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The Cerrado: Production and Protection

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Contents

Foreword	3
Foreword by report authors	4
Executive summary	5
1 Cerrado: the tropical savanna leading agricultural production	8
1.1 Unveiling the Cerrado's rich natural capital	9
1.2 The human habitats and communities of the Cerrado	10
1.3 The Cerrado: a global agricultural production and export hub	11
1.4 Greenhouse gas emissions in Brazil	13
1.5 The conversion challenge	14
1.6 Policies, legal instruments and government regulation	16
2 Vision for a future of sustainable production and protection	19
2.1 Boosting sustainable, high-value production in the Cerrado	21
2.2 Improving protection and restoration in the Cerrado	25
3 Call to action to implement the new vision for the Cerrado	31
3.1 Different sector roles to deliver on the new vision	32
Conclusion	34
Contributors	35
Endnotes	37

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Foreword



Joaquim Levy
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The transformation of the central region of Brazil from ranching backlands where “little would grow” into a powerhouse of food production in a mere 40 years is not so much a miracle as the result of a vision born of international cooperation and the entrepreneurship of Brazilian farmers. Plentiful surpluses of soy and corn from the Cerrado now help feed billions of people, notably in Asia, and have freed land closer to Brazilian cities for growing staples such as black beans, roots and fruits. Innovation has been the hallmark of this expansion, with every tonne of grain grown in newly planted areas being matched by the increased productivity of existing farms that often yield two or more crops a year.

The extraordinary success of agriculture in the Cerrado has come with costs. As the sector becomes more robust, many people in Brazil, including farmers, believe it is high time to address and minimize these costs, especially regarding the environment, to ensure the sustainability of this bounty for coming generations. Addressing this issue is particularly important given global climate change, the negative effects of which will be felt more strongly in tropical zones. Fortunately, there are ways to protect the Cerrado without stifling food production or voiding the opportunities that have now started to reach people in some of the poorest states in Brazil.

The elimination of native vegetation is among the biggest costs of agricultural expansion in most parts of the world as well as in Brazil. Changes in land use can increase greenhouse gas emissions and affect rain patterns, the quality of the soil and, of course, biodiversity. Although the conversion of native vegetation in the Cerrado has dropped in relation to the early 2000s, it has increased in recent years and related emissions added close to 100 million tonnes of CO₂-equivalent to the atmosphere in 2022

(0.15% of global emissions). These negative impacts to climate and biodiversity could be substantially reduced by decelerating the conversion of native vegetation in specific regions and accelerating the conversion of old, degraded pastures into areas dedicated to low-carbon food production techniques, including regenerative agriculture.

This report cogently illustrates that the sustainability of the Cerrado can be strengthened in a way that balances production, better life conditions for Brazilians and protection of the biome. Such an approach, already under way, could form part of a government strategy to move the country towards a green, net-zero economy in the next two decades. This transition has the potential to be both fair and rich in jobs, while helping partner countries reduce their own emissions.

The World Economic Forum is to be commended for publishing this excellent report on promoting a sustainable development pathway for the Cerrado when Brazil is hosting the G20 Summit and preparing for the UN’s Climate Change Conference COP30 in 2025.

I urge leaders and decision-makers to give the proposals outlined in this document serious consideration. Together, let us harness this critical moment to enhance the protection and productivity of the Cerrado and foster sustainable economic growth at local and global levels.

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Foreword by report authors



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The Cerrado biome is equivalent to the size of England, France, Germany, Sweden and Spain combined. Yet this most biodiverse of all the world's savannas has seen more than half its area converted to croplands and cattle pastures in recent decades – a loss of native vegetation that represents one of the fastest transformations of nature on Earth.¹

The expansion of agricultural production into the Cerrado region has brought with it significant economic development for the country and its agribusiness sectors. But such development is putting at risk the critical ecosystem services that this biome – the largest in South America after the Amazon – provides to the wider region. It serves as a giant reservoir of water for much of the country, it regulates regional rainfall patterns, it acts as a vast carbon sink and it is home to 5% of the planet's animal and plant species. The Cerrado is also home to 100,000 Indigenous peoples and traditional communities who have lived there for millennia.

This report makes the case for reconciling agribusiness production with the protection and

restoration of the Cerrado's native vegetation. The challenge is to build on Brazil's success in deploying technology, policies and science to boost agricultural development on existing productive or degraded land, while demonstrating that ecosystem protection can add economic value to the country. Measures proposed include the sustainable intensification of agriculture, the restoration of already degraded areas back into productive croplands, well-designed renewable energy and green industrial development, more generous incentives for protection that include carbon and biodiversity markets, and more robust law enforcement.

Finding a balance between production and protection is possible. This report demonstrates how these differing agendas, rather than being opposed to each other, can together form an integral approach to regional development that strengthens the well-being of all the life that shares this landscape. The vision proposed in this paper outlines a sustainable development pathway for the Cerrado that can contribute to both Brazil's prosperity and global climate goals.

Executive summary

Brazil's Cerrado region has the potential to reconcile agricultural production with environmental protection in a way that delivers gains for climate, nature and people.

Agricultural development in the Cerrado has come at a high environmental cost

The Cerrado made headlines as an agricultural miracle in the 2010s,² having become the leading production hub in Brazil for global exports of soy, cattle, corn and sugarcane, representing 60% of Brazil's total agricultural output.³ The growth of such an economic powerhouse in the central region of the country has shifted national power dynamics and given a strong voice to political actors from rural areas.

However, the expansion of the agricultural sector has come at a high price for the Cerrado, the world's most biodiverse savanna and – at 2 million km² – the second-largest biome in South America. The growth in the region's agricultural production has been achieved by clearing relatively cheap and plentiful lands,⁴ resulting in half the native vegetation being lost.⁵ In 2023, according to the Brazil government's DETER database,⁶ 7,800 km² were converted to agriculture in the Cerrado – an increase of 43% on the year before. This is in sharp contrast to the downward trend in the Amazon,⁷ where forest conversion in 2023 was 4,000 km² – a reduction of 62% on the year before.⁸

Ecosystem services provided by the Cerrado are critical to Brazil's economy and peoples

Relatively unknown compared to the Amazon rainforest, the Cerrado biome provides numerous ecosystem services to the wider region. It is home to 5% of all the animal and plant species on Earth.⁹ As a reservoir for 14% of Brazil's freshwater resources,¹⁰ it is pivotal for the country's water security and regulation of regional rainfall patterns. It acts as an important carbon sink; and it is home to numerous traditional communities and Indigenous people who have inhabited the region for millennia.

The biome's abundant water supply, stable temperatures and regular rainfall allow the land to

yield three harvests per year in selected regions. Yet the conversion of the Cerrado biome, combined with a more fragile Amazon, threatens the region's ecological balance on which the long-term sustainability of agricultural production depends. As a result, the Cerrado is trapped in an apparent dilemma between fast economic development and the safeguarding of its natural capital.

Experience shows that production and protection can work together for the benefit of people, nature and the economy

The Cerrado is a victim of its own strengths – its rich and relatively accessible lands, generous rainfall and availability of water, coupled with a policy environment that favours agricultural production, still make it the ideal land for agricultural expansion. But there is an opportunity for Brazil to leverage the potential of the Cerrado to lead the world not only as an agricultural powerhouse but also as an environmental problem-solver for future decades.¹¹ To achieve this, Brazil can build on its success in deploying policy and technology to enhance agricultural development, while detaching production from the need for new conversion and simultaneously demonstrating that ecosystem protection can add economic value to the country.

Experience on the ground demonstrates ways to align the production and protection agendas in the Cerrado. For example: increased enforcement of no-conversion policies (e.g. Plan of Action for Prevention and Control of Conversion and Fires in the Cerrado, Brazilian Forest Code) has not undermined agricultural productivity or economic growth. It is feasible to restore degraded lands for agricultural production; improved technology does increase productivity; there is room for regenerative agriculture and landscape agriculture; and strengthening the policy framework can promote incentives to protect native vegetation on private lands.

“ In 2023, conversion in the Cerrado increased 43% – compared to a 62% reduction in the Amazon.



BOX 1 | Production and protection agendas



Production agenda

As the driver of economic growth and development, production needs to be coupled with a clear pathway to protect the natural ecosystems on which it depends. This could be achieved in the Cerrado by:

Sustainable intensification of agriculture on productive and degraded land

- Transition agricultural production towards sustainability and couple it with value aggregation.
- Increase productivity and encourage the adoption of regenerative and integrated systems in the current production area, as well as on over 30 million hectares of degraded land.
- Sustainable intensification of agriculture could add an additional \$29-40 billion to the country's GDP.

Well-designed renewable energy and green industry

- Fuel industrial and bioenergy production through solar power, freshwater and biomass resources.
- Renewable energy and green industry could add an additional \$6-11 billion to the country's GDP.
- The success of this agenda depends on a healthy Cerrado biome and preventing further loss of native vegetation.



Protection agenda

Reduce drastically further conversion of the Cerrado

- Strengthen command and control, reducing illegal deforestation to zero.
- Develop a set of strategies that can create financial incentives to substantially reduce deforestation and conversion.

Value creation for native vegetation through carbon markets and the bioeconomy

- There is potential to create value for native vegetation (\$12-21 billion) by capitalizing on the opportunities of global carbon markets and the bioeconomy, combined with the scale-up of incentives for producers to protect private properties.

Creation of incentives for protection

- For the Cerrado, the Brazilian Forest Code mandates forest protection at the property level (legal reserves) of between 20% and 35% (compared to 80% in the Amazon).
- Consequently, there is an urgent need to develop a set of mechanisms that incentivize landowners to conserve the existing 30+ million hectares of private land that could be legally converted.
- This includes leveraging a number of public policies to improve the state of the biome, e.g. strengthen implementation of the Brazilian Forest Code, the low carbon agriculture plan and the Plan of Action for Prevention and Control of Conversion and Fires in the Cerrado (PPCerrado).

“ 66% of Brazil's net greenhouse gas emissions arise from deforestation, land conversion and agriculture.

A new approach to sustainable development in the Cerrado could provide a blueprint for other global biomes

The Cerrado has a strategic significance beyond Brazil: no other biome has such a key role to play in furthering food security while continuing to protect such rich biodiversity. The Cerrado's vast area has experienced more extensive agricultural and economic transformation than any other savanna on Earth.¹² Yet this development no longer needs to come at the expense of destroying the biome. A new model is possible, in which sustainable agriculture and diversified economic growth are combined with environmental conservation that protects the Cerrado from further land conversion while restoring degraded soils and vegetation.¹³ Protecting the biome is also a global challenge, as many nations depend on the Cerrado – whether it is for food, fuel, feed or ecosystem services. Collaborative efforts from governments, the private sector and international partners are required to comprehensively address these challenges and take advantage of the existing levers of a sustainable and growing Cerrado.

Reversing land conversion in the Cerrado is as important for the climate as it is for nature. In contrast to the rest of the world, where 78% of total net greenhouse gas (GHG) emissions originate from the energy, waste and industrial sectors,¹⁴ in Brazil the majority of emissions (66%) arise from deforestation, land conversion and agriculture.¹⁵ So the country needs to reduce land conversion in

the Cerrado to cut down its emissions and meet its climate targets. Curbing deforestation and the conversion of native vegetation, along with the adoption of low-carbon agricultural practices, could greatly reduce emissions. By one account Brazil could achieve net-zero by 2036, remove an additional 1.2 gigatonnes (Gt – billion tonnes) of carbon dioxide equivalent (CO₂e) by 2050,¹⁶ and become the proof case for an emerging business model for tackling the climate and nature crises, driven by public and private sector action.

This paper aims to showcase the Cerrado as a leading global case study in how responding to the imperatives of protecting climate and nature can be reconciled with food security concerns, while boosting social and economic development. It demonstrates not only that protection and production can be kept in balance, but that their roles are mutually dependent in creating a future Cerrado that is sustainable for both people and nature.

The upcoming G20 Summit in 2024 and the COP30 Climate Change Conference in 2025, both of which Brazil is presiding over, provide platforms to showcase the country's commitment to a green Cerrado economy, as well as its ambition to attract investment in sustainable agriculture and contribute to global climate ambition. The Cerrado's significance to the world's emerging green economy makes these efforts not only a recommendation but a necessity for a sustainable and harmonious future.



1

Cerrado: the tropical savanna leading agricultural production

The Cerrado is a critical, unseen ecosystem that has spearheaded Brazil's agricultural exports, but at the cost of half its native vegetation.

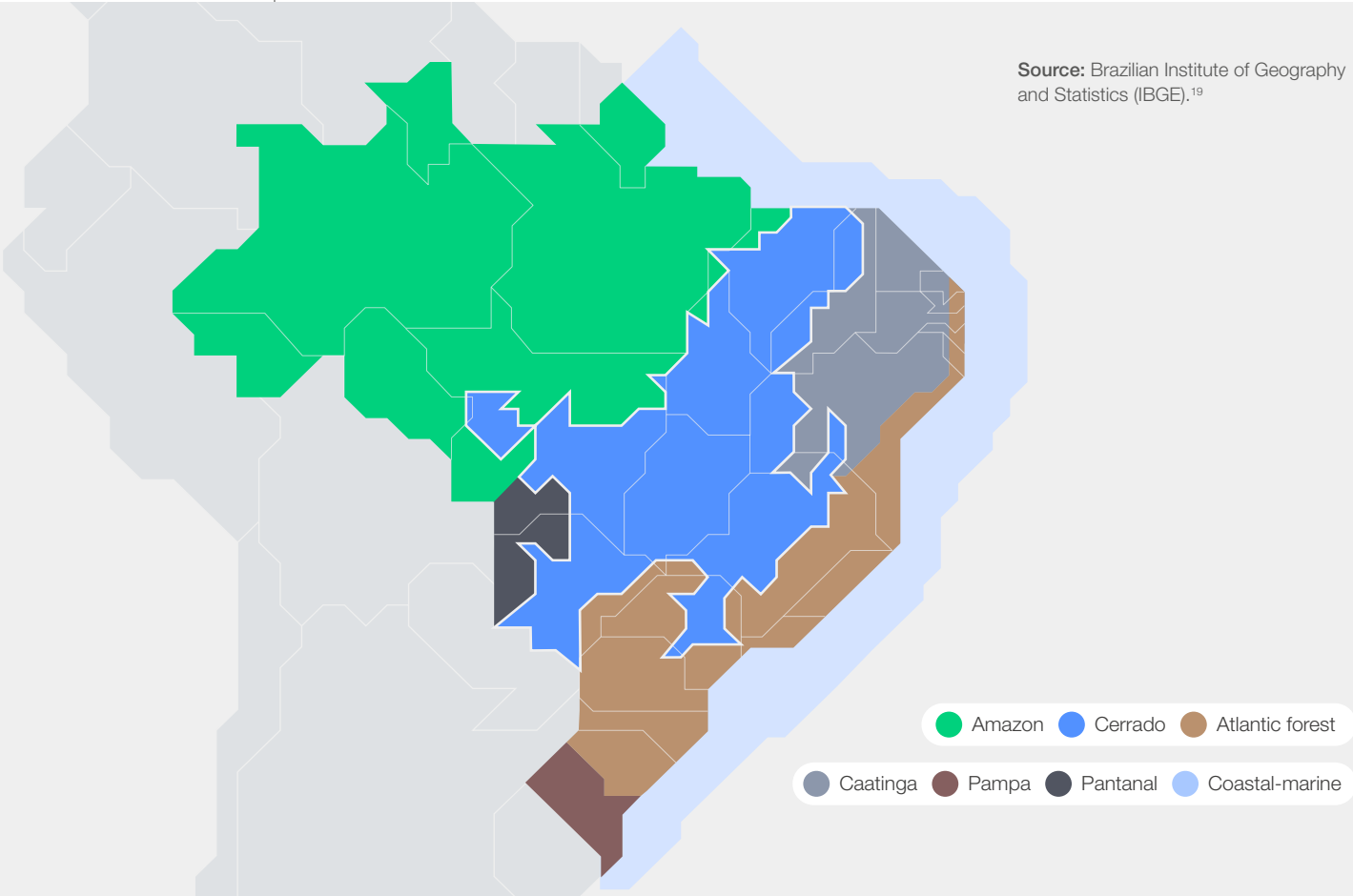
“ 30 million hectares (Mha) of the Cerrado have been converted over the past 20 years.

When thinking about Brazil's environmental treasures that need to be protected, the global spotlight is often on the Amazon. Nevertheless, Brazil is home to other critical ecosystems, with the Cerrado standing out due to its biodiversity value and the ecosystem services it provides to the entire region. While for years civil society groups and academia have called attention to the ecological importance of the Cerrado and the dangers it has faced due to global agricultural expansion, the centre of Brazil has made headlines as an agricultural powerhouse, producing crops and cattle for international markets.

In the last two decades, the Cerrado was responsible for over 60% of total Brazilian production of soy, corn and sugar cane.¹⁷ However, this level of production has come at a high price – the biome has lost 50% of its native vegetation as 30 million hectares (Mha) were converted over the past 20 years.¹⁸

This white paper explores strategies to balance the biome's protection and its productive activities, defining pathways for sustainable growth to be pursued by the private sector and enabled by philanthropy and public policy-makers.

FIGURE 1 Map of Brazilian biomes



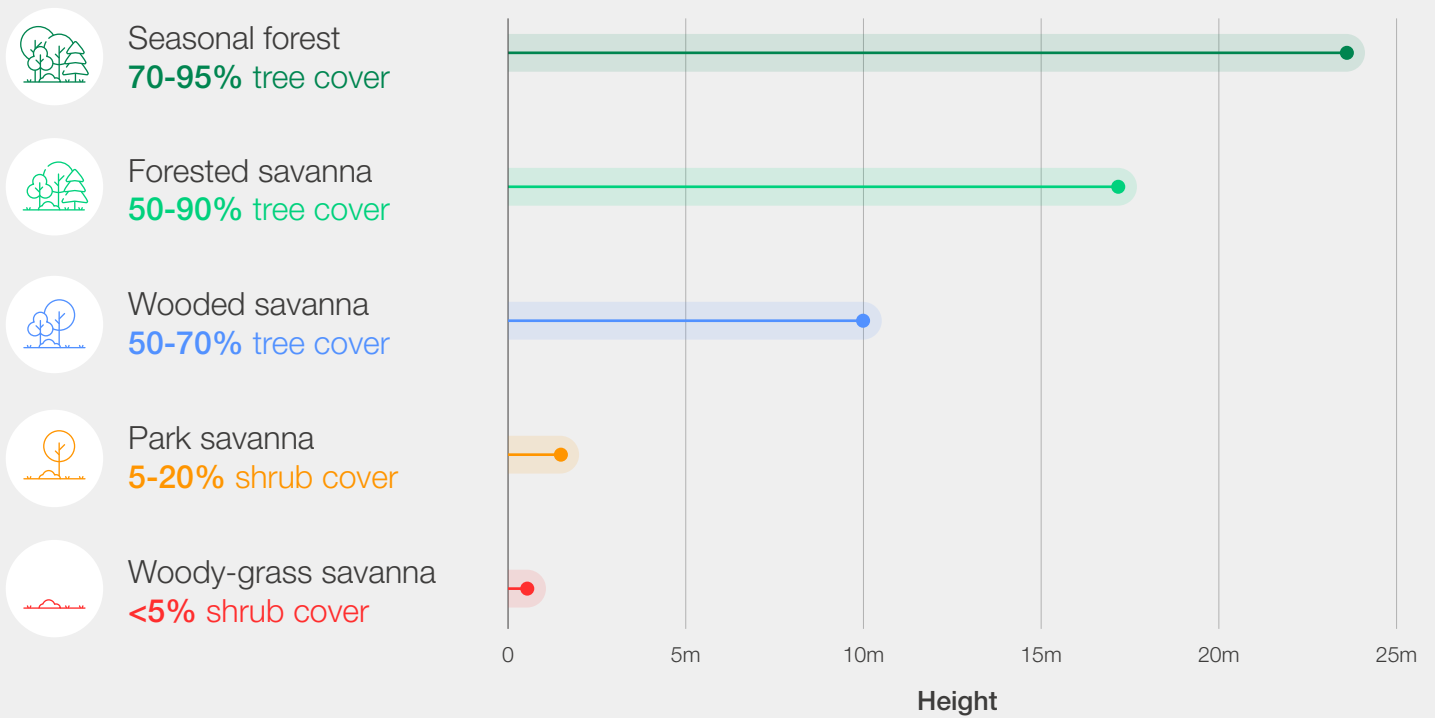
1.1 Unveiling the Cerrado's rich natural capital

The Cerrado is a tropical savanna that covers over 200 million hectares (23.3% of Brazil)²⁰ and is the second-largest biome in Latin America. As the world's most biodiverse savanna, the Cerrado hosts more than 330,000 species,²¹ making it home to 5% of all the species on the planet.²²

The rich biodiversity of the Cerrado region is attributed to the heterogeneity of the landscape, which includes woody-grass combinations, as well as forest features in the transition with the Amazon and the Atlantic Forest (see Figure 2).

FIGURE 2 Types of Cerrado

The high species richness (number of species) and vegetation structure (height and canopy cover) show the ecological complexity of the Cerrado



Sources: graphs – Cerrado Initiative.²³



Beyond its biodiversity, the Cerrado accounts for 14% of the nation's surface water resources.²⁴ This is particularly significant for energy security, given that around 60% of Brazil's electrical matrix relies on hydropower.²⁵ The conversion of native vegetation into cropland not only impacts rainfall regulation, it also threatens the vital role of the Cerrado as a

major carbon sink, which currently locks away 16% of Brazil's total stored carbon.²⁶ Several other South American biomes – such as the Amazon, Pantanal and Caatinga – depend on the ecosystem services provided by the Cerrado and thus the significance of protecting the Cerrado spans beyond the biome's borders.²⁷



1.2 The human habitats and communities of the Cerrado

The Cerrado biome can be found in 11 of Brazil's 27 states, spanning across the centre-west, north and northeast political regions of Brazil. Its population numbers 25.5 million inhabitants, of whom 83% live in urban areas,²⁸ including major cities such as Brasília (Brazil's capital), Goiânia and Campo Grande. The Cerrado saw the highest population growth in Brazil (15%) between 2010 and 2022,²⁹ boosted by migrants from all parts of Brazil.

Among the peoples living in the Cerrado, 100,000 are from settlements founded by fugitive slaves (*quilombolas*) in the late 19th century as well as Indigenous communities from 83 distinct ethnicities. They are distributed across 216 Indigenous and 44 *quilombola* protected territories. These groups are

predominantly situated in rural areas of the states of Maranhão, Tocantins, Goiás, Mato Grosso and Mato Grosso do Sul.³⁰

Additionally, the Cerrado grapples with ongoing territorial disputes between Indigenous communities and rural producers. The absence of formal land regularization for some Indigenous lands poses a serious threat to the survival of numerous Indigenous communities, as it leads to conflicts that are influenced by economic and political interests contested at the highest levels of the Brazilian political and business landscape. In 2019, there were 540 registered conflicts in the Cerrado – 43% more than in 2003 – perpetrated mostly against traditional communities and the landless rural workers movement.³¹

1.3 The Cerrado: a global agricultural production and export hub

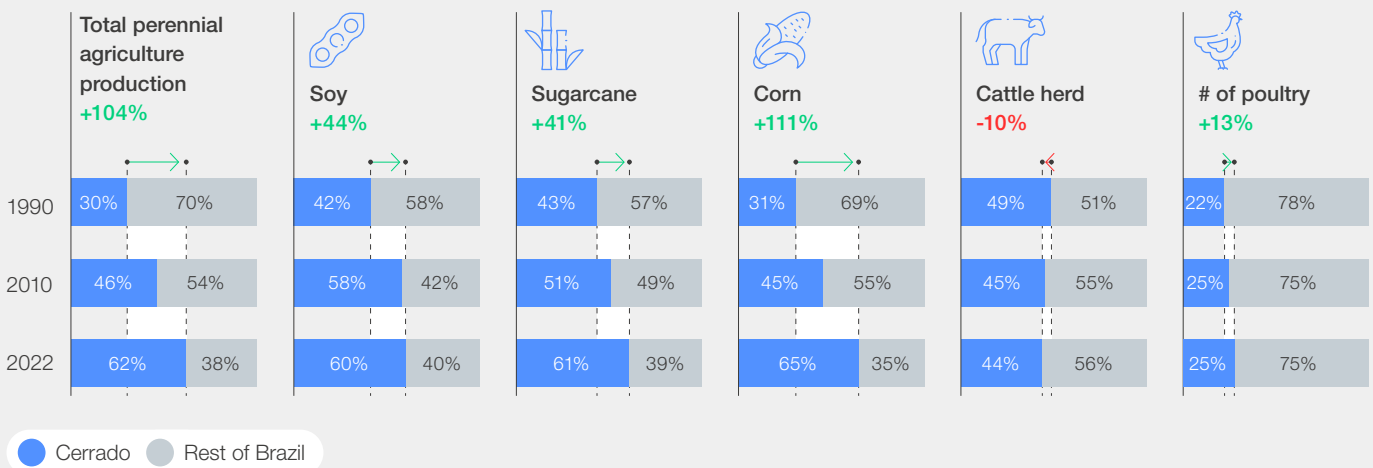
“ The Cerrado contributes over 60% of Brazil’s agricultural output.

Over the past decade, the Cerrado has gained a greater role in Brazil’s agribusiness sector, owing to the production of commodities such as soy (60% of national production in 2022), corn (65%) and cattle (44%). For the evolution of agribusiness in the Cerrado since 1990, see Figure 3.³²

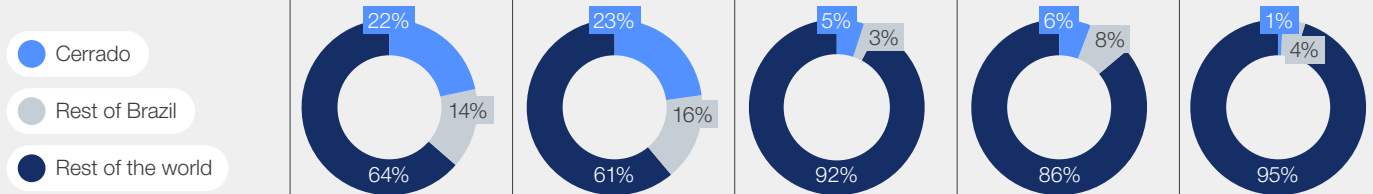
Currently, the Cerrado contributes over 60% of Brazil’s total agricultural output,³³ which amounts to 22% of soybean and 23% of sugarcane production worldwide. Agribusiness contributes 25% of Brazil’s GDP, making the agricultural regions extremely influential both financially and politically.

FIGURE 3 The Cerrado’s share in agribusiness production

Percentage of the Cerrado's production in relation to total Brazilian agricultural production value



Global production, 2021



Sources: Brazilian Institute of Geography and Statistics (IBGE), Resourcetrade.earth, US Department of Agriculture.³⁴

As a result, the Cerrado region has shaped Brazil’s export landscape. The nation’s agricultural and cattle exports surged from \$45 billion in 2020 to \$74 billion in 2022, a significant 64% increase within two years.³⁵ This growth was concentrated in soy and corn, together with growing exports of cattle, coffee and cotton, among other products. More generally, the share of the top five exported commodities (soy, iron ore, crude oil, meat and corn) has

steadily increased from 16% of total exports in 2000, to more than half of total exports today.³⁶ Government policies, particularly tax exemptions totalling around \$12 billion for production and trade,³⁷ have incentivized this shift in commodity production. However, this expansion has brought costs to the environment, with 3.5 Mha of land converted in the country between 2020 and 2022, leading to an increase of 6% in GHG emissions.³⁸

BOX 2 | The changing nature of production in the Cerrado

Production in the Cerrado languished until the mid-1970s, being limited mostly to cattle. Real change happened when the government provided cheap land to farmers from the south of Brazil and invested in improvements to grain genetics, soil management techniques and transportation infrastructure that drove increasingly productive agriculture.³⁹

The growth of grain production is upending the traditional cattle ranching model and creates an opportunity to expand production not only by

increasing yields per hectare, but by converting large tracts of existing pastureland into agricultural areas, thereby reducing the pressure to convert untouched land.

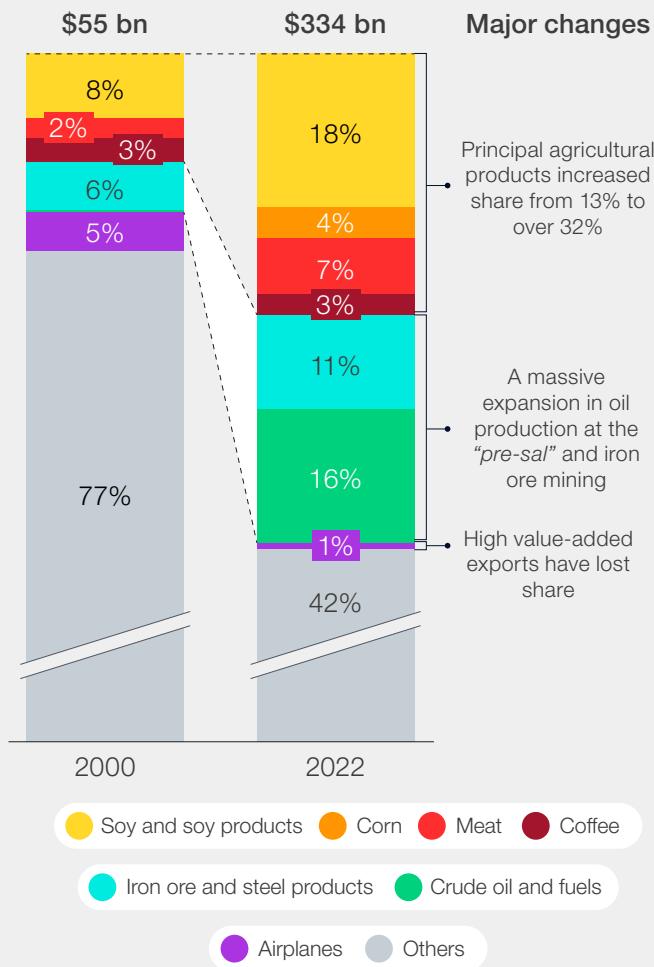
The challenge now is to build on Brazil's success in deploying technology, policies and science to boost agricultural development with less use of virgin land, thus demonstrating that ecosystem protection can make the country more prosperous and the world more resilient to climate and nature risks.

The growth in commodity exports responded largely to the recent development of Asia, with China's share of Brazilian exports surging from 2% in 2000 to 27% in 2022 (see Figure 4).⁴⁰ Despite the prominence of China, Brazilian exports have reached an increasing number of markets, diversifying away from the US and Europe in the last few decades, with the four largest destinations

accounting for 57% today, versus 64% in 2000. Argentina remains an important partner: although its share of total exports has fallen, demand has risen for industrial goods, where a common market facilitates production integration and trade. The Middle East has become an important destination, together with numerous countries in South Asia.

FIGURE 4 | Brazilian export matrix changes over the last two decades

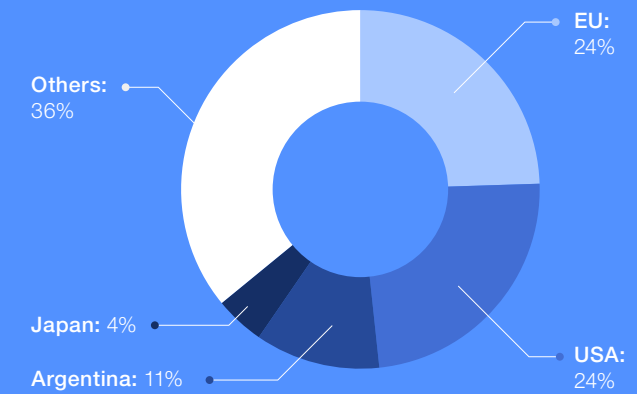
Brazilian export matrix



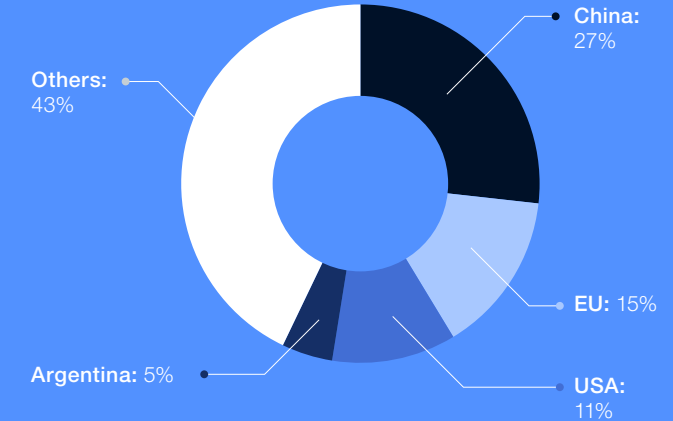
Sources: Comex Stat, Ministério do Desenvolvimento, Indústria, Comércio e Serviços.⁴¹

Export share by destination markets

2000



2022



The economic growth of the Cerrado has allowed GDP in central Brazil to grow at a 5% annual average rate,⁴² well above that of the rest of the country, especially during the recession years of the second half of the last decade. This growth has boosted labour mobility and wealth creation for most of the population there, although not fully insulating lower-income households from

the economic shocks of those years. Indeed, the region saw the share of low-income people increasing during the economic downturn in the country.⁴³ Looking forward to the next 10 years, however, the share of low-income people is expected to decline significantly faster in central Brazil (from 48% to 40% by 2032) than in the rest of the country.⁴⁴

1.4 Greenhouse gas emissions in Brazil

“Agriculture and land conversion in the Cerrado accounted for 304 Mt CO₂e in 2022 – 18% of Brazil’s total net emissions.

While globally, 78% of total net emissions are generated by the energy, waste and industrial sectors,⁴⁵ in Brazil it is land use and agriculture that contribute the majority of emissions (66%).⁴⁶ The main factor driving these emissions is the conversion of natural ecosystems and agribusiness operations, with cattle production standing out as a major source of emissions due to enteric fermentation and manure. Consequently, Brazil’s economic model, focused on commodity production and export, significantly contributes to its overall greenhouse gas emissions.

In 2022, net emissions from the Cerrado totalled 396 megatonnes (Mt – million tonnes) of CO₂e. Of this total, roughly 304 Mt or 77% arose from land use and agriculture (see Figure 5) – representing

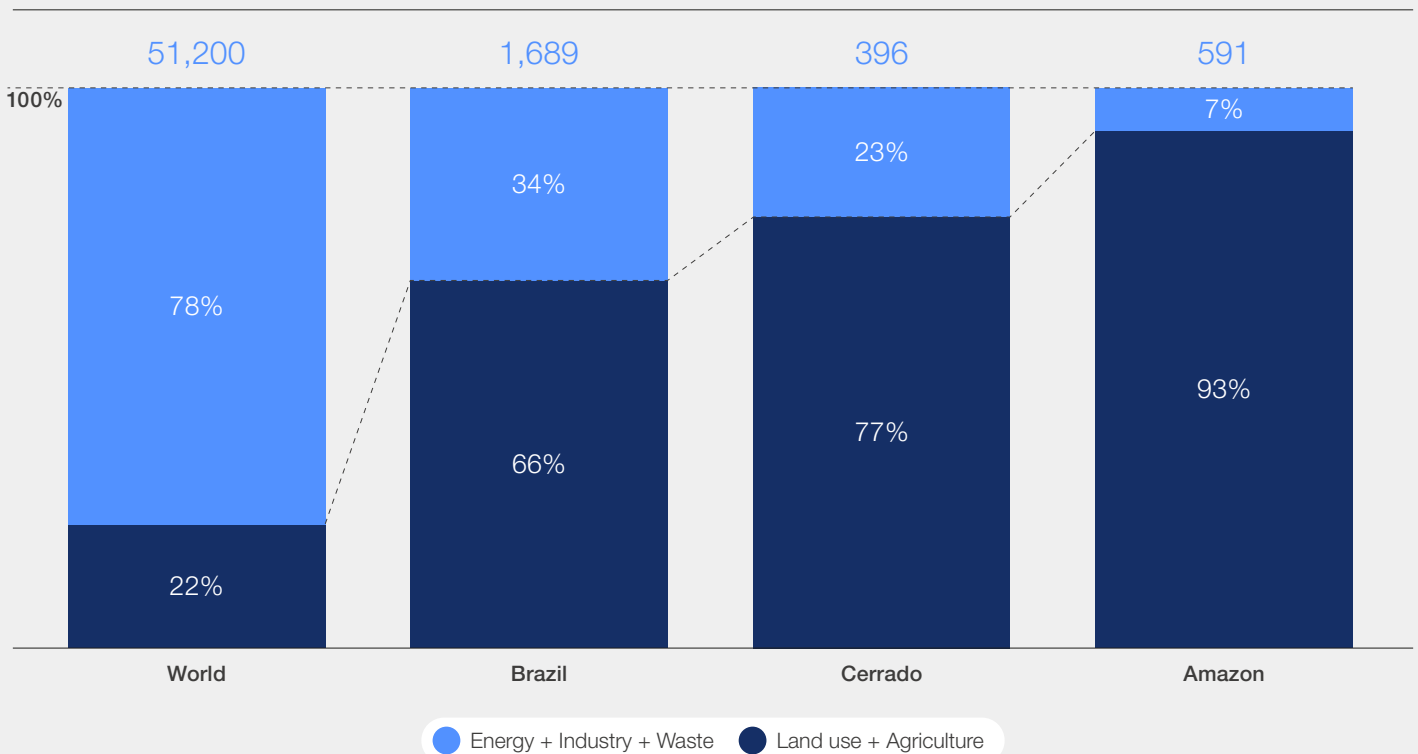
about 18% of Brazil’s total net greenhouse gas emissions. The Cerrado’s remaining emissions stem from energy use, waste and industrial processes.

The 304 Mt figure is a net amount that takes into account carbon removals from secondary forests and protected land. It breaks down as follows:

- Net emissions from land-use in the Cerrado: 97.5 Mt CO₂e.
- Net emissions from cattle raising in the Cerrado: 137 Mt CO₂e.
- Net emissions from agricultural production in the Cerrado: 69 Mt CO₂e.⁴⁷

FIGURE 5 Net GHG emissions by region in Brazil (2022)

Net GHG emissions by region (Mt CO₂e)



Note: Global estimates do not include land sink and ocean sink removals. Sources: SEEG, The Food and Land Use Coalition.⁴⁸



1.5 The conversion challenge

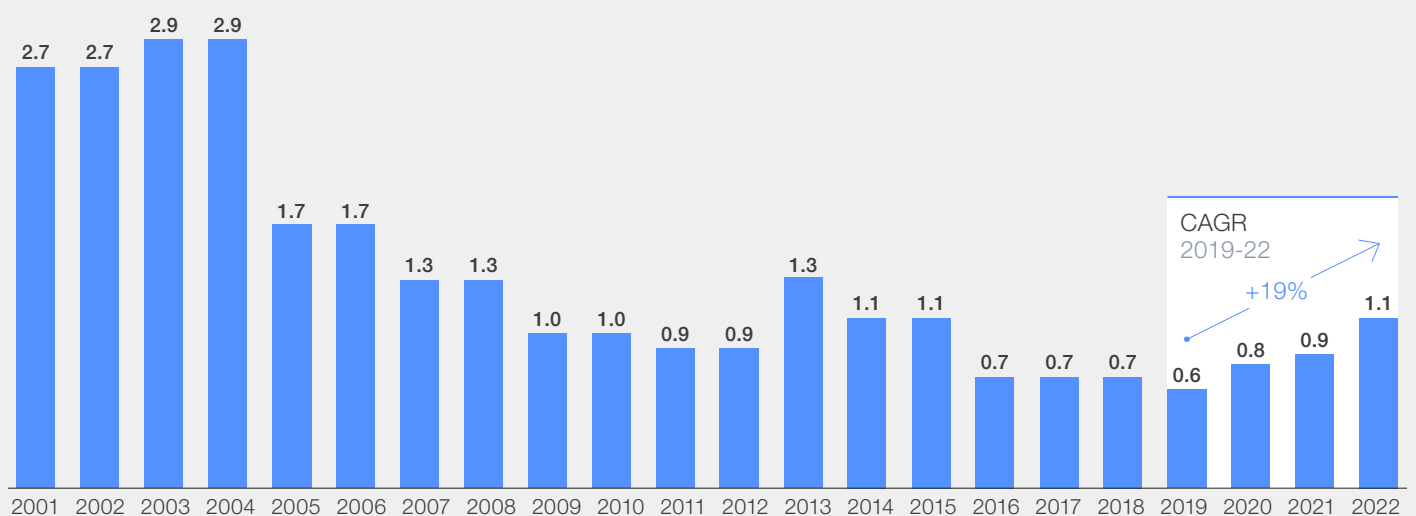
The rapid expansion of agricultural production in the Cerrado has been made possible by the conversion of native vegetation to agriculture over many decades. From 2001-2022, 30 Mha were converted.⁴⁹ While there was a decline from 2005-2012, mainly due to federal policies curbing conversion, the region then experienced an alarming 19% increase in conversion rates from 2019 to 2022, attributed to the lax enforcement of command-and-control measures and the growing profitability of agricultural activities over more sustainable uses of the land (see Figure 6). In 2023, according to the Brazil government's DETER database, 7,800 km² were converted to agriculture

in the Cerrado – an increase of 43% on the year before. This is in sharp contrast to the downward trend in the Amazon, where forest conversion in 2023 was 4,000 km² – a reduction of 62% on the year before.

The great majority (84%) of the Cerrado's territory is on private properties,⁵⁰ with only 8% of the biome registered as protected areas, compared to 46% of the Amazon territory.⁵¹ Conversion mostly takes place within private properties, where owners can engage in agricultural activities on 65-80% of their property, in contrast to 20% in the Amazon⁵² (see Box 3).

FIGURE 6 Conversion trends in the Cerrado

Land area of native vegetation in the Cerrado biome converted to agriculture and pasture (Mha)



Note: CAGR (compound annual growth rate) is the annualized average rate of growth between given years). Different from Mapbiomas data, which measures the net loss of native vegetation over time (net loss shows the difference between loss/deforestation and gain/regeneration in a period). PRODES – TerraBrasilis assesses annual incremental conversion (without showing regeneration of native vegetation).

Source: PRODES – TerraBrasilis.⁵³

“ Without sustainable land use, river flows in the Cerrado are expected to decline one-third by 2050.

Current conversions in the Cerrado are heavily focused in the biome's northern region, known as MATOPIBA⁵⁴ – an acronym for the states of Maranhão, Tocantins, Piauí and Bahia – that accounted for most of the conversion across the biome in 2023.⁵⁵ The region hosts both the largest remaining native vegetation as well the current agricultural frontier.⁵⁶ Across the Cerrado, 77% of all conversions were identified on rural properties officially registered with the Rural Environmental Registry (CAR). In these cases, the federal government can pinpoint the responsible party, whether it is the landowner or someone in possession of the land going through a process of regularizing their legal title. Another 15.9% occurred in rural settlements created by the government in past decades, with a smaller fraction (4.2%) taking place in designated environmental preservation areas.⁵⁷

A protection agenda is fundamental to enable the economic development and social prosperity of the biome. Changes in land use in the Cerrado impact regional weather, typically raising temperatures and delaying rainfall. The Cerrado biome is pivotal for water security, with surface vegetation playing a crucial role in soil water retention and maintaining water cycle equilibrium. Conversion exacerbates erosion, reduces water retention and disrupts water cycle equilibrium, resulting in a 10% reduction in the water recycled to the atmosphere every year and a 0.9°C increase in average land surface temperature to date.⁵⁸ Between 1985 and 2022, 88% of analysed watersheds in some studies experienced decreased water flows.

Most of Brazil's soybean and corn production is not irrigated, revealing the importance of rainfall patterns. Projections indicate, however, that 51% of the region's agricultural areas will no longer be within optimal climate production conditions by 2030, a proportion rising to 74% by 2060.⁵⁹ Risks also exist in irrigated areas, such as Western Bahia, where the conversion of native vegetation has changed hydraulic and physical soil properties, leading to erosive processes and a decrease in land productivity and soil quality in intensively irrigated areas.⁶⁰ While agronomic strategies can help address the challenge (e.g. utilizing seeds more resistant to drier climates), preserving native vegetation beyond the 20% minimum required by Brazilian law is likely to be crucial for stabilizing the regional climate and guaranteeing long-term production conditions.

Without sustainable land-use practices – and given the looming threat of global climate change – river flows within the Cerrado are expected to decline by one-third by 2050.⁶¹ This could lead to potentially disastrous consequences not only for agricultural productivity but also for the energy security of Brazil and neighbouring countries, which are heavily dependent on hydropower.

Although the scope to deepen our knowledge around the Cerrado and the correlation between production, biodiversity and protection is quite large,⁶² available evidence points towards the need to preserve and recover native vegetation to preserve soil fertility and productivity in the region.



1.6 Policies, legal instruments and government regulation

To preserve native vegetation, reduce GHG emissions and meet Nationally Determined Contribution (NDC) targets, land-use conversion within the Cerrado must be addressed. To do this several existing public policies and national plans can be leveraged, as detailed further below, including: the Brazilian Forest Code (2012), the Plan of Action for Prevention and Control of Conversion and Fires in the Cerrado (2023), the Ecological Transformation Plan (2023), and two agricultural development plans known as Plano Safra and Plano ABC/RenovAgro.

Brazilian Forest Code (2012)

The Brazilian Forest Code balances agricultural development with environmental conservation in Brazil, by establishing mandatory forest conservation areas on private properties, thus requiring landowners to maintain a percentage of their land as legal reserves. The specific percentage varies depending on the biome in which the property is located. In the

Amazon biome, landowners need to preserve 80% of their land, while in the Cerrado the percentage is between 20% and 35% (the latter in land belonging to the “Legal Amazon” region).⁶³ Legitimate conversions occur within the prescribed Code parameters, whereas criminal conversions are perpetrated either on private land when exceeding the stipulated code limits or in public or protected territories.

The Code includes mechanisms such as the Environmental Regularization Program (PRA) to facilitate compliance and provide incentives for landowners to adhere to the new regulations. Additionally, the 2012 Forest Code introduced the concept of “environmental easement”, allowing landowners to compensate for conversion by restoring or preserving vegetation on other degraded lands in the same biome. This innovative approach seeks to strike a balance between agricultural productivity and environmental sustainability, acknowledging the importance of both in Brazil’s unique ecosystem.

BOX 3

Brazilian Forest Code and its challenges

The Brazilian Forest Code (FC) is the primary legal instrument governing the environmental protection of all rural properties in Brazil. Its implementation, led by the Ministry of Environment, has been slow. The FC was initially developed in 1934 and overhauled in 2012. The current FC sets standards for protecting native vegetation through Permanent Preservation Areas (PPA or Área de Preservação Permanente) and Legal Reserves (LR or Reserva Legal), defined below:

- PPAs are private land holdings that require absolute protection of environmentally significant and fragile ecosystems, such as riparian zones of rivers and hilltops, which cannot be converted; this is to prevent erosion, landslides and destruction of springs.
- LRs are areas within private properties that landowners are required to set aside to keep native vegetation intact, with the proportion of the total property required to be set aside depending on the biome.

Both public and private properties face land conversion challenges. Except for LRs and PPAs, other areas within private properties can be legally converted. As of September 2023, the areas with native vegetation in excess of statutory LRs in the Cerrado ranged between

28 and 32 Mha, while there was a deficit of 0.7-1.0 Mha in PPA areas – and farmers with an LR surplus could legally convert that land. Meanwhile, most areas already converted lack proper adherence to legal procedures. Notably, only 11% of permitted converted land relies on government bodies’ authorization (SINAFLOR/IBAMA or subnational environmental systems). Indeed, detailed map analysis indicates that 51% of soy farms in the Cerrado violated the FC in converting areas that should have been maintained as standing forest or native vegetation between 2003 and 2014.⁶⁴

All rural properties must comply with the Forest Code through a multi-step process involving various stakeholders, but governmental enforcement is lagging. The initial step entails the registration and validation of the Rural Environmental Registry (CAR or Cadastro Ambiental Rural). Landowners self-declare the preserved areas on their lands through a CAR, which needs to be validated by regional or local government bodies to be fully compliant with the code. The limited human and technical capacities of these bodies lead to low compliance oversight at the national, regional and local levels. In the decade since the Congressional approval of the FC, only 26% of CARs have begun to be analysed, with less than 1% fully processed.

“ 51% of soy farms in the Cerrado violated the Forest Code in converting areas that should have been maintained as standing forest or native vegetation between 2003 and 2014.

“ Brazil’s Ecological Transformation Plan could add \$430 billion to the country’s GDP by 2030, while creating 10 million new jobs.

Plan of Action for Prevention and Control of Conversion and Fires in the Cerrado (2023)

The fourth phase of the Plan of Action for Prevention and Control of Conversion and Fires in the Cerrado (PPCerrado), was launched in 2023 under Brazil’s Climate Change Policy. It represents a strategic and comprehensive approach by the Brazilian government to combat conversion and wildfires in the Cerrado biome. This plan underscores the recognition of the critical need to balance agricultural development and environmental conservation in this biodiverse region. The plan’s four thematic areas include:

- Focus on sustainable productive activities to encourage responsible land use
- Environmental monitoring and control to enforce regulations effectively
- Land and territorial planning to optimize resource allocation
- Normative and economic instruments to provide incentives and penalties that align with conservation objectives

By addressing these key areas, the PPCerrado aims to create a synergistic and coordinated effort involving various stakeholders, including government agencies, local communities and the private sector, to achieve lasting results in reducing conversion and preventing wildfires.

Ecological Transformation Plan (2023)

Launched by the Brazilian Finance Minister in May 2023 and presented to international stakeholders at COP28, the Ecological Transformation Plan identifies opportunities for fostering sustainable development in Brazil and boosting job opportunities, productivity and growth, while accelerating the decarbonization of the Brazilian economy. This strategic programme delineates key areas where net-zero carbon solutions can be integrated into the development agenda, emphasizing a harmonious balance between economic growth and environmental preservation. By pinpointing opportunities for sustainability, the plan serves as a roadmap to guide policies and practices that could contribute to the ecological transformation of the whole country including the Cerrado biome.

Brazil’s approach complements the policies of other major countries and markets that aim to create economic growth aligned with decarbonization approaches (see Box 4).

BOX 4

National plans to embrace net-zero, nature-positive economies – Brazil, US and Europe

A voluntary task force to support Brazil’s Ecological Transformation Plan (ETP) launched a report during COP28 suggesting pathways to accomplish the goals of the government’s programme. As a collective effort from the private sector and civil society – in dialogue with government stakeholders – the taskforce identified opportunities to be followed in seven strategic economic sectors aligned to a net-zero and nature-positive economy. These are: (1) energy transition, (2) bioeconomy and biotech, (3) industry and mobility, (4) sustainable agriculture, (5) infrastructure and climate resilience, (6) circular economy and (7) sustainable finance. The report also shows how the ETP, which aims to create the foundations for a highly prosperous economy, could add up to \$430 billion to the country’s GDP by 2030, while creating up to 10 million new jobs.⁶⁵

Brazil’s plan echoes the policies of other major governments and markets across the world, which have sought to align the speed and scale of their net-zero strategies with ambitious economic

incentive packages. In the US and the European Union, these economic packages have yielded opportunities to invest in clean energy and green solutions but have also led to an unlevel playing field, especially for countries in the Global South.

In 2022, the US passed the Inflation Reduction Act (IRA), an economic recovery package valued at \$1.7 trillion to help the country meet its climate and clean energy security goals. The IRA represents the most substantial stimulus effort since the New Deal and introduces a range of incentives designed to enhance the competitiveness and productivity of American businesses while simultaneously facilitating large-scale emissions reduction efforts.

The European Union’s response to climate challenges has come in the form of the European Green Deal industrial plan and its infrastructure bill. Valued at \$1.8 trillion, the Green Deal sets ambitious targets of 55% emissions reduction by 2030 and carbon neutrality by 2050.

Sources: Systemiq, Government of Brazil’s Ecological Transformation Plan.⁶⁶



Plano Safra and the RenovAgro programme (Plano ABC)

The Brazil government's annual public credit programme, known as Plano Safra, drives agricultural development through targeted measures, encompassing rural credit, subsidies and incentives. The primary objectives include enhancing production, ensuring food security and invigorating rural economies, especially smallholder farmers. One notable component within Plano Safra is the RenovAgro programme (previously called Plano ABC), which focuses on providing low-interest credit for sustainable practices, such as the revitalization of degraded pasturelands and the implementation of integrated crop-livestock-forestry systems (ICLFS).

The overarching goal of RenovAgro is to reduce greenhouse gas emissions in Brazilian agriculture, aligning with the National Policy on Climate Change. Specific objectives include contributing to voluntary emissions reduction commitments, improving agricultural management practices to decrease emissions and enhance carbon sequestration, and encouraging the adoption of sustainable production systems. The plan focuses on technologies such as pasture recovery, integrated crop-livestock-forestry systems, agroforestry, no-till farming, biological nitrogen fixation and afforestation. Additionally, it promotes the use of animal waste treatment for biogas generation, supports studies focused on adaptation to climate change and aims to curb conversion resulting from livestock expansion. In addition, the plan encompasses actions such as awareness-raising campaigns, environmental and land regularization, technical training and assistance, technology transfer, research and innovation, provision of inputs, production of forest seeds and seedlings, and provision of rural credit.

A major implication of the RenovAgro programme is its promise to help balance the incentives between conversion of land with protection of native vegetation and recovery of degraded land. To the extent to which the latter becomes economically more interesting it will reduce the impetus of

conversion and decelerate the expansion of the agricultural frontier. The programme, if successful, can therefore slow down conversion in areas such as MATOPIBA by fostering production on "old land" in locations such as Goias.

Although historically there have been challenges in aligning the production and protection agendas, specialists and policy-makers now agree there is an opportunity to recover degraded lands to expand agriculture, produce food and supply industries without the need for further conversion of native vegetation.

National Programme for the Conversion of Degraded Pastures into Sustainable Agricultural, Livestock and Forestry Production Systems and its Interministerial Steering Committee (PNCPD)

The federal government has recently instituted the PNCPD to complement the RenovAgro programme through the mobilization of a broader set of resources. The committee steering PNCPD aims to raise \$120 billion⁶⁷ from both Brazilian and international investors for the conversion of degraded pastures into sustainable agricultural and forestry production systems in Brazil. This financial mobilization will not involve budgetary resources and aims to provide medium- and long-term credit lines with maturities compatible with the typical payback period of pasture recovery (i.e. from when soil management starts until the first crops are harvested). With adequate planning, part of this financing can come from global carbon credits based on avoided conversion elsewhere in the Cerrado and soil organic carbon (SOC) stored in recovered pastures and new agricultural fields, especially when integrated crop-livestock-forestry systems are present. Recovered pastures can store up to 100 tonnes per hectare of SOC, a volume that can be increased when the forestry component is included. For example, planted fast-growing trees can eventually become a feedstock to produce biochar that can be mixed with the soil, following age-old techniques developed by Indigenous populations in Brazil and recently successfully adopted in many places around the world.⁶⁸

“ Policy-makers now agree there is an opportunity to recover degraded lands to expand agriculture, produce food and supply industries without the need for further conversion of native vegetation.

Vision for a future of sustainable production and protection

A vision that reconciles agricultural production in the Cerrado with protection of native vegetation and biodiversity is both feasible and necessary.

Any new vision for the Cerrado must start by placing the biome's ecological value front and centre, recognizing that no place can be a land of opportunities for economic gain at any cost. Neglecting the protection and restoration of native vegetation of the Cerrado will damage the ecological balance of the biome as well as erode its agricultural productivity, on which so many livelihoods depend. A vision that reconciles production with protection is even more urgent given the accelerating impacts of global climate change on tropical regions.

“ Economic development in the Cerrado can be achieved without further illegal deforestation and by focusing on significantly reducing the speed of legal conversion.

Central to the approach outlined here is the recognition that, although the agricultural frontier of the Cerrado is providing economic opportunities in some of the poorest areas of Brazil, this not only should not, but need not, be achieved through yet more conversion of native vegetation. Put another way, maintaining economic development in the Cerrado can be achieved without further illegal deforestation and by focusing on significantly reducing the speed of legal conversion. The focus should be on transforming pasture land – which accounts for 30% of the biome's area⁶⁹ and is often in a degraded condition – into productive agricultural land.

Based on analysis of data provided by the voluntary taskforce that delivered recommendations to the Brazil government on its Ecological Transformation Plan (ETP), approximately 14 Mha of the Cerrado's pastures could be restored⁷⁰ – providing enough productive agricultural land to support the growing global demand for grain in the coming decades,

especially considering the steady increase in crop production per hectare achieved by Brazilian farmers in the past 20 years. Restored land can also support the development of other crops and sources of biomass, the availability of which can play an important role in reducing emissions from fossil fuels in Brazil and in partner countries.

Strategies to increase both production and well-being in the region, considering only already converted land, include the sustainable intensification of agricultural production, financial incentives to protect native vegetation, and the creation of value from the protection or restoration of natural habitats. However, to achieve this, policy-makers, law enforcement, the private sector and financial institutions will all need to collaborate to create an enabling environment that tackles existing perverse incentives.

As calculated by the task force advising the government on the ETP, the country's green economy has the potential to generate \$430 billion per year and create 10 million new jobs by 2030,⁷¹ while cutting GHG emissions dramatically. Achieving these targets would require direct annual investments of around \$160 billion as well as the creation of enabling policy conditions. The ambition proposed by the task force for the ETP includes establishing a vision for the Cerrado that puts it at the centre of a transition towards sustainable and value-add solutions⁷² in sectors such as food, materials, bioenergy and renewable electricity that can accelerate the decarbonization of the economy.

“The Cerrado could add \$47-72 billion to annual GDP, through boosting sustainable production and creating value from natural habitats.

The potential of low-carbon solutions for the Brazilian industry and transport sectors is very large and providing these solutions could represent a key economic opportunity for the region. While the Cerrado’s energy matrix relies mainly on low-carbon hydropower, the scope for solar and wind power is quite extensive and would help reduce the reliance of the local and national economy on fossil fuels for transportation and other uses,

including in hard-to-abate sectors such as steel and cement production.

Analysis conducted for this report, based on the government’s ETP priorities, has found that the Cerrado has the potential to add \$47-72 billion annually to the country’s GDP, through boosting sustainable production and creating value from natural habitats (see Figure 7).

FIGURE 7 The Cerrado’s potential added value to the Brazilian economy

Estimated added value to Brazil’s GDP in 2030 (\$ billion)

Sustainable intensification of agricultural production	Bioeconomy and protection and restoration of the native vegetation	Bioenergy and renewables	Green industry
\$17-19bn Bioinputs ~1	\$11-20bn	\$12-19bn	\$7-14bn Light industry, aviation and shipping ~1
Agroforestry ~1	Sustainable extractivism 1-2	Biomethane and renewable natural gas ~1	Heavy industry (chemicals) 1-2
Agri for local markets (ILPF)* 2-3	Ecotourism 1-2	Solar and wind 1-2	Motor vehicles and components 1-3
Sustainable agri exports (beef) 3-4	Biohealth and biocosmetics 2-4	Other sustainable fuels (biodiesel, ethanol E1G, E2G) 4-5	Cement and steel 1-2
Sustainable agri exports (soy, corn) 10-11	Carbon markets 2-3	Sustainable aviation fuel (SAF) 6-12	Light industry (EVs) 1-2
	Bioindustry 5-9		Extractive industry (critical minerals) 1-3
			Green hydrogen 1-2

*Note: ILPF means crop-livestock-forest integration technologies.

Source: Systemiq.



Section 2.1 of this chapter discusses three key opportunities for boosting sustainable production in the Cerrado:

1. Sustainable intensification of beef, grain and biomass production, using the 38 Mha of land that has already been cleared in the last 50 years.
2. Promotion of sustainable bioenergy production, renewables and other sustainable fuels.
3. Scale-up of green industry.

Of course, the production of biofuels or biomass-based electricity is not a silver bullet – there is a risk that their production could lead to additional conversion of native vegetation or compete with the production of crops for food and feed production.⁷³ Therefore promoting these activities must be paired with investments and measures to protect the

Cerrado to ensure it continues to deliver biodiversity and ecological services. These services include food production, energy generation and water provision. The restoration of native vegetation is also needed to reverse degradation in areas with high ecological importance, such as river margins and buffer zones bordering protected areas.

Section 2.2 discusses four priority actions to improve the protection and restoration of habitats within the Cerrado:

- Strengthen policies and commitments.
- Create no-conversion financial incentives.
- Reinforce command and control measures.
- Create value from restored and protected natural habitats.

2.1 Boosting sustainable, high-value production in the Cerrado

Sustainable intensification of agricultural production

The Cerrado presents an opportunity to add \$17-19 billion annually to the country's \$2 trillion GDP by 2030 through the application of integrated agricultural production systems. This opportunity requires an annual investment of \$12.7 billion to restore degraded land, according to analysis carried out for this report.

The sustainable intensification of agricultural production embraces measures that drive higher productivity and profitability without degrading the natural environment. Inefficient pasture management from cattle ranching has degraded over 30 Mha of the Cerrado – an area equivalent to the size of Italy – while delivering relatively low economic benefits.⁷⁴

Sustainable agricultural production models, such as agroforestry, integrated systems and semi-intensification of livestock production can help leverage more value from the land. These models are not only economically viable, but also provide a range of co-benefits including job creation, carbon sequestration, soil fertility and biodiversity conservation. An integral part of the solution is to restore degraded pasturelands, to minimize pressure on native vegetation and put land that currently has little or no productive value to good use.

To achieve a sustainable agricultural production model the following actions should be considered:

- **Pasture recovery and livestock semi-intensification:** This involves the adoption of advanced ranch management techniques such as superior genetic selection, pasture refurbishment, rotation and enriched diets. A comparison between the average levels of Brazilian meat production and an optimized scenario reveals the potential to increase productivity from 67 to 157 kilogrammes of meat per hectare per year, resulting in a 45% reduction in emissions per kilogramme of meat produced.⁷⁵ Moreover, studies show that even moderate intensification of cattle production would allow the expansion of crop production without the need for further conversion (see below).⁷⁶
- **Recovery of degraded land and utilization of already cleared land:** Within the Cerrado, there is the possibility to produce more without further conversion of untouched areas, decreasing the pressure on the agricultural frontier and better utilizing already converted lands which remain below optimal productivity levels. Up to 38 Mha of degraded pasturelands could be restored and used for the production of soy and corn.⁷⁷

**\$17-19
billion**

Annual addition to Brazil's GDP by 2030 from sustainable intensification of agriculture.

“ Up to 38 Mha of degraded pasturelands could be restored and used for the production of soy and corn.

- **Agroforestry systems (AFS):** These are models of agricultural production that combine crops and forestry activities to increase yields and diversify production. AFS offers numerous advantages, such as shading and microclimatic safeguarding and can be deployed for crops from soy to cocoa trees. These systems can be used on recovered pastures.
- **Integrated crop-livestock-forestry systems (ICLFS):** These are multi-functional land-use systems that integrate livestock rearing with annual or perennial crops (e.g. corn, soybeans, fruit trees) and forestry. Forestry can offer shade for livestock as well as providing direct economic benefits from timber and non-timber forest products, including the production of renewable fuels and biochar that can be used to accelerate carbon sequestration in the soil. Other productive integrated combinations are livestock-forestry and crop-livestock.

The process of sustainably intensifying agriculture has already started, with very robust results. ICLFS now occupy approximately 17.4 Mha of land in Brazil. Agriculture is also increasingly happening on previously degraded land. As a result, the proportion of pasture land in the Cerrado considered highly degraded has dropped from 40% in 2000 to 27% today.

Building on this success, the government's sectoral plan for adaptation and low-carbon agriculture, known as RenovAgro (formerly Plano ABC), aims to reduce emissions by 1.1 billion tonnes of CO₂e in the agricultural sector by 2030. To make this happen, the government is investing resources across 73 Mha of land, including: pasture recovery (30 Mha), no-till systems (13 Mha), the production of bio-inputs (13 Mha), integrated crop-livestock-forestry systems (10 Mha) and afforestation (4 Mha).⁷⁸ As mentioned in Chapter 1, RenovAgro is now complemented by the PNCPD that aims to mobilize domestic and global funds to finance pasture recovery and redeployment for agricultural production.

In summary, there are significant opportunities for economic growth in the Cerrado through the recovery of degraded pastureland and the expansion of more sustainable production models for soy and corn (potential added value per year: \$10-11 billion), cattle (\$3-4 billion) and ICLFS (\$2-3 billion).

While there is already sufficient land available in the Cerrado to support a thriving agricultural economy in the region, to transform it into a sustainable model would require annual investment of \$12.7 billion.

Bioenergy production, renewables and other sustainable fuels

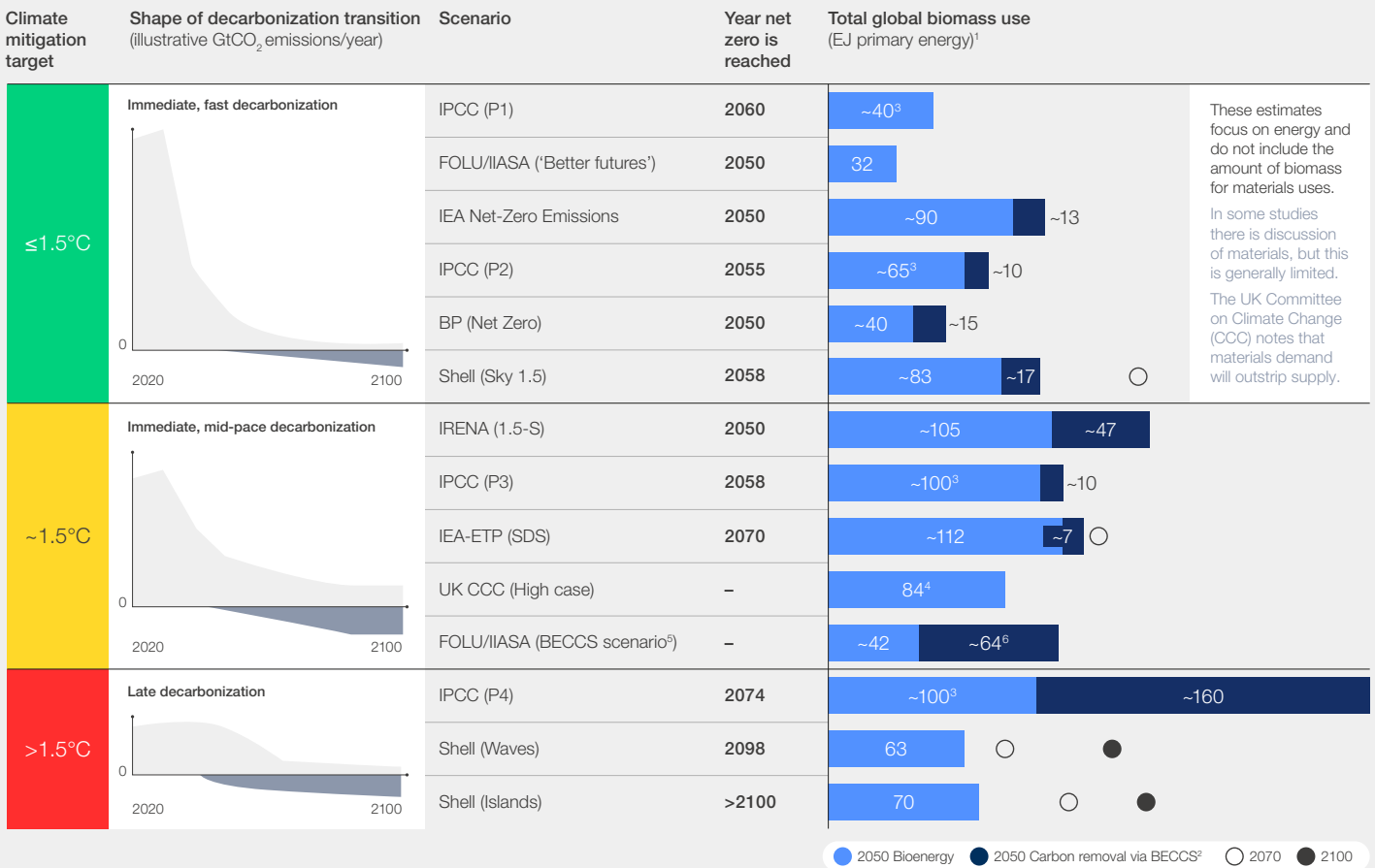
The global decarbonization journey will require a sustainable supply of bioenergy feedstocks (see Figure 8), especially for aviation, given the long lag time to introduce and disseminate new technology in this field. Bioenergy is renewable energy derived from biological sources, including solid biomass, biogas and biofuels, and it looks set to play an important role in the future global energy system.⁷⁹ The Cerrado could help add \$12-19 billion annually to the country's GDP by 2030 through the development of bioenergy and renewable sources, with an investment of \$1.6 billion annually, mostly by the private sector and largely self-financing.

Economic growth has to go hand in hand with practices that guarantee an overall sustainable approach when scaling-up bioenergy, in order to uphold the following priorities:⁸⁰

- **Conserving biodiversity and land:** It is imperative to avoid producing bioenergy feedstocks in high-biodiversity areas. Balancing economic production and preserving natural land, fauna and flora requires careful land management, which can be facilitated by specific land-use models.
- **Ecosystem well-being:** While capturing biomass, especially from forestry and agricultural residues, it is crucial to extract only a portion of the residues to uphold the health of ecosystems and soil.
- **Social dimensions:** Equitable practices and cultural protection, including the rights of Indigenous people to their land, are crucial considerations in biomass extraction.

“ Bioenergy and renewables in the Cerrado could add \$12-19 billion annually to Brazil's GDP by 2030.

FIGURE 8 | Climate mitigation pathways through bioenergy and biomass



Notes: 1 Modern bioenergy, excluding traditional biomass. 2 BECCS energy use determined under an assumption of ~10 EJ biomass per 1 GtCO₂ sequestered. 3 Calculated from IPCC reported percent increase relative to primary energy from biomass in 2010 (~50 EJ, Haberl et al. (2010)). 4 Excludes non-tradable biomass (i.e., feedstocks that are not suitable for long-distance trade due to low energy densities or other physical properties). BECCS estimates not included as estimated for the UK only. 5 Unpublished scenario from FOLU/IIASA (2019), Growing Better. 6 Amount of biomass used for BECCS not specified. Total increase in bioenergy compared to FOLU/IIASA 'Better futures' scenario without BECCS is 77 EJ, of which the difference in non-food crop bioenergy between scenarios is 51 EJ.

Source: Energy Transitions Commission.⁸¹

“ One million hectares would be enough to produce 6.48 billion litres of SAF from ethanol, which would satisfy 90% of Brazil’s current demand and be worth up to \$12 billion per year.

The Cerrado region has already established itself as the main producer of ethanol from sugarcane and corn, and other bioenergy applications are gaining traction, including second-generation ethanol and biogas. In 2022, Brazil produced 2.8 billion cubic metres of biogas, generated by 885 biogas plants across the country of which at least one-third are in the Cerrado. Estimates indicate a short-term viable potential of 10.8 billion cubic metres of biogas per year and a total potential of 84.6 billion cubic metres of biogas per year.⁸² There is also an opportunity to approach new markets, for example by producing sustainable aviation fuel (SAF). Just one million hectares of the Cerrado would be enough to produce 6.48 billion litres of SAF (from ethanol), which would satisfy 90% of Brazil’s current demand.⁸³ This production would be worth up to \$12 billion per year.

Although the Cerrado is an ideal location to scale-up bioenergy production, such production will need to be decoupled from habitat conversion and competition with food production to be truly sustainable. To achieve this, a number of investments will be needed in, for example, restoring some of the 30 Mha⁸⁴ of degraded land in the Cerrado, infrastructure updates to produce feedstock from alternative crops in the long term⁸⁵ and the development of new trade opportunities.

A key challenge for Brazil is to create a national and regional plan to balance the use of land between food, soy and fuel production. This has not yet been addressed by either the government or civil society, but it is imperative to ensure sustainable development – based on the triple bottom line of economic, social and environmental priorities that are in the best interests of the country and the biome.

“ Green industry in the Cerrado could add \$7-14 billion annually to Brazil's GDP by 2030.

Green industry











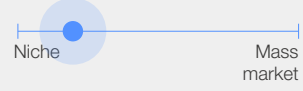

The Cerrado presents an opportunity to add \$7-14 billion to the country's GDP by 2030 through the development of green industrial activities, which would require an investment of \$5.9 billion.

Through the strategic integration of biogenic feedstock and renewable energy sources, multiple industrial sectors can effectively reduce their environmental footprint while engaging in circular

practices. For example, the manufacturing, chemicals and agriculture sectors⁸⁶ could leverage nature-derived biomaterials from various macromolecules, including proteins, cellulose, starch, pectin, lignin and chitin that can replace fossil fuel-derived materials.⁸⁷

Different solutions within the Cerrado's green industrial sectors – including green ammonia, green hydrogen and sustainable aviation fuel – display different levels of market and technical readiness (see Figure 9).

FIGURE 9 Priority Cerrado feedstock production to support decarbonization

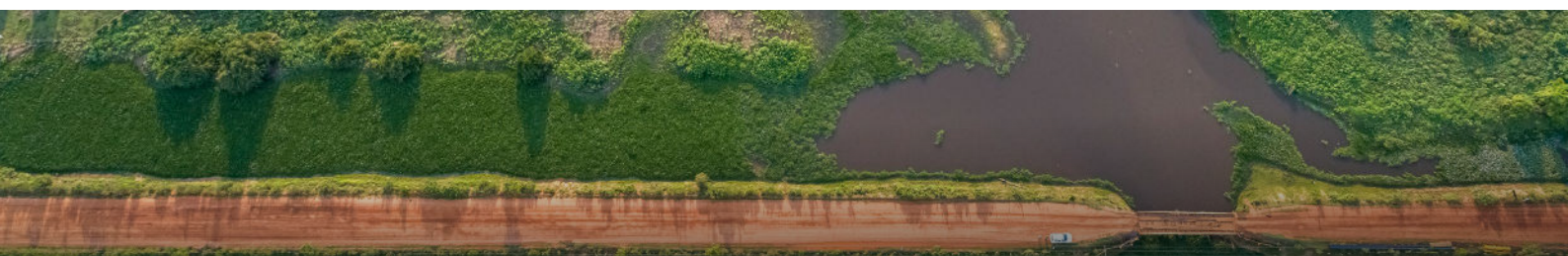
Sector	Solution	Cerrado's role	Current state	Confidence in tipping point*
 Fertilizer	Green ammonia	Provision of feedstocks from agricultural residues for: – renewable power generation (biogas and biomethane) – fuels (sustainable aviation fuels, SAF) – industrial inputs (oils and sugar biomass)		
 Steel	Green hydrogen for direct-reduced iron (DRI)			
 Shipping	Green ammonia			
 Aviation	SAF from biomass			
 Food & agriculture	Alternative proteins	Produce key ingredients (e.g. soy, baru, macaúba) for plant-based proteins		
 Avoiding land-use change	Valuing nature-based solutions	Can scale Integrated systems for agriculture and livestock production and restoration solutions from degraded land		

* Tipping point in this context is when a zero-carbon solution reaches sufficient maturity to compete with market-leading high-carbon solutions

Source: Systemiq.⁸⁸

As in other industries,⁸⁹ cleaner and more advanced processes and materials may come with higher costs, constraining scalability for certain solutions. Given this, Brazil should prioritize investments in research and development, fostering collaboration between the public and private sectors domestically and abroad. This approach of pursuing innovation is crucial for the relevance

and integration of these solutions in the Cerrado region. The Brazilian timber industry provides a good example of these possibilities, with composite materials (e.g. nanotechnology-based products and replacements for fossil fuel chemical feedstocks) opening markets and becoming relevant sources of revenue for the sector.⁹⁰



2.2 Improving protection and restoration in the Cerrado

“ 51% of the Cerrado’s agricultural areas will no longer be within their optimal climate space by 2030, rising to 74% by 2060.

Although agricultural production has been the economic driver in the Cerrado, its prosperity depends on the long-term ecological services that the biome can provide. Current practices have already had a negative impact on the biome. For example, Brazil’s dominance in soybean and maize production hinges on the reliability of rainfall in the Amazon-Cerrado agricultural frontier. Recent regional warming and increased aridity have already displaced 28% of current agricultural lands from their ideal climate conditions, given change in soil properties and rain patterns. Projections indicate that 51% of the region’s agricultural areas will no longer be within their optimal climate space by 2030 and this figure will rise to 74% by 2060.⁹¹ While agronomic adaptation strategies can alleviate some of these effects, preserving native vegetation is a crucial component of the solution for stabilizing the regional climate.⁹²

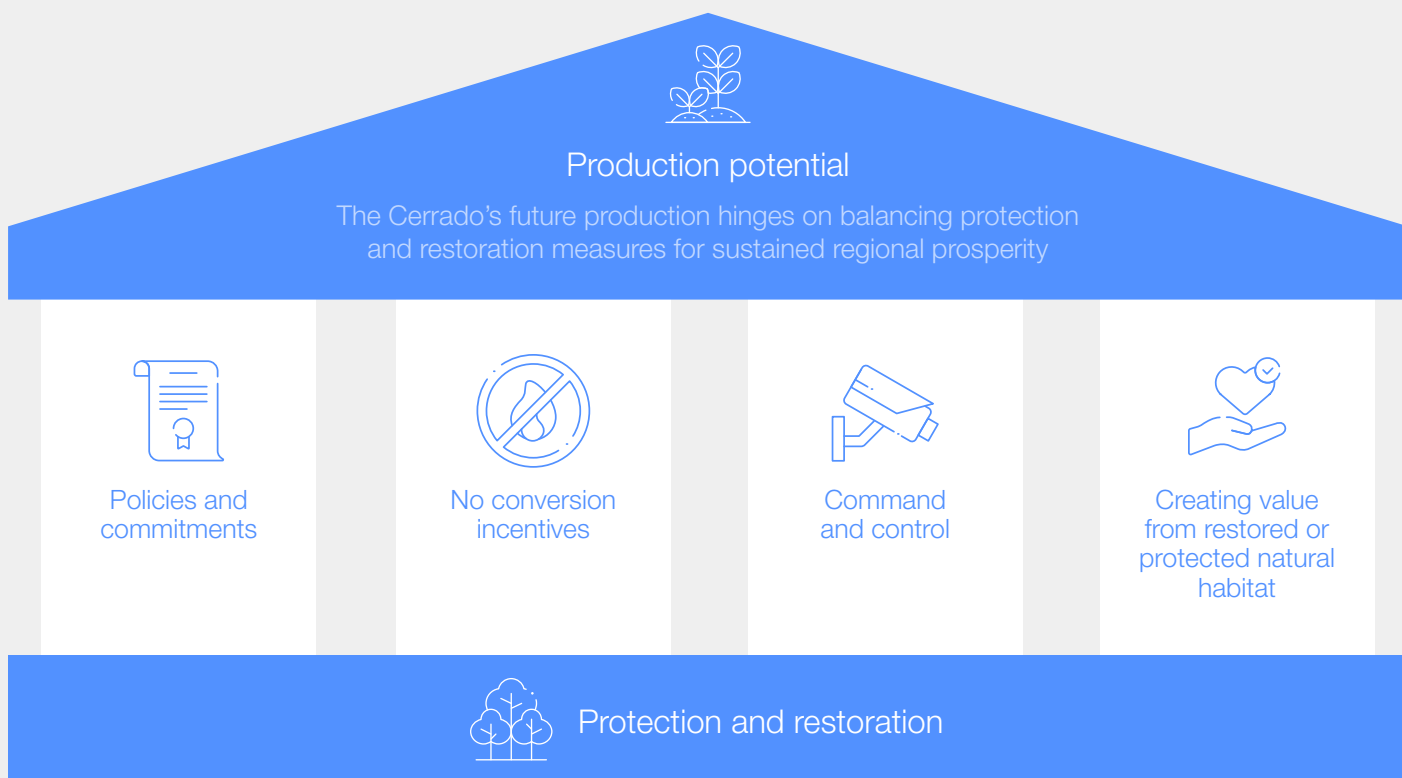
When thinking about solutions and incentives to protect native vegetation, it is important to consider the complexities at stake. For example, while there has been overall agreement that agricultural intensification can help meet productive,

conservation and social goals, as it helps increase productivity on a limited area, research shows that it can also create the perverse incentive (known as Jevons Paradox) to expand agricultural land for intensive production.⁹³ This paradox potentially applies to the Latin American context, raising a red flag about the pressures associated with the production agenda in the Cerrado.

As of 2023, the Cerrado has 80 Mha of intact natural habitat in privately-owned properties. Approximately 40% of this is classified as “surplus reserves”, which are allowed to be repurposed for other economic activities. This presents an implicit opportunity cost between immediate exploitation and the maintenance of a long-term source of value that can accrue from protecting and restoring the biome.

Based on the above and discussions with experts, this paper identifies four levers to enhance the protection of the biome, examined in more detail below (see Figure 10): policies and commitments, no-conversion incentives, command and control, and creating value from restored and protected natural habitats.

FIGURE 10 Protection and restoration as mandatory enablers for resilient production





Policies and commitments

Protecting surplus legal reserves is key to achieving a sustainable future for the Cerrado, and both government policies and corporate actions can help in advancing this journey.

Strengthening policies to discourage conversion

In June 2023, the European Union Regulation on Deforestation-free Products (EUDR) – a policy prohibiting the import of products linked to tropical deforestation – entered into force. While currently the regulation applies only to land defined as “forest” by the UN’s Food and Agriculture Organization and therefore leaves much of the Cerrado – which is a complex mosaic of forests and savannah – unprotected, the European Commission is conducting an impact assessment to determine if the regulation should be expanded in scope to include “other wooded land”.

Discussions are underway in the US to adopt a similar approach to the EUDR. Additionally, carbon taxes are now a reality in some European countries and will impose economic disadvantages on products associated with excessive land conversion. These regulations are expected to impact Brazil’s economy and exports soon, so the process of adapting to the international market is expected to gain importance during the coming years.

As these policies continue to expand, regions such as the Cerrado are facing growing pressure to decrease conversions, as unsustainable production may increasingly struggle to find a market. Nationally, the Brazilian Forest Code has established a trading mechanism known as environmental reserve quotas (ERQs), or *cota de reserva ambiental* (CRA), that offer a solution to conversion on private land. ERQs are certificates that represent natural vegetation cover on a property and can be utilized to compensate for the absence of a legal reserve on another property. Each quota corresponds to one hectare; they can be generated by rural landowners who possess an excess of legal reserve and traded with producers who have less reserve area than the minimum requirement. Estimates indicate a demand of 1.3 Mha of ERQs in the Cerrado with a market value that varies between \$289 million and \$1.9 billion.⁹⁴

Corporate commitments

Private sector companies are increasingly committing to sustainability by adopting environmental, social and governance transparency, driven by perceived business advantages. Private sector supply-chain interventions are becoming increasingly widespread to incentivize agrarian development decoupled from the degradation of ecosystems and the depletion of carbon stocks.⁹⁵ The influence of these leading companies extends throughout their supply chains, encompassing commodities producers in regions like the Cerrado. Consequently, there is a compelling economic incentive from key suppliers to transition towards greener operations and refrain from converting natural habitat.

“ Unveiled at COP28, the Brazil government's Tropical Forests Forever fund seeks to raise \$250 billion to aid up to 80 tropical countries in safeguarding and rejuvenating their rainforests.

Recently, big players in agribusiness such as Bunge, Cargill and Marfrig have made commitments regarding their Brazilian supply chain operations and traceability. Each has promised to reach zero conversion in the Cerrado (by 2025 for Cargill and Bunge and by 2030 for Marfrig).⁹⁶ These commitments are part of a trend. More and more businesses are signing up to pledges such as the Science Based Targets initiative (SBTi) and the Science Based Targets Network (SBTN), which are key for determining pathways for sustainable operations and driving transparency within the corporate market.

However, incentives need to be developed to enable producers to sustain the transition of production models in line with these new science-based targets and to enable broader adoption of these goals by other market actors.

Financial incentives for no-conversion

In addition to restrictive policies and voluntary commitments, positive reinforcement through financial incentives and blended finance solutions plays a fundamental role in turning the preservation of native vegetation into a more attractive business and environmental opportunity. The role of multilateral institutions in providing low-cost resources at scale is likely to be a crucial companion to the success of restrictions to market access of less sustainable products. There are already several financial support, compliance and stimulus packages from the Brazilian government, businesses associations and philanthropies supporting agricultural activities aligned with the protection of native vegetation, restoration of degraded lands and other steps to accelerate the implementation of a more sustainable economy. Some examples that stand out are presented next.

Safra Plan 2023/24

This is a federal government programme supporting the agriculture sector by providing credit lines, incentives and agricultural policies for rural producers, ranging from family farmers to large-scale producers. It offers diverse credit lines addressing various needs, including investment, operational expenses, marketing and industrialization. To access rural credit, producers must comply with the social, environmental and climatic requirements outlined in the Brazilian central bank and credit manuals, notably registration at the CAR.⁹⁷ In September 2023, significant changes were included to ensure the enforcement of socio-environmental restrictions across the entire rural property, not just the financed activity. These restrictions include:

- Inability to obtain credit in cases where the Rural Environmental Registry (CAR) is cancelled or suspended.

- Inclusion of environmental embargoes issued by state agencies, not only federal, and applicable to all biomes.
- Denial of rural credit to enterprises located in rural properties wholly or partially included in undesignated “public forests” registered in the National Register of Public Forests of the Brazilian Forest Service.

Tropical Forests Forever fund

Unveiled at the COP28 Climate Change Conference by Brazilian Environment Minister Marina Silva and Finance Minister Fernando Haddad, the Tropical Forests Forever fund seeks to raise \$250 billion from governments and the private sector. Its objective is to aid tropical countries in safeguarding and rejuvenating their rainforests. The fund may benefit up to 80 countries and – although initial pledges of resources have been modest, making the specific allocation for the Cerrado biome still uncertain – there is potential for a positive impact on available funds for the biome in the coming years.

Brazilian Banking Federation (Febraban)

A new regulation approved by the self-regulation council of Febraban has established partnerships and a common protocol for managing the risk of illegal deforestation in credit operations granted to meatpacking plants and slaughterhouses in Brazil. The new rules, approved in March 2023, require participating banks to request meatpacking plants in the Legal Amazon and Maranhão to implement a traceability and monitoring system by December 2025. This system aims at certifying that no meat acquired by these businesses came from cattle associated with illegal deforestation.

Innovative Finance for the Amazon, Cerrado and Chaco (IFACC)

The Innovative Finance for the Amazon, Cerrado and Chaco (IFACC) initiative – a collaboration between the UN Environment Programme (UNEP), The Nature Conservancy (TNC) and the Tropical Forest Alliance (TFA) – serves as a pivotal entity for financial endeavours related to deforestation- and conversion-free beef and soy in South America. In Brazil, IFACC aims to support leading financial institutions, supply chain companies and asset managers in creating and scaling-up innovative finance mechanisms to facilitate the agricultural transition in the region. With a \$30 billion potential, IFACC represents a substantial opportunity for banks, companies and investors to safeguard South America's vulnerable biomes while sustaining crucial commodities amidst increasing global demand for sustainable foods and evolving environmental regulations. The initiative seeks commitments of \$10 billion and disbursements of \$1 billion by 2025. This strategic trajectory aims to accelerate capital flow towards sustainable commodity production, establishing new standards for lending and investing in deforestation- and conversion-free cattle and soy production.

Reverte programme

Improving already cleared land is a key opportunity for sustainable agriculture, but needs incentives to prosper. Reverte is a programme created by Brazilian and global corporations to support rural producers in restoring degraded areas through an integrated solution that mixes sustainable agricultural practices, financial mechanisms and fertilizer protocols.⁹⁸

Responsible Commodities Facility (RCF)

Established with the aim of fostering the cultivation and trade of conversion-free Brazilian soy, RCF serves as a financially sustainable platform designed to offer incentives to farmers, contributing to the growth in global demand for zero-conversion supply chains.



Command and control initiatives

Due to slow implementation of the CAR and other administrative documentation, at least half of land conversion in the Cerrado happens without the required authorizations. The regularization and enforcement of environmental protection⁹⁹ is therefore a key priority. The federal government has been carrying out the following measures to address this challenge:

- Strengthening the performance of federal institutions to ensure accountability for environmental crimes and administrative infractions linked to land conversion including deforestation, forest fires and forest degradation.
- Improving the government's capacity to monitor, analyse, prevent and control conversion, degradation and production chains.
- Reducing forest fires through the implementation of integrated fire management.

- Improving systems and flow of relevant data including conversion authorization data, embargoes, state and municipal infraction notices.
- Strengthening coordination with the Cerrado states to promote actions to control conversion, forest fires and implementation of the Forest Code.

The decoupling of illegal land conversion from increased productivity is well illustrated by the example of Mato Grosso. This state achieved all-time-high levels of production, while at the same time slowing land conversion rates between 2006 and 2010.¹⁰⁰ This was achieved mostly through command and control mechanisms.

Of course, command and control mechanisms are most effective in tackling illegal conversion, especially on public land. However, conversion on privately-owned properties within the limits allowed by the law is harder to address using these tools. To address this challenge, increasing the value of standing vegetation is the most effective alternative to slow down agriculture expansion based on conversion.

Creating value from restored and protected natural habitats

In addition to establishing compliance mechanisms, it is crucial to introduce incentives that discourage conversion. Research conducted for this report has found that an estimated \$11-20 billion of value could be added to Brazil's GDP by 2030, through restoring and protecting the Cerrado's natural habitats – if such protection were to be monetized through mechanisms that reward the global impact of this protection (e.g. its role in slowing down global warming and preserving biodiversity). Some of these initiatives are highlighted below.

Carbon markets

Preserving or restoring standing forests could contribute an estimated \$2-3 billion to the biome's GDP through global voluntary and compliance carbon markets – based on an investment estimated at \$800 million. Two major companies¹⁰¹ have already announced the development of conservation carbon projects in the Cerrado. Brazil is strategically positioned to meet 48.7% of global voluntary carbon market demands and 28% of the global demand under Article 6.4 of the Paris Agreement.¹⁰² By capitalizing on these opportunities – in particular leveraging the potential of the Cerrado region, Brazil has the potential to earn up to \$120 billion by 2030.¹⁰³ This potential not only allows for the preservation of land but also presents an opportunity to generate substantial value from the international demand for nature-based solutions as part of, for example, corporate decarbonization plans.

To fulfil this market and environmental opportunity, Brazilian companies have begun to create ways of restoring degraded environments (currently

focused on forests) counting on the demand for carbon credits in national and international markets. Companies taking the initiative with this opportunity in Brazil, such as Regreen, Momback and Biomax, are creating projects that will meet the most stringent international certification requirements for the generation of carbon credits, while also bringing a positive social impact to communities in surrounding areas and to the region, if successful in selling these credits on international markets.

The development of voluntary carbon markets is likely to get a boost from pending legislation in Brazil aimed at establishing a regulated carbon market focused on industrial emissions and providing a robust framework for the generation of carbon credits from nature-based activities. The current bill follows the international standard, excluding the agricultural sector from regulated carbon markets, but can nonetheless create incentives for carbon reduction in the sector. The passage of the bill is likely to promote a faster adaptation of common certification methodologies, originally developed with temperate climates in mind, to take into account the specificities of the Cerrado and other tropical biomes.

There are also market challenges. Depending on the price set for carbon credits within the region, agricultural activity may still generate more income and prove more profitable for landowners – weakening the instrument's effectiveness.¹⁰⁴ Of course, carbon markets can be an efficient deterrent to land conversion if the income they bring to those preserving native vegetation matches the opportunity cost of not converting land to agricultural production. The gap between current prices in voluntary markets (\$10-15/tCO₂e) and regulated markets in advanced economies (\$50-100/tCO₂e) may need to narrow if this approach is to realize its full potential in reducing global emissions.

**\$11-20
billion**

of value could be added to Brazil's GDP by 2030, through restoring and protecting the Cerrado's natural habitats.



“ Bioeconomy solutions in the Cerrado offer an untapped economic value that could generate \$8-16 billion per year by 2030.

Payment for environmental services

In 2021, as an additional means to increase the value of standing vegetation, the federal government established the National Policy on Payments for Environmental Services (PNPSA). This legislation encourages the conservation of ecosystems, water resources, soil, biodiversity, genetic heritage and associated traditional knowledge. The PNPSA functions as an economic instrument to stimulate environmental preservation, defining criteria for compensating individuals for rendered environmental services. Potential recipients encompass diverse groups such as settled farmers, family farmers, rural producers, Indigenous communities and traditional societies.

The policy does not involve direct payments from the government, but creates important tax incentives for those providing such services. Several financial instruments have been developed along these lines, providing, for instance, tax-free credit to farmers that adopt sustainable practices and protect the biodiversity in their properties.

Bioeconomy solutions

Bioeconomy solutions provide another promising pathway to generate value from standing vegetation within the Cerrado. The biome's rich biodiversity provides an opportunity to create by-products in the pharmacological, energy and food sectors, among others. These solutions offer an untapped economic value that could generate \$8-16 billion per year by 2030. To realize the opportunity will require additional research and investment of \$3.6 billion annually.

Ecotourism

The potential value of ecotourism in the Cerrado has been estimated at \$1.5-2.0 billion per year by 2030. Ecotourism offers an economic solution that balances economic viability and nature conservation, while providing environmental education to visitors and maintaining local biodiversity. The greater proximity of the northern half of the Cerrado to Europe and the US, together with the recent privatization of airports in the northern part of Brazil and support mechanisms to tourism investment, can boost the interest of global travellers in the unique landscape of the Cerrado. An estimated investment of \$1.1 billion is necessary to realize this opportunity.

3

Call to action to implement the new vision for the Cerrado

Sustainable economic growth in the Cerrado offers a unique opportunity to generate \$47-72 billion of value plus climate and nature benefits, but only if production and protection proceed hand in hand.

Climate change poses serious risks to society and ecosystems. To limit warming to 1.5°C, the world must become net zero by 2050, with GHG emissions reductions of at least 45% by 2030.¹⁰⁵ There is no path to delivering a global net-zero, nature-positive future without a “Green Brazil”.

Transitioning to a Green Brazil and meeting its NDC goals require action across key sectors that have outsized impacts on climate and nature, including agricultural production, where Brazil plays a leadership role. The Cerrado presents a unique opportunity to deliver positive climate and nature benefits, while creating a \$47-72 billion economic prize.

Seizing this prize requires a convergence pathway to promote sustainable economic growth, while simultaneously protecting and restoring the Cerrado biome. Collaboration across public, private and civil society sectors in Brazil and worldwide is critical for mobilizing resources and promoting action in and for the Cerrado.

The complexity of the challenge ahead for a balanced production and protection agenda in the Cerrado requires an integrated approach, which embraces key stakeholders in the Cerrado and prioritizes four action areas:

1. **Regulations and policies:** Policies are needed that increase the value of the standing vegetation within the Cerrado, while not harming production levels within the biome. Surveillance of conversion must be increased, along with penalties for perpetrators.
2. **Development finance:** This needs recalibration, with increased support for sustainable practices and early-stage investments opening a tremendous opportunity for multilateral institutions, while also attracting private capital.
3. **Transparency and standards:** Enhanced traceability systems, adoption of high-integrity metrics and disclosure of environmental impacts are all needed to deliver greater transparency.
4. **Significant investment in research and development:** Research is required that is tailored to the Cerrado’s unique ecological characteristics and production potential, as well as identifying the potential of carbon sequestration in its soil and landscape. Research is also needed to identify disruptive technologies, from nascent decarbonization techniques such as the use of biomass in the chemical industry to mature solutions such as livestock-agriculture-forestry systems.



3.1 Different sector roles to deliver on the new vision

Brazil's federal government, state land institutes and land registry offices

- Implement and enforce regulations that support sustainable agriculture, nature protection and traditional communities' rights maintenance.
- Invest in monitoring and command and control capabilities to limit irregular activity within the region.
- Accelerate CAR review, correcting eventual land certification irregularities within the region.
- Evolve the investment taxonomy for sustainable agricultural solutions. Develop better traceability systems to be applied to agricultural products.
- Develop a plan for land use in the Cerrado, specifying how much area should be dedicated for the production of food, fuel, fibre and other uses, based on balancing competing economic, social and environmental demands.
- Expand policies and incentives that are currently available for forests to all critical ecosystems, including the Cerrado.

Farmers and producers in Brazil

- Invest in sustainable solutions focused on restoring degraded land in the Cerrado region (ensuring no conversion of native vegetation areas for expansion), agroforests and ILPF systems.
- Pursue technical assistance and training to devise sustainable approaches in the field, enhancing intensity and productivity in the region without resorting to conversion.

Brazilian economic decision-makers, public and international private banks

- Enhance the availability of both public and private credit to regenerative agriculture and low-carbon solutions by streamlining the application process and bridging knowledge gaps.
- Utilize local networks to disseminate information and improve risk assessment.
- Support the sustainable intensification of agriculture, such as integrating agriculture, livestock and forestry practices.

Corporate actors

- Embrace and expand the implementation of strict sourcing regulations and protocols.
- Strengthen these initiatives with rigorous monitoring and enforcement mechanisms, maintaining a high level of transparency for investors, clients and civil society.
- Commit to off-take agreements that prioritize agricultural production derived from regenerative systems and low-carbon solutions; and apply actions that prioritize these operations and suppliers in the business.
- Support the development of global voluntary carbon markets based on high-integrity nature-based solutions, good agricultural practices and the avoidance of land conversion.

Multi-stakeholder coalitions of supply chains

- Participate in and lead discussions for the creation of new public policies focused on the Cerrado's preservation.
- Monitor the development of conversion within the biome and promote progressive change within the private agribusiness sector.
- Mobilize funds for large-scale sustainable agriculture and nature protection projects.

Philanthropic actors

- Recognize the absence of tangible proof and the perception of high risks associated with sustainable farming practices, especially how commercial models and markets act as barriers for both farmers and financiers in venturing into new initiatives.
- Overcome these barriers by de-risking projects in their early stages and demonstrating this is possible through catalytic investment models.
- Ensure these models not only attract private investment, but also showcase the viability and scalability of nature-positive businesses.
- Secure funding from family and corporate foundations, philanthropists and the donor community to ensure early-stage de-risking. Through a combination of reimbursable and non-reimbursable grants, as well as first-loss capital and loan guarantees, support can be provided to incubate and accelerate nature-positive projects.

Development finance institutions (DFIs) and donor-funded vehicles

- Leverage access to long-term capital and catalytic funding by employing blended finance strategies. An effective approach involves directing these public sector resources through regional development banks, which have demonstrated capabilities in financial allocation due to their proximity to regional markets and sectoral expertise.
- Support from multilateral institutions can be effective if resulting in a combination of multi-year credit lines accompanied by a guarantee fund, technical cooperation for project preparation and syndicated loans for project execution.
- DFI's efforts should target strong private capital mobilization to reach the scale required to effectively respond to the challenge.

- Collaboration with market aggregators can be instrumental in showcasing successful cases and cultivating markets that attract private capital from food processing, distribution, trading and wholesale firms. This strategic use of funds and partnerships aims to maximize impact and promote sustainable development.

Knowledge creators

- Develop research on biotechnology and bioeconomy solutions within the Cerrado.
- Partner with universities, corporations and other allies to create socially relevant and economically feasible activities for the biome, in ways that maximize the rich biodiversity of the region.
- Deepen studies on pathways for the reconciliation of the production and protection/restoration agendas in the Cerrado.



Conclusion

The economic productivity of the Cerrado can only continue if production and protection priorities are reconciled.

The Cerrado is the largest and most biodiverse tropical savanna in the world. Home to several critical water basins, it regulates rainfall regimes in a large part of Brazil and maintains an important stock of carbon. Nonetheless, its ecological value often goes unnoticed and is overshadowed by the region's extraordinary agricultural productivity, which accounts for almost 60% of Brazil's agricultural production.

However, this economic miracle in the Cerrado can only continue into the long-term if the biome is healthy, well-preserved and able to continue providing the ecosystem services on which its economy depends. There is an opportunity to

strongly mitigate the current pattern of expansion based on the conversion of native vegetation, positioning the Cerrado at the centre of a transition to a net-zero and nature-positive economy.

This paper aims to demonstrate how the Cerrado region can lead the world not only as an agricultural powerhouse but also as an environmental problem-solver for the next century, becoming the proof case of how to reconcile the production and protection agendas. The report calls on a number of stakeholder groups to act, focusing on the following production and protection priorities:

Production priorities

- Sustainable intensification of agricultural production and restoration of degraded lands
- Promotion of sustainable bioenergy production, renewables and other sustainable fuels
- Scale-up of green industry

Protection priorities

- Strengthen policies and commitments
- Create no-conversion incentives
- Reinforce command and control measures
- Create value from restored and protected natural habitats

To stay within a 1.5°C pathway by 2030, the world needs to combine a strong energy transition towards renewable energy sources and a phasing-out of deforestation and ecosystem conversion, with significant progress in the next few years. If Brazil manages to substantially abate the current conversion trends in the Cerrado while boosting the region's economy through collective efforts, this could become a model of reference to protect other critical ecosystems around the world.

To ensure a prosperous Cerrado for generations to come, every stakeholder has a role to play. Brazil currently finds itself presented with an opportunity to take the lead, as it hosts the G20 this year and COP30 in 2025. This provides a strategic moment for Brazil to spearhead global change, directing attention to the protection and enhancement of not only the Amazon's but also the Cerrado's biome and population. Moreover, it offers the chance to attract investments aimed at developing a cutting-edge model for an economy centred on production, protection and green industrialization.

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