MATOPIBA

REGIONAL POTENTIAL FOR THE EXPANSION OF SOY IN MATOPIBA

Solidaridad

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REGIONAL POTENTIAL FOR THE EXPANSION OF SOY CROPS IN MATOPIBA

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SOLIDARIDAD BRAZIL

Regional Potential for the Expansion of Soy Crops in MATOPIBA: Solidaridad; São Paulo: 2021.

26p. : il. color ; 297x210cm.

1. Expansion of soy crops. 2. MATOPIBA. 3. Cerrado. 4. Payment for Environmental Services (PES). 5. Soy. 6. Pasture. 7. Financial mechanisms

INTRODUCTION

About Solidaridad Brazil

Solidaridad Brazil is an international not-for-profit organization that has developed socially inclusive, environmental responsible, and economically sound farming supply chains for more than ten years. We seek to speed up the transition to an inclusive, low-carbon production system, contributing to food and climate security in Brazil and worldwide. Today, we develop sustainability initiatives for cotton, cocoa, coffee, sugarcane, mate herb, orange, and soybean crops, as well as livestock farming. The Soy Program has been active in Brazil since 2010 and contributes to making the soy supply chain more sustainable in different biomes. Under our Soy Fast Track Program, we support 22 projects that span 2.1 million hectares of sustainable management in 1,014 properties owned by 939 producers.

Additionally, we've also worked on the landscapes of soy growing fields, focused on three areas. The first one, Changes to Business Practices, led to 493 landowners' adoption of continuous improvement systems. The second one, Landscape Governance, saw 848 landowners and employees be educated on forest law and restoration, and enabled multi-sectoral groups to be formed. The third one, Sustainability in the Field, resulted in 493 landowners trained and 698,731 hectares that now employ good farming practices. Since 2018, **Solidaridad Brazil's** Soy Program plans actions based on the territorial dynamics of main soy growing areas and invites private organizations to double down on low-carbon agriculture with efficient land use in the Cerrado, mainly in MATOPIBA.

PRESENT IN MORE THAN **40 COUNTRIES**, **SOLIDARIDAD** ALSO WORKS ON THE **SOY SUPPLY CHAIN** ON A REGIONAL AND GLOBAL LEVEL

VISION

Sectoral environmental governance

Understanding the potential of each of MATOPIBA's sub-region in the expansion of soy crops with more efficient land use is an important step towards sectoral environmental and production governance. The dynamics of the expansion of soy crops in the Cerrado has changed over the past 10 years. In MATOPIBA, there has been a trend to convert pastures and other crops into soy crops. However, there are areas where investments are still required to solidify this trend.

Brazil's Ministry of Agriculture, Livestock, and Supply (MAPA) estimates that by 2030 MATOPIBA will see an increase of 1.1 million hectares of crop lands, which points to the need of an integrated view of the region's capabilities and limitations so the production increase takes into account the conservation of the Cerrado biome through integrated territorial, agronomic, and economic planning.

To better understand the dynamics of soy crops in MATOPIBA, Solidaridad Brazil carried out this study to look into how land use change trends and the potential expansion of soy crops are distributed across MATOPIBA. Investigating local dynamics is necessary to expand the sectoral environmental governance in soy growing areas, contributing to a more efficient use of land and financial, political, and social resources.

As a result, 49 municipalities across MATOPIBA were looked into and ranked according to their potential for converting areas into soy. **These municipalities represent the areas where soy crops can be expanded more intensively over the next decades** due to the characteristics that were evaluated: availability of continuous pasture areas and/or a surplus of Legal Reserves that are suitable for soy crops, proximity of those areas to existing soy crops and storage infrastructure, a considerable average soy production growth rate over the past few years, and substantial native vegetation conversion rates in recent years. Of these municipalities, **the total suitable pasture area meets 67% of the soy crop expansion needs estimated for Matopiba by 2030**. These municipalities have been grouped together as expansion hubs in each state, which show the dynamics and potential regional expansion of soy crops through the conversion of pastures and surplus of Legal Reserves. This study breaks new ground by identifying the potential and different strategies required for each region to expand soy production and, at the same time, contributing to the conservation of the Cerrado.

Solidaridad Brasil understands that sustainable expansion and access to low-carbon agriculture in different territories require customized sectoral and public policies that can be set up together with local and sectoral institutions. Coordinating financial and non-financial investments is key to promote a change in decision-making when it comes to farming expansion and innovation, as well as the conservation of the Cerrado, concomitantly. With this study, Solidaridad expects to contribute to making territorial planning key to inclusive, low-carbon, sustainable rural development in the Cerrado.

Solidaridad Brazil

SOLIDARIDAD BRAZIL CONDUCTED A STUDY TO BETTER **UNDERSTAND TRENDS IN LAND USE CHANGES** FOCUSED ON HUB MUNICIPALITIES WHERE THERE'S MORE **POTENTIAL FOR THE EXPANSION OF SOY CROPS**

CONTENTS

1.

Territorial dynamics in the Cerrado and MATOPIBA

The Cerrado is the second largest biome in South America. Its geographical location and ecological characteristics make it a very important biome for the Brazilian society and agriculture. The area also has a huge water potential and it's home to the sources of rivers like Araguaia, Jequitinhonha, Tocantins, and Formoso. Forty-seven per cent of the Cerrado's area (95.8M ha) has been anthropized[1], of which 61M ha (67%) is taken up by pastures[2].

Considering how suitable it is for intensive and industrial agriculture, the Cerrado has been targeted for farming and industrial expansion. MATOPIBA, an area that covers parts of the states of Maranhão, Tocantins, Piauí, and Bahia, is one of Brazil's top soy producers. Thus, agriculture and conservation have become extremely relevant subjects.

[1] Source: Mapbiomas Col. 5, base year 2019 (2020); [2] Source: (Lapig, 2020)

CERRADO

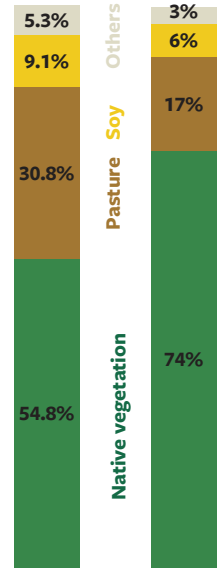
204M ha

ACCOUNTING FOR **22%** OF THE BRAZILIAN TERRITORY

66.6M ha

MATOPIBA ACCOUNTS FOR **33%** OF THE CERRADO

LAND USE/COVER

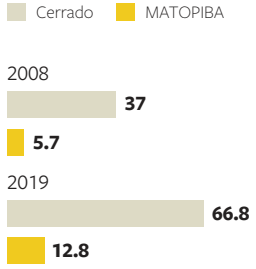


Source: Mapbiomas Col. 5, base year 2019 (2020)

ALMOST A THIRD OF THE EXPANSION OF SOY CROPS IN THE CERRADO TOOK PLACE IN **MATOPIBA**, AN AREA FORMED BY THE STATES OF MARANHÃO, TOCANTINS, PIAUÍ, AND BAHIA

SOY PRODUCTION

(millions of tons)

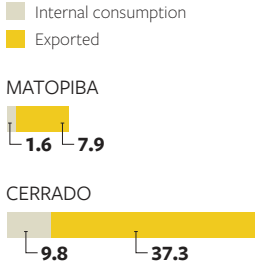


BETWEEN 2008 AND 2019, PRODUCTION JUMPED **80%** IN THE CERRADO AND **125%** IN MATOPIBA

Source: IBGE/PAM, 2020

TOTAL SOY VOLUME IN 2018

(millions of tons)

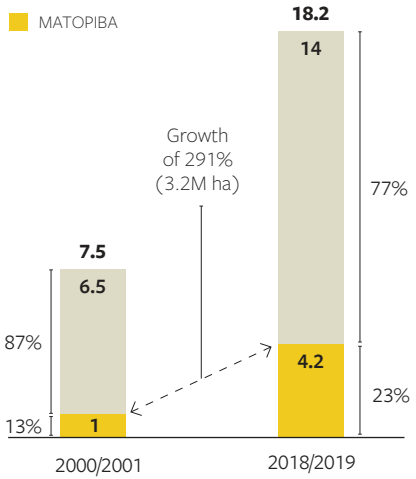


83% OF SOYS PRODUCED IN MATOPIBA IS EXPORTED

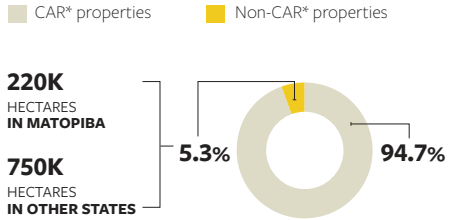
Source: Trase Platform

SOY PRODUCTION AREA AND MATOPIBA'S SHARE

(millions of hectares)



94.7% of the soy crops in the Cerrado are in CAR properties



* Cadastro Ambiental Rural/CAR (Rural Environmental Registry)

Source: Agrosatélite, 2020

2.

Dynamics of the expansion of soy crops in the Cerrado

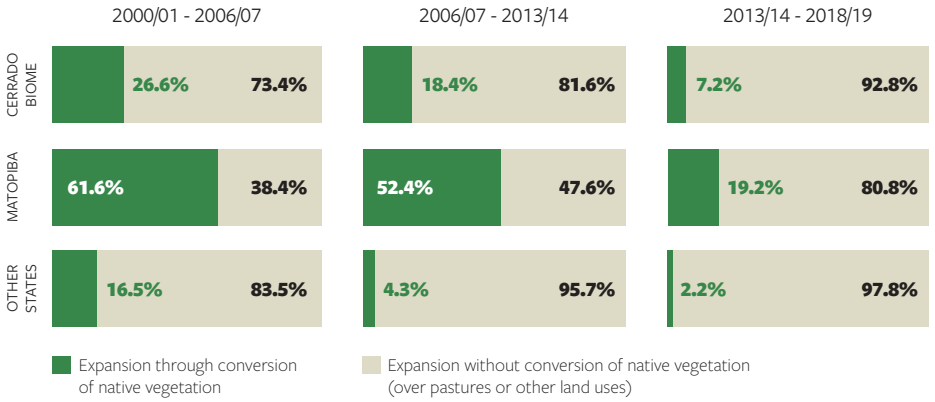
THE **EXPANSION OF SOY CROPS OVER NATIVE VEGETATION** DECREASED BETWEEN 2014 AND 2019

Among other aspects, the expansion and increase of soy production depends on high levels of technology and productivity, as well as a more intensive use of land and conversion of pastures, with farming practices like crop rotation or fallow land, in addition to the conversion of native vegetation.

Initiatives intended to sustainably intensify livestock farming activities in the Cerrado are extremely relevant and strategic to accommodate the agricultural expansion without harming the remaining native vegetation.

The consolidated agricultural frontiers have shown that this is an ongoing process with great potential to promote a livestock-soy transition, expanding agriculture over pasture areas.

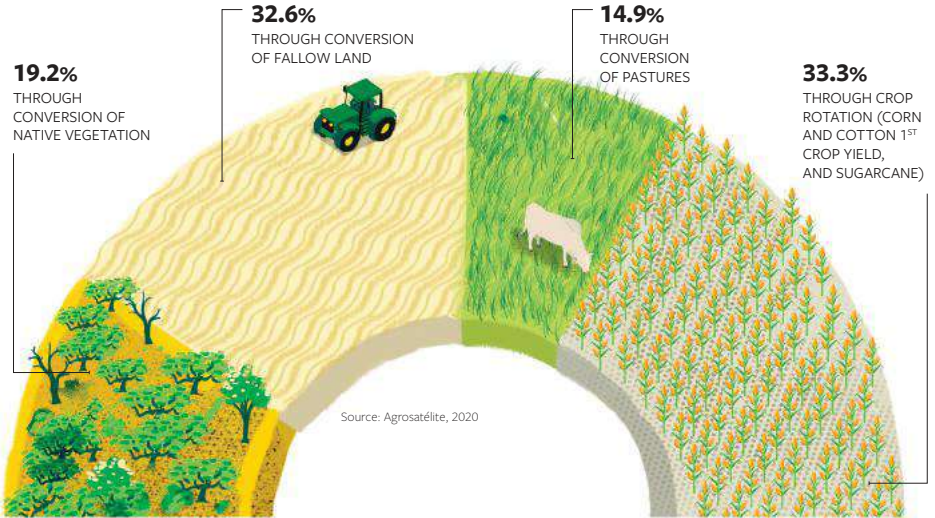
SOY EXPANSION TIMELINE



Source: Agrosatélite, 2020

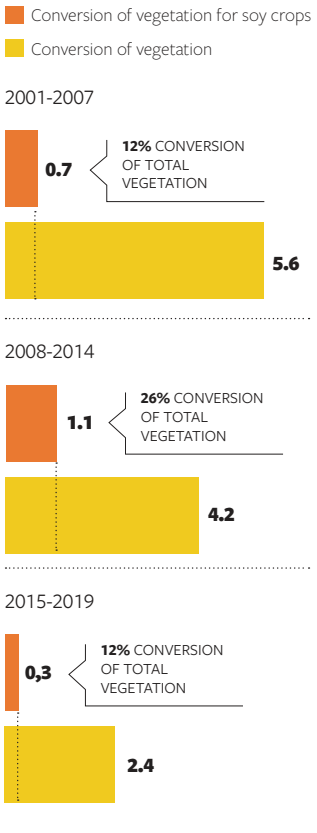
EXPANSION IN MATOPIBA

2013/14 to 2018/19



SOY'S SHARE IN THE CONVERSION OF NATIVE VEGETATION IN MATOPIBA

CONVERSION OF VEGETATION IN EACH PERIOD, IN MILLIONS OF HECTARES



Source: Produced by Solidaridad (2020) based on INPE/PRODES Amazônia (2020), and Agrosatélite (2020)

3.

Future scenarios for the expansion of soy crops

Soy is the crop whose production area will grow the most over the next decade, followed by 2nd harvest corn.

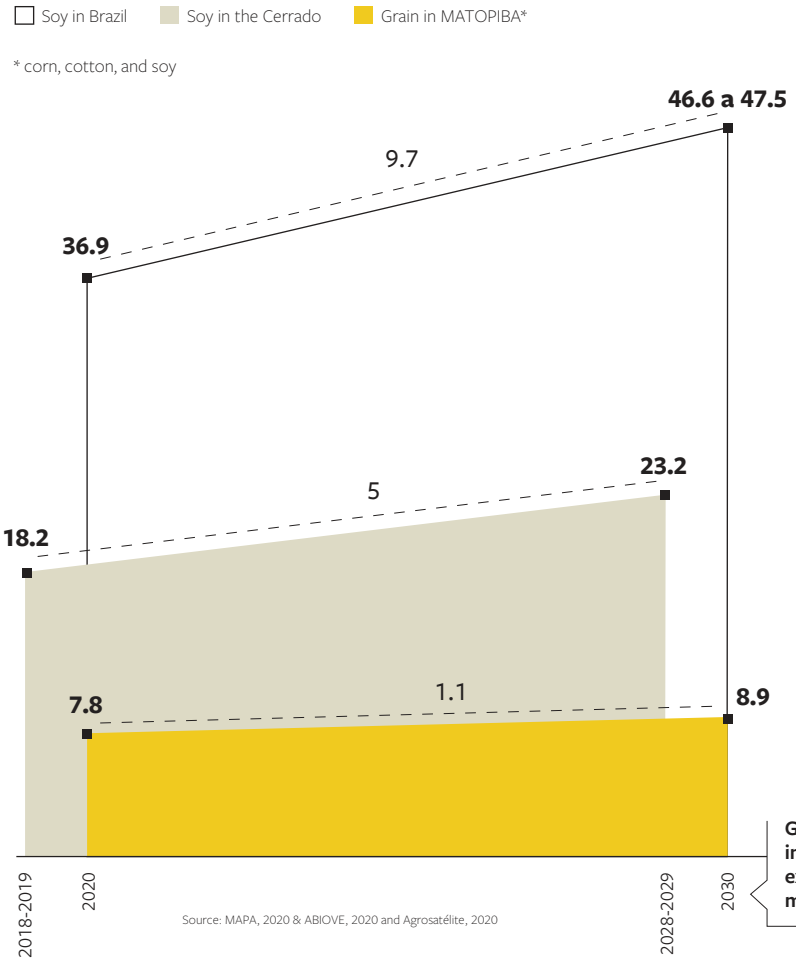
Implementing a soy expansion model that does not convert the Cerrado's native vegetation will require technological and financial incentives that promote the efficient use of pastures for livestock farming and the conversion of degraded or non-degraded pastures into farmlands. It will also require incentive mechanisms to protect the Cerrado's vegetation, such as the Payment for Environmental Services.

Soy productivity is considered a challenge over the next years. However, it can potentially have a "land sparing" effect if productivity can be boosted between 3.3 and 3.8 tons per hectare.

Source: Produced by Solidaridad Brasil based on Aiba, 2017; Conab, 2019; CESB, 2019

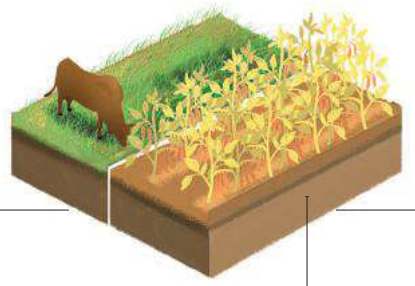
CROP EXPANSION PROJECTIONS

(millions of hectares)



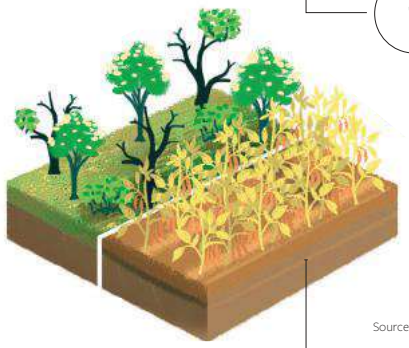
Source: MAPA, 2020 & ABIOVE, 2020 and Agrosatélite, 2020

Grain production in MATOPIBA is expected to hit 32.7 million tons by 2030.



THE AREA TAKEN UP BY SOY CROPS IN MATOPIBA IS EXPECTED TO GROW **1.1 MILLION HECTARES** BY 2030 (MAPA, 2020).

SOY EXPANSION MODELS

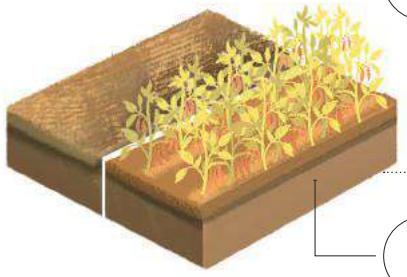


1 CONVERSION OF PASTURES INTO SOY CROPS

Different studies show that the area of pastures suitable for soy crops in the Cerrado could meet soy expansion needs for over three decades.

In Brazil, this expansion tends to take place especially over pasture areas.

Sources: Carneiro e Costa, 2017; Agrosatélite, 2020; MAPA, 2020



2 CONVERSION OF NATIVE VEGETATION INTO SOY CROPS

The expansion of soy crops where there's a surplus of vegetation areas in Legal Reserves, which may be legally suppressed.

3 CONVERSION OF FALLOW LAND

The expansion over crop areas that used to be fallow land is more substantial in MATOPIBA than in other states of the Cerrado.

Source: Agrosatélite, 2020

4.

Soy production areas in MATOPIBA

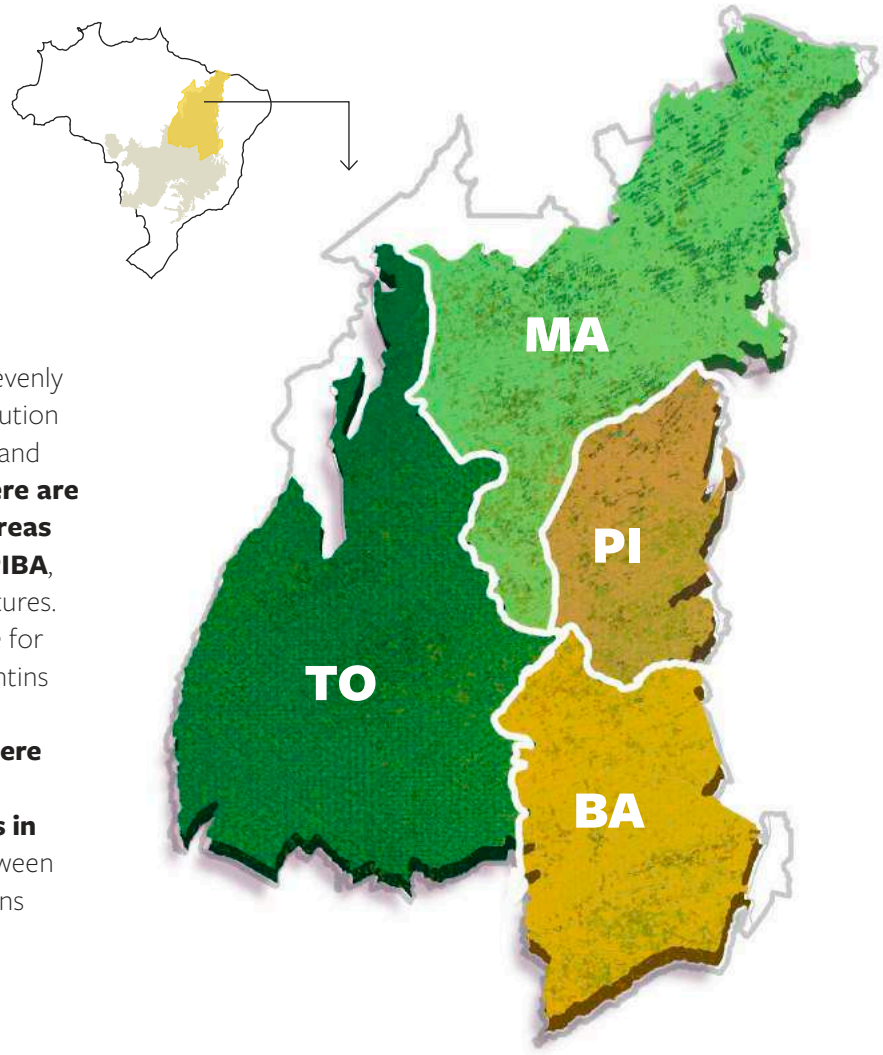
In view of these scenarios and considering MATOPIBA's potential to absorb the expansion of soy crops, **Solidaridad Brazil's** Soy Program saw an opportunity to **conduct a more in-depth investigation in soy growing regions across the MATOPIBA states**. The goal is to help develop and implement expansion models that boost land use efficiency, showing the potential positive carbon balance that can result from this. Boosting and making low-carbon practices recurring will require ongoing financial mechanisms, as well as economic incentives that recognize ecosystem services the Cerrado can offer.

The municipalities considered hubs can lead strategic actions according to their applicable territorial dynamics. To do that, a range of mechanisms can be jointly designed and implemented depending on each territory's characteristics. For instance, those with potential to intensify pastures and conversion to soy crops can make use of such mechanisms as expanding ABC credits for investment, or private Environmental Reserve Quota programs, such as the Payment for Environmental Services in areas with a surplus of Legal Reserves, in addition to ongoing investments in agronomic research to continually improve practices and productivity. The following topics will dig deeper into this regionalized analysis and shall contribute to future actions.

5.

Distribution of the potential for soy conversion in MATOPIBA

DATA REGARDING THE POTENTIAL FOR CONVERSION OF **PASTURES AND SURPLUS OF LEGAL RESERVES INTO SOY CROPS** IN THE STATES



The areas suitable for soy crops are not evenly distributed across MATOPIBA. Their distribution reflects the territorial differences between and within the states that form this region. **There are over 6.6 million hectares of pasture areas suitable for agriculture/soy in MATOPIBA**, 4 million (61%) of which are degraded pastures. However, 97% of the pasture areas suitable for soy crops are located in the states of Tocantins (54%) and Maranhão (43%), whereas the other 3% are in Bahia. At the same time, **there is an estimated 4.6-hectare surplus of Legal Reserves (SLR) suitable for crops in MATOPIBA**, distributed almost evenly between Maranhão (32%), Bahia (30%), and Tocantins (29%), with a smaller area (8%) in Piauí.

1 See **methodological note 1** on page 24; 2 See **methodological note 2** on page 24

PASTURE AREAS SUITABLE FOR AGRICULTURE/SOY 1

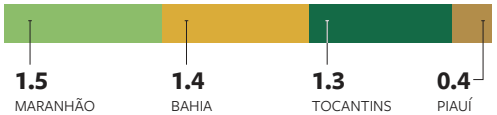
(millions of hectares)

6.6+ million
HECTARES

97% OF THE PASTURE AREAS SUITABLE FOR AGRICULTURE ARE LOCATED IN TOCANTINS AND MARANHÃO

SURPLUS OF LEGAL RESERVES (SLR) IN AREAS SUITABLE FOR AGRICULTURE/SOY 2

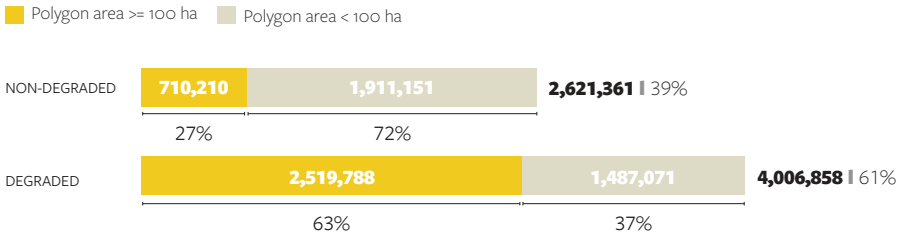
(millions of hectares)



4,6 million
HECTARES

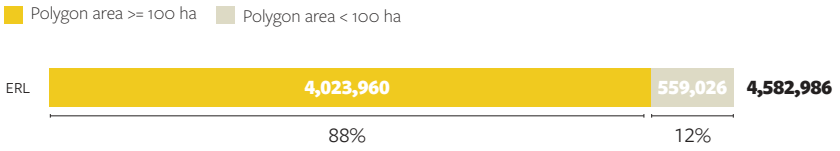
In addition to the distribution of areas suitable for soy crops across the region's states, this study considers other territorial and institutional characteristics of the soy complex, which expand the business dynamics for certain regions. One of these characteristics is the dispersion or concentration of suitable continuous areas (100 hectares or more), whose size is attractive for the expansion of soy crops.

PASTURES SUITABLE FOR SOY CROPS IN MATOPIBA [1]



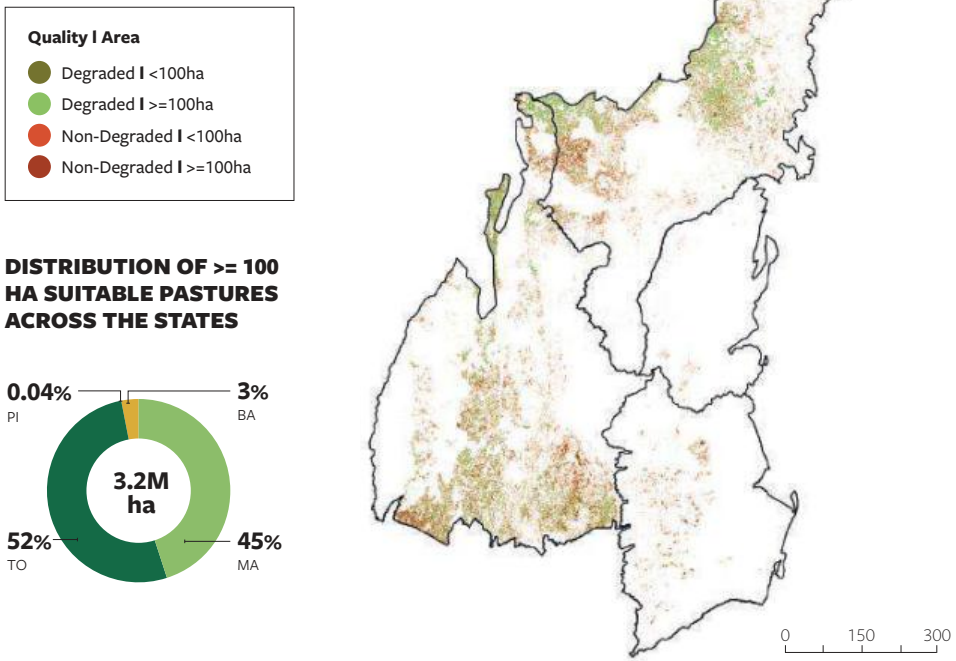
LARGE PASTURE AREAS AMOUNT TO **3.2 MILLION** HECTARES, OF WHICH **2.5 MILLION** HECTARES SHOW SOME DEGREE OF DEGRADATION

SURPLUS OF LEGAL RESERVES IN AREAS SUITABLE FOR SOY CROPS IN MATOPIBA [2]



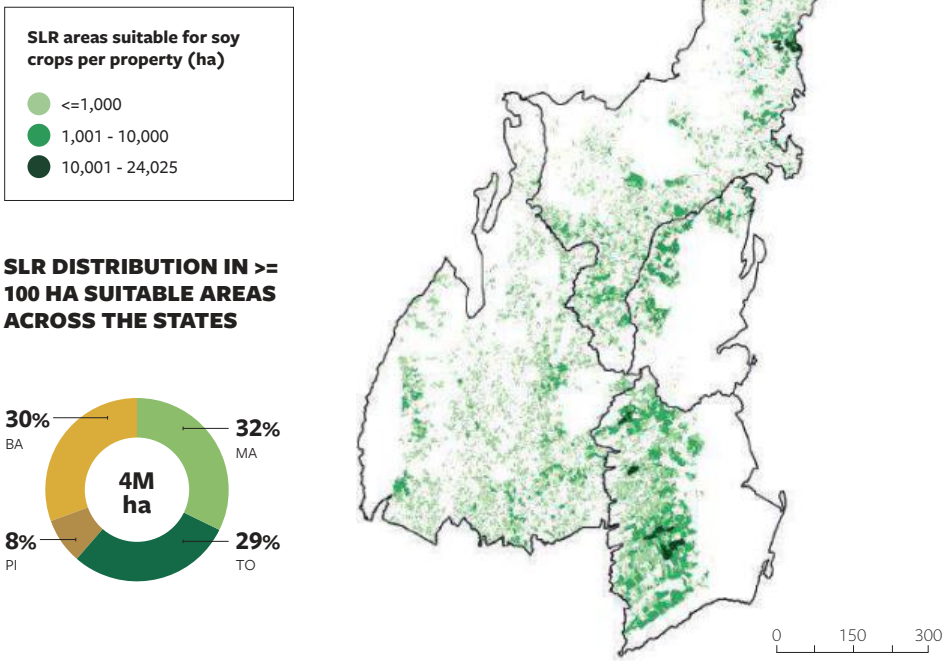
THE SLRS IN CONTINUOUS AREAS SUITABLE FOR AGRICULTURE AMOUNT TO **4 MILLION** HECTARES

PASTURES IN AREAS SUITABLE FOR SOY CROPS – PASTURE QUALITY AND AREA



DISTRIBUTION OF >= 100 HA SUITABLE PASTURES ACROSS THE STATES

PROPERTIES WITH SLR AREAS SUITABLE FOR SOY CROPS AND 100-HECTARE MINIMUM AREA



SLR DISTRIBUTION IN >= 100 HA SUITABLE AREAS ACROSS THE STATES

Produced by Solidaridad Brasil. [1] See **methodological note 1** on page 24; [2] See **methodological note 2** on page 24

6.

Identification of hub municipalities

METHODOLOGY TO IDENTIFY
HUB MUNICIPALITIES
IN THE DYNAMICS OF
THE EXPANSION OF SOY
CROPS IN MATOPIBA

In order to provide a regionalized perspective of territorial characteristics that determine the potential for the expansion of soy crops in each state of MATOPIBA, **Solidaridad Brazil**, under its Soy Program, adopted the Analytic Hierarchy Process [3] to identify hub municipalities for the dynamics of the expansion of soy crops in each state.

To consider the two most relevant models for the sustainable expansion of soy crops over pasture areas and native vegetation, two distinct analysis were performed:

A **Analysis of potential for conversion of pastures into soy crops (P-S)**

B **Analysis of potential for conversion of surplus of Legal Reserves (SLR) into soy crops (SLR-S)**

In this study, a set of criteria was selected to represent the potential for conversion looked into by each analysis, which show the potential and dynamics of the conversion into soy crops, in addition to the available infrastructure. There were two cut-off criteria to decide whether each municipality would be included or excluded: (i) the existence of a minimum 5,000-hectare area of soy crops, and (ii) the existence of a minimum 500-hectare pasture area suitable for soy crops (applying only the P-S analysis).

Each analysis (P-S and SLR-S) resulted in a 10-municipality **ranking** for each state in MATOPIBA. In other words, up to 10 municipalities were ranked in the P-S analysis and 10 in the SLR-S analysis. Therefore, up to 20 municipalities in each state have been identified.

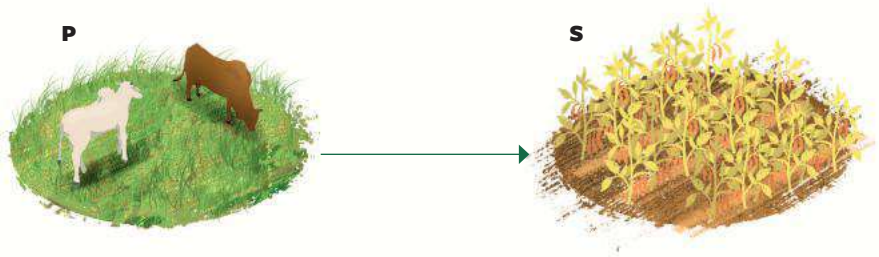
MUNICIPALITY RANKING

Each analysis ranked the municipalities according to their potential for conversion to soy crops (P-S or SLR-S), based on an index calculated from the values set by the criteria and pre-assigned weight for each criterion.

Step-by-step for ranking the municipalities [4]

[3] See **methodological note 3** on page 24; [4] See **methodological note 4** on page 24

A ANALYSIS OF POTENTIAL FOR CONVERTING PASTURES INTO SOY CROPS (P-S)

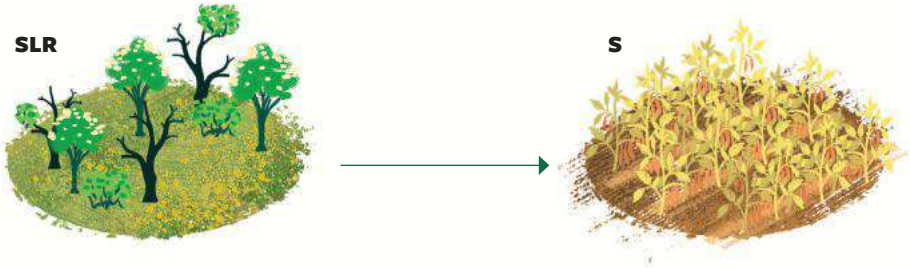


CRITERIA	WEIGHT
>= 5K ha soy crop area per municipality (Agrosatélite, 2018)	(cut-off criterion)
>= 500 ha suitable pasture area per municipality [1]	(cut-off criterion)
Average annual soy expansion rate between 2014 and 2018 (IBEGE/PAM, 2020)	●●○○○
Degraded pastures suitable for soy crops in >= 100 ha continuous areas [1]	●●●●○
Non-degraded pastures suitable for soy crops in >= 100 ha continuous areas [1]	●●●○○
Degraded pastures suitable for soy crops in >= 100 ha continuous areas and a 20km radius from soy crops and silos [1]	●●○○○
Non-degraded pastures suitable for soy crops in >= 100 ha continuous areas and a 20km radius between soy crops and silos1 [1]	●○○○○

RESULT

A ranking of up to 10 municipalities in each state according to their potential for converting pastures into soy crops.

B ANALYSIS OF POTENTIAL FOR CONVERTING SURPLUS VEGETATION OF LEGAL RESERVES INTO SOY CROPS (SLR-S)



CRITERIA	WEIGHT
>= 5K ha soy crop area per municipality (Agrosatélite, 2018)	(cut-off criterion)
Average annual soy expansion rate between 2014 and 2018 (IBGE/PAM, 2020)	●○○○○
Surplus of Legal Reserves in >= 100 ha continuous areas [2]	●●●○○
Surplus of Legal Reserves in >= 100 ha continuous areas and a 20km radius from soy crops and silos [2]	●●●●●
Expansion of soy crops through conversion of Cerrado in relation to the total expansion of soy crops between 2014 and 2017 (Agrosatélite, 2018)	●●○○○
Average annual Cerrado conversion rate between 2017 and 2019 (INPE/PRODES, 2020)	●○○○○

RESULT

A ranking of up to 10 municipalities in each state according to their potential for converting SLR into soy crops.

This methodology enabled the same municipality to be ranked in both P-S and SLR-S if their characteristics met the requirements for each expansion model. For the results, we split the ranked municipalities into three categories, according to their conversion potential:

P-S Municipalities

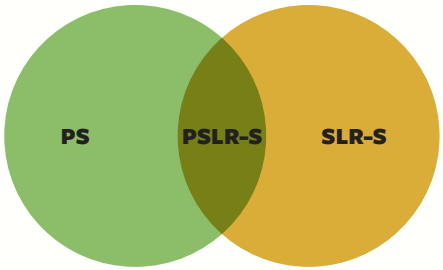
Municipalities ranked only through the analysis of potential for converting pastures into soy crops.

SLR-S Municipalities

Municipalities ranked only through the analysis of potential for converting surplus of Legal Reserves into soy crops.

PSLR-S Municipalities

Municipalities ranked through the analysis of potential for converting pastures into soy crops and surplus of Legal Reserves into soy crops.



[1] See **methodological note 1** on page 24; [2] See **methodological note 2** on page 24

7.

Hub municipalities for the expansion of soy crops

THE SELECTED MUNICIPALITIES SHOW **KEY REGIONS** FOR THE EXPANSION OF SOY CROPS

As a result of the analyses of potential for conversion (P-S analysis and SLR-S analysis), we have identified 13 municipalities in Maranhão, 17 in Tocantins, 10 in Piauí, and 9 in Bahia, for a total of 49 municipalities across MATOPIBA. **These municipalities show the areas of each state where the expansion of soy crops probably will be more intensive over the next decade**. They have been selected for featuring such characteristics as: availability of continuous areas of suitable pastures and/or SLRs suitable for soy crops, proximity of those areas to storage infrastructure, a considerable soy crop area growth rate, and substantial native vegetation conversion rates in recent years, for both soy crops and other land uses (in the case of municipalities ranked through the SLR-S analysis).

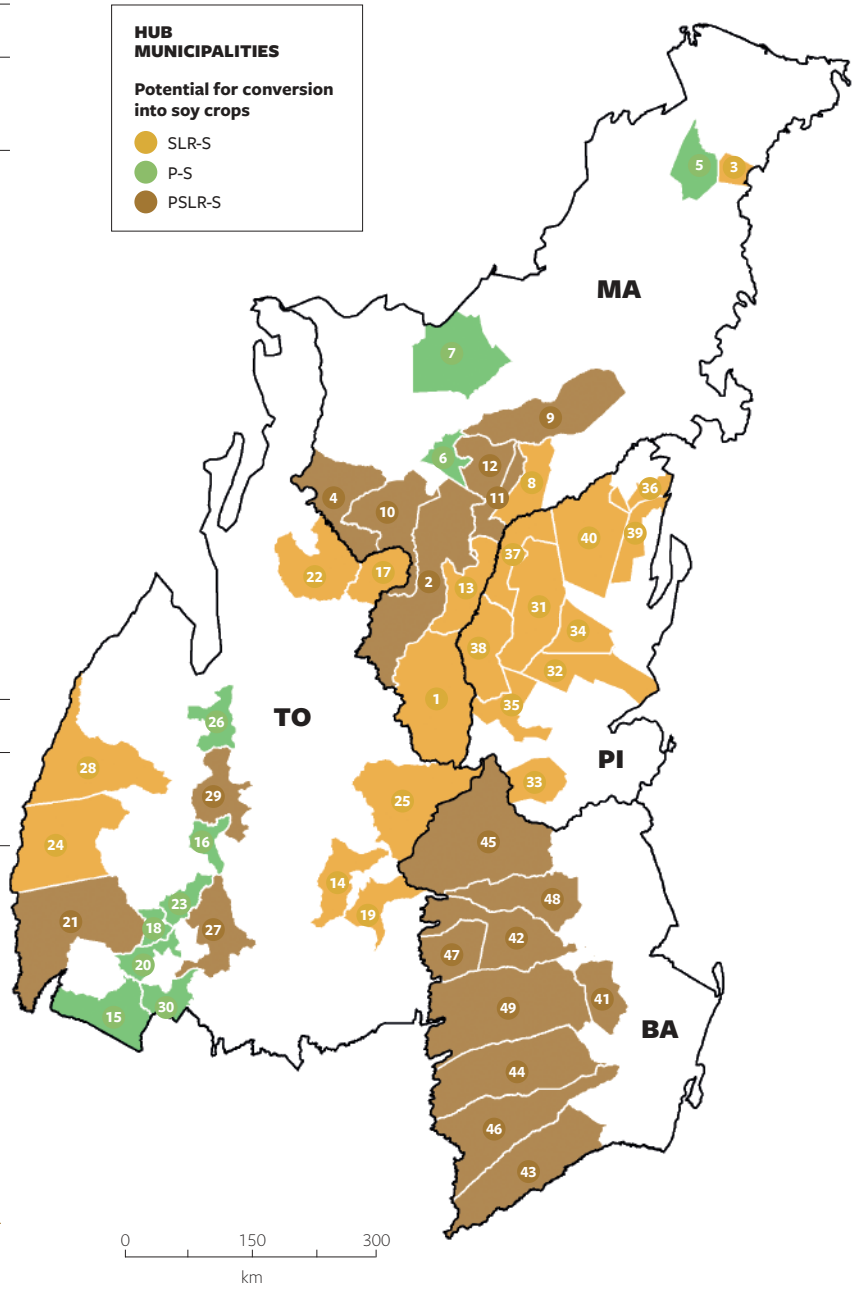
MARANHÃO | MA

Potential for converting pastures

RANKING	MUNICIPALITIES
1st	7 GRAJAÚ
2nd	2 BALSAS
3rd	4 CAROLINA
4th	10 RIACHÃO
5th	11 SAMBAÍBA
6th	9 MIRADOR
7th	12 SÃO RAIMUNDO DAS MANGABEIRAS
8th	6 FORTALEZA DOS NOGUEIRAS
9th	5 CHAPADINHA

Potential for converting SLR

RANKING	MUNICIPALITIES
1st	2 BALSAS
2nd	1 ALTO PARNAÍBA
3rd	10 RIACHÃO
4th	4 CAROLINA
5th	13 TASSO FRAGOSO
6th	8 LORETO
7th	12 SÃO RAIMUNDO DAS MANGABEIRAS
8th	11 SAMBAÍBA
9th	9 MIRADOR
10th	3 BURITI



PIAUÍ | PI

Potential for converting pastures

No municipalities were selected for failure to meet the cut-off criteria

Potential for converting SLR

RANKING	MUNICIPALITIES
1st	38 SANTA FILOMENA
2nd	37 RIBEIRO GONÇALVES
3rd	31 BAIXA GRANDE DO RIBEIRO
4th	40 URUÇUÍ
5th	39 SEBASTIÃO LEAL
6th	35 GILBUÉS
7th	36 LANDRI SALES
8th	34 CURRAIS
9th	32 BOM JESUS
10th	33 CORRENTE

TOCANTINS | TO

Potential for converting pastures

RANKING	MUNICIPALITIES
1st	15 ARAGUAÇU
2nd	27 PEIXE
3rd	23 GURUPI
4th	20 FIGUEIRÓPOLIS
5th	30 TALISMÃ
6th	29 PORTO NACIONAL
7th	18 CARIRI DO TOCANTINS
8th	16 BREJINHO DE NAZARÉ
9th	26 MIRACEMA DO TOCANTINS
10th	21 FORMOSO DO ARAGUAIA

Potential for converting SLR

RANKING	MUNICIPALITIES
1st	28 PIUM
2nd	24 LAGOA DA CONFUSÃO
3rd	19 DIANÓPOLIS
4th	14 ALMAS
5th	22 GOIATINS
6th	17 CAMPOS LINDOS
7th	21 FORMOSO DO ARAGUAIA
8th	27 PEIXE
9th	25 MATEIROS
10th	29 PORTO NACIONAL

BAHIA | BA

Potential for converting pastures

RANKING	MUNICIPALITIES
1st	49 SÃO DESIDÉRIO
2nd	44 CORRENTINA
3rd	48 RIACHÃO DAS NEVES
4th	42 BARREIRAS
5th	47 LUÍS EDUARDO MAGALHÃES
6th	46 JABORANDI
7th	45 FORMOSA DO RIO PRETO
8th	41 BAIANÓPOLIS
9th	43 COCOS

Potential for converting SLR

RANKING	MUNICIPALITIES
1st	49 SÃO DESIDÉRIO
2nd	45 FORMOSA DO RIO PRETO
3rd	44 CORRENTINA
4th	42 BARREIRAS
5th	46 JABORANDI
6th	47 LUÍS EDUARDO MAGALHÃES
7th	48 RIACHÃO DAS NEVES
8th	41 BAIANÓPOLIS
9th	43 COCOS

8.

The role of hub municipalities in the expansion of soy crops in MATOPIBA

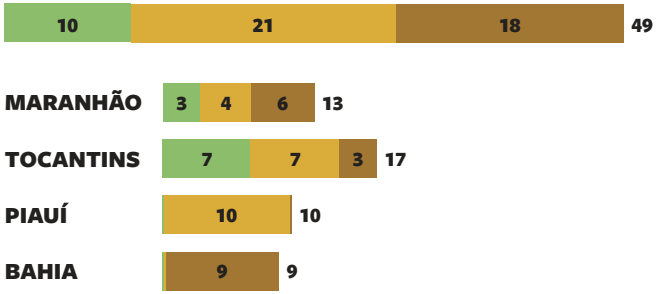
HUB MUNICIPALITIES' POTENTIAL TO ABSORB THE EXPANSION OF SOY CROPS

It is necessary to consider alternatives for the expansion of soy crops, but also to preserve the Cerrado biome. The axis municipalities concentrate 23% of the suitable pastures and 60% of the suitable ERL in continuous areas considering the total area of MATOPIBA. These municipalities can absorb 67% of the 1.1 million hectares grain production expected for MATOPIBA by 2030, only in suitable pasture areas larger than 100 hectares.

In those municipalities, there is also a great opportunity to direct resources to Cerrado conservation mechanisms.

Potential for converting pastures into soy crops (P-S)
Potential for converting SLR into soy crops (SLR-S)
Potential for converting pastures and SLR into soy crops (PSLR-S)

49 MUNICIPALITIES IDENTIFIED IN MATOPIBA



Source: MAPA, 2020

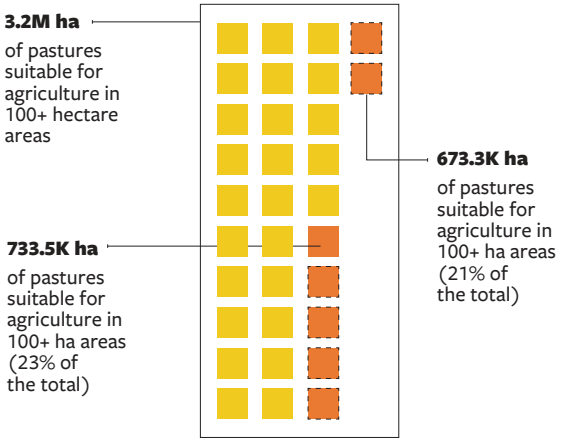
PASTURES SUITABLE FOR SOY CROPS IN MATOPIBA

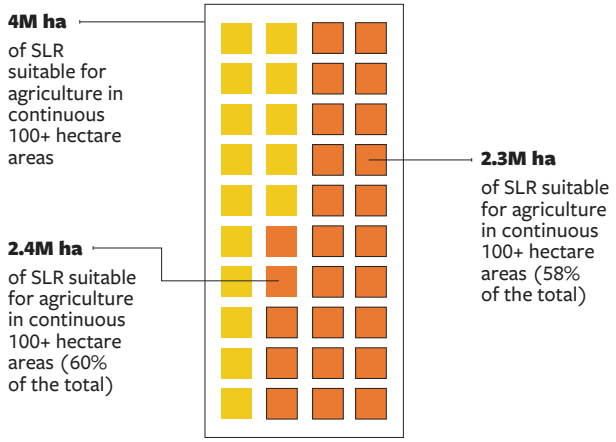
The existing suitable pasture areas with 100+ hectares in the 49 municipalities identified in MATOPIBA would be enough to meet 67% of the demand for grain production expansion expected for MATOPIBA by 2030. If only degraded pastures are considered (and the other conditions), 40% of the projected expansion would be absorbed.

SURPLUS OF LEGAL RESERVES IN AREAS SUITABLE FOR SOY CROPS

Sixty per cent (2.4 mi ha) of the total existing SLRs in areas suitable for soy crops with 100+ hectares in MATOPIBA are concentrated in 49 municipalities. The municipalities identified as SLR-S e PSLR-S provide a great opportunity to channel resources into direct mechanisms for the conservation of the Cerrado and to boost agricultural production.

MATOPIBA
49 municipalities identified in MATOPIBA
28 municipalities with potential for converting pastures into soy crops (10 P-S and 18 PSLR-S)
39 municipalities with surplus of Legal Reserves in areas suitable for soy crops (21 SLR-S and 18 PSLR-S)





HUB MUNICIPALITIES' POTENTIAL FOR ABSORBING THE EXPANSION OF SOY CROPS IN MATOPIBA BY 2030

Projected expansion of soy crops that can be absorbed by >=100 ha suitable pastures in the hub municipalities
Projected expansion of soy crops that cannot be absorbed by >=100 ha suitable pastures in the hub municipalities

MARANHÃO

13 MUNICIPALITIES IDENTIFIED

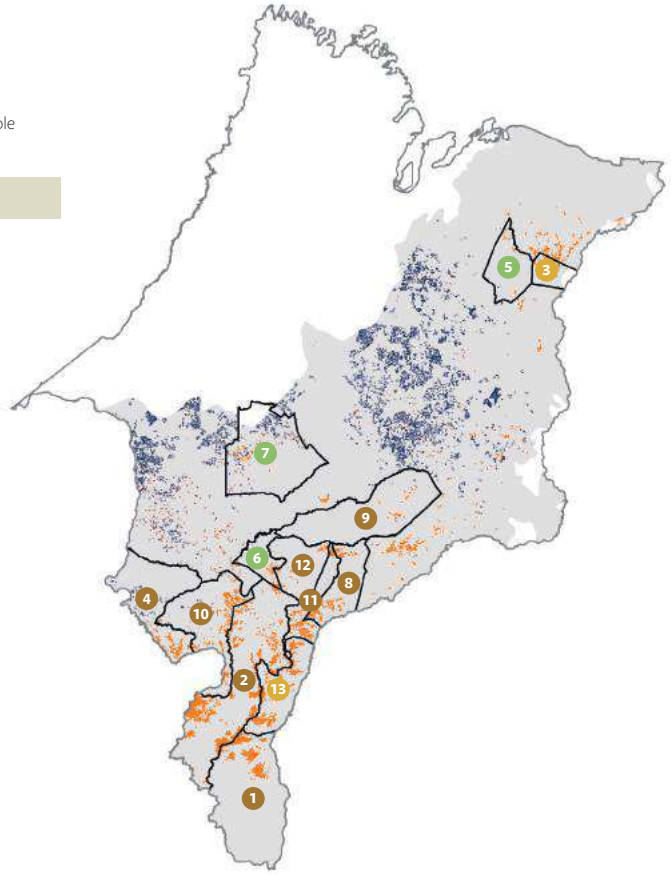
3	4	6

Most hub municipalities are located near Balsas, one of the state's production and infrastructure centers.

HUB MUNICIPALITIES' POTENTIAL FOR ABSORBING THE EXPANSION OF SOY CROPS IN MATOPIBA BY 2030

- Projected expansion of soy crops that can be absorbed by >=100 ha suitable pastures in the hub municipalities
- Projected expansion of soy crops that cannot be absorbed by >=100 ha suitable pastures in the hub municipalities

10%	90%



- Soy (2017)*
- Matopiba - Cerrado biome
- Ranked municipalities
- State border

>=100 ha suitable pasture (1)

- Non-degraded
- Degraded

Potential for conversion into soy crops (page.15)

- SLR-S
- P-S
- PSLR-S

0 125 250
km

*Source: Agrosatélite, 2017 (1) See **methodological note 1** on page 24

TOCANTINS

17 MUNICIPALITIES IDENTIFIED

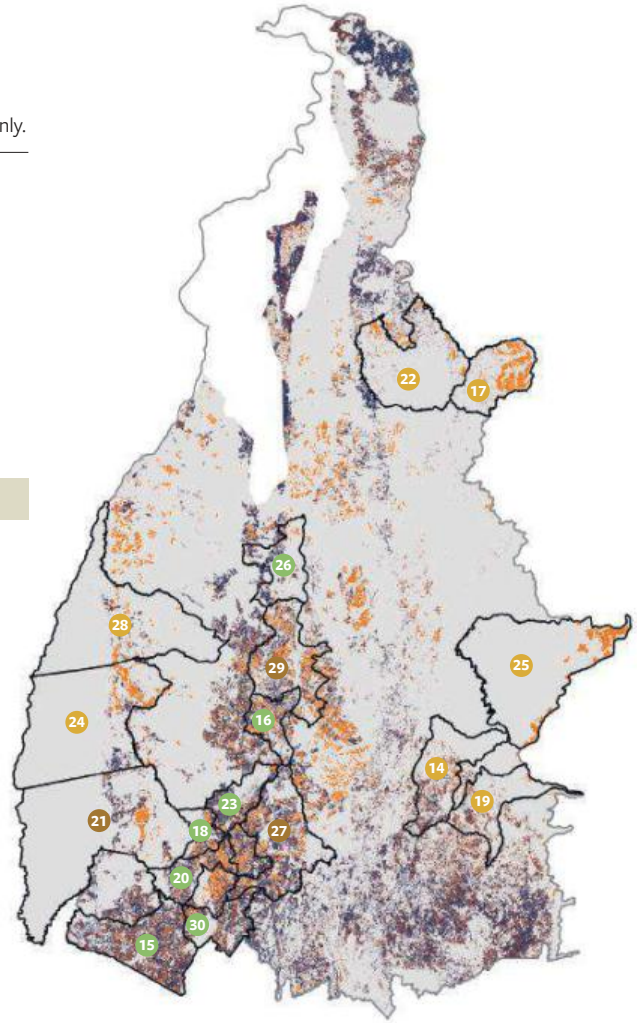
7	7	3

The municipalities with potential for converting SLRs are grouped under three cores: i) Southwest, with the most potential for P-S and part of the potential for SLR-S; ii) East, close to the border with Bahia; and iii) North, close to the border with Maranhão. Cores ii and iii are composed of municipalities with potential for SLR-S only.

HUB MUNICIPALITIES' POTENTIAL FOR ABSORBING THE EXPANSION OF SOY CROPS IN MATOPIBA BY 2030

- Projected expansion of soy crops that can be absorbed by >=100 ha suitable pastures in the hub municipalities
- Projected expansion of soy crops that cannot be absorbed by >=100 ha suitable pastures in the hub municipalities

49%	51%



- Soy (2017)*
- Matopiba - Cerrado biome
- Ranked municipalities
- State border

>=100 ha suitable pasture (1)

- Non-degraded
- Degraded

Potential for conversion into soy crops (page.15)

- SLR-S
- P-S
- PSLR-S

0 90 180
km

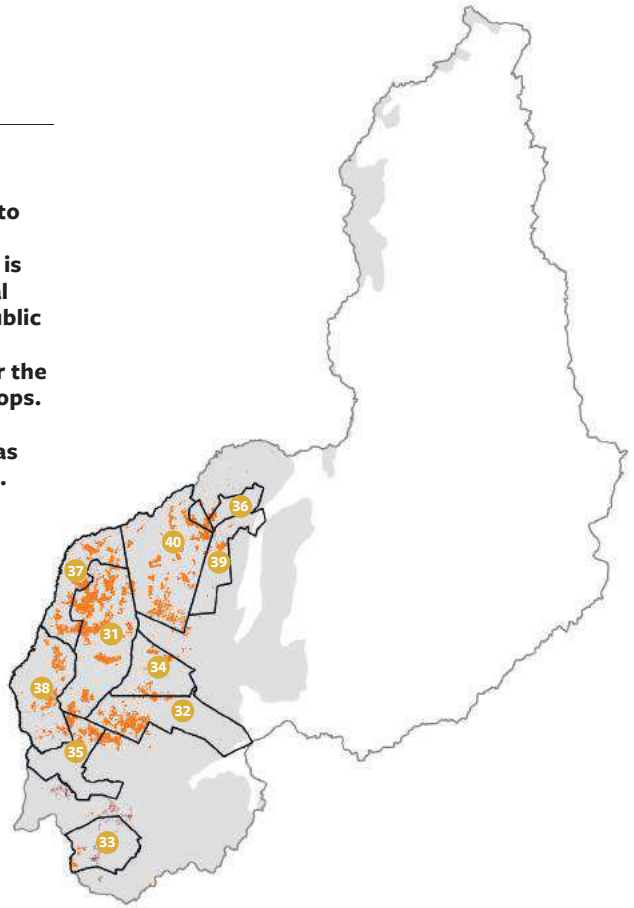
PIAUÍ

10 MUNICIPALITIES IDENTIFIED

10

The municipalities identified are located close to the border with the state of Maranhão, near to the municipalities with potential for converting SLR-S in that state.. All 10 municipalities have only shown potential for expansion over SLR, since no municipality met the criterion of having at least 500 ha of pasture areas suitable for soy crops.

The trend in Piauí shows that expanding the soy production area in the state is conditioned to converting native vegetation of surplus Legal Reserves. Thus, it is important to evaluate additional mechanisms for sectoral and public policies in the state of Piauí in connection with alternatives for the sustainable expansion of soy crops. This trend should be taken into account, as converting new areas of Cerrado should be prevented.



- Soy (2017)*
- Matopiba - Cerrado biome
- Ranked municipalities
- State border

>=100 ha suitable pasture 1

- Non-degraded
- Degraded

Potential for conversion into soy crops (page.15)

- SLR-S
- P-S
- PSLR-S

0 100 200
km

*Source: Agrosatélite, 2017 1 See **methodological note 1** on page 24

BAHIA

9 MUNICIPALITIES IDENTIFIED

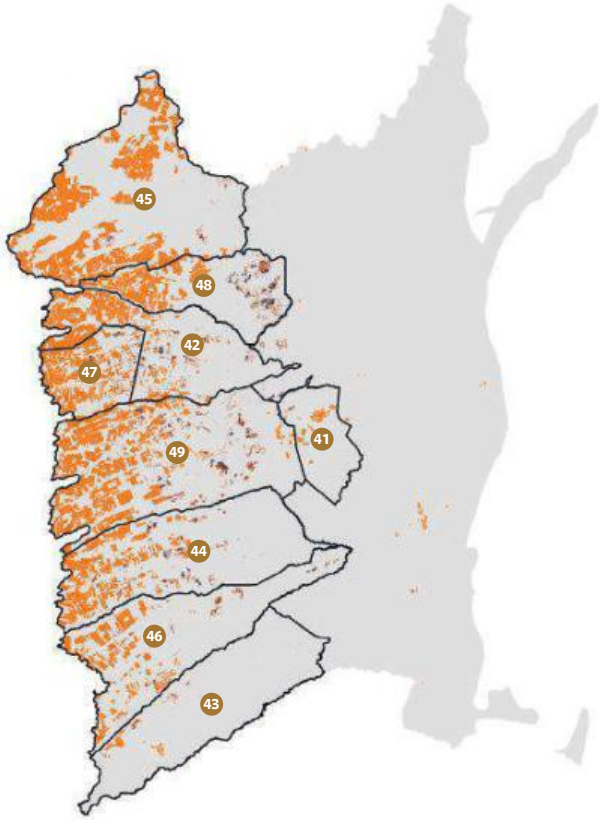
9

The selected municipalities are located in the West end of the state, MATOPIBA's main soy producing region, and have potential for converting pastures and SLR into soy crops.

HUB MUNICIPALITIES' POTENTIAL FOR ABSORBING THE EXPANSION OF SOY CROPS IN MATOPIBA BY 2030

- Projected expansion of soy crops that can be absorbed by >=100 ha suitable pastures in the hub municipalities
- Projected expansion of soy crops that cannot be absorbed by >=100 ha suitable pastures in the hub municipalities

8% **92%**



- Soy (2017)*
- Matopiba - Cerrado biome
- Ranked municipalities
- State border

>=100 ha suitable pasture 1

- Non-degraded
- Degraded

Potential for conversion into soy crops (page.15)

- SLR-S
- P-S
- PSLR-S

0 70 140
km

SUMMARY OF HUB MUNICIPALITIES

	MARANHÃO	TOCANTINS	PIAUÍ	BAHIA
Hub municipalities	3 4 6 13	7 7 3 17	10 10	9 9
Soy area (2017) (Agrosatélite, 2018)	636.6K ha	444K ha	614.4K ha	1.6M ha
Average annual soy area growth rate (2014-2018) (IBGE/PAM, 2020)	32.9K ha	22.97K ha	26.6K ha	83.5K ha
Pastures suitable for soy crops in continuous area (>=100 ha) [1]	111.96K ha	535.5K ha	683 ha	85.4K ha
Degraded pasture suitable for soy crops in continuous area (>=100 ha)	74K ha — 66% of >= 100 ha suitable pastures	345.6K ha — 64% of >= 100 ha suitable pastures	144 ha — 21% of >= 100 ha suitable pastures	21K ha — 25% of >= 100 ha suitable pastures
SLR in continuous area (>=100 ha) suitable for soy crops [2]	512.7K ha	319K ha	282.5K ha	1.3M ha
Average annual Cerrado conversion rate (2017-2019) (INPE/PRODES, 2020)	48K ha	40.3K ha	33.4K ha	58.8K ha
Expansion of soy crops through Cerrado conversion between 2014 and 2017 (area and percentage of total expansion) (Agrosatélite, 2018)	21.8K ha — 24%	19.1K ha — 21%	24.5K ha — 17%	21.5K ha — 4%
Potential for absorbing the projected expansion of soy crops by 2030*	10% / 90%	49% / 51%	0,1% / 99,9%	8% / 92%

■ Projected expansion of soy crops that can be absorbed by >=100 ha suitable pastures in the hub municipalities

■ Projected expansion of soy crops that cannot be absorbed by >=100 ha suitable pastures in the hub municipalities

* In suitable => 100 ha continuous pasture existing in hub municipalities

[1] See **methodological note 1** on page 24; [2] See **methodological note 2** on page 24

9.

Climatic risk and the importance of water in soy productivity

In crop growing areas across **MATOPIBA**, most farming activities are directly reliant on the rainy season. For soy crops, which are planted and harvested during this period, water availability is the main hindrance to productivity. Thus, **the climate has a direct impact on soy productivity and production in the region**. Extreme weather events, like "veranicos" – dry periods of extreme heat and insolation that last for at least seven days –, may compromise entire soy crop yields.

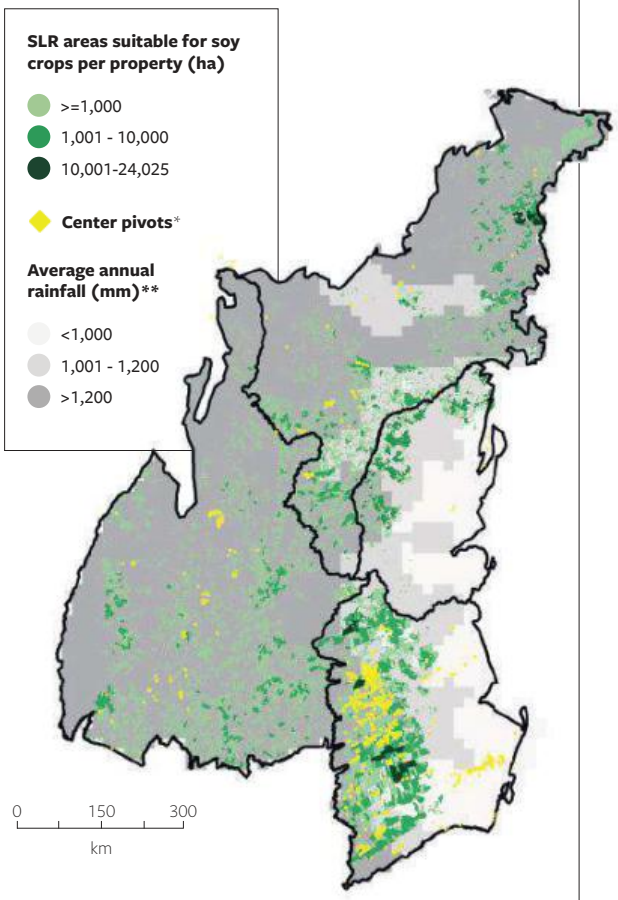
The climatic risk can be defined in terms of rainfall regime, water intake by plants, the soil's water availability, the crop's evapotranspiration, crop cycle duration, critical stages of plant phenology, and soil texture. Therefore, to ensure soy productivity, it is important to delimit areas that show climatic risk and adopt conservation management practices, in addition to keeping the ecosystem balanced and, consequently, the components of hydric balance, by preserving native vegetation.

In certain regions, such as Western Bahia, considering economic incentives, like the Payment for Environmental Services, can help promote the conservation of the native Cerrado, ensuring the availability of ecosystem services like water, pollination, and climate regulation. This way, soy production in MATOPIBA can grow.

To tackle "veranicos" and ensure good soy productivity and production, **farmers have already implemented farming practices that can resist climatic adversities**, like the No Tillage Farming System (SPD – Sistema de Plantio Direto). This system aims to improve water infiltration and prevent runoff, in addition to boosting the plants' capacity to explore deeper soil layers in search for water and nutrients. The three basic principles of the DSS are: i) Do not revolve the soil; ii) Permanent soil coverage, and iii) Crop rotation.

Implementing technologies like the SPD, combined with the preservation of native Cerrado areas, will contribute to **improving the climatic viability of soy crops in the region**. Just like soil conservation is essential for agriculture to thrive in the region, preserving the Cerrado is directly responsible for the intake of groundwater, since it reduces runoff. The native vegetation is responsible for regulating the local micro-climate, affecting the rainfall regime. Therefore, conserving the Cerrado's vegetation is vital to ensure the Ecosystem Service (ES) of water availability, which is essential for the farming industry.

OPPORTUNITIES OF PAYMENT FOR ECOSYSTEM SERVICES FOR REDUCING CLIMATIC RISKS



* Source: ANA & Embrapa, 2015
** Source: WorldClim

10.

Engagement actions in the sustainable expansion of soy crops

MUNICIPALITIES
SELECTED FOR
ENGAGEMENT ACTIONS
IN THE SUSTAINABLE
EXPANSION OF SOY CROPS

To implement engagement actions and encourage the adoption of low-carbon and efficient land use practices in the Cerrado, **this study has identified hub municipalities that have characteristics that are relevant to the soy and livestock production chains**. The Soy Program understands how important it is to create a range of sectoral actions to speed up and promote a progressive transition to low-carbon practices in different soy-producing regions of MATOPIBA.

The identified municipalities reflect different dynamics of expansion of soy crops and provide an overview of each territory. From the group of hub municipalities, we've selected **four municipalities for each state that are regional production and infrastructure centers**, have shown a considerable average soy production growth, and feature available pasture areas suitable for soy crops and/or areas with a surplus of Legal Reserves. These characteristics make these municipalities relevant scenarios for actions that seek to understand the expansion of soy crops in MATOPIBA.

The Soy Program seeks to **make it easier to put together institutional arrangements** that enable the **development of regionalized strategies that have a positive impact** on business models for different soy expansion scenarios based on the progressive improvement of carbon balance and conservation of the Cerrado.

SUMMARY OF MUNICIPALITIES FOR ENGAGEMENT ACTIONS

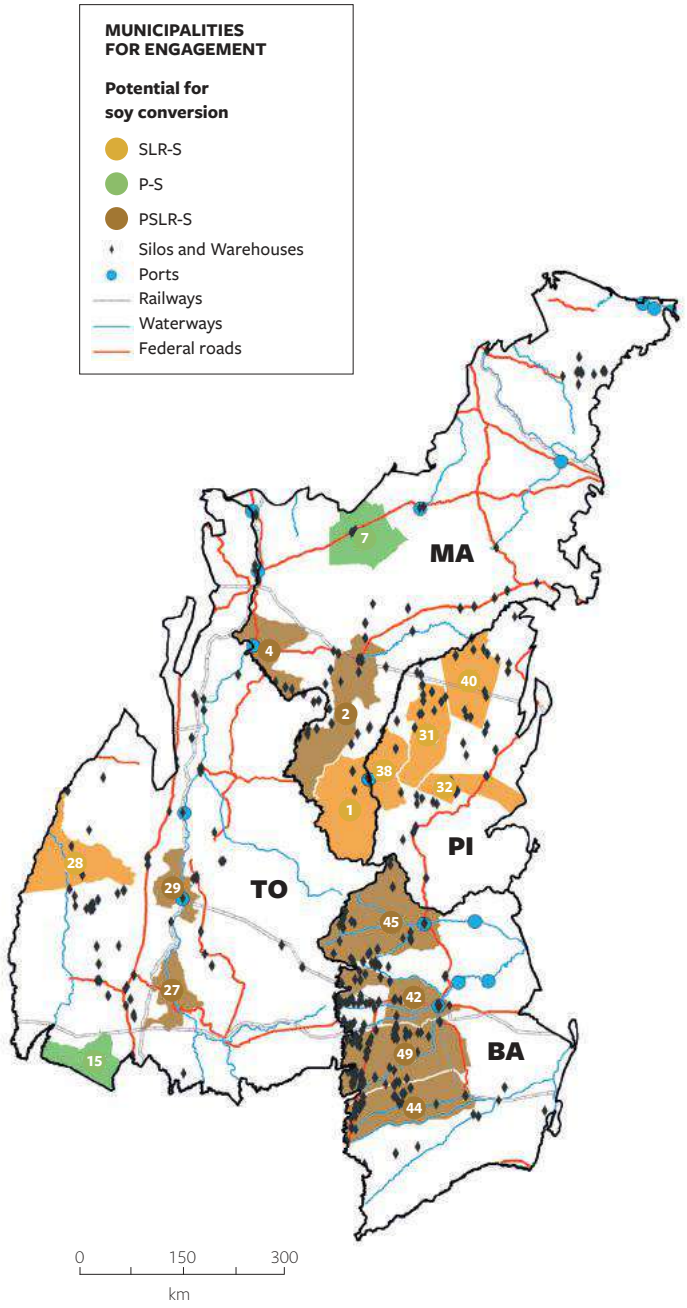
* (=> 100ha)

MARANHÃO | MA

Municipality	Area of soy crops in 2017	SLR in suitable areas*	Pastures in suitable degraded areas*	Pastures in suitable degraded areas*
7 GRAJAÚ	14.6K ha	5K ha	17.1K ha	42K ha
4 CAROLINA	27.8K ha	52.2K ha	3.6K ha	22K ha
2 BALSAS	226.9K ha	116.6K ha	2.34K ha	0.11K ha
1 ALTO PARNAÍBA	78.9K ha	63.2K ha	--	--

TOCANTINS | TO

Municipality	Area of soy crops in 2017	SLR in suitable areas*	Pastures in suitable degraded areas*	Pastures in suitable degraded areas*
15 ARAGUAÇU	13.5K ha	28.5K ha	79.5K ha	74K ha
28 PIUM	17.6K ha	32.7K ha	3.2K ha	3.3K ha
27 PEIXE	39.4K ha	20.1K ha	24.1K ha	67.3K ha
29 PORTO NACIONAL	58.2K ha	21K ha	13.7K ha	14.7K ha



PIAUÍ | PI

Municipality	Area of soy crops in 2017	SLR in suitable areas*	Pastures in suitable degraded areas*	Pastures in suitable degraded areas*
40 URUÇUÍ	128.7K ha	30K ha	--	--
31 BAIXA GRANDE DO RIBEIRO	176.8K ha	52.3K ha	0.28K ha	--
38 SANTA FILOMENA	53.8K ha	78.4K ha	0.13K ha	--
32 BOM JESUS	69.3K ha	0.37K ha	--	--

BAHIA | BA

Municipality	Area of soy crops in 2017	SLR in suitable areas*	Pastures in suitable degraded areas*	Pastures in suitable degraded areas*
49 SÃO DESIDÉRIO	377.7K ha	32.9K ha	21.1K ha	5.8K ha
45 FORMOSA DO RIO PRETO	460.2K ha	213K ha	2.8K ha	0.13K ha
44 CORRENTINA	183.6K ha	196K ha	11.6K ha	3.1K ha
42 BARREIRAS	176.7K ha	137K ha	7.7K ha	2K ha

11.

Final thoughts

The dynamics of the expansion of soy crops across MATOPIBA differ from one region to another. It is important to know these particularities so that actions can be customized on a regional level. Thus, this study has identified groups of municipalities for each state with plenty of available pasture areas (degraded or not) suitable for soy crops that could be converted into soy crops, without harming livestock farming activities, which can be improved by efficient land use. We've also identified municipalities that don't have that same potential due to other territorial specificities, such as unavailable expansive pasture areas suitable for soy crops, but feature areas with a surplus of Legal Reserves suitable for soy crops. In these cases, the expansion could be achieved over SLR, if there aren't compelling alternatives for business and conserving the Cerrado. **Once these distinct expansion of soy crops dynamics have been identified**, it is understood that the soy production chain, government players, civil society, and farmers can work together to prioritize actions that suit the reality of each region, mainly by: i) leveraging anthropized areas of soy crops and intensifying sustainable livestock farming activities by investing in technology and management to boost productivity and increase resilience to climate changes; and ii) developing public and private mechanisms for conserving the Cerrado in areas where the conversion of native vegetation is still seen as a business opportunity.

METHODOLOGICAL NOTES

1

Estimated by Solidaridad, based on a combination of the following data:

- Pasture areas in 2019 (Mapbiomas col. 5);
- Pasture quality in 2018 (Lapig/UFG). Areas classified as 1 were considered not degraded and areas classified as 2-4 were considered degraded;
- Agricultural suitability for soy crops (Agrosatélite, 2015). Areas classified under high edaphoclimatic suitability without restrictions or with altitude and/or declivity restrictions, and medium edaphoclimatic suitability without restrictions or with altitude restrictions were considered suitable for soy crops.

The definition of continuous areas equal or greater than 100 ha has considered the area of single part-polygons of degraded and non-degraded pastures suitable for soy crops.

The 20km radius considers the area of soy crops in 2017 (Agrosatélite, 2018) and silos/storage facilities (Conab & SICARM, 2015).

2

Estimated by Solidaridad, based on the following data:

- Area covered by native vegetation in 2019 (Mapbiomas 2019 col. 5), classified as "Forest Formation," "Savanna," and "Grasslands;"
- Suitability for soy crops (Agrosatélite, 2015). Classification described in note 1;
- Land grid and surplus of Legal Reserves, taken from the Atlas da Agropecuária Imaflora (Guidotti et al. 2017).

The definition of continuous areas equal or greater than 100 ha has considered the area of single part-polygons of native vegetation.

The 20km radius considers the area of soy crops in 2017 (Agrosatélite, 2018) and silos/storage facilities (Conab & SICARM, 2015).

3

In the AHP (Analytic Hierarchy Process) approach, there is a set of criteria that represents the process you wish to evaluate and each of these criteria is assigned a weight according to how important it is to the process.

In this study, we chose this analytic approach because it is also employed by the Sistema Agroideal Soja, an important decision-making platform for the soy chain jointly developed by several industry players. However, to hit our targets and observe the premises set by the analyses performed for this study, we adopted some criteria and databases different than those used by Agroideal.

4

i) Standardizing the value of each criterion between 0 and 1;

ii) Assigning a weight (0-5) to each criterion indicating how important it is;

iii) Calculating the index for potential P-S or SLR-S conversion for each municipality based on the weighted average;

iv) Ranking municipalities according to the index value (the closer they were to 1, the better they ranked)

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