MINISTRY OF AGRICULTURE AND LIVESTOCK

BRAZILIAN GOVERNMENT
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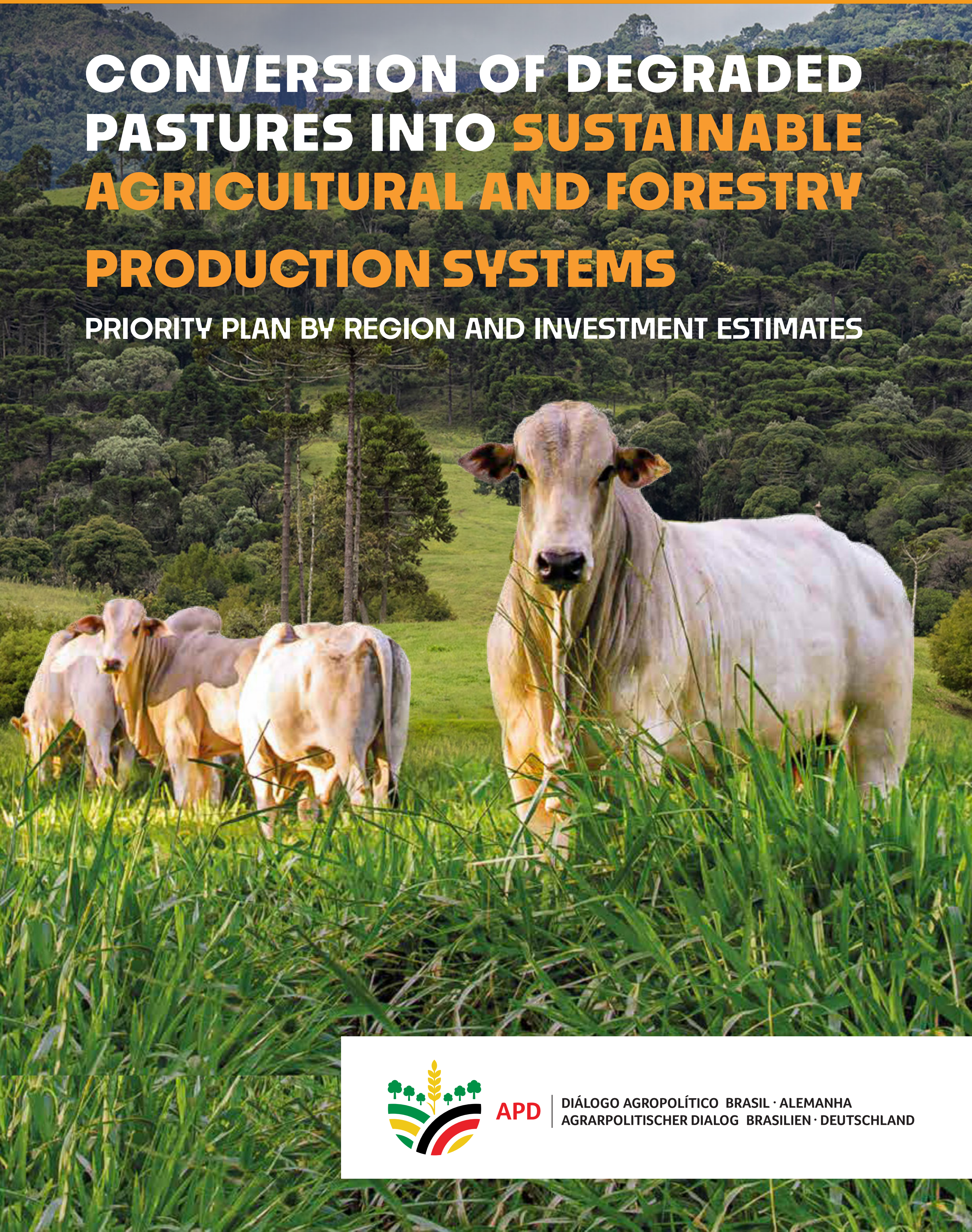
With support from

Federal Ministry of Agriculture, Food and Regional Identity

by decision of the German Bundestag

CONVERSION OF DEGRADED PASTURES INTO SUSTAINABLE AGRICULTURAL AND FORESTRY PRODUCTION SYSTEMS

PRIORITY PLAN BY REGION AND INVESTMENT ESTIMATES



APD | DIÁLOGO AGROPOLÍTICO BRASIL · ALEMANHA
AGRARPOLITISCHER DIALOG BRASILIEN · DEUTSCHLAND

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The Agricultural Policy Dialogue Brazil-Germany (German acronym: APD) is a mechanism for exchanging knowledge and information on bilateral and global challenges in the field of agricultural and environmental policy. For more than two decades, the Federal Ministry of Agriculture, Food and Regional Identity (German acronym: BMLEH) has been conducting similar initiatives with multiple countries, which are important references for APD in Brazil.

The activities conducted by APD are based on the Memorandum of Understanding signed by BMLEH, the Ministry of Agriculture and Livestock (Portuguese acronym: MAPA) and the Ministry of Agrarian Development and Family Agriculture (Portuguese acronym: MDA). Representatives from the Brazilian and German ministries, civil society, the agricultural and food industry and the scientific community are an active part of the dialogue.

In view of the growing global challenges related to climate, agriculture, livestock and the environment, the objective of APD is to achieve a better mutual understanding of the agricultural and environmental policies of both countries. Knowledge exchange and publication take place on webinars, conferences, publications and travels.

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GFA CONSULTING GROUP
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PRESENTATION

The Brazilian Government is honored to present the report "Conversion of Degraded Pastures into Sustainable Agricultural and Forestry Production Systems", the result of a partnership between the Ministry of Agriculture and Livestock (MAPA), through the Secretariat for Rural Development (SDR), and the German Federal Ministry of Agriculture, Food and Regional Identity (BMLEH) through the Agricultural Policy Dialogue Brazil-Germany (APD).

This publication marks an important step in the cooperation between the governments of Brazil and Germany and contributes to the dissemination of public policies that directly support rural development, food security, and the conservation of natural resources - such as the National Program for Converting Degraded Pastures into Sustainable Agricultural and Forestry Production Systems (PNCPD), one of the Brazilian federal government's key initiatives to promote sustainability and increase productivity in rural areas.

Established by Decree No. 11.815/2023, the PNCPD aims to convert up to 40 million hectares of degraded pastures into sustainable production areas over the next decade, without encroaching on native vegetation. This reinforces Brazil's commitment to a low-carbon, competitive agriculture aligned with climate and conservation goals.

To support this effort, MAPA developed the study "Priority Plan by Region and Investment Estimates", which maps degraded pastures in nine Brazilian states: Mato Grosso, Mato Grosso do Sul, Goiás, Minas Gerais, Bahia, Tocantins, Rondônia, São Paulo, and Pará. The study identifies areas with potential for conversion into sustainable production systems, applying a multi-criteria geospatial methodology and presenting investment and economic return estimates. It offers technical input to guide public policies and foster strategic partnerships.

This initiative reinforces the Brazilian government's commitment to planning a transition toward low-carbon agriculture, combining productivity, environmental conservation, and regional development. The methodology was designed to be replicable nationwide, while respecting the specific characteristics of each state. The original Portuguese version of the document includes detailed studies for each of the states mentioned and is available at: https://repositorio-dspace.agricultura.gov.br/handle/1/5319.

For Brazil, converting degraded pastures represents an opportunity to reconcile economic growth, food security, and environmental preservation - encouraging innovative practices and efficient land use.

We hope this publication serves as a reference for global cooperation in restoring degraded areas, aiming for a sustainable agriculture that is resilient to climate change.

Marcelo Narvaes Fiadeiro
Secretary for Rural Development – SDR
Ministry of Agriculture and Livestock – MAPA

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*Translators' Note: The original publication in Portuguese breaks down the study findings into Brazil, and the states of Bahia, Goiás, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Rondônia, São Paulo, and Tocantins. This English translation only considers the Brazil findings. The full study in Portuguese can be found at: https://repositorio-dspace.agricultura.gov.br/handle/1/5319.

CONVERSION OF DEGRADED PASTURES INTO SUSTAINABLE AGRICULTURAL AND FORESTRY PRODUCTION SYSTEMS

PRIORITY PLAN BY REGION AND INVESTMENT ESTIMATES

CONTENTS

INTRODUCTION

The **NATIONAL PROGRAM FOR CONVERTING DEGRADED PASTURES INTO SUSTAINABLE AGRICULTURAL AND FORESTRY PRODUCTION SYSTEMS (PNCPD)**,[1] established by Decree No. 11815, December 2023, reaffirms Brazil's commitment to the Sustainable Development Goals and the Paris Agreement by promoting policies and actions to mitigate greenhouse gas (GHG) emissions and adapt to climate change. This program emerges in a context in which it is believed that the preservation and sustainable use of natural resources are integrated with the promotion of food and nutritional security, and with the country's economic development.

Brazil is among the largest producers and exporters of agricultural products, including soybean, corn, cotton, orange, sugar, poultry, and beef. Regarding cattle farming, in 2022, its livestock totaled 234.3 million heads of cattle (IBGE, 2022),[1] producing eight million tons of meat (IBGE, 2024).[2] Of these, 2.9 million tons were exported, representing 22.9% of the global meat exports (FAO, 2023).[3] To maintain this production, Brazilian livestock farming uses 179 million hectares of pastures (LAPIG, 2022).[4] Nevertheless, over 60% of these pastures are of low or medium vigor (either degraded or in the process of degradation), resulting in low productivity and high GHG emissions. Converting these degraded areas into sustainable production systems is imperative for preserving biomes, reducing emissions, and increasing the productivity of agriculture and livestock.

The PNCPD is expected to encourage financial institutions and the capital market to devise solutions to support the recovery and conversion of degraded pastures into different Sustainable Agricultural and Forestry Production Systems.[5] It is then expected to achieve a sustainable increase in the production of meat, milk and other agricultural and forestry products, to avoid deforestation and to enhance the sequestration of soil carbon and biomass.

The PNCPD is especially aligned with the National Policy on Climate Change (PNMC), established by Law No. 12187/2009, and with the goals set out in the Plans and Programs that constitute its instruments, such as the Sectoral Plan for Adaptation to Climate Change and Low Carbon Emissions in Agriculture and Livestock Farming, targeted at Sustainable Development 2020–2030 (ABC+ Plan), the National Policy for the Recovery of Native Vegetation (Proveg), and the Action Plans

1 Municipal Livestock Survey: https://sidra.ibge.gov.br/pesquisa/ppm/quadros/brasil/2022.

2 Quarterly Survey of Livestock Slaughter: https://sidra.ibge.gov.br/tabela/1092#resultado.

3 FAO. 2023. Food Outlook – Biannual report on global food markets. Food Outlook, November 2023. Rome. https://doi.org/10.4060/cc8589en

4 Remote Sensing and Geoprocessing Laboratory: https://atlasdaspastagens.ufg.br/map.

5 These are: a) Agriculture, solely with temporary crops or crops under an integrated system, such as integrated crop-livestock-forestry (ICLF), integrated crop-livestock (ICL) or integrated crop-forestry (ICF) systems, according to soil and climate conditions, which can include intercropping, succession cropping or crop rotation; b) Improved pasture as a strategy to intensify livestock systems; c) Planted forest; and d) Agroforestry, which is a form of land use and occupation in which shrub and/or tree species are planted or managed in association with agricultural or forage crops to establish production systems closer to nature.

for the Prevention and Control of Deforestation (PPCDAMs), the latter developed or under development for the Amazon, Cerrado, Atlantic Forest, Caatinga, Pampa, and Pantanal biomes.

Additionally, the PNCPD is in line with the principles, guidelines, and objectives of the National Biodiversity Policy (PNB) and the National Policy to Combat Desertification and Mitigate the Effects of Drought (PNCD).

Particularly, the convergence and synergy between the PNCPD and the ABC Plan are evident, as both share the objective of promoting sustainable agricultural production systems while focusing on mitigating GHG emissions. The uniqueness of the PNCPD lies in its focus on conversion to sustainable production systems on degraded pasture areas or on those in the process of degradation. Since 2010, the ABC Program (currently named Renovagro6), created to support the activities under the ABC Plan, has offered specific credit lines for low-carbon agriculture, as laid down in the ABC Plan. These credit lines are also available to farmers taking the actions outlined in the PNCPD. From 2010 to 2020, the program generated R$32.3 billion through 38,300 contracts (BRASIL, 2023).7 After this period, the ABC Plan entered a second phase, called the ABC+ Plan, effective from 2020 to 2030, now supported by the Renovagro credit. lines The convergence between Renovagro and PNCPD makes access to funds easier, encouraging a faster and more effective transition to sustainable practices.

On the other hand, the integration of PNCPD with policies such as Proveg and PPCDAMs is directly related to the restoration of native vegetation and the prevention and control of deforestation, laying the foundations for the development of agroecosystems that are more biodiverse, better adapted, and more climate resilient. Besides, the recovery and conversion of degraded pastures may include the incorporation of native vegetation into agroforestry systems or systems integrated with the forestry component, reinforcing the environmental, social, and economic benefits of these production systems.

The implementation of the range of policies, plans, programs, and actions outlined in the PNMC, as well as in the PNCPD, involves the cooperation of different government ministries, non-governmental organizations, the private sector, and international organizations. The convergence of these instruments supports the coordination of actions and the optimization of the use of resources, ensuring that their goals may be achieved in an integrated, synergistic, and efficient manner, creating an investment-friendly atmosphere.

6 Program for the Financing of Sustainable Agricultural Production Systems — RenovAgro.

7 https://www.gov.br/agricultura/pt-br/assuntos/sustentabilidade/planoabc-abcmais/plano-abc/acoes-do-plano

To transform approximately 40 million hectares of pastureland with some level of degradation into sustainable production systems in Brazil, the PNCPD attracts international and national private investments to complement the Harvest Plan (Plano Safra). To ensure the structuring of these efforts and the effective execution of this program, an interministerial Management Committee was established to serve as a consultative and deliberative body coordinated by the Executive Secretariat of the Ministry of Agriculture and Livestock (Mapa).

The studies conducted by SDI/Mapa — responsible for elaborating public policies for rural innovation and development with an emphasis on the recovery of degraded areas and forest restoration, including other issues, according to Decree No. 11332/2023— have found the necessity to develop a "Priority Plan by Region and Investments for the Recovery and Conversion of Degraded Pastures" into sustainable agricultural and forestry production systems, aligned with national and state-level commitments of nine Brazilian states. It was suggested to start with the states with the highest concentration of pastures of low and medium vigor: Minas Gerais, Mato Grosso, Mato Grosso do Sul, Bahia, Goiás, Pará, Tocantins, Rondônia, and São Paulo, devising a methodology for preparing the plan that can be replicated in other states in the country.

These efforts are reflected in this document, which presents a diagnosis of Brazilian pastures, identifying degraded areas or those in the process of degradation (low and medium vigor) with potential for recovery or conversion into sustainable production systems. In addition, it provides an estimate of the investments required for recovery or conversion. The nine Brazilian states here considered hold 79% of Brazil's degraded pastures or pastures in the process of degradation. To estimate the conversion and recovery potential, six sustainable agriculture, livestock, and forestry production systems were considered, namely: i) Intensification of cattle ranching; ii) Intensification of dairy cattle farming.

iii) Agriculture; iv) Planted forests (silviculture); v) Agroforestry systems; and vi) Crop, livestock, and forest integrated systems.[8]

In the states of Mato Grosso, Mato Grosso do Sul, Goiás, Minas Gerais, Bahia, Tocantins, Rondônia, São Paulo, and Pará, the diagnosis was prepared with spatially explicit information at the rural property level, complemented by information collected in workshops with stakeholders (one per state) to validate and accommodate regional characteristics. Those workshops were designed to build a shared state-level understanding regarding the priority regions and sustainable systems for the PNCPD, and the encounters played a crucial role in adapting the

8 The results are presented for integrated crop-livestock (ICL) and integrated crop-livestock-forest (ICLF) systems.

Program's proposed performance potential to the reality of each state, ensuring that the planning for pasture conversion and recovery was as aligned as possible with the perspectives of the government, civil society, and local producers. Additionally, the municipalities and/or regions prioritized for the implementation of each of the six sustainable production systems were indicated and validated, as well as data sources on more detailed variables for analysis and cost/investment estimation, where available. This personalized approach aimed to meet the specific needs and opportunities of each state, considering their regional heterogeneity.

1

METHODS

1.1.
POTENTIAL FOR CONVERSION OR RECOVERY OF DEGRADED PASTURES INTO SUSTAINABLE AGRICULTURAL AND FORESTRY PRODUCTION SYSTEMS

The potential for converting degraded pasture areas into sustainable production systems was estimated using a **geospatial model**[8] that generally considered the following major steps:

1 Identification of degraded pasture areas for recovery or conversion into sustainable agricultural and forestry production systems

2 Biophysical feasibility analysis for conversion or recovery of selected degraded pasture areas

3 Estimation of the biophysical potential for recovery or conversion of selected degraded pastureland into sustainable agricultural and forestry production systems

8 Worked out by GPP-ESALQ (gppe-salq.agr.br) and CITE (citeinstituto.org).

MODELED SUSTAINABLE AGRICULTURAL AND FORESTRY PRODUCTION SYSTEMS

Intensification of cattle ranching

Intensification of dairy cattle farming

Conversion into crop production

Conversion into silviculture

Conversion into agroforestry systems

Conversion into integrated systems

1 IDENTIFICATION OF DEGRADED AREAS FOCUSING ON RECOVERY OR CONVERSION INTO SUSTAINABLE AGRICULTURAL AND FORESTRY PRODUCTION SYSTEMS

In the first stage of the analysis, data from the pasture vigor assessment conducted by the Image Processing and Geoprocessing Laboratory (Lapig),[9] from the year 2022, were used. Pastureland, or other degraded land, classified as "of low vigor or medium vigor" (i.e., degraded or with some level of degradation) were considered with potential for recovery or conversion into sustainable production systems.

Furthermore, to comply with the provisions of Article 4 of Decree No. 11815/2023,[10] only low or medium vigor pasture areas located within the boundaries of rural properties registered in the Rural Environmental Registry (CAR, portuguese acronym) and that do not overlap spatially with areas of restricted use (Integral Protection Conservation Units — UCPI, Indigenous Lands and Military Areas) were selected. For this analysis, data from SICAR (Rural Environmental Registration System) and the land categories mapped out by the Cartas da Terra[11] initiative were used.

Finally, potential deforestation in rural properties registered in the CAR (and outside restricted areas) after 2008 was spatially analyzed. For this purpose, official PRODES[12] data was used. Events of deforestation after 2008 are only an indication of environmental infringement (according to Law No. 12651/2012, or the Native Vegetation Protection Law), since it is not possible to confirm the legality or illegality of deforestation through remote sensing. However, evidence of environmental infringement was considered a factor for not including the properties as an investment priority under the PNCPD. On the other hand, data disregarding this criterion were also presented.

The **focus areas for recovery or conversion into sustainable production systems** sare low or medium vigor pastureland located in:

☑ **Rural properties registered in CAR, which do not overlap with restricted areas or have not shown any events of deforestation after 2008**

9 Available at <atlasdaspastagens.ufg.br/map>.

10 Institutes the National Program for the Conversion of Degraded Pastures into Sustainable Agricultural and Forestry Production Systems and its Interministerial Management Committee.**11** Disponível em <cartasdaterra.com.br>

12 Available at <cartasdaterra.com.br>

2 BIOPHYSICAL FEASIBILITY ANALYSIS FOR CONVERSION OR RECOVERY OF SELECTED DEGRADED PASTURE AREAS

For selected low or medium vigor pastureland to have potential for recovery or conversion into sustainable production systems, they must present appropriate biophysical conditions. Four criteria were used to define the **biophysical feasibility** of recovery or conversion of low/medium vigor pasture areas:

Altitude[13]

Declivity[14]

Annual water deficit[15]

Agricultural suitability deficit[16]

The criteria used for each sustainable agricultural or forestry production system are detailed in item “Criteria.”

13 Farr, T.G., Rosen, P.A., Caro, E., Crippen, R., Duren, R., Hensley, S., Kobrick, M., Paller, M., Rodriguez, E., Roth, L., Seal, D., Shaffer, S., Shimada, J., Umland, J., Werner, M., Oskin, M., Burbank, D., and Alsdorf, D.E., 2007, The shuttle radar topography mission: Reviews of Geophysics, v. 45, no. 2, RG2004, at https://doi.org/10.1029/2005RG000183.

14 Ibid.

15 Abatzoglou, J.T., S.Z. Dobrowski, S.A. Parks, K.C. Hegewisch, 2018, Terraclimate, a high-resolution global dataset of monthly climate and climatic water balance from 1958-2015, Scientific Data 5:170191, doi:10.1038/sdata.2017.191

16 Agricultural suitability map prepared by IBGE. Potencialidade Agrícola Natural Das Terras no Brasil. 2022. Available online: https://biblioteca.ibge.gov.br/index.php/bibliotecacatalogo?view=detalhes&id=2101980

3
ESTIMATE OF THE POTENTIAL FOR RECOVERY OR CONVERSION OF SELECTED DEGRADED PASTURE AREAS INTO SUSTAINABLE AGRICULTURAL AND FORESTRY PRODUCTION SYSTEMS

The criteria for characterizing the available production infrastructure[17] determine the potential for converting degraded pastureland into sustainable agricultural and forestry production systems. By adapting the methodology presented by Harfuch et al. (2021), five databases were employed to apply the production infrastructure criteria, in addition to biophysical criteria (previously presented):

- **i) Meatpacking plants**[18]
- **ii) Dairy products**[19]
- **iii) Silos and warehouses**[20]
- **iv) Forest-based industries**[21]
- **v) Land use**[22]

CRITERIA

The biophysical and available production infrastructure criteria considered in the modeling of each sustainable agricultural and forestry production system are presented below.

17 In the modeling, production infrastructure is broadly considered as the production surroundings of properties, considering economic variables, land use, property size and profile, and closeness to agro-industrial processing centers.

18 LAPIG/SIF-MAPA 2021 — Data produced from information from Slaughterhouses and/or Bovine Meatpacking Plants in Brazil approved for export (SIF-MAPA), with location reviewed by LAPIG. Available at: < atlasdaspastagens.ufg.br/map>

19 MAPA — Open Data Portal of the Ministry of Agriculture and Livestock (MAPA 2024). Available at: <https://dados.agricultura.gov.br/dataset/servico-de--inspecao-federal-sif/resource/97277e-92-264a-4dc0-9aea-f87b8ea93798>

20 CONAB/Lapig - Companhia Nacional de Abastecimento (CONAB) (Revised by LAPIG-UFG). Armazenagem (2019). Available at: <conab.gov.br/armazenagem>.

21 Data prepared by GPP specifically for this study. These include paper pulp plants and steel mills powered by charcoal belonging to the following industry leaders: Suzano, Bracell, Klabin, Sylvamo, CMPC, Veracel, Dexco, Gerdau, and Vallourec.

22 MapBiomas Project – Collection 8 of the Annual Series of Land Cover and Use Maps of Brazil, accessed on 01/07/2024 at: <https://storage.googleapis.com/mapbiomas-public/initiatives/brasil/collection_8/lclu/coverage/brasil_coverage_2022.tif>

INTENSIFICATION OF CATTLE RANCHING

TYPE	VARIABLE	RESTRICTIVE CRITERION
Biophysical criteria	Altitude	Exclusion of areas with altitude >1,800 m
	Declivity	Exclusion of areas classified as mountainous or steep (>45%)
	Annual water deficit	Exclusion of areas with WD>600 mm/year
	Agricultural suitability	Exclusion of areas classified as highly restrictive
Production infrastructure criteria	Distance from low or medium vigor pasture areas to meatpacking plants	Exclusion of low/medium vigor areas located more than 150km away from meatpacking plants
	Livestock farming as the property's main activity (pasture areas/anthropic use on the property)	Properties in the Amazon must have at least 10% of the total area covered by pasture; in the Legal Amazon and Cerrado, properties must have at least 32.5% of the total area covered by pasture; in other regions, properties must have at least 40% of pasture.

INTENSIFICATION OF DAIRY FARMING

TYPE	VARIABLE	RESTRICTIVE CRITERION
Biophysical criteria	Altitude	Exclusion of areas with altitude >1,800 m
	Declivity	Exclusion of areas classified as mountainous or steep (>45%)
	Annual water deficit	Exclusion of areas with WD>600 mm/year
	Agricultural suitability	Exclusion of areas classified as highly restrictive
Production infrastructure criteria	Distance from low or medium vigor pasture areas to dairy plants	Exclusion of low/medium vigor areas located more than 50km away from dairy plants
	Livestock farming as the property's main activity (pasture areas/anthropic use on the property)	Properties in the Amazon must have at least 10% of the total area covered by pasture; properties in the Legal Amazon and Cerrado must have at least 32.5% of the total area covered by pasture; properties in other regions must have at least 40% of pasture.

CONVERSION IN CROP PRODUCTION

TYPE	VARIABLE	RESTRICTIVE CRITERION
Biophysical criteria	Altitude	Exclusion of areas with altitude >1,800 m
	Declivity	Exclusion of areas classified as strongly undulated, mountainous or steep (>16%)
	Annual water deficit	Exclusion of areas with WD>500 mm/year
	Agricultural suitability	Exclusion of areas classified as highly restrictive and restrictive
Production infrastructure criteria	Distance from low or medium vigor pasture areas to established soybean areas	Exclusion of low/medium vigor areas located more than 50km away from established soybean areas (at least 50 hectares)
	Distance from low or medium vigor pasture areas to silos and warehouses	Exclusion of low/medium vigor pasture areas located more than 50km away
	Production scale	Exclusion of properties with less than 50 hectares of low/medium vigor pasture within them

CONVERSION TO SILVICULTURE

TYPE	VARIABLE	RESTRICTIVE CRITERION
Biophysical criteria	Altitude	Exclusion of areas with altitude >1,800 m
	Declivity	Exclusion of areas classified as mountainous or steep (>45%)
	Annual water deficit	Exclusion of areas with WD>600 mm/year
	Agricultural suitability	Exclusion of areas classified as highly restrictive
Production infrastructure criteria	Distance from low or medium vigor pasture areas to established silviculture areas	Exclusion of low/medium vigor areas located more than 50km away from established silviculture areas (of at least 50 hectares)
	Distance from low or medium vigor pasture areas to paper pulp mills/forestry units/steel mills	Exclusion of low/medium vigor pasture areas located more than 200km away

CONVERSION TO AGROFORESTRY SYSTEMS

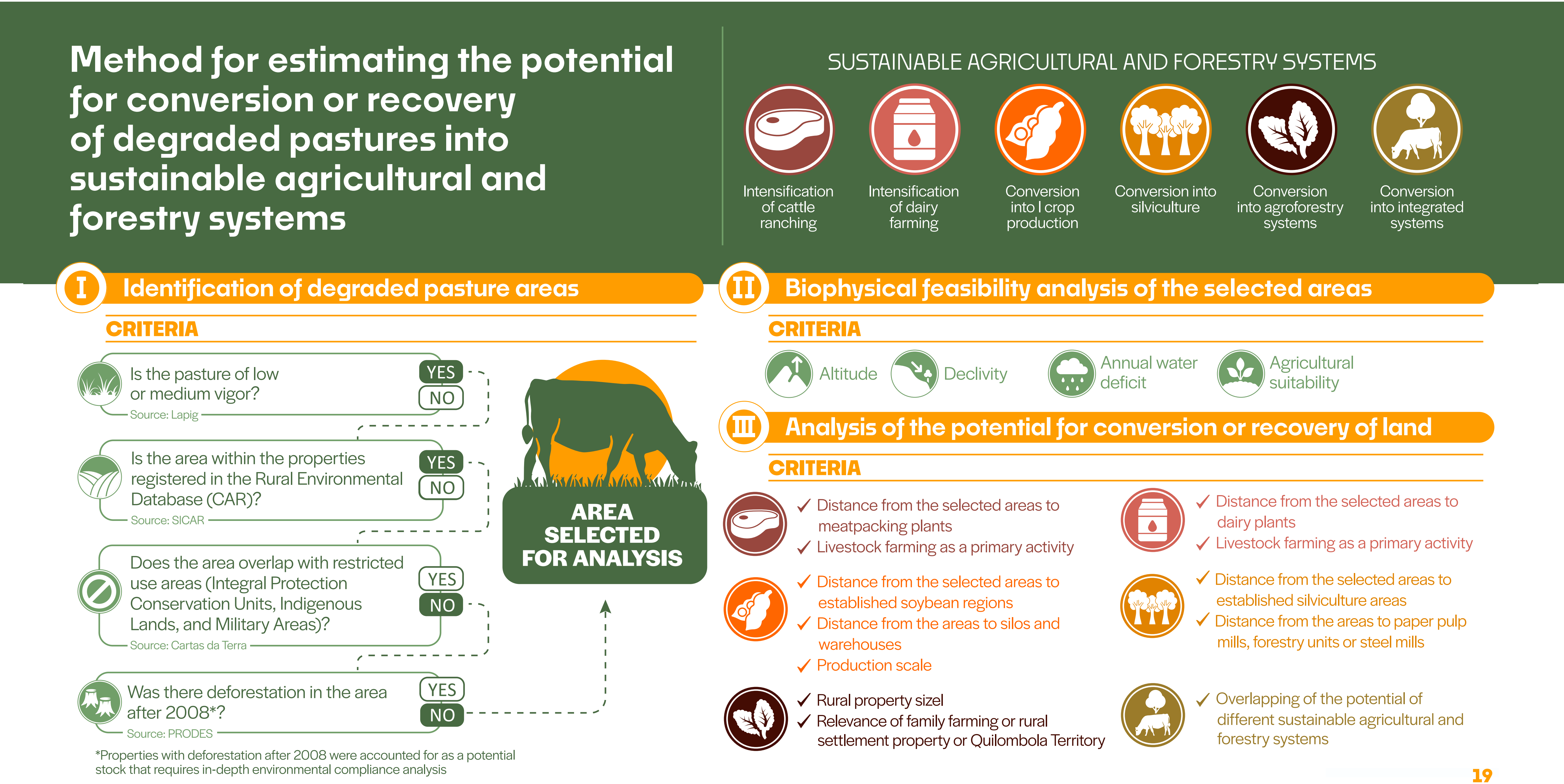
TYPE	VARIABLE	RESTRICTIVE CRITERION
Biophysical criteria	Altitude	Exclusion of areas with altitude >1,800 m
	Declivity	Exclusion of areas classified as steep (>100%)
	Annual water deficit	Exclusion of areas with WD>600 mm/year
	Agricultural suitability	Exclusion of areas classified as highly restrictive
Production infrastructure criteria	Rural property size	Exclusion of low or medium vigor pasture areas on properties larger than 4 fiscal land units
	Relevance of family farming or rural settlement property or any property based in *Quilombola* Territories (settlements established by escaped slaves in Brazil)	Municipalities whose family farming production earnings are greater than or equal to 30% of the total production earning of the municipality or properties located in rural settlements or *quilombola* territories

LAND CONVERSION FOR INTEGRATED SYSTEMS

VARIABLE	RESTRICTIVE CRITERION
Intersection of the potential of different sustainable production systems, namely: **Crop-livestock integrated system (ICL)** Overlapping of potential areas for crops and cattle production (beef or dairy) **Crop-forest integrated system (ICF)** Overlapping of suitable land for crops and planted forests (silviculture) **Crop-livestock-fores t integrated system (ICLF)** Overlapping of potential areas for crops, livestock farming (cattle or dairy farming) and planted forests (silviculture)	The previous criteria for each system (crop production, livestock farming (cattle or dairy farming) and planted forests (silviculture))

Figure 1 presents a brief description of the method for estimating the potential for recovery or conversion of degraded pastures.

Figure 1 Brief description of the method used in spatial modeling for analyzing the potential of sustainable agricultural and forestry systems



1.2. ECONOMIC AND FINANCIAL ANALYSES FOR RECOVERY OR CONVERSION OF DEGRADED PASTURES INTO SUSTAINABLE AGRICULTURAL AND FORESTRY PRODUCTION SYSTEMS

The economic-financial evaluation models[23] of recovery or conversion of degraded pastures were adapted to estimate the necessary investments and cash flow throughout the project (revenue, operating costs and depreciation), to calculate the economic feasibility of investment projects over time and to compare the scenarios evaluated, considering the role of financing..

SUSTAINABLE AGRICULTURAL AND FORESTRY PRODUCTION SYSTEMS

The PNCPD encourages the use of good sustainable practices, as described above, and seeks to facilitate access to financing with external funds without subsidies or with funds from existing programs. The economic and financial analyses of the conversion or recovery of degraded pastures considered the following sustainable production systems, comparable among themselves, and compared to extensive livestock farming (beef cattle farming):

1. Intensification of cattle ranching, considering the full cycle activity, simulated to recover medium and low vigor pastures.
2. Conversion to soybean farming using high technology and no-till farming systems.
3. Conversion to soybean and second crop – corn succession system in the states where this system is well established under no-till farming.
4. Conversion to crop-livestock integrated system, considering soybean and second crop – corn succession and cattle ranching;
5. Conversion to eucalyptus farming (planted forest).
6. Conversion to livestock-forest integrated system combined with teak farming (considering some parameters for the state of Mato Grosso, validated with local stakeholders).
7. Conversion to agroforestry, with cocoa and açaí as the main crops, and shading with banana and andiroba (considering some parameters for the state of Pará, validated with local stakeholders).

23 Agroicone (agroicone.com.br) has economic and financial models to assess the economic feasibility of recovering or converting degraded pastures into sustainable production systems from the farmers' perspective.

The models were simulated from the perspective of the farmer who will make the investments, either considering or ignoring the financing of the investment and the operating costs of each system. Table 1 presents the simulated systems and a brief description.

Table 1 Description of simulated production systems

PRODUCTION SYSTEM		STATES	DESCRIPTION
Baseline (BAU)	Maintenance of extensive cattle ranching, full cycle	MT, GO, MS, RO, PA, TO, BA, MG, SP, RS	Livestock farmer does not recover degraded pasture and maintains an extensive livestock production system without access to financing (only using their own funds to cover operating costs)
Medium vigor livestock farming	Recovery of medium-vigor to high-vigor pasture, intensifying production	MT, GO, MS, RO, PA, TO, BA, MG, SP, RS	Livestock farmer recovers degraded pasture and achieves 18 arrobas/ha/year of live weight gain in the full production cycle. There are investments in the implementation of pasture rotation, with fences, troughs and drinkers, and operations to restore pasture vigor. 15-year period (project duration).
Soy	Conversion of medium-vigor pasture to soybean farming	MT, GO, MS, RO, PA, TO, BA, MG, SP, RS	Soybean farmer leases low-vigor pasture and converts it to no-till soybean farming. The farmer makes investments to convert pastures into croplands with operations to restore soil fertility, minimal acquisition of machinery and implementation of soybean farming (annual cycle).
Soy+Corn	Conversion of medium-vigor pasture to the implementation of soybean and second crop – corn succession system	MT, GO, MS, MG, SP	Soybean farmer leases medium-vigor pasture and converts it to soybean-corn double cropping using no-till farming. The farmer makes investments to convert pasturelands into crops with operations to recover soil fertility, minimal acquisition of machinery, and implementation of soybean-corn double cropping.
Livestock +Soy	Recovery of medium-vigor pasture to high-vigor pasture, intensifying production and conversion of medium-vigor pasture to cropping	RO, PA, TO, BA, RS	Livestock farmer recovers degraded pasture and achieves 18 arrobas/ha/year of live weight gain in the full production cycle on half of the area. There are investments in pasture rotation, with paddocks, troughs and drinkers, and operations to recover pasture vigor. The soybean farmer leases the other part of the medium-vigor pasture area and converts it to soybean and second crop – corn succession system using no-till farming. Makes investments to convert pasturelands into crops with operations to restore soil fertility, minimal acquisition of machinery, and implementation of soybean and second crop – corn succession system. The results of this system are presented in a combined form for all activities performed (15 years).
Livestock + Soy + Corn		MT, GO, MS, MG, SP	

PRODUCTION SYSTEM		STATES	DESCRIPTION
Eucalyptus	Conversion of medium-vigor pasture into eucalyptus farming (planted forest)	MT, GO, MS, RO, PA, TO, BA, MG, SP, RS	Farmer implements eucalyptus crops in medium-vigor pasture areas, investing in operations to restore soil fertility, manual and mechanized operations to plant eucalyptus, and operating activities for the 15-year project cycle.
Livestock-Forestry Integrated System and Teak Farming	Conversion of medium-vigor pasture into livestock-forest integrated system with teak farming	MT	In a joint farming system, the livestock farmer makes investments to intensify livestock farming and restore pasture vigor, with a full production cycle (introduces livestock after 2 years of teak farming). After these interventions, the farmer assigns the area to the forestry producer (in exchange for part of the timber revenue), who makes investments to restore soil fertility, and runs operations to plant teak. The results of this system are presented in a combined form for all activities performed. 20 years of project duration.
Agroforestry System (cocoa + acai)	Conversion of a small area of medium-vigor pasture for the implementation of an agroforestry system with cocoa and açaí as the primary activities.	PA	The cattle breeder converts a small pasture area into an agroforestry system with cocoa, açaí, banana (for shading) and andiroba (forestry component). Makes investments to restore soil fertility and to plant the crops, including manual and mechanized operations, and operating activities for the 15-year cycle.

Source: study findings. Prepared by: Agroicone

The economic-financial model structure is in the Annex.

1.3. ESTIMATION OF THE POTENTIAL FOR SOIL CARBON EMISSIONS AND SEQUESTRATION FROM THE CONVERSION OR RECOVERY OF DEGRADED PASTURES INTO SUSTAINABLE AGRICULTURAL AND FORESTRY PRODUCTION SYSTEMS

Based on the survey and identification of pastureland with signs of degradation (medium and low vigor) to find out the potential for conversion or recovery of these areas into sustainable agricultural and forestry production systems, calculations were made to derive the potential for carbon (CO_2) emission and sequestration through the increase of organic carbon in these soils. The estimate of carbon mitigation potential depends on the type of land use and management, which may generate an increase or reduction in soil carbon, resulting in CO_2 sequestration or emissions, respectively (IPCC, 2006).

The emission or sequestration of soil carbon was accounted for considering various potential scenarios for the conversion or recovery of pasture areas with some level of degradation, namely:

i) Cattle ranching intensification systems;
ii) Dairy farming intensification systems;
iii) Crop production;
iv) Silviculture;
v) Agroforestry systems;
vi) Integrated systems (crop-livestock-forestry).

For the conversion of degraded pasture into beef and dairy cattle farming intensification systems, pasture recovery using good agricultural practices was considered for the purposes of ensuring increased livestock productivity and quality, considering well-managed pastures.

Additionally, from the perspective of soil carbon emission and sequestration, for the area of conversion into agriculture, it is necessary to break it down into three scenarios that consider the type of management employed in that area, as different soil management methods lead to different rates of CO2 emissions or removal. Therefore, the scenarios considered were:

a. Agriculture with conventional farming practices.
b. Agriculture with no-till farming practices (NT).
c. Agriculture with no-till farming system practices (NTS).

For the scenario involving conventional farming, practices with less conservationist approaches to soil management are considered, with high levels of soil disturbance in the upper layers and partial soil exposure, with no cover crops. As for no-till and no-till farming system, both result in carbon sequestration. The no-till farming system (NTS) generates greater sequestration due to practices that include only mobilization of the sowing line or hole, permanent soil cover maintenance, and diversification of species through crop rotation and/or intercropping. No-till (NT), on the other hand, merely involves the practice of sowing without more intense soil disturbance (EMBRAPA, 2021).

The carbon dioxide sequestration rate per area (tCO_2 ha^{-1} $year^{-1}$) was obtained from secondary data in national literature, seeking values that represent the sequestration potential through the adoption of management practices in production systems resulting from the conversion of pastures with signs of degradation. Worthy of note, only those areas with no deforestation since 2008 were considered for carbon estimates, according to PRODES data.

Table 1 CO_2 emission and removal factors by type of conversion to sustainable agricultural and forestry production systems.

SUSTAINABLE AGRICULTURAL AND FORESTRY PRODUCTION SYSTEMS		EMISSION/REMOVAL FACTOR tCO_2 HA^{-1} YEAR^{-1}	REFERENCE
Intensification of cattle ranching (pasture)		-2,24	Maia et al., (2009)
Intensification of dairy farming (pasture)		-2,24	Maia et al., (2009)
Agriculture	Plantio Convencional (PC)	1,47*	Costa Junior et al., (2013)
	Plantio Direto (PD)	-0,44	Costa Junior et al., (2013)
	Sistema Plantio Direto (SPD)	-1,84	Cerri et al., (2007)
Silviculture		-0,81	Lima et al., (2006)
Agroforestry Systems		-7,33	GHG Protocol — Forests (2020)
Integrated systems		-5,51	Oliveira et al., (2024)

*The positive sign indicates soil CO_2 emission, while the negative sign indicates soil CO_2 sequestration.

Note: To derive the conversion carbon stock increase rate into CO^2 sequestration, the values were multiplied by 3.67, according to the ratio of the molecular mass of CO_2 to that of C. One ton of CO_2 is equivalent to one ton of CO_2e.

Thus, the emission and sequestration potential through conversion to sustainable agricultural and forestry production systems was calculated by multiplying the potential areas considered for conversion in the previous stage by the respective soil carbon emission and sequestration factors:

$$V_{(E/R)} = A_{(system)} \times EF_{(E/R)}$$

Where:

$V_{(E/R)}$: Tons of soil CO_2 emissions or sequestration per year (tCO_2 year^{-1});

$A_{(system)}$: Potential area for conversion to sustainable agricultural and forestry production systems (ha);

$EF_{(E/R)}$: CO_2 emission or sequestration factor per area per year by type of conversion to sustainable agricultural and forestry production systems (tCO_2 ha^{-1} year^{-1}).

To estimate soil carbon sequestration potential, factors related to the permanence of soil carbon stock over the years were not considered. Moreover, the soil carbon saturation point was also disregarded due to the lack of more detailed information on these aspects (IPCC, 2006). Despite the use of emission and sequestration factors representative of national agriculture, further studies are required on soil carbon emission and sequestration by the different production and management systems in place, considering local edaphoclimatic and management aspects.

Finally, it should be noted that GHG emissions from the emitting sources and activities of each of the production systems with potential for recovery and conversion of degraded pastures were not accounted for. The increases or reductions in carbon stock increments from other reservoirs, such as above-ground and below-ground biomass from crops, litter and dead wood, were not accounted for either (IPCC, 2006). This document focused on soil carbon emissions and removals.

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2

FINDINGS

2.1. BRAZIL

• Brazil has approximately 179 million hectares (Mha) of pastures, of which approximately 60% (107.6 Mha) present some level of degradation, classified as low or medium vigor (Lapig, 2022).

• **Nine Brazilian states** concentrate **79% of the low and medium vigor areas (84.5 Mha)**, namely: Minas Gerais (17.2 Mha), Mato Grosso (12.5 Mha), Mato Grosso do Sul (12.3 Mha), Bahia (10.6 Mha), Goiás (10.1 Mha), Pará (7.8 Mha), Tocantins (5.4 Mha), Rondônia (4.7 Mha), and São Paulo (3.9 Mha).

• Of the pastures with some level of degradation in the country (107.6 Mha), 88.6 Mha are located on private rural properties registered in CAR, and 87.8 Mha of these areas do not overlap with restricted areas. The area of low or medium vigor pastures on private properties registered in CAR that does not overlap with restricted areas, and without deforestation after 2008, totals **40.7 Mha** – located on **1.8 million properties**. Spatial modeling considered this area to estimate the potential for conversion or recovery, based on biophysical, production, and infrastructure criteria.

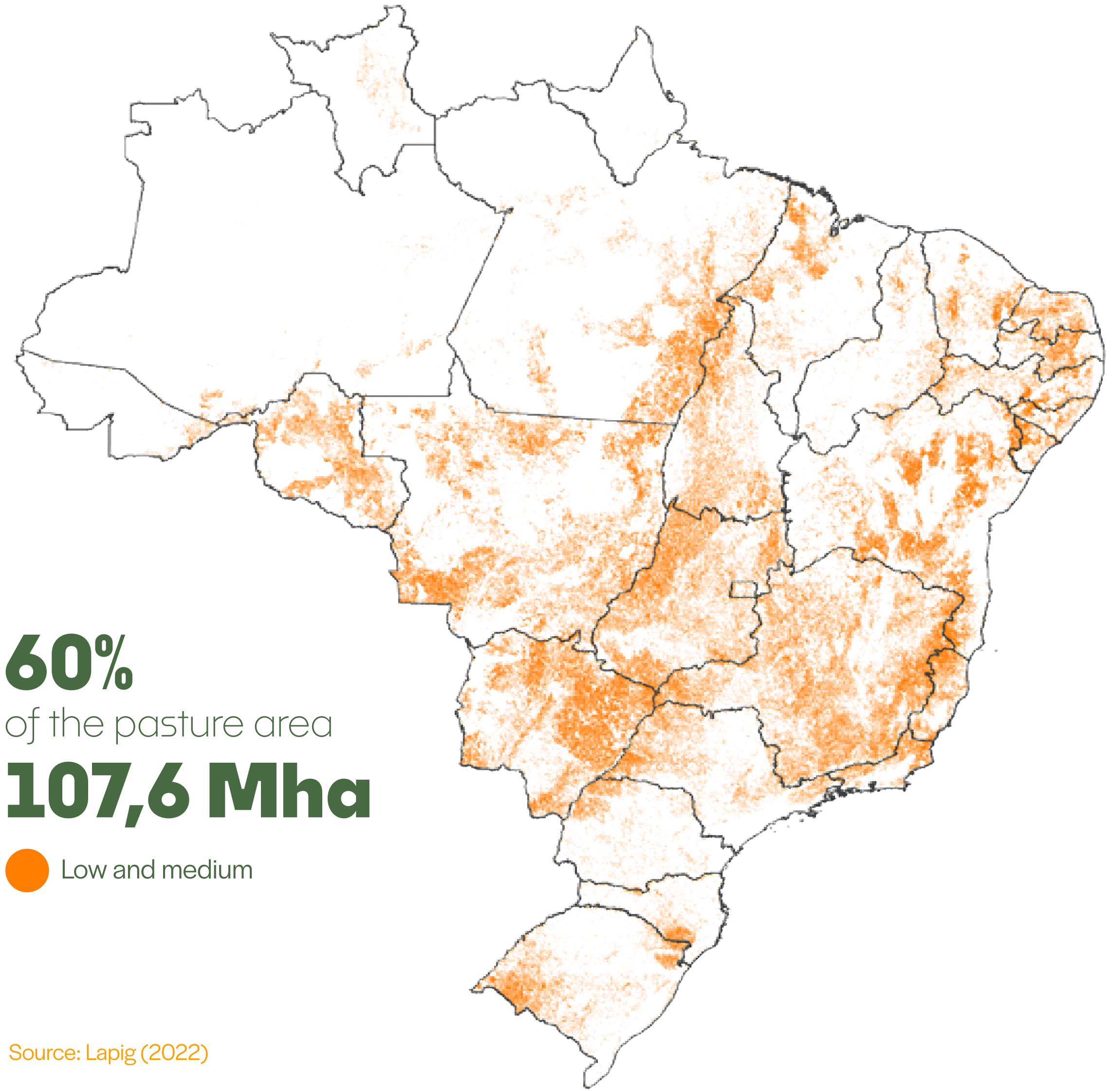
• Another **47 Mha**, found over **733,000 properties with deforestation** after 2008, were not included in the current accounting, but represent an additional potential to expand the PNCPD activity beyond the 40.7 Mha identified in properties without deforestation.

• According to the geospatial model, Brazil has about **27.7 Mha** of pastures with some level of degradation and potential for conversion into Sustainable Agricultural and Forestry Production Systems, which are distributed across **1.02 million properties**. Of these 27.7 Mha, **25.1 Mha have potential for intensification of cattle ranching, 16.9 Mha for dairy farming, 11.5 Mha for silviculture, 8.8 Mha for crops, and 7.1 Mha for agroforestry systems**.

Figure 2 Infographic synthesizing the assessment of low and medium vigor pastures in Brazil overlayed with CAR, restricted areas, and deforestation after 2008

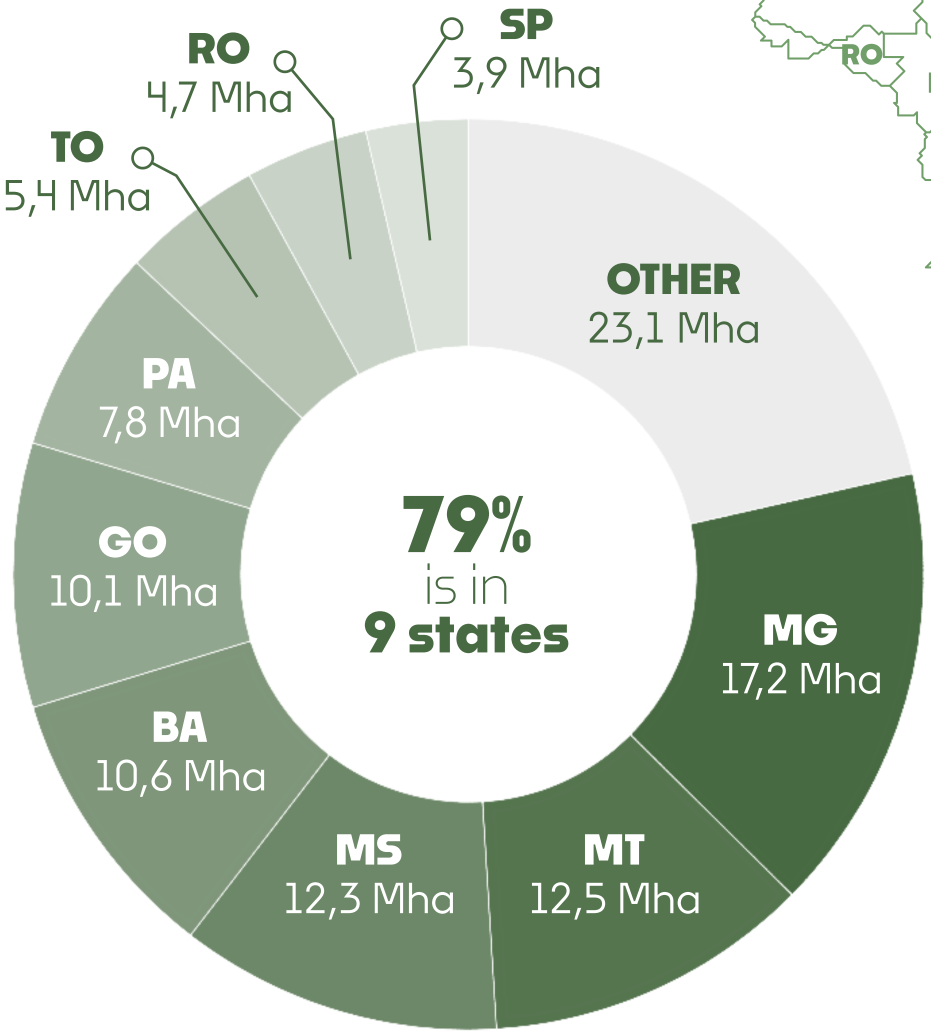
BRAZIL

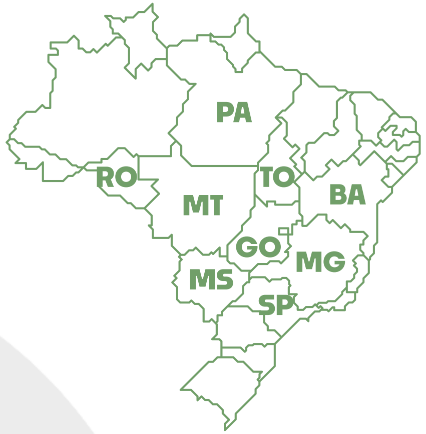
WHERE ARE THE LOW AND MEDIUM VIGOR PASTURES?



60%
of the pasture area
107,6 Mha

Low and medium





Source: Lapig (2022)

Figure 3 Infographic on potential areas for conversion of low and medium vigor pastures to Sustainable Agricultural and Forestry Production Systems

BRAZIL

HOW LARGE IS THE POTENTIAL PASTURE AREA?

Low and medium vigor pasture area — **107,6 Mha**

Area in rural properties registered in CAR — **88,6 Mha**

Area in properties registered in CAR not overlapping restricted areas* (suitable properties) — **87,8 Mha**

Area of suitable properties without deforestation after — **40,7 Mha**

POTENTIAL AREA
Area that meets the previous criteria, plus biophysical and infrastructure criteria — **27,7 Mha**

POTENTIAL AREA BY PROPERTY SIZE

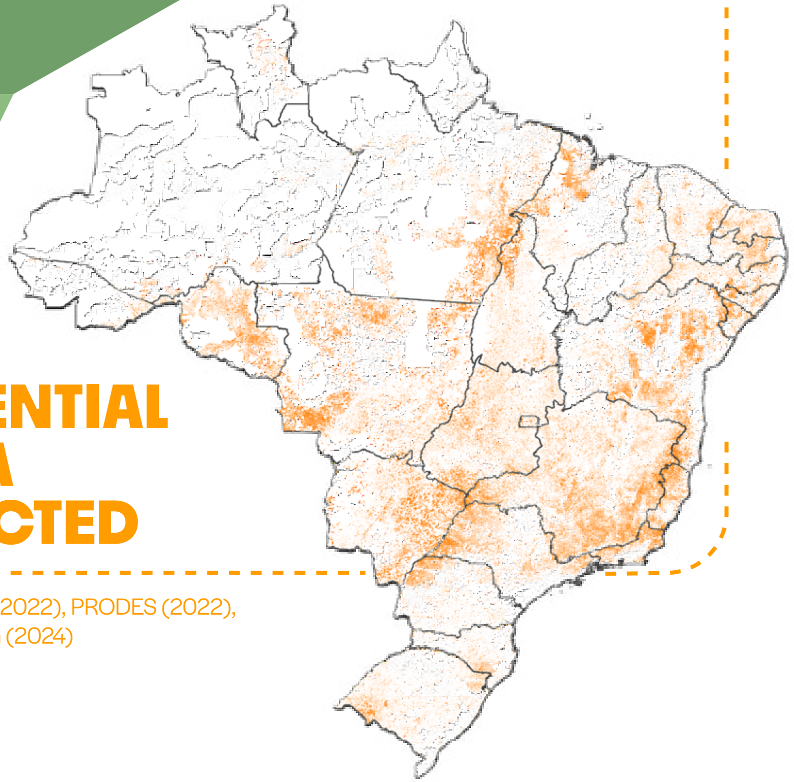
22% | 14% | 30% | 12% | 18% | 4%

PERCENTAGE OF PROPERTIES WITH POTENTIAL AREA, ACCORDING TO SIZE

73% | 13% | 11%

- 1 - 50 ha
- 51-100 ha
- 101- 500 ha
- 510-1.000 ha
- 1.001-5.000 ha
- >5.000 ha

POTENTIAL AREA SELECTED



Source: Lapig (2022), PRODES (2022), Cartas da Terra (2024)

POTENTIAL AREA FOR CONVERSION INTO EACH AGRICULTURAL AND FORESTRY SYSTEM

Potential areas on rural properties can be classified into multiple systems and may overlap. Therefore, the sum exceeds 27.7 Mha.

TOTAL POTENTIAL AREA — **27,7 Mha**

INTENSIFICATION OF CATTLERANCHING — **25,1 Mha**

INTENSIFICATION OF DAIRY FARMING — **16,9 Mha**

CONVERSION INTO SILVICULTURE — **11,5 Mha**

CONVERSION TO CROPS — **8,8 Mha**

CONVERSION INTO AGROFORESTRY — **7,1 Mha**

CONVERSION INTO INTEGRATED SYSTEMS — **2,6 Mha**

*Restricted areas are Integral Protection Conservation Units, Indigenous Lands or Military Areas.

AREA ALLOCATION FOR AGGREGATE COST AND INVESTMENT ESTIMATES

This study presents findings for the states of Mato Grosso, Mato Grosso do Sul, Goiás, Pará, Rondônia, Tocantins, Bahia, Minas Gerais, and São Paulo, which represent 79% of the low and medium vigor pasture areas in Brazil.

Based on spatial modeling, which included filters (CAR, restricted areas, and deforestation after 2008) and biophysical and production infrastructure criteria, these nine states have a total potential area of 23.1 million hectares.

Each state presented different shares in the conversion potential per system, considering land use characteristics and production dynamics. To evaluate the potential allocation of the total potential area of these states, as well as to estimate in an aggregated manner the need for investments and annual operating costs, the following criteria were considered for prioritizing the potential area of each state and aggregates[24]:

1. Priority was given to allocating the potential area for conversion to crops and crop-livestock integrated system.
2. Priority was given to allocating each state's ABC+ goals, if available, exploring the maximum possible potential in each system – such as silviculture, integrated, and agroforestry systems.
3. The areas were allocated for the intensification of cattle ranching.

The following figure presents the priority system of areas per system, the investment estimates per hectare, and aggregated for the 9 states selected, and the operating costs involved per year per hectare.

24 Economic and financial analyses were conducted with estimates of investments and costs required for the conversion of low and medium vigor pasture areas only into some of the systems with potential presented: agriculture, silviculture, crop-livestock system, livestock-forest system (only for the state of Mato Grosso), agroforestry systems (only for the state of Pará), and intensification of beef cattle farming. The other systems presented require local information, which is not available in this phase of the study. This does not prevent the conversion of degraded pastures into these systems, given the estimated area potential in each state.

ESTIMATE OF AGGREGATE COSTS AND INVESTMENTS (9 STATES)

9 states simulated: MT, MS, GO, PA, TO, RO, SP, MG, BA
Database adapted for each state, resulting in weighted-average investments and costs per hectare and aggregated according to the allocation of areas for each system

SUSTAINABLE PRODUCTION SYSTEM	AREA SELECTED BY SYSTEM (thousand ha)	INITIAL INVESTMENT (R$/ha)	TOTAL INITIAL INVESTMENT (thousand R$)	OPERATING COST PER YEAR (R$/ha)
Soybean or soybean and second crop – corn succession	4.053.532	6.099	24.723.586	8.598
Crop-livestock integrated system	4.179.816	6.121	25.584.515	5.403
Intensification of beef cattle farming	12.202.094	5.145	62.773.887	2.285
Silviculture	2.229.175	8.825	19.671.692	1.933
Livestock-forest integrated system	389.875	7.929	3.091.336	3.069
Agroforestry system	100.000	31.378	3.137.827	134
TOTAL	**23.154.492**	-	**138.982.841**	-

Considering the estimated potential area of 23.1 million hectares, initial investments of at least R$139 billion will be needed to convert low and medium vigor pasture areas to the sustainable systems described in the figure above. Adding up the operating costs, R$90.8 billion will be required annually.

Finally, the decision to convert these pastures to each system must come from the farmers, as this is only a theoretical estimate based on the results found. Furthermore, other policies and boundary conditions for conversion to each system must be observed, as not all sustainable systems have shown economic and financial feasibility across all states in Brazil, as presented in this study.

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ANNEX

ECONOMIC-FINANCIAL MODEL

Levered Free Cash Flow economic-financial analysis was used for all simulations. The main economic indicators used to compare the baseline scenario (BAU) of maintaining degraded pasture with the simulated sustainable production systems, whether conversion to agriculture (grains), integrated systems, silviculture, agroforestry systems or pasture intensification for economic feasibility were:

- **Weighted Average Cost of Capital – WACC** represents the discount rate on the discounted cash flow or the cost of capital used to evaluate investment projects. It is calculated by:

$$WACC=Kd*(1-T)*D\%+Ke*E\%$$

where Kd is the pre-tax cost of debt, T is the tax rate, $D\%$ is the percentage of debt to total value, Ke is the cost of equity, and $E\%$ is the percentage of equity over the total.

- **Net Present Value – NPV** is the difference between the present value of cash inflows and the present value of cash outflows over a period. It accounts for the time value of money and can be used to compare similar investment alternatives. NPV is used in capital budgeting and investment planning to analyze the profitability of an investment or project. The NPV formula is the following::

$$NPV=\sum_{t=1}^{n}\frac{R_t}{(1+i)^t}$$

where R_t are the net cash inflows and outflows over a single period t, i is the discount rate or rate of return that could be obtained from alternative investments, and t is the number of periods.

- **Internal Rate of Return – IRR** is a discount rate that sets the net present value (NPV) of all cash flows equal to zero in a discounted cash flow analysis. It is used in financial analysis to estimate the return on potential investments. It is calculated by:

$$0=\sum_{t=1}^{T}\frac{C_t}{(1+TIR)^t}-C_0$$

where C_t is the net cash inflow during period t, C_0 is the total cost of the initial investment, TIR is the internal rate of return, and t is the number of periods.

- **Necessary investment or Capital Expenditure (CAPEX)** are resources used to acquire, upgrade, and maintain physical assets such as real estate, plants, buildings, technology, or equipment. The CAPEX formula is:

$$\Delta PP\&E + Depreciação\ Corrente$$

where $\Delta PP\&E$ are changes in fixed assets (investments made). For the conversion or recovery of degraded pastures, the necessary investment includes soil amendments, seeds, seedlings, manual and mechanized operations to make interventions, fences, troughs, drinkers, machinery, etc.

- ***Payback*** refers to the time required to recover the cost of an investment. It is calculated by the ratio of the required investment to the annual net cash inflow. This indicator was not presented in the results, although they were calculated.

To structure the economic-financial model, the following were considered:

- **Project period**: 15-year period for all systems except for the livestock-forest integrated system with teak (20-year period).

- **Agronomic and zootechnical indicators throughout the project period**: Historical productivity growth rate for soybean and second crop – corn succession system, increase in livestock productivity reaching a live weight gain of 18 arrobas /ha/year (starting from 3 arrobas/ha/year of the degraded pasture). For eucalyptus production systems, productivity indicators change according to the year of harvesting, while for teak, they remain the same.

- **Financial indicators over the project period** (projected inflation rates, 15% income tax on positive return, etc.).

- **Conversion/recovery area**: A 500-hectare module was used for all states and simulated systems, except for the agroforestry system, simulated only for the state of Pará, considering a 5-ha module for conversion. For the states of São Paulo and Rio Grande do Sul, a 100-hectare module was added to the analysis.

- **Capital structure**: Land purchases or land price appreciation due to changes in land use were not considered; only in the conversion models that contain grains is there a small investment in machinery, with no machinery acquisition in the other systems, which consider machine-hour costs. Operating costs included leasing costs for grain conversion models (soybean or soybean and second crop – corn succession system) and a joint farming system or the livestock-forest integrated system with teak in Mato Grosso, without land costs.

- **Structure of financing sources** (to calculate the real WACC): For operating costs and investments (equity, financing with official rural credit, financing with market credit, trading operations, etc.), payment conditions, interest rates, etc.

Table A1 presents a brief description of the indicators and sources consulted.

Table A1 Indicators used in the business models

	VARIABLE	UNIT MEASUREMENT	SOURCE
Investment Project	Project period	15 years (except for teak, 20 years)	Agroicone (previous studies)
Agronomic indicators	soybean and second crop – corn succession system productivity	ton/ha (productivity below average until year 3 and growing until year 15)	CONAB
	Livestock productivity	arroba/hectare/year and heads/hectare/year	IHS-Markit - Anualpec Beef Report ABIEC Agroicone (previous studies)
	Eucalyptus productivity	m³/ha (2 cuts)	IHS-Markit - Agrianual IBGE - PEVS
	Teak productivity	m³/ha (1 cut)	Local stakeholders from Mato Grosso
Property structure	500-hectare area module for production systems, except for agroforestry system in Pará, of 5 hectares.	Hectare	Agroicone com base em estudos anteriores
Capital structure for production system transition*	Capital investments for conversion and/or recovery of degraded pasture areas (manual operations, mechanized operations, purchase of inputs)	R$/hectare	HS-Markit — Agrianual and IHS-Markit Anualpec (with updates and differences between states) Agroicone (previous studies and conversations with local stakeholders)
	Intensification of beef cattle farming: pasture rotation includes investments in fencing, drinkers and troughs. Conversion to soy, soybean and second crop – corn succession system, and crop-livestock includes minimal investments in crop machinery.		
Structure of financing sources*	Interest rate on rural credit	% p.a.	2024/2025 Harvest Plan (nominal rate of 8% p.a.)
	Interest rate for barter or equity (operating loan)	% p.a.	The nominal Selic rate of 10.5% p.a. was considered a proxy (Agroicone studies)
	Interest rate for investments (rural credit)	% p.a.	2024/2025 Harvest Plan (e.g. RenovAgro Recuperação e Floresta with nominal rate of 8.5% p.a. and 5-year grace period, Moderfrota with nominal rate of 10.5% p.a. and 1-year grace period, Pronaf Bioeconomia for Agroforestry Systems, with nominal rate of 3% p.a.) and cost of equity (nominal rate of 10.5% p.a.)

	VARIABLE	UNIT MEASUREMENT	SOURCE
Economic indicators**	Operating costs for soybean and second crop – corn succession system (includes machine-hour costs, man-hour costs, input costs, leasing costs, etc.)	R$/sack/year or R$/ton/year	CONAB
	IHS-Markit — Agriannual	R$/@ ou R$/ha	IHS-Markit - Anualpec Beef Report ABIEC
	Operating costs of intensified livestock farming	R$/arroba or R$/ha	IHS-Markit — Annualpec Beef Report ABIEC
	Operating costs for eucalyptus (includes machine-hour costs, man-hour costs, input costs, etc.)	R$/ha	IHS-Markit — Agrianual (with updates)
	Operating costs for teak (includes machine-hour costs, man-hour costs, input costs, etc.)	R$/ha	Local stakeholders consulted
	Operating costs for cocoa and açaí agroforestry systems	R$/ha	Agroicone (previous studies)
	Prices (soy, corn)	R$/sack or R$/ton	CONAB
	Beef cattle prices	R$/arroba[5] or R$/animal	CONAB
	Scot Consultoria	R$/kg	CONAB Atores locais consultados
Financial indicators	Interest rate (equity)	% p.a.	The nominal Selic rate of 10.5% p.a. was considered a proxy (Agroicone studies)
	Inflation rate	% p.a.	Boletim Focus, IPCA (average rate of 3.82% p.a.) IGP-DI for cost/investment updates when necessary and to deflate amounts for December 2023

* The composition of capital structures for agricultural interventions differs according to each production system, as does the composition of investment and operating loans.
** Economic indicators refer to the year 2023 or the average of the past six years, depending on the variable, in actual amounts as of December 2023.
Source: study findings. Prepared by: Agroicone

[5] Translation Note: Arroba = weight unit equivalent to 15 kilograms, or approximately 33.07 pounds. In Brazil, 1 arroba is a traditional unit of weight commonly used in agriculture and livestock.

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