ORBITAS
Navigating climate response risks

Room to Grow: The Economic Case for Forest Restoration in Brazil

CLIMATE ADVISERS

June 2025

ORBITAS
A Climate Advisers Initiative

About ORBITAS

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> Further information is available at **orbitas.finance**.

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Climate Advisers, a B Corporation, strengthens climate action in the United States and around the world through research, analysis, public policy advocacy and communications strategies. Climate Advisers develops and promotes sensible, high-impact initiatives that improve lives, enhance international security and strengthen communities.

> Further information is available at **climateadvisers.org**.

REPORT

Acknowledgements

Authors

ORBITAS AUTHORS:

Matt Piotrowski, Orbitas Interim-Director and Senior Director of Policy and Research, Climate Advisers

Anthony Mansell, Orbitas Former Interim-Director and Senior Fellow, Climate Advisers

André D. S. Amaral, Orbitas Consultant

Anna Mervosh, Orbitas Former Associate and Program Associate and Executive Assistant, Climate Advisers

COLLABORATING AUTHORS:

Dr. Alexandre Köberle, Guest Scholar, Potsdam Institute for Climate Impact Research

Dr. Michael Obersteiner, Director of the Environmental Change Institute, University of Oxford.

Alvaro Iribarrem, Researcher, International Institute for Sustainability

Prof. Dr. Alexander Popp

Dr. Jan Phillip Dietrich

Dr. Florian Hmpenöder

Dr. Miodrag Stevanovic

Dr. Wanderson Costa

Pascal Sauer

David Chen

Patrick José von Jeetze

PROJECT MANAGEMENT, LEADERSHIP, DESIGN AND COMMUNICATION:

Nigel Purvis, CEO, Climate Advisers

Natasha Ferrari, Senior Director of Communications, Climate Advisers

Kyle Saukas, Director of Communications, Climate Advisers

MG Strategy and Design, a strategy, branding, content, design and development agency

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Executive Summary

Over the next 30 years, large-scale forest restoration of pasture-land in Brazil can generate up to USD 141 billion while creating more than 350,000 full-time jobs annually. Under the right conditions, this economic activity could restore forests and biodiversity on about 60 million hectares (Mha) of total degraded agricultural land — an area the size of France.[a] These outcomes are within reach, but only if Brazil's public and private sectors take immediate action.

Brazil's agriculture sector is a major driver of national economic growth, representing nearly 30 percent of the country's gross domestic product (GDP) and expanding in value about 8 percent per year, thanks to a boom in export demand since the turn of the millennium. However, this growth has come at a cost: Between 1985 and 2022, 64.5 Mha of forests were cleared, mainly in the Amazon, the Atlantic Forest and the Cerrado biomes, to make way for farms and pasturelands.[1]

[a] Considering the land area of France and its overseas territories.

Against this backdrop, unsustainable agricultural activity has degraded soil quality on 28 Mha of Brazilian pastureland — about 20 percent of the country's pastures. An additional 40 percent is at risk.[2] Not only can degraded land impede Brazil's long-term sustainable development goals; it can also create a vicious cycle of farmers expanding their agricultural activities further into native forests in search of higher quality soil and therefore, driving even more forest loss.

Fortunately, public and private actors in Brazil appear interested in building a sustainable bioeconomy that pairs continued growth in its agricultural sector with efforts to monetize the economic benefits associated with restoring degraded land to harvest forest products, store carbon, manage fresh water, revive biodiversity and boost rural economies. This strategy took center stage when a multi-stakeholder coalition of investors, companies, NGOs and Brazil's government launched the Brazil Restoration & Bioeconomy Finance Coalition in November 2024, aiming to raise USD 10 billion and restore 5 Mha by 2030. The coalition aims to achieve these goals through a combination of public and private investments in key bioeconomy activities, such as low-emissions agriculture, forestry projects and land-use actions.[3]

Brazil has an opportunity to scale up reforestation investments in ways that hold enormous promise for people and nature. This potential is not limited to environmental improvements and economic returns for investors. Forest restoration can also significantly improve the livelihoods of Indigenous Peoples and local communities near project areas. In addition to creating high-quality direct and indirect jobs, restoration projects directly contribute to community health and livelihoods by providing cleaner air and water, improving opportunities for sustainable subsistence and economic activities (e.g., farming, fishing, and harvesting of edible fruits and nuts), and unlocking new potential for community members to participate in economic opportunities such as ecotourism.

Four major forces, acting in tandem, are poised to shape the future of the Brazilian economy by making reforestation highly profitable, jumpstarting new economic opportunities and simultaneously delivering sustainable jobs, economic growth and nature conservation.

Unsustainable agricultural activity has degraded soil quality on about 20 percent of the country's pastures. An additional 40 percent is at risk.

Four Major Forces Poised to shape the Future of the Brazilian Economy

1. Policy

Political will is building to free up degraded land for forest restoration.

Brazil's growing interest in reducing greenhouse gas emissions and supporting sustainable land management is expected to build political support for turning degraded agricultural lands into sustainably managed forests that provide both environmental and economic benefits (such as sustainable timber and other wood products).

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2. Ag Yields

Agricultural productivity gains will likely make Brazil's agricultural sector ripe for increasing overall efficiency and sustainability.

Brazil will likely continue a longstanding trend of technological improvements in agriculture. If these innovations significantly increase agricultural intensification and crop yields, it should free up low-value, unneeded land for forest restoration.

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3. Profits

Forest restoration is likely to become more profitable.

The emergence of strong, new financial incentives — through markets for carbon, biodiversity, sustainable timber products and ecosystem services — will drive forest restoration toward becoming an economically viable and competitive land-use choice for landowners and businesses.

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4. Scale

New financial and policy solutions are poised to scale forest restoration funding and implementation.

Innovative financial tools and specialized project developers will turn restoration potential into investable, scalable action. These include blended finance and green bonds, instruments that are already being employed by stakeholders such as the World Bank and leading restoration developers re.green and Mombak.

Despite promising momentum for scaling forest restoration in Brazil, stakeholders must address a number of key challenges. Carbon credit and certified sustainable wood markets must continue to mature, while new markets for ecosystem services, biodiversity and sustainable forest products need to be scaled to expand investment opportunities for restoration projects. Timely deployment of capital is also essential to get projects off the ground when funding is most needed. In addition, successful execution of restoration projects depends on accessing the right expertise and tools to deliver measurable results and distribute benefits effectively. Finally, demand for carbon credits must be activated by targeting buyers with the highest willingness to pay to unlock broader financing sources.

Collective action is necessary to overcome these challenges, secure a long-term path toward economic growth, climate protection and economic resilience, and capitalize on the urgent opportunity to generate USD 141 billion in reforestation benefits. Stakeholders — investors, companies, standard setters and value chain actors, project developers and policymakers — will need to take the following steps:

- **Strengthen the national strategy to support restoration of forests.** Developing and implementing a coordinated national restoration strategy can set clear and ambitious targets, mobilize public and private investment, and align policies across sectors to unlock Brazil's restoration potential.
- **Incubate financial mechanisms to support projects.** Establishing dedicated funding platforms, de-risking tools and public-private partnerships can accelerate the development of innovative financial instruments and attract early-stage capital for scalable forest restoration projects.
- **Embrace sustainable products and create a circular economy.** Monetizing the benefits of restored land — such as sustainable timber, carbon storage and ecosystem services — can build a bioeconomy that supports rural livelihoods while conserving nature.
- **Scale carbon markets.** Integrating forest restoration carbon credit projects into Brazil's emerging emissions trading system (ETS) can provide landowners with stronger financial incentives to restore degraded land.
- **Develop multi-stakeholder alliances.** The launch of the Brazil Restoration & Bioeconomy Finance Coalition underscores how partnerships between government, investors, companies and NGOs can mobilize billions in funding and drive large-scale restoration.

Time for Action

The economic, environmental and social gains identified above are not distant possibilities. They are within reach. At this pivotal moment, Brazil has a clear opportunity to lead the world in combining economic growth with large-scale forest restoration. The financial, social and environmental benefits are real if investors, companies, government and civil society pursue the right actions. With coordination and bold investment, Brazil can restore millions of hectares, generate billions in value, and set a global example for restoration for decades to come.

1. Policy

Political will is building to free up degraded land for forest restoration.

Forest Restoration Makes Economic Sense for Brazil's Agricultural Sector

In Brazil, agriculture is an economic engine. Between 2000 and 2020, the value of Brazil's agricultural sector rose by an average of 8 percent every year.[4] In 2021, the country's agriculture and food sector accounted for 29 percent of its GDP.[5] The role of agriculture in Brazil's economy is only expected to increase; a 2023 report by Brazil's Ministry of Agriculture projected that grain and meat production would increase by 27 and 22 percent, respectively, by 2034.[6]

This growth has come at the expense of the environment. It has resulted in the loss of biodiversity and carbon-rich forests, replaced by pastureland that is at risk of degradation from overgrazing and unsustainable land management practices.

Above: The Brazilian National Congress Palace

177 million hectares

Amount of land covered by Brazilian pastures according to data from the Federal University of Goiás Image Processing and Geoprocessing Laboratory and analyzed by Embrapa, around 40% of which have medium vegetation vigor and signs of degradation, while 20% have low vegetation vigor, i.e., severe degradation."[7]

Agriculture and livestock account for 27 percent of Brazil's greenhouse gas emissions, and the deforestation currently driving the growth in these sectors is hindering the country's ability to meet its emissions reductions goals.[8] Additionally, this growth is taking a major toll on the agricultural land itself.

Forest restoration could bring higher domestic investment that generates environmental benefits and employment opportunities.

The impact of degradation on the economic value of this land is twofold: the land can no longer produce the agricultural yields it once did, and it can no longer provide the ecosystem services of native vegetation, such as improved regional climate benefits (e.g., lower temperatures) from adjacent healthy forests.[9]

This complex reality raises a critical question: Can we change this trajectory? Can degraded agricultural land be restored into forests at a scale big enough to drive Brazil's burgeoning bioeconomy? Increased attention on forest restoration could bring higher domestic investment that generates both environmental benefits and employment opportunities for communities. Investors, meanwhile, could profit from a long-term asset that monetizes the carbon, biodiversity and bioeconomy, including revenues generated by the sale of sustainable products sourced from forest restoration projects.

Opportunities for restoration and increased investment are deeply connected with broader shifts that are occurring in response to climate change. These shifts are known as "climate transitions." Climate transitions are the result of government, private sector and civil society responses to climate change. As the physical impacts of the climate crisis intensify, these groups come under increased pressure to take action to mitigate the worst impacts of climate change through policy and legal responses, technological innovations, market developments and reputational considerations. Forest restoration, when aligned with these broader shifts, is both a climate solution and a catalyst for sustainable economic transformation.

Forest Restoration Is Capturing Global Attention

Given its significant environmental and economic benefits, forest restoration is emerging as a global investment opportunity. Under the Bonn Challenge, launched in 2011, governments have collectively committed to restore 350 Mha of land by 2030.[10]

National commitments are now mobilizing action. This is happening in both heavily forested countries, as demonstrated by Brazil spearheading new financing initiatives like the Tropical Forests Forever Facility,[b, 11] and countries dependent on imports of agricultural commodities with potential ties to deforestation, as shown by recently enhanced European Union reporting and disclosure rules.[12]

Public and private stakeholders' interest in forest restoration is driven by the multiple social and environmental benefits it provides, including:

- **Reducing greenhouse gas (GHG) emissions and enhancing carbon stocks:** Restoring 350 Mha of degraded land and water ecosystems globally in the next five years — as called for in the Bonn Challenge — could sequester up to 26 gigatons of greenhouse gases.[13] Restoring forests in Brazil alone would have a significant positive impact on meeting global climate goals.[14]
- **Enhancing biodiversity:** Restoring 30

[b] Another example of domestic policy action on forest restoration is Colombia's Sustainable Cattle Ranching pilot payment of ecosystem services program

percent of lands converted for farming in priority areas globally would prevent at least 70 percent of species extinctions worldwide.[c, 15] Even if only 15 percent of converted lands are restored and no additional land is converted to agriculture, approximately 60 percent of species currently projected to become extinct would be saved.[16]

- **Generating natural capital and community co-benefits:** For every USD 1 invested in ecosystem forest restoration, between USD 7 and USD 110 is generated in the form of ecosystem services and community investment.[17]

These imperatives make a strong investment case for forest restoration. Financial instruments, particularly voluntary carbon markets, offer revenues to fund forest restoration benefits based on their carbon benefits. Demand for nature-based removal credits — which include forest restoration and implementation of sustainable forestry practices — is forecast to grow to 40 million tonnes of CO_2 equivalent ($MtCO_2e$) annually in 2030, more than five times current levels.[18]

Investors in the voluntary carbon market are already capitalizing on forest restoration projects. Between 2021 and 2024, carbon projects focused on nature restoration comprised 45 percent of all announced capital raised.[19] Buyers are committing to increase the share of carbon credits from carbon removals in their portfolios, a trend that could reward forest restoration investors. With over 4,000 corporations agreeing to cut emissions in line with Paris Agreement goals, many will rely on carbon credits, as traded in the voluntary carbon market, to stay on track.[20] Corporations are also demonstrating an increased interest in forest and land use-based carbon credits for their positive contributions to conserving nature, alongside climate mitigation.[21]

Brazil Is Attracting Forest Restoration Investment

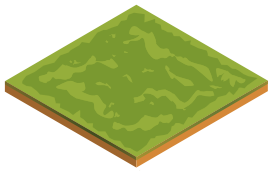
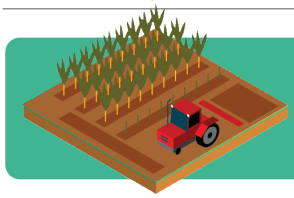
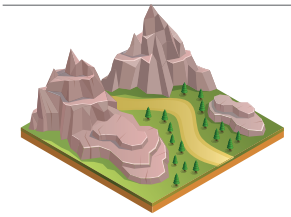
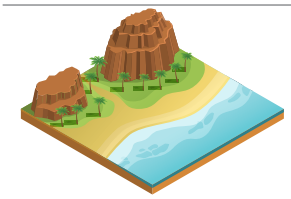
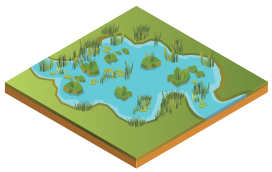
Forest restoration is part of Brazil's broader strategy to build political support for and investment in a strong and resilient rural economy. It is therefore important to understand what Brazil is doing across all the types of land that it can restore, which range from drained wetlands and coastal ecosystems to degraded forests and even urban areas.[22]

These opportunities, although not the focus of this analysis, are nevertheless significant. For example, the naturebase platform estimates that 144 $MtCO_2e$ could be seques-

[c] Projected prevented extinctions would be of mammals, birds and amphibians.

EXHIBIT 1.1: CATEGORIES OF LAND AVAILABLE FOR FOREST RESTORATION

List is non-exhaustive ■ Restoration approaches that are the focus of this report

Where restoration can be implemented	What type of restoration	Rationale
 Forests	Afforestation/Reforestation	The degraded pasturelands in Brazil are its largest restoration opportunity due to their minimal tree cover. It is estimated that even simple intensification techniques (pasture rotation) would be enough to minimize any potential negative impact of that land-use change.
 Fresh water	Agroforestry and silvopasture	
 Grasslands, shrublands and savannahs	Improved forest management	Restoring forests on agricultural land can create a new supply of wood to be harvested for various products. Restoration projects must therefore implement sustainable forestry practices to minimize the environmental impact of wood harvesting.
 **Farmlands**	Native vegetation silviculture	
 Mountains	Regenerative agriculture	
 Oceans and coasts		
 Peatlands		
 Urban areas		

tered through grassland restoration each year.[23] Exhibit 1.1 provides a non-exhaustive typography of forest restoration approaches available in Brazil, and how agriculture fits in a wider policy and investment context.

Brazil is poised to lead the way for other countries taking action on forest restoration.

Forest restoration is a priority in Brazil's diplomatic, economic and environmental strategies. On the international stage, Brazil is using its prominent role as the host of multiple major diplomatic summits to highlight the importance of forest restoration. Brazil hosted G20 meetings in 2024 and will host COP30 — the world's annual climate conference — in 2025, ensuring that nature and forest restoration will be high on the summit's agenda.

Thanks to its supportive policy environment, Brazil is poised to lead the way for other countries taking action on forest restoration. A comprehensive set of laws and commitments promote forest restoration in the country, stretching back nearly a century to Brazil's Forest Code of 1934 (most recently updated in 2012).[d, 24] The laws provide a foundation that Brazil is building upon for the future. Brazil's new international climate target, known as its Nationally Determined Contribution (NDC), aims to reduce emissions between 59 percent and 67 percent under 2005 levels by 2035, and highlights that forest restoration is critical for meeting its new target.[25]

Restoring agricultural land, in particular, is a major priority for Brazil. The country's Sectoral Plan for Mitigation and Adaptation to Climate Change for the Consolidation of a Low-Carbon Economy in Agriculture — otherwise known as its "ABC Plan" — was approved in 2011 with the goal of recovering 15 Mha of degraded pastures by 2020.[26] By 2018, the ABC Plan's goal was not only achieved, but surpassed: Brazil's Ministry of Agriculture and Livestock estimates that 26.8 Mha of degraded pastures were recovered.[27] Brazil extended the program (now the ABC+ Plan) until 2030. It acts as a core part of Brazil's strategy to achieve its NDC and reaffirm its commitment to support forest restoration efforts on agricultural land.

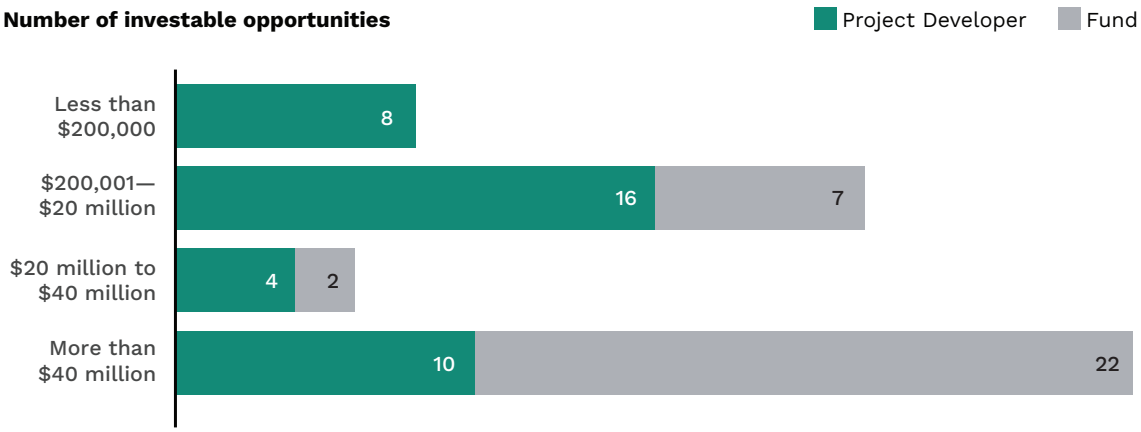
[d] Experts note that "Ecosystem protection [is] the most critical cost-effective climate mitigation measure for Brazil .... Full implementation of Brazil's Forest Code, a key policy for emission reduction in Brazil, would be enough for the country to achieve its short-term climate targets up to 2030 [but] it would not bridge the gap to its net-zero pledge by 2050."

Recognizing the potential of restoration to meet the country's climate goals, Brazil is creating an investment hub for forest restoration. The government was instrumental in building the Brazil Restoration & Bioeconomy Finance Coalition to mobilize at least USD 10 billion for conservation and forest restoration by 2030.[e, 28] Expanding upon collaboration with international groups, Brazil's National Bank for Economic and Social Development (BNDES) signed an agreement with the Inter-American Development Bank (IDB) in January 2025 to facilitate public-private partnerships that manage and restore public forests in the Amazon.[29] The government's interest expands the potential economic benefits that forest restoration could generate. If Brazil reaches its goal of restoring 12 Mha of forests by 2030, Instituto Escolhas estimates that this would generate USD 134.7 million in net revenue and create 2.5 million jobs.[f, 30]

Private investment is also increasingly being funneled to forest restoration-focused funds. Capital for Climate identifies 22 funds and 10 project developers ambitiously seeking over USD 40 million in capital for forest restoration, sustainable forest management and agroforestry in their priority geographies, which include Brazil.[31] Recently, Brazilian agricultural and institutional investor funds have also been deploying capital for forest restoration.

The following sections detail how forest restoration could accelerate based on three trends: 1) the potential to make restorable agricultural land available; 2) an increasing profitability for forest restoration; and 3) the emergence of durable ways to fund forest restoration and solutions to address implementation challenges. We also explore a potential pathway to go beyond those current solutions and achieve scale commensurate with the opportunity forest restoration provides for nature, economy and climate.

EXHIBIT 1.2: OPPORTUNITY SIZE OF PROJECT DEVELOPERS AND FUNDS INVESTING IN RESTORATION, SUSTAINABLE FOREST MANAGEMENT, AND AGROFORESTRY IN BRAZIL[32]



[e] Brazil has also demonstrated leadership to protect tropical forests not just within its own borders, but worldwide by proposing a new funding mechanism, the Tropical Forests Forever Facility, that would mobilize public and private funding to generate up to U4 billion for tropical forests each year: Manuela Andreoni, "An 'Elegant' Idea Could Pay Billions to Protect Trees."

[f] Exchange rate as of March 24, 2025: 1 BRL R$ = 0.17349 USD $.

2. Ag Yields

Agricultural productivity gains will likely make Brazil's agricultural sector ripe for increasing overall efficiency and sustainability.

More Agricultural Land Is about to Become Available for Forest Restoration

Brazil's reforestation opportunity is partly driven by the actions taken domestically and globally to address climate change, which we collectively refer to as climate transitions.[33] Depending on their intensity (see Exhibit 2.1), these actions could free up 59–64 Mha of pastureland for forest restoration by 2050. This represents a leap from Brazil's current commitment to restore 12 Mha by 2030. Investors can use forward-looking scenario analysis to estimate the potential land available for forest restoration.[g] Through this analysis, they can see a substantial sparing of agricultural land from today until mid-century across all scenarios.

[g] This report uses climate transition scenarios developed by the World Business Council on Sustainable Development (WBCSD). See Technical Annex for details.

An area the size of France[h]

Amount of Brazil's agricultural land — up to 64 Mha — that could be available for forest restoration by 2050.

Climate transitions will have significant impacts on the agricultural sector beyond sparing land, from agricultural yields to employment.[i] Converting 59–64 Mha of agricultural land into forests by 2050 is possible without undermining food security by preserving the 21st century trend of increased agricultural productivity in Brazil.

This shift forms a broader change in Brazil's land use that would increase carbon sequestration above its current trajectory by 360–451 $MtCO_2e$ per year by 2050, equivalent to Argentina.[34] These transitions could also slow the current decline of agricultural employment in Brazil and simultaneously create between 357,000 and 369,000 jobs annually for Brazil's emerging bioeconomy.

Transitions could...create between 357,000 and 369,000 jobs annually for Brazil's emerging bioeconomy.

Given its high emissions, Brazil's agricultural sector must be a key player in managing the impacts of climate transitions, and restoring or converting land is among the most impactful opportunities. Agricultural land use covers almost 40 percent of the Earth's ice-free surface and, globally, beef and soy production are the leading drivers of tropical deforestation and conversion of other habitats.[35]

In Brazil, production of these two commodities is responsible for more than two-thirds of the recorded habitat loss in the Amazon and Cerrado regions.[36] Former agricultural land should therefore be the focus of forest restoration investment.

Climate transitions are already impacting Brazilian agriculture today. There is increased pressure from key export markets to minimize agriculture's effect on deforestation and land conversion. For example, in June 2023 the European Union Regulation on Deforestation-free Products (EUDR) updated EU import restrictions prohibiting the sale of commodities — soy, beef, palm oil, wood, cocoa, coffee and rubber — sourced from regions affected by deforestation or forest degradation. Under the regulation, any operator or trader who places these commodities on the EU market, or exports from it, must be able to prove that the products do not originate from recently deforested land or have not contributed to forest degradation.[37]

Beyond regulation, major corporate buyers are also taking action. For example, Walmart has implemented a forest policy to mandate the sourcing of deforestation-free and conversion-free (DCF) products, which includes a specific goal to source 100 percent of beef from the Brazilian Amazon and Cerrado as DCF by 2025.[38] Other large corporations have also implemented forest policies, including IKEA, McDonald's, Starbucks, Colgate-Palmolive, Kimberly-Clark, and Cargill.

[h] Includes overseas France.

[i] Climate Transitions are the result of government, private sector and civil society responses to climate change. As the physical impacts of the climate crisis intensify, these groups are under mounting pressure to take action to mitigate the worst impacts of climate change through policy and legal responses, technological innovations, market developments and reputational considerations. We define agricultural land as encompassing cropland and pastureland in Brazil.

Brazil Has a Significant Opportunity to Free Up Agricultural Land for Forest Restoration

Brazil can spare between 59 and 64 Mha for forest restoration by 2050 — a land size comparable to the state of France.

Enhanced climate actions both within Brazil and internationally create the impetus for landowners to make land available for forest restoration. The voluntary carbon market, the potential to sell sustainable products at a premium, and companies' desire to mitigate their supply chain impacts all offer the potential for financial returns from restored land (more details in Section 3). Landowners are thus given an attractive opportunity to monetize former agricultural land that is no longer needed due to productivity improvements and lower demand for certain commodities (e.g., soy and cattle) through forest restoration.

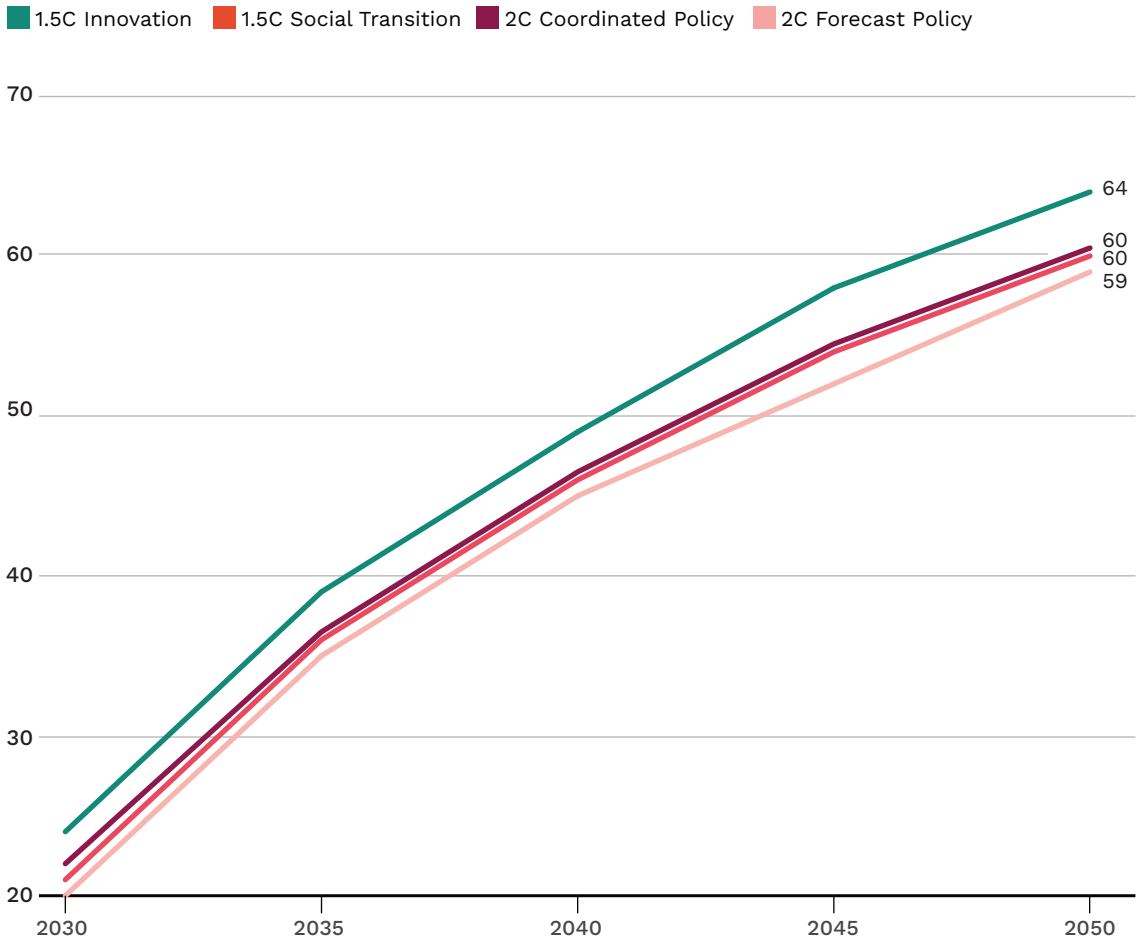
Given these incentives for landowners, it is likely that forest restoration activities will grow rapidly. Brazil can spare between 59 and 64 Mha (Mha) for forest restoration by 2050 — a land size comparable to the state of France (~69.6 Mha). The estimated spared land (in Mha) across scenarios is shown in Exhibit 2.1 below.[J] The two 2-degree-Celsius (2°C) scenarios generate similar levels of land spared; however, under a more ambitious scenario in which warming is limited to 1.5 degrees Celsius (1.5°C), another 7–9 percent of land could be made available for restoration.

Carbon sequestered: Restoring land at this scale is part of a broader shift in Brazil's land use that includes conserving existing forests. Depending on the level of climate action across the transition scenarios, Brazil could sequester approximately 360–451 Mt-CO_2e annually by 2050 through restoration activities.

Employment opportunities: One of many potential benefits for Indigenous Peoples and local communities living in and around resto-

[J] Scenarios consider spared land in addition to BAU, where the BAU scenario considers 0 additional Mha of land spared. See Technical Annex for model details.

EXHIBIT 2.1: LAND SPARED ACROSS SCENARIOS (Mha)



ration project areas is increased employment opportunities. The potential total impact on employment (e.g., including the potential loss in agricultural jobs), as well as the total growth in direct forest restoration jobs available, is significant. The former lens is relevant when considering the economy-wide impact of scaling forest restoration, and the latter is useful for quantifying a forest restoration project's potential socioeconomic benefits, which are increasingly emphasized alongside its environmental impact.

Recent analysis shows that over half a million Brazilian agricultural jobs (including farming of both crops and livestock) were lost between 2016 and 2023, representing a decline of almost 4 percent. This loss more than offset the over 330,000 jobs created in the same period by the agribusiness sector, which includes a wider range of jobs in the food and beverages and non-food sectors.[k, 39] In the Brazilian agricultural sector, there is a rising trend of formalization of previously informal types of employment, leading to average wage increases, better job security and labor rights.[40]

Climate transitions do not materially impact this ongoing trend — unrelated to land being converted from agriculture to restoration projects — of decline in Brazil's agricultural

[k] For example, a study found that there has been a decrease in informal jobs, with a smaller corresponding expansion of formal jobs. Total agricultural employment has thus decreased, but become higher quality, with fewer formal workers earning higher salaries, increased job security, and rights and benefits. Source: Fundação Getúlio Vargas. "Estudo mostra que universo agro está menor, porém mais formal e pagando mais," December 13, 2023. https://portal.fgv.br/noticias/estudo-mostra-universo-agro-esta-menor-porem-mais-formal-e-pagando-mais.

EXHIBIT 2.2: EXTERNAL ESTIMATES OF JOBS GENERATED BY FOREST RESTORATION PROJECTS

Source	**Date of study**	**Jobs estimate** *(Full-time equivalent/ha)*
Instituto Escolhas	2023	0.21
Brancalion et al.	2022	0.42
Planaveg (Brazilian Government National Native Vegetation Recovery Plan)	2017	0.2
Silva et al.	2015	0.31
Calmon et al.	2011	0.2

employment. Climate transition scenarios used in our analysis show a continued decline in the number of agricultural jobs of between 31 percent and 36 percent by 2050, compared to 2020 levels. However, forest restoration can help compensate for this expected continued decline in agricultural employment, as discussed next.

Forest restoration activities also generate direct employment benefits. A variety of recent studies quantify the employment impact on forest restoration in Brazil, with a range of 0.2–0.42 jobs per hectare (see Exhibit 2.2 above). Instituto Escolhas, for example, estimates in a recent analysis that achieving 12 Mha of forest restoration will generate 0.21 jobs per hectare. Using the most conservative estimate (0.2 jobs per hectare) and the projected hectares of land available to be restored presented in the following section, a potential 357,000-369,000 jobs could be created annually between 2025 and 2050, under 2°C climate transition scenarios. This accelerates to 396,000 annual direct jobs under the 1.5°C Innovation scenario.

There are various employment opportunities created by forest restoration projects. Brancalion et al., for example, categorize the jobs supported by forest restoration as activities focused largely on seeds, seedlings, planting/maintenance and services.[41]

Creating jobs benefits forest restoration projects for three key reasons:

1. Employment generation within local communities makes projects more durable, as local communities have an increased stakeholder interest.
2. Generating socioeconomic outcomes is a priority for philanthropic and multilateral funders, as a co-benefit to improved carbon sequestration and biodiversity protection.
3. Employment opportunities in forest restoration builds local capacity and skills that can be replicated in other project areas.

In practice, the total jobs and their regional distribution will depend on external factors such as workforce training, availability of skilled workers, labor market forces, wages, etc.

Restoration projects could also provide additional employment benefits in the form of indirect jobs spurred by the influx of workers directly employed in these projects.

Growth in Agricultural Productivity Limits Impacts on Food Security

Food insecurity, historically a major concern in Brazil, has been greatly mitigated in recent years. According to the Brazilian government, severe food insecurity — which affected 17.2 million Brazilians in 2022 — dropped by 85 percent to 2.5 million the following year, a reduction from 8 percent of the population to just 1.2 percent. The Brazilian government currently has a goal to achieve zero hunger by 2030.[42]

Forest restoration can grow significantly without impairing this progress to date or compromising the 2030 goal. Forest restoration and agricultural restoration go hand in hand. By employing regenerative agriculture or silvopasture practices to revive low-quality agricultural land, farmers can simultaneously improve productivity and increase carbon sequestration. Climate transitions therefore will create a multiple opportunities for sustainable investment, including deploying forest restoration activities on active agricultural land (and through sustainable land practices for cropland and pastureland, not included in this analysis), and increasing the amount of land no longer needed for agriculture that can lead to more investment in forest restoration.

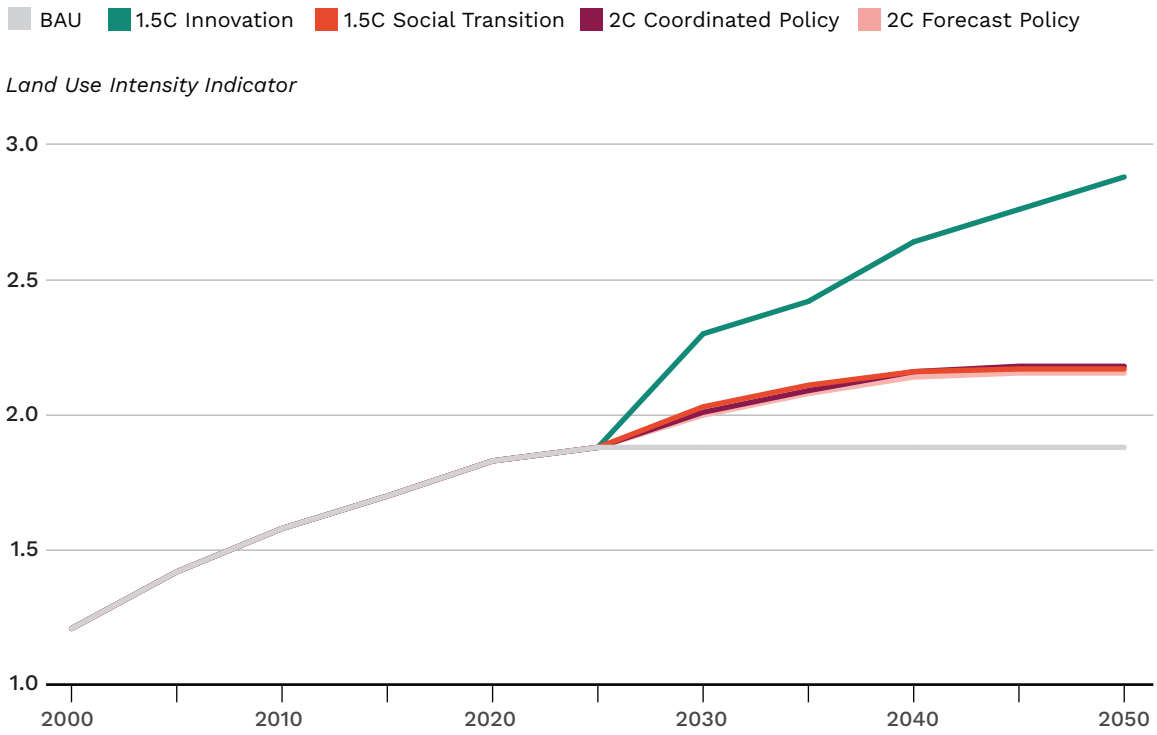
Land productivity, and specifically agricultural yields, are therefore critical to understand the potential for forest restoration. As shown in Exhibit 2.3 below, Brazil increased land productivity 55 percent between 2000 and 2025. The trend in land productivity for the next 25 years strongly depends on the underlying assumptions for business as usual (BAU), 2°C and 1.5°C scenarios.

- **BAU:** Productivity remaining at current levels until 2040, and only then increasing at the historical growth rate
- **1.5°C Social Transition scenario and both 2°C scenarios:** Consistent productivity growth at rate similar but below historical trends
- **1.5°C Innovation scenario:** Rapid land productivity growth faster than historical levels due to the emergence and deployment of technology

Exhibit 2.3 shows the estimated change in productivity and land intensity, a proxy measure for yield improvements, in each scenario.

Moreover, it is expected that climate transitions connected to changing consumer preferences and growing concern about the environmental impact of Brazilian agriculture will reduce demand for soy and cattle, the

EXHIBIT 2.3: PRODUCTIVITY/LAND USE INTENSITY ACROSS SCENARIOS, 1996–2050



two agricultural commodities most responsible for deforestation in Brazil. If these trends continue, it would open up additional land for forest restoration without reducing overall food consumption by Brazilian consumers (or consumers of goods exported by Brazil). Orbitas' previous analyses for the Brazilian soy and cattle sectors also concluded that climate transitions are compatible with food security. Relevant findings include that, by 2050:[43]

- Changing consumer preferences around ruminant meat consumption will decrease the demand for soy as a feedstock significantly, leading to a 3 percent decrease in demand in domestic Brazilian markets and driving a shift toward export markets that are increasingly prioritizing deforestation-free policies.
- Demand for ruminant meat will decline by 38 percent domestically and 5 percent globally, driving a shift toward export markets that are increasingly prioritizing deforestation-free policies.

Land use would therefore transition away from existing agricultural uses, yield improvements will reduce production costs and increase efficiency, and overall food consumption would be unaffected.

3. Profits

Forest restoration is likely to become more profitable.

Forest Restoration in Brazil Is Poised to Become Increasingly Profitable

The previous section discussed the growing trend in which climate transitions are incentivizing landowners to free agricultural land for forest restoration. There are also increasingly attractive mechanisms to specifically support and finance restoring land, detailed in the following section. This is key, because forest restoration involves large upfront costs for project implementation; in addition, returns can only be extracted years in the future, once the forest matures. Private capital is therefore crucial to realize forest restoration, evident by the surge of forest restoration investment Brazil is experiencing. Private investment is mobilized on the expectation of creating a return on investment, however. In other words, forest restoration investment by landowners, private finance or project developers requires profitability to be a scalable financial opportunity. Carbon credits and sustainable timber sales are two ways actors can ensure this profitability.

USD 60–141 billion

Amount over the next 30 years early adopters restoring the most profitable Mha of pastureland could generate.[l]

The ability to monetize forest restoration's benefits means land spared by the forces of current and future climate transition trends can become a profitable with the development of healthy native or working forest. Under a 2°C climate transition scenario, restoring spared pastureland can generate up to USD 7,000 per hectare over 30 years on average, if forest restoration benefits are effectively monetized. If climate transitions accelerate to bring about the 1.5°C scenarios, the most promising forest restoration opportunities could achieve up to USD 21,000 per hectare on average over a 30-year project. By comparison, a 2017 study found that the average cattle farmer in Brazil would earn USD 250 per hectare and year from cattle farming, totaling USD 3,750 over the next 30 years, or 4.4 percent of potential net present value (NPV) available under a 2°C climate transition scenario.[44]

In practice, this could create a virtuous cycle: Climate transitions make land available for forest restoration, which occurs because of access to markets that value forest restoration benefits, which mobilizes more landowners to pursue greater forest restoration. As these markets grow, new avenues for monetization can also mature and provide greater financing — for example, in the form of future biodiversity credits or more demand for non-timber forest products to fuel Brazil's bioeconomy even further.

Restoring spared pastureland can generate up to USD 7,000 per hectare over 30 years on average.

The Factors Impacting Project Profitability

Forest restoration on agricultural land is not a one-size-fits-all approach. Instead, there are both up-front design choices and external factors which can materially impact a project's profitability. This analysis includes stress-testing some of the key variables for forest restoration in Brazil, to see its impact on net present value.

- **Forest restoration archetypes:** Investors should be aware that not all agricultural land is equally suitable for forest conversion. For example, geographical features such as steep inclines and prohibitive distances from transportation networks could limit the potential to sell wood products generated on restored land. Cost data for each scenario, which varies by archetype, is then applied to the forest restoration archetypes represented by different types of land, categorized by a combination of their natural regeneration and mechanization potential, as explained below, to estimate project revenues.
- **Natural regeneration potential (high, medium or low):** The expected rate that a forest can grow unassisted on land after agricultural activities cease. High natural regeneration areas are best suited for unassisted forest restoration only, so there are no attractive opportunities for harvesting wood. Medium and low natural vegetation lands, however, do not grow sufficient forests to rely solely on carbon revenues, so the analysis includes the option to develop and harvest sustainable timber on the land.
- **Mechanization (feasible or infeasible):** There are expected challenges in using mechanized equipment on the land, which lowers the cost of implementing forest restoration projects and improves

[l] This section's profitability scenario analysis covers profitability of forest restoration of available Brazilian pastureland. Pastureland is a subset of total agricultural land available for forest restoration identified in the opportunity analysis shared in the previous section.

the potential to develop wood plantations and subsequently sell the harvested products.[m]

The five forest restoration archetypes that project developers prioritize due to a combination of proven track record of successful implementation, potential profitability and highest feasibility are shown in Exhibit 3.1 below.

Ownership structure: Project developers could elect to either lease or purchase the land on which the forest restoration occurs. This choice presents the range of fixed costs a project could encounter. As it is most costly, purchasing land to be held as restored forest in perpetuity would require additional up-front investment without increasing the project's revenue if the land cannot be sold in the future, for example for commercial development. The alternative would be for a project developer to lease land and operationalize the forest restoration at a lower cost than purchasing the land outright. In practice, negotiations between landowners and project developers could agree on terms in between these two scenarios — for example, limited or shared ownership rights over the land for an agreed amount of time.

Financial structure: There has been a shift in forest restoration project finance to provide the vast majority of capital deployed during initial implementation. For example, projects could receive 40 percent of funds in year one, 30 percent in year two, and 20 percent in year three, with the remaining 10 percent distributed as working capital over the remaining lifespan of the project (the structure which forms the baseline for this analysis). If investors instead distribute capital equally across the lifespan (e.g., 5 percent of funds each year for a 20-year project), the timeline for implementing the forest restoration and achieving either certified carbon benefits and/or harvesting wood is affected.

Implementation costs: The cost estimates used in the scenarios reflect observed forest restoration costs in Brazil. However, external circumstances could increase these costs, such as a spike in labor or machinery costs, unexpected or additional certification processes, or other unforeseen costs.

Forest restoration on agricultural land is not a one-size-fits-all approach.

[m] Note that mechanization affects forest restoration as a whole, not only the planting and harvesting of timber. Each forest restoration scenario considered has its own timeline of activities, which is impacted by mechanization.

EXHIBIT 3.1: ATTRIBUTES OF EACH FOREST RESTORATION ARCHETYPE USED IN THE ANALYSIS

Natural regeneration	High	Medium		Low	
Mechanization	No	Yes	No	Yes	No
Monetized benefits	CO_2 Carbon	CO_2 Carbon	CO_2 Carbon	CO_2 Carbon and wood	CO_2 Carbon

Climate Transitions Make Forest Restoration More Profitable

As climate transitions accelerate, more spared pastureland is restored. For example, only 2 percent of land spared under the 2°C Forecast Policy scenario has high natural regeneration potential, whereas the remaining 98 percent likely require active forest restoration. The baseline case analyzed in this section assumes land purchase costs are included, financing is provided up-front, and forest restoration costs are at baseline levels. All scenarios also assume forest restoration of degraded pastureland will overwhelmingly occur in areas already located in Brazil's forest biomes. To account for this, the scenarios use the amount of available pastureland located in those forest biomes (53 percent), as a proxy for how much land available will be restored. Below, Exhibit 3.2A delineates how much of the estimated spared land is categorized into each forest restoration archetype.

A continuation of current market trends ... would present positive returns for around 80 percent of forest restoration opportunities by hectare.

Depending on how climate transitions develop, the profitability of an average hectare of land varies significantly. As shown in Exhibit 3.2 below, achieving a 2°C pathway would generate an average NPV of between USD 3,500 and USD 7,000 per hectare depending on the scenario. If climate action accelerates to achieve a 1.5°C pathway, the average NPV across forest restoration archetypes grows to between USD 17,000 and USD 21,000 per hectare. The primary driver of the increased profitability is that restored land accesses a higher price for its carbon benefits in a 1.5°C scenario compared to a 2°C scenario.

Forest restoration could be profitable even in the absence of further climate transitions. A business-as-usual scenario assumes carbon prices of USD 4 per ton of CO_2 equivalent (tC02e), below current observed market rates and insufficient to generate positive cash flow to offset forest restoration costs. However, projects that harvest wood are profitable in areas with low natural vegetation but where mechanization is possible. Therefore, in the absence of climate transitions, project developers and investors should prioritize archetypes with diversified revenue streams (carbon and wood) and where wood production can be mechanized.

If prices and costs remain at today's level, most projects will be profitable. A continuation of current market trends — both carbon and wood prices and forest restoration costs — would present positive returns for around 80 percent of forest restoration opportunities by hectare. Across the profitable forest restoration archetypes, the average gain is USD 6,000 per hectare. The exception would be projects that monetize carbon benefits only, in areas with low natural regeneration and where mechanization is infeasible.

There is a major investment opportunity across forest restoration modes and scenarios. Across most scenarios and forest restoration archetypes, Brazilian forest restoration projects have the potential to generate positive NPV (Exhibit 3.2B) and return on investment (ROI). Exhibit 3.2C shows the ROI range climate transition scenarios and forest restoration archetypes. It is important to note, however, that the resulting NPV and ROI from forest restoration does not fully accrue to investors — it is shared between stakeholders including investors, project developers and communities. Therefore, the return on an investor's capital will, in practice, be lower after accounting for this distribution.

EXHIBIT 3.2: COMPARING FOREST RESTORATION ARCHETYPES

Natural regeneration	High	Medium		Low	
Mechanization	No	Yes	No	Yes	No
Monetized benefits	CO_2 Carbon	CO_2 Carbon	CO_2 Carbon	CO_2 Carbon and wood	CO_2 Carbon

EXHIBIT 3.2A: LAND RESTORED (Mha)

Scenario						*Total*
2C	Forecast policy	0.4	8.2	1.5	12.6	1.1	**23.8**
2C	Coordinated policy	0.4	8.5	1.7	12.9	1.2	**24.7**
1.5C	Innovation	0.6	9.5	2.3	12.5	1.6	**26.5**
1.5C	Social transition	0.5	8.9	2.1	11.6	1.4	**24.5**

Note: These numbers reflect baseline forest restoration costs, with an up-front financing structure and where land purchase costs are included.

EXHIBIT 3.2B: NPV PER HA

More than $150K | $100K–$150K | $75K–$100K | $50K–$75K | Less than $50K | Negative

Scenario						*Average*
2C	Forecast policy						**$3,500 USD**
2C	Coordinated policy						**$7,000**
1.5C	Innovation						**$21,000**
1.5C	Social transition						**$17,000**

Note: Net Present Value (NPV) calculated using a discount rate of 9 percent. These numbers reflect baseline forest restoration costs, with an up-front financing structure and where land purchase costs are included. Average represents weighted average.

EXHIBIT 3.2C: ROI RANGE

Scenario							*Average*
2C	Forecast policy	73%	61%	46%	55%	-6%	**54%**
2C	Coordinated policy	119%	95%	76%	77%	12%	**80%**
1.5C	Innovation	268%	219%	188%	135%	82%	**169%**
1.5C	Social transition	173%	154%	130%	101%	49%	**121%**

Investors can capture USD 60–141 billion of investment value by prioritizing opportunities in areas with the highest investment value. Returns over 30 years vary between 54 and 169 percent depending on forest restoration archetype and climate transition scenario. The variation in returns means there is a significant first-mover advantage for projects where the ROI is highest. If investors focus on the 5 Mha with the highest ROI, they would generate an aggregate value of USD 60–76 billion in a 2°C climate transition, rising to USD 123–141 billion in a 1.5°C climate transition. This compares with an investment value of USD 17–90 billion if the 5 Mha were distributed in proportion to each forest restoration archetype, without prioritizing the most valuable opportunities.

Investors can capture USD 60–141 billion of investment value by prioritizing opportunities in areas with the highest investment value.

Forest Restoration Opportunities in the Forest Biomes Are Concentrated in the Amazon

At a regional level, eight Brazilian states provide over 95 percent of the total pastureland available for forest restoration. Pará, the state with the second-highest share of cattle production in Brazil,[45] is home to the largest opportunity. In the 2°C Forecast Policy scenario, Pará alone could sequester 570 Mt-CO_2e over 30 years, an amount greater than Australia's annual GHG emissions in 2023.[46] The states are concentrated in Brazil's critical biomes, either the Amazon, Cerrado, Caatinga or Atlantic Forest. These states are detailed in Exhibit 3.3 below.

Project Structure and Costs Significantly Impact Forest Restoration Profitability

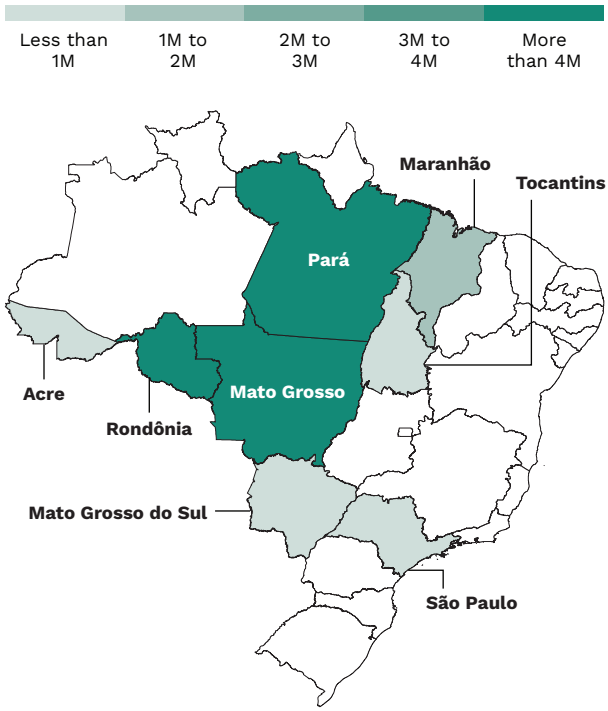
The results demonstrated above assume that project developers purchase the land for forest restoration; receive upfront financing;[n] and that forest restoration costs do not significantly increase from our projected baseline. However, there are alternative scenarios which could impact the profitability of forest restoration:

- **Land purchase costs are not included (e.g., land is rented):** If developers do not have to account for land purchase costs and rent instead, this decreases project costs and increases returns. Across all scenarios, there is an average

[n] The model assumes developers receive 40 percent of funds in year one, 30 percent in year two, and 20 percent in year 3, with the remaining 10 percent distributed as working capital over the remaining lifespan of the project.

EXHIBIT 3.3: BRAZILIAN STATES BY FOREST RESTORATION OPPORTUNITY OVER 30 YEARS

Pastureland restored in Ha



State	Predominant Biome	Cumulative tCO_2e sequestered	Pastureland restored in Ha	Average ROI
Pará	Amazon	570,000,000	**8,000,000**	153%
Mato Grosso	Amazon	330,000,000	**5,000,000**	149%
Rondônia	Amazon	370,000,000	**4,000,000**	145%
Maranhão	Cerrado & Amazon	70,000,000	**1,500,000**	132%
Tocantins	Cerrado	40,000,000	**800,000**	128%
Acre	Amazon	60,000,000	**600,000**	142%
São Paulo	Atlantic Forest	8,000,000	**400,000**	110%
Mato Grosso do Sul	Cerrado	10,000,000	**300,000**	108%
Total/average		1,500,000,000	21,000,000	146%

NPV increase of 262 percent. Across both 2°C scenarios, the average NPV increase is even higher, ranging from 244 percent to 615 percent.

- **Capital is provided over several years instead of upfront:** Should developers not secure up-front financing, and assuming investors instead distribute capital equally across the lifespan (e.g., 5 percent of funds each year for a 20-year project), this significantly reduces project feasibility. Areas with low regeneration potential that cannot be mechanized become infeasible for forest restoration, with negative NPVs across all scenarios. Such areas, even with medium regeneration potential, would have negative NPVs in both 2°C scenarios as well. The only feasible projects under the 2°C scenarios would be those that extract sustainable timber revenues.
- **Project costs are 30–50 percent higher:** Project costs are the major determinant of investor returns. Across scenarios and forest restoration archetypes, a 30 percent increase in project costs generates an average 35 percent, drop in NPV, and a 50 percent cost increase leads average NPV to decline by 58 percent. These cost scenarios represent a conservative projection, but they are useful for investors to stress-test project feasibility. For project developers, exercising active management to control implementation costs can help avoid reducing return on investment.

4. Scale

New financial and policy solutions are poised to scale forest restoration funding and implementation.

Solutions Are Emerging to Scale Funding and Implement Forest Restoration

Forest restoration is already a promising proposition, and climate transitions will increase both the supply of land available for forest restoration and its profitability. There are three established routes for projects to monetize their benefits: carbon credits sold in voluntary carbon markets, green bonds and sustainably certified wood products.

1. **Voluntary carbon markets** (VCM) certify a project's greenhouse gas benefits (in this case, the enhanced sequestration of carbon dioxide), creating carbon credits sold to corporations as part of their climate strategy (e.g., claiming that their products and/or operations are carbon neutral). Globally, VCMs are growing in importance and scale, with more companies making climate commitments that rely on offsets to be achieved.[47]

2. **Green bonds** issued with ties to a specified set of sustainability actions, such as restoring land. Typically, these actions are built into the bond's terms and constrain how the lender can use the funds.[o]

3. **Sustainably certified wood products** focus on how wood is planted, grown and harvested, and are aimed at companies and end users who desire a product that meets high environmental standards. The demand for these is also growing, as shifting consumer preferences favor sustainable products, potentially allowing sellers to capture buyers with a higher willingness to pay or a higher market share among consumers who prefer to purchase sustainable products.[48]

Beyond these, four additional ways to monetize forest restoration are emerging: two within Brazil, and two globally:

1. **Increasing access to domestic investors:** Brazil is making strides toward allowing two types of domestic funds to invest in forest restoration projects: agribusiness investment funds (Fiagros) and private pension funds.

2. **Regulated carbon market:** The forthcoming emissions trading system in Brazil (expected to be implemented by 2030) could allow forest restoration projects to sell compliance carbon credits to entities regulated under the program.

3. **Biodiversity credits:** If the nascent voluntary biodiversity credit market continues to scale, it could represent a significant additional monetization avenue for forest restoration projects.

4. **Corporate supply chains:** An increasing focus on reducing the environmental impact of supply chains means that forest restoration developers can partner with corporations who may fund project capital and operating expenses for forest restoration on lands that can be considered within the corporate supply chains.

All seven funding sources are examined in greater detail in case studies available in the appendix.

Across these funding routes, there are challenges to navigate. To reach the scale estimated through economic scenario analysis, there are obstacles across the project cycle. These challenges include:

- **Creating markets:** Developing and maturing investment use cases beyond carbon markets and sustainably certified wood products

- **Mobilizing finance:** Deploying capital when forest restoration projects need it most

- **Executing projects:** Deploying the expertise and tools to successfully achieve forest restoration, capture its benefits and funnel the benefits to use cases

- **Accessing demand:** Reaching buyers of forest restoration benefits across use cases, and targeting buyers with the highest willingness to pay

There is momentum toward addressing these challenges. A number of actions, each an example of climate transitions, are being taken by the Brazilian government, financial institutions, companies both supplying forest restoration projects and purchasing their credits/products, and standards that govern the relevant markets. Taken together, they paint an optimistic picture that expanding forest restoration is possible if the pace of action continues to accelerate.

This section looks at each challenge, why it is important, the challenges presented, and emerging solutions that market participants are deploying.

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[o] See, for example World Economic Forum: Henry, Patrick, and Madeleine North. "What Are Green Bonds and Why Is This Market Growing so Fast?" World Economic Forum, November 22, 2024. https://www.weforum.org/stories/2024/11/what-are-green-bonds-climate-change/.

Challenge: Creating markets

Forest restoration in Brazil is dependent on a narrow set of viable use cases. Of the six use cases included in this report, only sustainable commodities and voluntary carbon markets are at a mature stage, and these specific markets have room to scale significantly further. Two promising channels for further corporate investment, biodiversity crediting and supply chain (Scope 3) mitigation, have yet to mature into functioning environmental markets in Brazil.

A diverse set of use cases can match forest restoration investment with end user needs. A vibrant biodiversity crediting market will provide additional incentive to restore high-biodiversity degraded lands, for example. A clear signal to restore lands within global supply chains has brought about increased focus on pasturelands and croplands and their restoration potential. Achieving this diversity also reduces vulnerability to market trends, such as a decline in demand for nature-based removal credits for VCM buyers.

Current challenges:

- **The lack of a project pipeline using established biodiversity crediting methodologies.** Environmental markets rely on projects certifying their benefits using established and trusted methodologies. Afforestation and reforestation methodologies have existed in carbon markets for over 20 years, and sustainable forestry certification by the Forest Stewardship Council (FSC) has existed since 1994. Biodiversity crediting approaches, on the other hand, remain in the piloting and testing phase, and this makes it harder for suppliers and buyers to invest in a trusted and tested methodology. In addition, due the numerous variables and difficulty of measurement for biodiversity, over 600 different methods have been developed to measure biodiversity metrics resulting in confusion over the value of credits and how to create standardized approaches to ensure integrity.[49]
- **Insufficient demand for biodiversity credits from corporate climate strategies.** Companies are increasingly concerned about their impact on nature, but action lags behind established strategies for addressing climate. The Taskforce on Nature-related Financial Disclosures (TNFD) includes 300 companies express interest in reporting impacts on nature, compared to thousands of companies with a track record of reporting GHG emissions to CDP.[50] Disclosure does not automatically translate into biodiversity

crediting investments, but transparency can motivate companies to strategize how to reduce their impacts.

- **The market for biodiversity credits is illiquid and low volume.** Global biodiversity credit trading is approximately USD 8 million, less than 1 percent of annual volumes in the voluntary carbon markets. Until the biodiversity crediting market grows, secondary market operations that provide liquidity such as traders, brokerages and exchange platforms are unlikely to build biodiversity crediting, and this limits the retail options for potential buyers.
- **A lack of clear and consistent guidance allowing companies to achieve Scope 3 targets by restoring lands within and around their supply chains.** Carbon accounting standards such as GHG Protocol and corporate target-setting bodies such as the Science Based Targets initiative (SBTi) do not currently provide definitive guidance about whether supply chain emissions reductions that are linked to commodity supply chains can be accounted for in emissions frameworks (i.e., within a corporation's Scope 3 emissions accounting). In the absence of this guidance, corporates are relying on self-regulation through programs such as the International Platform for Insetting (IPI) and service providers such as Germany's Klima to invest in supply chain actions without certainty it can be counted toward their targets.
- **Possible future overlapping claims across use cases.** A forest restoration intervention is not restricted to a single use case for monetizing its benefits. For example, a sustainable forestry project could potentially access all six use cases elaborated in the previous section, though there is uncertainty about how Brazil's Emissions Trading System (ETS) will be regulated. This provides welcome diversification, but it also creates two complications. First, only one end user should claim ownership of the same benefits, which is complex to monitor across separate markets. Second, if the same project accesses a stack of revenue streams (e.g., biodiversity, carbon and sustainable timber), it must maintain that the carbon funding is additional (i.e., it would not have occurred without the revenues from retailing carbon credits).

SELECT EMERGING SOLUTIONS:

Biodiversity crediting standards	Biodiversity crediting standards are being piloted by independent standard-setting organizations to make up the voluntary biodiversity markets, including biodiversity crediting standards and project guidelines for developers and buyers (e.g., Life Institute, Regen Network, and Life Business and Biodiversity Coalition)
Supply chain mitigation guidance	Efforts to reduce the negative impacts of sourcing, production, or distribution processes — is being renewed by leading standards GHG Protocol and SBTi, focusing on how to use supply chain mitigation in Scope 3 accounting and targets.
Supply chain crediting standards are being clarified.	For example, carbon crediting standard Verra is developing a new standard specifically for mitigating Scope 3 emissions in a company's value chain, including guidance to avoid double claiming credits.

Challenge: Mobilizing finance

Access to capital is critical for forest restoration project developers. Ensuring that capital is deployed quickly and efficiently, and that it is deployed in ways compatible with investors' risk and return tolerances, are among the major challenges for scaling this work.

Dedicated mechanisms tailored to forest restoration's investment characteristics, satisfying large up-front capital needs and tailoring returns for different investor profiles, can help scale forest restoration by boosting investment in Brazilian projects.

Current challenges:

- **A lack of up-front capital for forest restoration projects, which require significant early-stage funding.** Reforestation projects don't typically achieve full maturity (in carbon sequestration terms) for three to seven years, as time is needed for tree growth. This is evident in current carbon market conditions for afforestation and reforestation projects, where experts don't expect increased capital deployment to translate into significant increases in credit issuances until 2027 to 2030.[51] Projects therefore require significant upfront investment for planting and other capital costs, while incremental revenues such as carbon credits or sustainably certified timber occur after successful implementation. Under current financial conditions with above-historical average interest rates, accessing commercial debt financing is more challenging for project developers.[52] Climate Policy Initiative also notes that there is a particular shortage of such financing mechanisms in Brazil tailored to forest restoration's unique characteristics.[53]
- **An insufficient number of vehicles enabling co-investment across different capital sources for forest restoration funds or projects (i.e., blended finance).** As an investment opportunity, forest restoration has particular char-

acteristics (see above). This means that investors with a higher risk appetite can absorb the risk of pre-implementation losses, while institutional investors (e.g., pension funds) accept a lower rate of return to be insulated from first losses in a project. Because of these characteristics, forest restoration projects benefit significantly from investment mechanisms such as blended finance schemes that pool assets from different types of capital (e.g., private banks, philanthropic sources, national development banks), in order to create larger pools of funds and maximize available capital. However, there is currently an insufficient number of such vehicles in the forest restoration market.[54]

SELECT EMERGING SOLUTIONS:

Offtake agreements for nature-based removals	Offtake agreements for nature-based removals (typically forest restoration) projects increased from 1 in 2022 to 10 in the first half of 2024. These agreements provide a commitment for project developers to deliver carbon results, usually in exchange for up-front capital to deploy the project(s). Advanced Market Commitments (AMCs) such as the Symbiosis Coalition are developing a buyer coalition to deliver 20 $MtCO_2e$ sequestration annually by 2030 through offtake agreements with reforestation and sustainable forestry projects around the world.
Blended finance pools	Blended finance pools can be structured so that investors with higher risk tolerance absorb earlier losses, and risk-averse investors (e.g., institutional investors such as pension funds) are insulated in exchange for a lower rate of return. Workable forms of blended finance already exist. For example, a combination of guarantees, concessional loans and impact bonds is being applied to protect coastal ecosystems while reducing private investors' exposure, and the Brazil Restoration & Bioeconomy Finance Coalition is an example of coalition-building across members with diverse risk and return profiles from public, private, philanthropic and concessional capital.

Challenge: Executing projects

On top of constraints around accessing capital, delivering forest restoration projects on the ground is far from certain. Implementation is a complex mix of ecology, project management and expertise in delivering and measuring results. The challenges projects face are both internal, from within the project itself, and external, from factors beyond the project's direct control.

Internal challenges include deciding the optimal restoration approach, deploying skilled teams that can adequately oversee the projects, and achieving carbon sequestration targets, particularly if the forest restoration area is large-scale. External challenges include determining complex land tenure in the Brazilian context, convincing landowners to transform their land, and navigating regulatory uncertainty to be able to retail carbon or other benefits internationally.

Projects often fail to meet their predefined objectives. Carbon Direct found that "project execution risk is significant, reflecting the inexperience of many project developers and the uncertainty surrounding their business models. A comprehensive survey of 240 studies across various aquatic and terrestrial forest restoration projects found that while 35 percent documented complete recovery within 10–40 years, an additional 35 percent showed mixed results, while 30 percent showed no recovery at all." This exacerbates the lack of up-front financing available to projects, as "current contractual practices in the industry, such as offtake agreements that defer payment until delivery of credits, place the burden of production risk on project developers."

Current challenges:

- **Choosing the right approach, and then delivering it on the ground, is not straightforward.** The diversity of available forest restoration approaches requires important design decisions including: choosing a source for project revenue (e.g., carbon and non-carbon such as biodiversity, commodity harvesting, quotas, and techniques), and forest restoration approach itself (e.g., regeneration method; including total planting, direct seeding, enrichment planting, assisted regeneration and natural regen-

eration).[55] These choices can significantly influence the project costs. For example, Koberle et al. found that the average cost of different forest restoration methods can vary from between USD 60 and USD 400 per hectare in Brazil (excluding natural regeneration).[56] Once a decision on the optimal approach is made, execution relies on skills including, but not limited to: understanding the species and planting techniques that are most likely to lead to long-term forest growth; navigating national, regional and local laws that can limit their flexibility to implement or monetize a project; developing sophisticated economic and financial models for the project; and navigating rules set by certification standards.

- **The difficulty of achieving sufficient scale to deliver profitable projects across localities.** For forest restoration opportunities such as supply chain mitigation there is an opportunity to capture economies of scale by implementing landscape-scale reforestation activities. However, this goal is challenged by the realities of Brazil's site-specific, hyper-local ecology, where forest restoration approaches are difficult to standardize over a large project area. Instead, each project requires a unique plan, limiting models for large-scale implementation and financing.[57]

- **Carbon sequestration from a project is sometimes below pre-implementation efforts.** Pastureland forest restoration in Brazil, for example, can generate an estimated 5.5 tCO_2/ha of carbon sequestration[58] once the project reaches full maturity. However, relying on this when estimating a project's revenue overlooks the risk of underperformance, and reversal/non-permanence. First, tree planting and sustainable harvesting cannot be precision engineered, as they rely on natural forces. Forests could grow at a slower than estimated rate, or fail to grow in certain areas, due to unusual weather, invasive species or other natural factors. Second, forest loss can occur either through natural disasters (e.g., wildfires), unauthorized human intervention (e.g., illegal land grabbing), or political change (e.g., changes in policy or law enforcement resources). All these factors, leading to tree loss, can impact project revenues — for example, by interrupting a timber harvest, or releasing previously sequestered carbon dioxide monetized into carbon credits.

- **There is regulatory and political uncertainty facing forest restoration projects.** The Brazilian ETS is an important use case to monetize forest restoration projects. However, this use case depends on the ETS being implemented and on assumptions of its future regulation and guidelines. With full ETS implementation not expected until at least 2029, forest restoration developers seeking access to the regulated market for projects being implemented today need to design projects around future expected market rules. This creates a timing mismatch between regulatory certainty and project implementation — either a project could be subject to regulations after implementation has commenced, or the project could lose valuable implementation time seeking clarification over the policy's regulations.

- **Forest restoration projects often need to navigate complex land tenure issues for project sites.** Establishing land tenure in Brazil is complex. Forest restoration developers need to navigate several requirements, both formal and informal, to secure and maintain land tenure for project sites. The tenure of degraded land (e.g., illegally deforested protected land previously used for agriculture) is often disputed, and land use can simultaneously involve public, private, Indigenous and even criminal actors. Brazil's constitution requires that rural land serve a "social function" that is efficient, sustainable and serves the public good, as a complement to the right of private ownership. This provision can cause decades-long disputes around the ownership of private land. Navigating unclear or disputed land ownership can complicate project implementation and discourage investment, and navigating the legal and administrative processes for land use and project approval is time-consuming and costly.[p, 59]

SELECT EMERGING SOLUTIONS:

Project developer specialization	Project developers are beginning to specialize in specific types of reforestation activities, such as a combination of commercial tree farms and restoration of native species (e.g., BTG Pactual Timberland Investment Group). Projects are also taking advantage of advanced technologies to optimize design choices, such as using automated geospatial assessments to determine the best planting strategy for a specific site.
Availability of insurance products	Insurance products are increasingly available to compensate for carbon credits that do not materialize within a particular project and manage under-performance and reversal/non-permanence risks. Several markets use carbon credit buffer pools that can be shared across projects in case of full or partial project loss. Improving effectiveness of wildfire and other natural disaster prevention and management can help safeguard project outcomes.
Recent offtake agreements between developers and corporations	Recent offtake agreements between developers and corporations have set large-scale volumes (1 million-plus tCO_2e). For example, Microsoft has agreed to large-scale offtakes from BTG Pactual Timberland Investment Group (up to 8 million tCO_2e through 2043),[60] Mombak (1.5 million tCO_2e through 2032) and re.green (6.5 million tCO_2e across two agreements).[61, 62] These larger deals provide sufficient up-front capital to replicate over larger project areas. Developers can limit offtakes to a set percentage of expected supply (e.g., 70 percent of delivery sales), to reduce risk exposure, as evident in a recent offtake agreement between U.S.-based Chestnut Carbon and Microsoft.[63]
Developers are prioritizing land with secure tenure	Developers are prioritizing land with secure tenure (e.g., privately owned agriculture land parcels) and advocating for greater land security from local, state and the federal government (e.g., via public concessions and policy enforcement). Startups such as Mombak are vertically integrating across the value chain, acting as both project developer and landowner. This gives them control to develop benefit-sharing agreements with local communities.

[p] Historically, land tenure issues have also been found to be a driver of deforestation, which could present a future risk to restored forests. Pacheco and Meyer, for example, found that "17.4% of Brazil's originally forested 30-m pixels lost forest to agriculture between 1985 and 2018. The vast majority of this deforestation occurred on private (78%) and undesignated/untitled lands (19%). The latter are publicly owned lands with poorly defined tenure rights that are not yet designated to any use but may be inhabited by rural settlers without a formally recognized land claim or title. Such undesignated/untitled tenure regimes cover vast areas across the tropics, and in Brazil alone, account for almost one hundred million hectares (963,357 km^2; an area larger than Tanzania)." Source: Pacheco, Andrea, and Carsten Meyer. "Land Tenure Drives Brazil's Deforestation Rates across Socio-Environmental Contexts." Nature Communications 13, no. 1 (October 1, 2022): 5759. https://doi.org/10.1038/s41467-022-33398-3.

Challenge: Accessing demand

Forest restoration doesn't just deliver carbon solutions — projects are increasingly expected to deliver benefits based on environmental outcomes, commodity certifications, and demonstrated community impact. The Brazil Restoration & Bioeconomy Finance Coalition, for example, allocates funding that directly benefits Indigenous peoples and local communities. BNDES has also set aside BRL 1 billion for projects,[q] but it seeks to simultaneously impact social inclusion and reduce "regional inequalities."[64] While this is a positive development, it means project developers must go beyond the traditional metrics of success.

Increasing resources and guidance available to developers on best practices and implementation support can ensure that projects can continue to sell to buyers with the highest willingness to pay and access the broadest sources of financing available.

[q] Equivalent to around 175 million USD, as of May 1, 2025.

Current challenges:

- **Premium carbon market buyers are adopting enhanced requirements.** Over the past five years, corporate buyers of reforestation carbon credits have increased their due diligence screening of projects beyond independent carbon standards. Specifically, they are establishing individual or coalition-level requests for proposals (RFPs), requiring supplemental certification of co-benefits, and/or using carbon ratings agencies to screen potential investments for their carbon benefits:

Value chain actor	Examples	Role	Additional requirements *(non-exhaustive)*
Company RFPs	Amazon, Apple, Microsoft, Symbiosis Coalition	Establish a specific funnel for projects that the buyer can elect to purchase from.	Socioeconomic and community benefits beyond carbon standards.
Supplemental certifications	Climate, Community & Biodiversity Alliance (CCBA)	Verify that a project achieves biodiversity and community benefits.	Qualitative and quantitative information on benefits.
Carbon ratings agencies	Sylvera, Renoster, Calyx, BeZero Carbon	Perform due diligence that projects achieve their certified carbon benefits.	Verification of carbon benefits and check that projects are additional.

- **Sustainable certification benefits must be accurately and consistently quantified in order to be monetized.** International consumers of sustainably sourced commodities typically require certification. For example, the FSC is the leading certification for harvested wood products traded globally. Sustainably certified products can sell for a higher price (such as a 25 percent premium for FSC wood), but initial and ongoing FSC certification fees, for example, can range from several thousand to tens of thousands of dollars, excluding the internal costs required to maintain compliance (e.g., additional hiring, staff training and required tracking systems).

SELECT EMERGING SOLUTIONS:

Updated methodological guidance	Updated methodological guidance is beginning to trickle down into project plans. For example, a project based in Argentina is seeking validation under Verra's recently revised afforestation and reforestation methodology VM00047, a first in South America. This methodology will, over time, become the expectation for carbon credit buyers.
Developers including local communities	Developers are actively including local communities in implementation across the project cycle. For example, re.green partners with tree nurseries that train local communities in seed collection, and also offer employment in wood processing.
Rating agencies using biodiversity data	Third-party rating agencies such as Sylvera are incorporating biodiversity data into their project assessments, so carbon buyer projects can identify projects with high natural capital returns in addition to carbon sequestration.
Stakeholders offer increased access to training	Stakeholders offer increased access to training and to help all commodity producers, including smallholders, meet certification requirements. For example, FSC Brazil offers courses on supply chain and ecosystem considerations, and in 2024 the federal government launched the Brazil Green Seal program to standardize and support the voluntary certification of sustainable products.

Conclusion: Brazil's Forest Restoration Opportunity Will Continue to Accelerate

By committing USD 10 billion to restore 5 Mha by 2030, the 2024 launch of the Brazil Restoration & Bioeconomy Finance Coalition demonstrated an appetite to invest in Brazil's forest restoration opportunity. This could be the starting point of an ambitious 2050 pathway in which restoring more than 10 times that amount of forest is feasible.

Three trends will contribute to this pathway. Land that is no longer needed for agriculture becomes available for forest restoration. Forest restoration becomes increasingly profitable. Finally, additional methods to fund and successfully implement forest restoration mature.

Collaboration between private, public and non-governmental actors can overcome existing challenges to scaling the forest restoration opportunity.

	Recommendation	Benefit
Investors	Prioritize forest restoration where it has the highest value based on region, land type and what commodities it generates.	Maximize the returns to distribute between investors, project developers and communities.
	Provide up-front financing to reduce execution risk.	Increased financial predictability and stability for project developers.
	Use scenario analysis to forecast high-value forest restoration opportunities.	Inform decision-making on how a 20-30-year investment will perform.
Companies	Build nature into environmental strategies, including actions that restore nature within or around value chains.	Create a pathway for forest restoration projects to monetize their natural capital and biodiversity benefits.
	Certify projects that harvest wood as compliant with global sustainability standards such as FSC.	Improve land management practices, and earn up to a 25 percent premium for wood sold.
	Use offtake agreements to support project developers to bridge their financing gap.	Protect the future stream of carbon credits or other benefits by giving projects the early-stage capital necessary to succeed.

	Recommendation	Benefit
Standards and value chain actors	Develop standards for using forest restoration for supply chain mitigation and biodiversity crediting.	Increase the ways that forest restoration projects can monetize their benefits and generate the revenue needed to be profitable.
	Provide training for agricultural producers who transition land toward sustainable agricultural production, reforestation practices and wood harvesting.	Support newcomers to reforestation and wood harvesting on how to obtain the highest price for their products.
Project developers	Prioritize forest restoration projects with highest potential profitability.	Increase the potential profitability for projects to distribute to investors, project developers and communities.
	Develop projects aligned to buyer guidelines for premium buyers.	Access the highest carbon prices and most durable funding support for projects.
Brazil's government	Provide clarity on land tenure for forest restoration of agricultural land, where feasible.	Reduce the risk of lengthy delays to operationalize forest restoration projects.
	Integrate forest restoration carbon credit projects into the forthcoming ETS.	Provide a domestic pathway for forest restoration projects to monetize their carbon benefits.
	Develop guidance on biodiversity crediting projects.	Offer clarity to market participants on what activities have government approval for biodiversity crediting.

Appendix 1

Case studies on how forest restoration in Brazil can be funded

Beyond voluntary carbon markets and sustainably certified wood, new possibilities are emerging to capitalize on the benefits created by restoring spared agricultural land.

Forest restoration requires mechanisms to mobilize investment, and the number of use cases for forest restoration in Brazil is expanding. We identified three investment drivers: domestic policy, environmental markets and corporate action. This annex details seven case studies for monetizing forest restoration benefits, which are not exhaustive or mutually exclusive.

	Opportunity	Driver
Existing	Carbon credits	Environmental markets
	Green bonds	Environmental markets
	Sustainable wood products	Corporate action
In development	Domestic investment funds	Domestic policy
	Regulatory carbon market	Domestic policy
	Biodiversity credits	Environmental markets
	Supply chain mitigation	Corporate action

CASE STUDY

Carbon credits

Existing | Environmental markets

Opportunity

The voluntary carbon market (VCM), where companies purchase carbon credits to retire toward achieving their climate goals, is increasingly focused on scaling carbon removal and sequestration projects such as restoration. Indeed, nature restoration projects were the largest recipients ($7.2 billion of the $14 billion of capital raises and commitments for carbon projects in 2024).[65]

Carbon credits are open to multiple restoration categories — sustainable forestry, monoculture or multiple species plantation, afforestation and reforestation, etc. — and Brazil is already an attractive investment location for restoration carbon projects.

Recent example

In January 2025, Microsoft agreed to purchase a significant portfolio of offtakes from restoration developer re.green, active in Brazil. A recent second agreement adds 17,500 hectares to the original restoration pledge, bringing the total to 33,000 hectares slated to be restored — an area equivalent to three times the size of the city of Paris.

To date, re.green has planted over 4.4 million seedlings spanning 80 native species and 11,000 hectares of degraded or abandoned pasturelands. Restoration projects can also include additional revenues (e.g., at one re.green site, açaí and bacaba are sustainably extracted by local community members).

Investors can seek to partner with reputable developers with high standards whose credits will be attractive to large and rigorous buyers such as Microsoft.[66]

Potential challenges

- **Policy overlap:** The ETS could attract reforestation projects away from VCM
- **Buyer confidence:** Carbon credits are under heightened scrutiny, so projects must reach ever-increasing integrity standards
- **Execution:** Implementing entities require multi-disciplinary expertise to successfully generate credits and demonstrate co-benefits such as biodiversity and local employment

CASE STUDY

Green bonds

Existing | Environmental markets

Opportunity

Green bonds involve bond issuances tied to specific sustainability-linked activities, such restoring degraded lands. In 2023, there were $575 billion in such issuances, according to S&P Global.[67] These bonds are also already being used by Brazil's government for Amazon conservation efforts.

Forest restoration project developers could issue bonds in exchange for up-front capital to support new forest restoration projects. The subsequent monetization of carbon, biodiversity and/or wood benefits can repay the principal financed by the bond.

Long maturity bonds can support multi-decade restoration projects. There is also potential to co-finance projects with development partners such as BNDES, Brazil's national development banks or multilateral lenders (e.g., World Bank).

Recent example

In 2024, reforestation project developer Mombak secured financing through a record nine-year, $225 million outcome bond issued by the World Bank.[68]

The bond, known as the Amazon Reforestation-Linked Bond, provides a coupon priced below market rates. The reduced coupon payments of $36 million are instead channeled to Mombak.

In exchange for a foregone guaranteed payment, bond investors receive additional variable coupon payments based on the delivery of carbon credits for a purchase pre-arranged with Microsoft.

MOMBAK
THE WORLD BANK
Microsoft

Potential challenges

- **High interest rates:** Currently elevated interest rates increase the return requirements for lenders
- **Linkage to other mechanisms:** Project developers rely on carbon credits or wood sales to repay bond principal

CASE STUDY

Sustainable wood harvesting

Existing | Environmental markets

Opportunity

Consumers of agricultural and forest commodities are increasingly environmentally conscious. One way consumers can take action is to purchase goods certified to meet high sustainability standards, and be willing to pay a higher price for that guarantee.

This is creating a financial incentive for companies operating in Brazil to capture a "green premia" for adopting sustainable practices. For example, adopting sustainable forest management for harvested wood products such as paper or wood can be certified and achieve a market premia of 20% or more.[69]

Sustainability certification can be combined with other monetization pathways. These additional revenues are not mutually exclusive of monetizing carbon or biodiversity benefits through environmental markets.

Recent example

Tora Brasil, a high-end furniture company, uses 100% FSC[s] certified wood from sustainably managed forest areas in the Amazon region.

The company employs local communities to sustainably harvest a limited number of trees from its project areas.

Its products are used by leading hotels and restaurants (e.g., Rosewood São Paulo, Fasano Rio de Janeiro, Kosushi Miami) and positioned toward luxury clients with high willingness to pay.[70]

The premium is backed by the FSC certification, as well as the company's proven commitment to sustainable extraction and economic development.

Potential challenges:

- **Willingness to pay:** Sustainable sourcing relies on a durable commitment by consumers to pay a higher price over substitutes
- **Certifications:** Meeting certification standards can require technical qualifications in planting and harvesting techniques
- **Long-term returns:** Successfully foregoing short-term economic gains in favor of longer-term commitments and benefits

[s] Forest Stewardship Council provides independent assurance that the wood you buy supports forests managed to the highest standards.

CASE STUDY

Domestic investment funds

Emerging | Domestic policy

Opportunity

Restoration projects are specialized and typically require multi-decade commitments. Therefore, specialist funds and/or funds with long-term horizons are ideal capital providers.

Recent shifts in Brazilian government regulation have permitted two domestic investor fund categories to incorporate restoration into their portfolios:

1. **Private pension funds** (assets >R$ 2.75 trillion):[71] In 2024, the Brazilian Private Pension Fund Superintendency (Previc) requested regulatory authorization for private pension funds to invest in carbon projects and agricultural funds (Fiagros)[72]
2. **Fiagros** (assets ~R$ 40 billion):[t] have recently been authorized to invest in agricultural-related carbon credits[73]

Recent example

Brazil is already receiving forest restoration investments from institutional investors.

For example, the Canada Pension Plan (CPP) committed up to $30 million to the Amazon Reforestation Fund. This $100-million fund (closed December 2023) is managed by Mombak and is backed by Bain Capital Partnership Strategies, Kaszek Ventures, Union Square Ventures, CI Ventures, and Byers Capital, and aims to restore large areas of degraded land with native tree species.[74]

A Brazilian investor could leverage this model by co-investing into established developers with a defined pipeline of future projects.

Potential challenges

- **Expertise:** Lack of widely disseminated standards/criteria to aid in due diligence of projects
- **Partnerships:** Risk tolerance/exposure may vary significantly and limit potential partners for investments
- **Returns:** Ensuring consistent and successful project execution to achieve returns and avoid risk for returns-focused investors (e.g., pension funds)

[t] Funds for Investment in Agroindustrial Production Chains, a special class of Brazilian private investment funds, created in 2021, that invest in agribusiness assets such as land or real estate.

CASE STUDY

Brazil Emissions Trading System

Emerging | Domestic policy

Opportunity

A centerpiece of Brazil's strategy to meet its long-term climate targets is an emissions trading system (ETS), which will take effect on or after 2029.

Unlike prior laws that directly regulate and/or impact restoration, the ETS provides an indirect incentive to invest. Regulated companies in industries such as power, cement and steel will have the option to purchase compliance credits from land-sector projects, including restoration.

This also applies to existing projects. Jurisdictional programs such as in Pará, and projects currently traded in voluntary markets, may be convertible to be eligible under the ETS.[75]

Agricultural producers can also benefit from accessing the ETS market. They can sell credits generated from maintaining or restoring forests on their lands.[u]

Recent example

Potential insight into the future of Brazil's ETS can be derived from California and Québec. Those regional ETS programs allow sustainable forestry projects to retail carbon credits to covered companies.

In both cases,improved forest management projects (e.g., longer harvesting time frames) earn credits eligible to meet compliance obligations. Compliance market projects typically trade at a higher price over voluntary market projects of the same methodology.[76]

Investors can build client relationships with companies subjected to the ETS as potential premium buyers for future projects.

Potential challenges

- **Uncertainty:** The ETS' governance still needs to be structured and defined, and regulated sectors are yet to be defined
- **Competition:** If conservation-based credits (REDD+) are also eligible, they could provide a lower-cost substitute to restoration

[u] While this was already a requirement in Brazil's Forest Code, landowners can now monetize compliance.

CASE STUDY

Biodiversity credits

Emerging | Environmental markets

Opportunity

Companies are increasingly setting internal targets for their impact on nature (beyond climate change), which is spurring innovation in credits that quantify biodiversity benefits.

Methodologies are being developed by expert groups including the LIFE Institute, Regen Network and the Ecosystem Regeneration Association to standardize benefit quantification. For example, the LIFE Institute calculates credits by combining a range of indicators, including the size and biological importance of the conserved ecoregion, preservation actions, and outcomes including ecosystem services, animal and plant species, and landscapes.[77]

Potential buyers include companies seeking to offset their pressure on biodiversity or meet ESG goals, financial institutions, governments and traders.

If these markets scale, restoration projects can diversify their monetization beyond carbon, particularly for projects with high conservation or restoration of biodiversity (e.g., flora, fauna) and delivery of ecosystem services (e.g., watersheds).

Recent example

Although biodiversity credits are not yet trading in Brazil, projects are being implemented by developers including aDryada and Fronterra, as well as local organizations in Brazil.

One such project, developed by the conservation organization Society for Wildlife Research and Environmental Education (SPVS), focuses on nature restoration within the 8,677-hectare Guaricica natural reserve, in Brazil's Atlantic Forest. The project will include fauna and flora monitoring to inform biodiversity assessments, and can generate both carbon and biodiversity credits.

The selected area for restoration has been identified as an important habitat for several endangered animal and plant species, showcasing the potential for verified biodiversity outcomes.

Potential challenges

- **Demand creation:** Companies are currently unsure about how biodiversity credits fit into their nature strategy due to a lack of consensus on guidance (e.g., Science Based Targets Network)
- **Methodological uncertainty:** However, projects and verification methodologies are in currently in very early stages and the market has yet to scale
- **Nascent value chain:** Only a few companies currently use biodiversity credits; growing this market is critical to create a tradable commodity

CASE STUDY

Supply chain mitigation

Existing | Environmental markets

Opportunity

Corporate climate strategies are expected to include actions that reduce impacts across supply chains. For example, the 10,000+ companies with commitments under the Science Based Targets Initiative (SBTi) are required to commit to reduce their supply chain (Scope 3) emissions.[78]

Agriculture and forest commodity companies have responded by actively pursuing projects with their suppliers, internally monetized through company balance sheets (or innovative approaches such as internal carbon fees), or via external green bond financing.

Project developers can partner with corporations who will fund project capital and operating expenses for restoration on lands that can be considered within the corporate supply chains.

Recent example

Swiss multinational Nestlé has a 2050 net-zero goal with an ambitious trajectory of 50% emissions reduction by 2030. Nestlé is already using nature restoration as part of this strategy in other value chains; for example, in Côte d'Ivoire Nestlé has supported the the nature reforestation of almost 1,500 hectares.

This approach could also be applied to Brazilian supply chains such as coffee. For example, the Nespresso AAA Sustainable Quality™ Program helps farmers use nature-based practices such as intercropping to increase soil and water resource health, biodiversity and the productivity of farming landscapes.[79, 80]

Carbon reductions are part of a broader suite of benefits, as conservation and restoration practices can lead to yield improvements in the supply chain.

Potential challenges:

- **Traceability:** Companies don't have a full map of their commodity supply chains to mitigate
- **Commitments:** Companies are unsure whether to preserve their net zero commitments, with 200 companies de-listed by SBTi in 2024
- **Guidance:** The rulebook for using supply chain mitigation to account for Scope 3 emissions, and to use it as a way to meet corporate targets, remains unclear.

Technical Appendix

Additional details on modeling analyses

Climate transition scenarios

EXHIBIT A.1: SUMMARY OF SCENARIOS TESTED IN ECONOMIC MODELING

	BAU	Current	2C Policy forecast	2C Coordinated policy	1.5C Innovation	1.5C Societal transformation
Global temperature scenario	>3C	>3C	2C	2C	1.5C	1.5C
2050 Carbon price *(2017 USD/tCO_2e)*	USD 4	USD 25	USD 88	USD 100	USD 153	USD 153
Policy drivers	Limited to existing policies	Same as BAU, but projects achieve current carbon prices	Forest restoration and reduced deforestation pledges in line with the Paris Agreement (to the levels specified by global temperature scenario)			
Deforestation outcomes	WDPA protected areas		Biodiversity Hotspots protected by 2035		Biodiversity Hotspots protected by 2030	30x30 outcomes achieved
Physical risk vulnerability *(H/M/L)*	High	High	Medium	Medium	Low	Low
Agricultural yield improvements *(YoY)*	No change	No change	Medium	Medium	Medium	High

Force Two

This analysis estimated the land spared under different scenarios. Climate transitions were the major driver of land use change modeled in this analysis. To estimate the forest restoration opportunity in Brazil, Orbitas tested the change in unit economics for land use across six scenarios, using the MAgPIE model.[v] The scenarios are based on WBCSD's climate

[v] Orbitas economic modeling uses MAgPIE, an open-source techno-economic model of the land use sector developed by the Potsdam Institute for Climate Impact Research (PIK). For more information on the economic modeling, please visit orbitas.finance.

scenario catalogue, which examines a range of potential climate transitions (as defined in Box 2.1). The scenarios are detailed in Exhibit A.1 below, with more details on the model's assumptions in Appendix 2.

One way to understand the modeled climate transitions is that they may reflect the impact of landowners' rational response to changes in the economic costs and opportunities for their pastureland. If restored land becomes valuable, landowners are motivated to spare land because of the potential to monetize the benefits of forest creation and conservation, either through enhanced carbon sequestration, additional biodiversity or ecosystem benefits, or by retailing sustainably harvested wood products. This provides an additional incentive to existing legal mandates to spare a percentage of agricultural and pastureland, which in practice are not uniformly or strictly enforced.[81]

What is the MAgPIE model?

MAgPIE is a spatially explicit partial equilibrium model of the agriculture and forestry sector with global coverage, which can be used for scenario projections in 5-year time steps. Food demand for each region, which is an exogenous driver to the model, is estimated using population, GDP and dietary assumptions. MAgPIE determines the "least cost way" to meet this food demand, while accounting for biophysical constraints including those on land and water, as well as potential crop yields. Spatially explicit time-series of crop yields, carbon densities and water availability are provided to MAgPIE by LPJmL (Lund-Potsdam-Jena managed Land), a global dynamic vegetation and hydrology model also developed and maintained at PIK. MAgPIE endogenously models investment in agricultural R&D and irrigation, and in so doing captures the effect of potential future increases in agricultural productivity. Consequently, the framework captures land use competition between varying uses, such as forestry, bioenergy, and agriculture and models how this competition evolves over time.[w]

Summary of major changes between MAgPIE v4.6.10 and v4.9.0

Economic and Cost Updates:

- GDP base year changed from 2005USD to 2017USD (MER)
- All economic input data updated to 2017USD (MER)

Climate and Land Use Policies:

- Start year of policies moved to 2025
- NPI/NDC policies harmonized until 2025
- Number of forest age-classes doubled (from 150 to 300 years) for better growth modeling

Model Enhancements:

- Revision and simplification of forestry sector implementation; forestry sector included by default
- Inclusion of additional information on potential forest area, which is used to constrain re/afforestation and forest recovery

[w] A short general description of the model can be found at https://github.com/magpiemodel/magpie as well as in Dietrich et al. (2019) https://doi.org/10.5194/gmd-12-12992019. Previous Orbitas projects using MAgPIE in 2023 were the Orbitas Soy and Cattle reports (https://orbitas.finance/reports-insights/), which used MAgPIE model version 4.6.10. This report uses MAgPIE model version 4.9.0.

Nationally Determined Contributions (NDCs) in MAgPIE v4.9.0:

The MAgPIE model integrates National Policies Implemented (NPI) and Nationally Determined Contributions (NDCs) to align with afforestation targets, restricting additional areas from agricultural use. It incorporates land-based climate mitigation measures pledged by nations, parameterized from UNFCCC data. Three key land-use policies are modeled:

- Avoiding Deforestation (AD): Targets forest protection, halting deforestation by the start of afforestation policies, with pledges from 76 countries to either completely stop or reduce deforestation.
- Avoiding Other Land Conversion (AOLC): Protects non-forest land from conversion to cropland or pasture, with pledges from 31 countries to limit or halt such conversions.
- Afforestation (AFF): Simulates future afforestation targets, with area-based goals from 45 countries, measured in Mha, to be achieved by 2030.

For Brazil, specific targets are set for biomes like the Legal Amazon, Cerrado, and Atlantic Forest, with afforestation and forest protection goals defined. These policies ensure gradual achievement of climate mitigation objectives as per Brazilian NDC, including targets for 2030:

- **Legal Amazon:** Afforestation of 6.94 Mha and complete forest protection.
- **Cerrado:** Afforestation of 1.81 Mha and 40 percent forest protection.
- **Atlantic Forest:** Afforestation of 1.66 Mha and full forest protection.
- **Other Forests:** Afforestation of 1.58 Mha.

The globally consistent technoeconomic results from MAgPIE for Brazil are used as input to the PANGEA model which determines the regional and biome-specific forest restoration potential across forest restoration categories as described in Section 3.

Employment numbers in MAgPIE:

The model calculates agricultural employment based on its relation to total labor costs. It projects that hourly labor rates increase with rising GDP per capita. The increase in the baseline wages over time is assumed to be matched by a corresponding increase in labor productivity.

Force Three

This analysis uses proprietary cost data for each of the forest restoration archetypes, which includes estimates of land acquisition and implementing forest restoration and harvesting activities. This data informs project siting for a major forest restoration developer in Brazil.

The profitability analysis focuses on a subsection of the total land spared under climate change. The analysis specifically examines the opportunities for restoring pastureland used for cattle grazing. Pastureland was selected for this analysis for three reasons:

1. Pastureland has been a major driver of historical deforestation while also accumulating 100Mha of degraded pastures.[82]
2. In its NDC, Brazil set a target of restoring 15 Mha of degraded pastureland by 2030.[83]
3. Finally, the economic drivers created by climate transitions are visible because forest restoration is “in competition” with agricultural commodities that can also generate revenue on the land.

First, the results from the techno-economic modeling in the previous section are combined with spatial modeling to show where agricultural land is converted in each climate transition scenario. This analysis clarifies the areas most suitable for forest restoration, which are tested in the profitability analysis. The objective of the profitability analysis is to estimate the net present value of restoring spared pastureland. It adapts the pastureland spare under MAgPIE in the previous section, and uses a Brazil-specific model using the PAN tropical investigation of bioGeochemistry and Ecological Adaptation to test how the land sparing affects land use in Brazil's diverse geographical regions, focusing on pastureland excluding lands deforested within the last ten years.

Forest restoration, as an investment, requires significant upfront capital costs that vary widely based on geography. Once established, a forest restoration project has multiple potential revenue streams. The most important monetization avenues, as identified by our modeling, are carbon and biodiversity benefits, as well as revenues from sustainable timber sales, as detailed below. The analysis considers both projects that monetize carbon benefits only, and those that also incorporate sustainable timber revenues.[x] There are other possible revenue streams not included in this analysis, such as ecotourism, which could potentially be leveraged to generate additional returns.[84]

- **Carbon:** Projects can certify their carbon benefits to generate credits for sale via environmental markets (e.g., the voluntary carbon market).
- **Sustainable Timber:** For sustainable forest management projects, timber harvesting is the main source of project revenue, and projects can obtain certification that the wood products are sustainably harvested to obtain a price premium in consumer markets. Sustainable timber can also be a supplemental source of revenue for forest restoration projects that allow for a limited extraction of timber from the project area.

The profitability analysis uses a proprietary model of forest restoration costs that varies by climate transition scenarios as the basis to project the net present value (NPV) achieved for a 30-year restoration project. The analysis tests the four climate transition scenarios assessed in the economic and spatial analysis, plus a scenario where real carbon prices remain at USD 25/tCO_2e, broadly in line with observed market prices for afforestation/reforestation projects.

All model currency figures are in 2024BRL, and have been converted to USD at a rate of 1 USD = 5.75 BRL for this paper.

[x] In scenarios where wood is harvested, we apply a substantial deduction to the amount of carbon credits generated, leading to a difference in carbon revenues considered alongside the additional timber revenues.

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Contact

—

info@orbitas.finance
www.orbitas.finance

info@climateadvisers.org
www.climateadvisers.org

Social Media

—

LinkedIn:
@Orbitas
@ClimateAdvisers