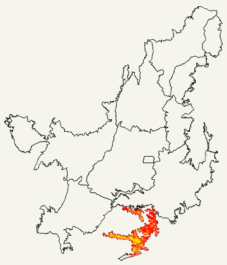
Source: LAPIG/MapBiomas

Dynamics of pastures' quality

Continued non-degraded (>0.01 Mha)
Continued degraded (>0.01 Mha)

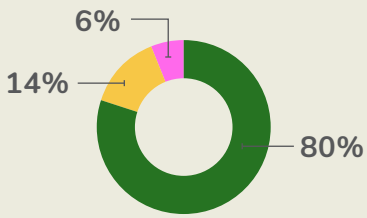
Continued non-degraded (>0.01 Mha)
Continued degraded (>0.01 Mha)

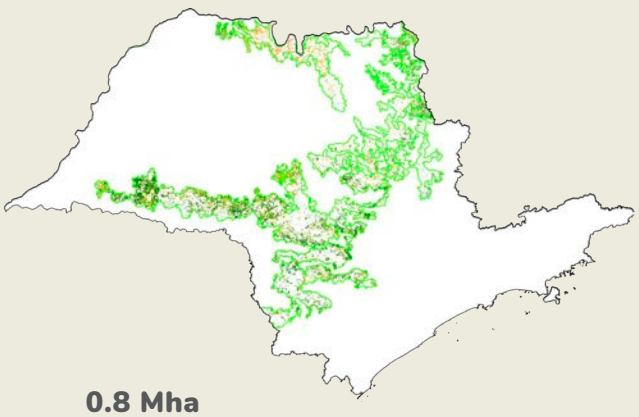
Quality of pastures in São Paulo



Severely degraded
Moderately degraded
Non-degraded

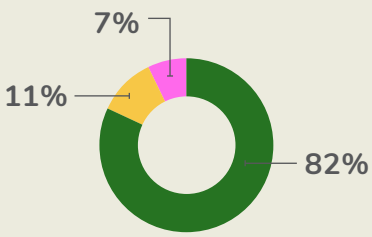
2010

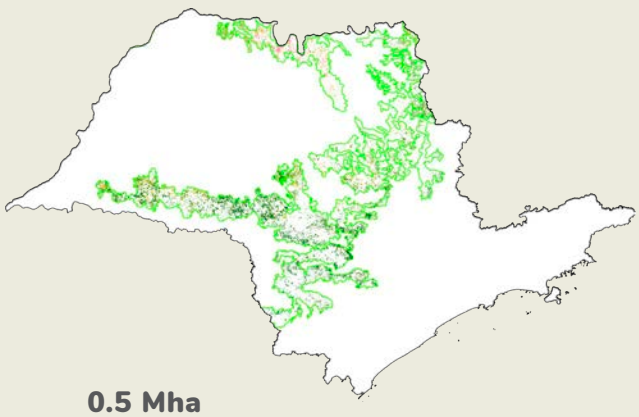




0.8 Mha

2018



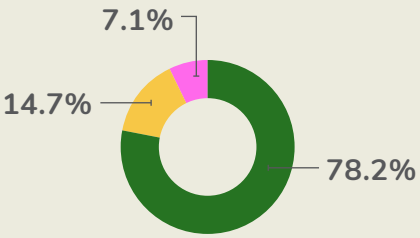


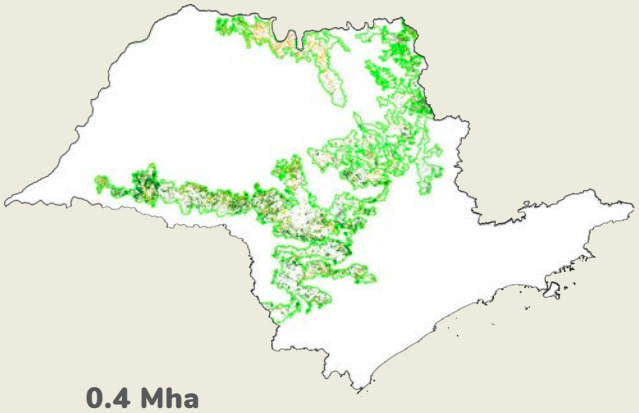
0.5 Mha

Source: LAPIG/MapBiomas

Severely degraded Moderately degraded Non-degraded

Abandoned or converted pastures





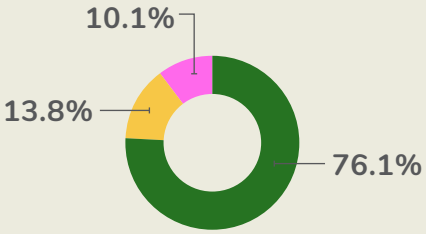
0.4 Mha

Pastures in the municipality

2018 (Mha)

- < 25,000
- 25,000 - 50,000
- 50,000 - 100,000
- 100,000 - 250,000
- > 250,000

New pastures

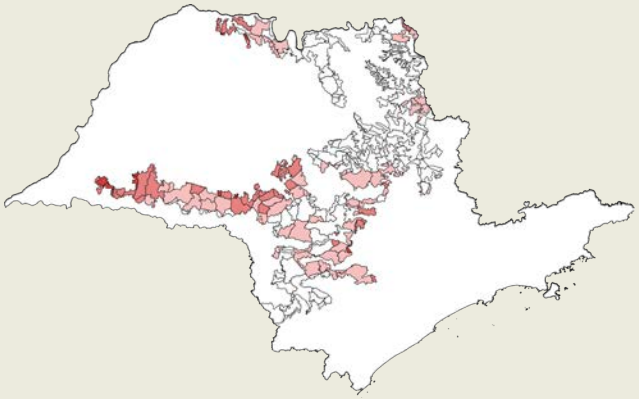


0.1 Mha

Percentage of area covered by pastures in the municipality

2018 (%)

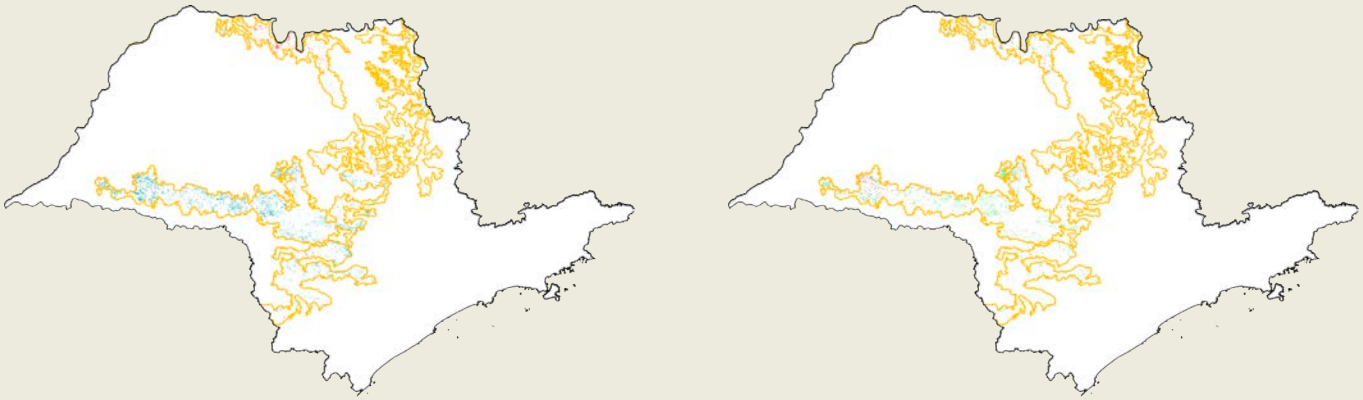
- < 10
- 10 - 20
- 20 - 40
- 40 - 60
- > 60



Source: LAPIG/MapBiomas

Dynamics of pastures' quality

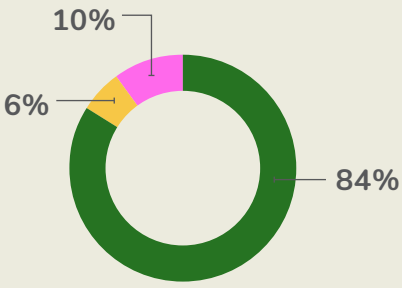
Continued non-degraded (0.3 Mha)
Continued degraded (0.03 Mha)
Recovered pasture (0.1 Mha)
Pasture with signs of degradation (0.7 Mha)

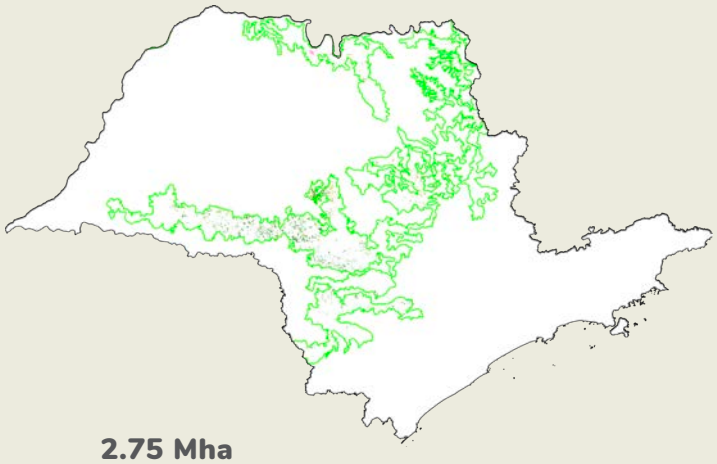


Severely degraded
Moderately degraded
Non-degraded

Pastures with high agricultural suitability per quality class

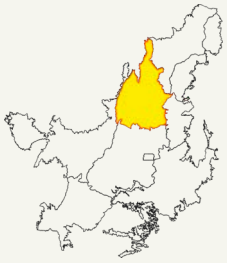
2018 (%)





2.75 Mha

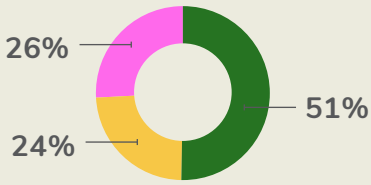
Source: LAPIG/MapBiomas

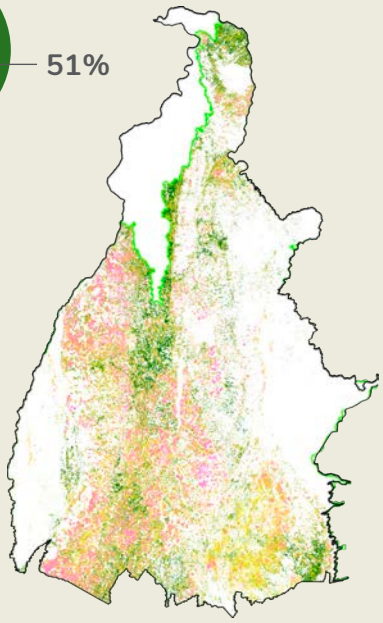


Quality of pastures in Tocantins

Severely degraded Moderately degraded Non-degraded

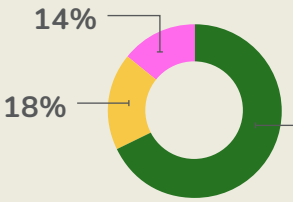
2010

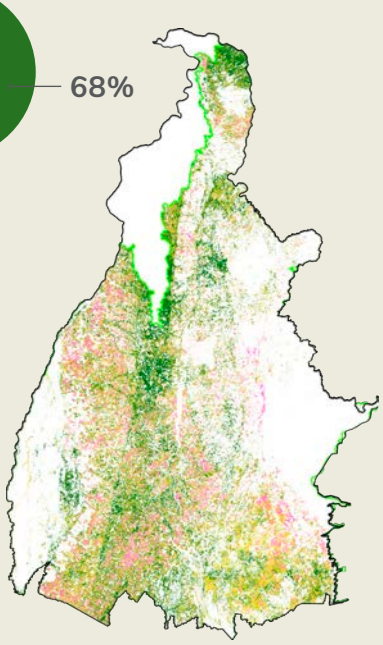




5 Mha

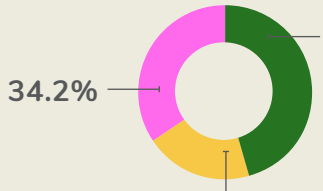
2018

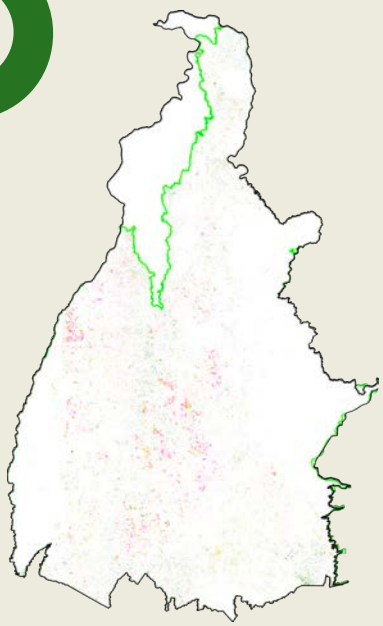




5.9 Mha

Abandoned or converted pastures



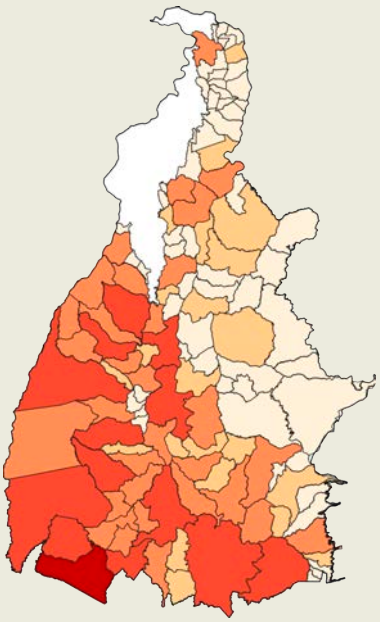


5 Mha

Pastures in the municipality

2018 (Mha)

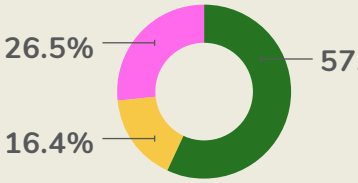
- < 25,000
- 25,000 - 50,000
- 50,000 - 100,000
- 100,000 - 250,000
- > 250,000

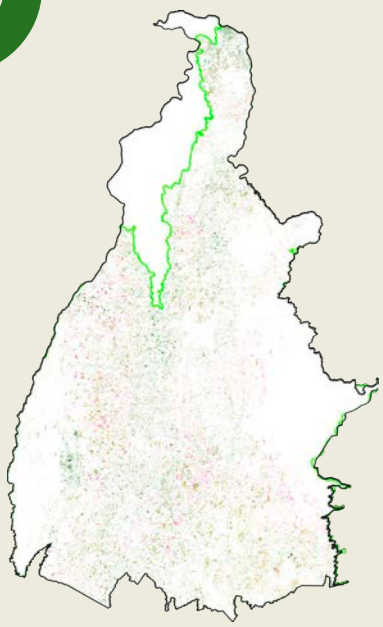


Source: LAPIG/MapBiomas

Severely degraded Moderately degraded Non-degraded

New pastures



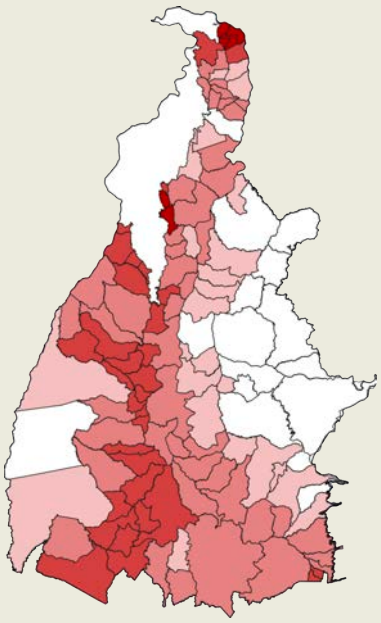


1.8 Mha

Percentage of area covered by pastures in the municipality

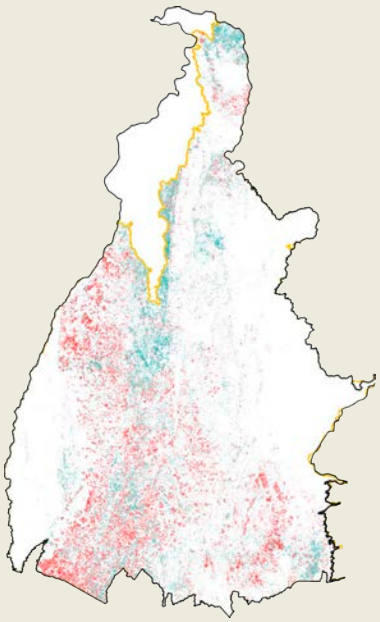
2018 (%)

< 10
10 - 20
20 - 40
40 - 60
> 60

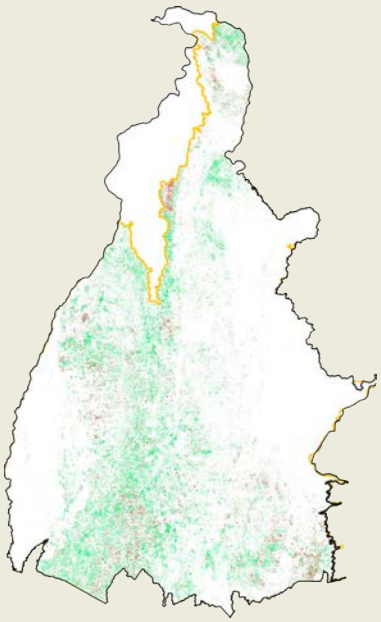


Dynamics of pastures' quality

Continued non-degraded (1.4 Mha)
Continued degraded (1.6 Mha)



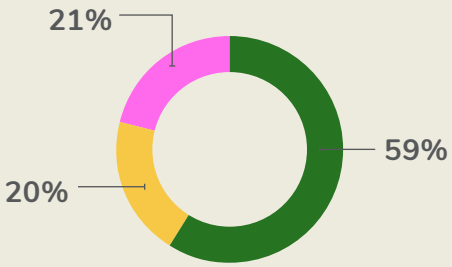
Recovered pasture (1.6 Mha)
Pasture with signs of degradation (0.7 Mha)

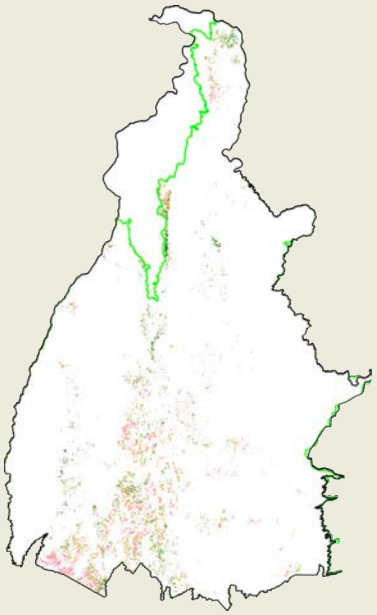


Severely degraded Moderately degraded Non-degraded

Pastures with high agricultural suitability per quality class

2018 (%)





2.75 Mha

Source: LAPIG/MapBiomas

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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.

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Cataloguing

Potential for soil carbon sequestration from the rehabilitation of degraded pastures in the Cerrado. Ciniro Costa Junior Piracicaba/SP Imaflora, 2020 57p..

1. Soil carbon 2. Degraded pasture 3. Cerrado 4. Carbon stock 5. Sampling methods

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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.