# Beyond the Amazon – Biodiversity, Development and Emerging Bioeconomy Agendas in Brazil

Antônio Márcio Buainain
Institute of Economics
University of Campinas – Unicamp

# Key points of the presentation

# Biodiversity, Development and Emerging Bioeconomy Agendas in Brazil

> "Brazil is neither a pristine biodiversity sanctuary, nor merely an agricultural powerhouse, nor only a site of environmental degradation. It remains a society negotiating tensions between conservation, productivity, inequality and unfinished development."

Central argument of this presentation

### Beyond Romantic Conservation Narratives

Understanding Brazilian biodiversity requires moving past simplified, idealized framings of nature and wilderness.

### Beyond Simplistic Development Notions

Development in Brazil is complex, contested, and deeply uneven across territories and social groups.

### Beyond Homogeneous Views of Bioeconomy

No single bioeconomy model can capture the diversity of pathways emerging across Brazilian biomes and sectors.

# Brazil Beyond the Amazon
# The Complexity of a Continental Nation

Brazil is not a single ecosystem — it is a mosaic of six distinct biomes, each with unique biodiversity, ecological functions, and bioeconomic potential. Understanding this territorial heterogeneity is essential for any serious engagement with Brazilian science and sustainability policy.

### Amazon

The world's largest tropical rainforest. Home to ~10% of all species on Earth and a critical global carbon sink.

### Cerrado

The world's most biodiverse savanna. A biodiversity hotspot and Brazil's agricultural heartland, under severe pressure from land conversion.

### Atlantic Forest

One of the most threatened biomes globally. Only ~12% of original cover remains, yet it shelters extraordinary endemic species.

### Caatinga

Brazil's only exclusively national biome. A unique semi-arid ecosystem with remarkable drought-adapted flora and fauna, largely understudied.

### Pantanal

The world's largest tropical wetland. A UNESCO World Heritage site of extraordinary ecological richness and seasonal flooding dynamics.

### Pampa

Brazil's southernmost biome, shared with Argentina and Uruguay. A temperate grassland of high cultural and ecological significance, often overlooked in national narratives.

Together, these six biomes make Brazil the most megadiverse country on Earth — hosting over 20% of the world's known species and representing an unparalleled natural heritage for science, policy, and sustainable development.

# Multiple Biodiversities, Multiple Bioeconomies

There is no single bioeconomy in Brazil. Different territories, different communities, and different ecological contexts generate distinct bioeconomic pathways — each with its own logic of value creation, inclusion, and sustainability. Understanding this plurality is essential for both research and policy design.

### Sociobiodiversity

Traditional and indigenous communities as stewards and innovators — generating livelihoods from native species, agroforestry, and territorial management in ways that blend ecological knowledge with market access.

### Low-Carbon Agriculture

Brazil's agribusiness sector navigating the transition toward reduced emissions — integrating crop-livestock-forest systems, no-till farming, and carbon markets into large-scale production landscapes.

### Biological Inputs

A rapidly growing sector replacing synthetic agrochemicals with biologically derived solutions — biopesticides, biofertilizers, and microbial inoculants — positioning Brazil as a global leader in biological agriculture.

### Health & Bioprospecting

Biodiversity as a source of pharmaceutical, cosmetic, and nutraceutical innovation — from Amazonian plant compounds to Cerrado fruits, linking conservation with high-value bioeconomic chains.

### Bioenergy

Brazil's decades-long leadership in sugarcane ethanol and the emerging frontier of second-generation biofuels — a mature bioeconomic sector with lessons for global energy transitions.

These five pathways are not mutually exclusive — they overlap, compete, and co-evolve across Brazil's territories, demanding integrated analytical frameworks that go beyond sectoral silos.

## Key Dimensions of Plurality

### Socio-Cultural Diversity

Indigenous peoples, quilombola communities, and traditional populations are knowledge holders and active agents of bioeconomic innovation.

### Technological Frontiers

From genomics and synthetic biology to agroecology and ethnobotany, Brazilian research spans the full spectrum of biosciences.

### Governance Challenges

Benefit-sharing, access and use regulations (Nagoya Protocol), and land tenure remain critical governance challenges across all biomes.

# Plural Realities – Multiple Bioeconomies

There is no single Brazilian bioeconomy. Across the country's six biomes, distinct socio-ecological contexts give rise to radically different models of value creation from biological resources. Recognising this plurality is fundamental to designing effective research and policy frameworks.

## What Is Bioeconomy?

Bioeconomy encompasses the production, utilisation, and conservation of biological resources — including knowledge, technology, and innovation — to provide goods, services, and energy in a sustainable manner. In Brazil, this concept takes on multiple forms depending on the biome, the community, and the institutional context.

### Forest-Based Bioeconomy

Non-timber forest products, sustainable forestry, carbon markets, and bioprospecting in the Amazon and Atlantic Forest.

### Agro-Bioeconomy

Bioenergy, bioinputs, and sustainable agriculture in the Cerrado and Pampa, integrating traditional knowledge with cutting-edge biotechnology.

### Dryland Bioeconomy

Caatinga-based innovations in drought-resistant crops, medicinal plants, and community-led conservation enterprises.

### Wetland Bioeconomy

Ecotourism, sustainable fisheries, and biodiversity monitoring in the Pantanal, integrating science with local livelihoods.

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# FAPESP-Supported Research Agenda in São Paulo

The São Paulo Research Foundation (FAPESP) has been systematically supporting a research agenda that brings together scholars from São Paulo institutions, Brazilian universities, and international partners to address the most pressing questions at the intersection of biodiversity, bioeconomy, and sustainability transitions.

### Measurement & Valuation

How do we measure biodiversity-related economic activity? What metrics capture the full value of ecosystem services, traditional knowledge, and biological inputs in national and regional accounts?

### Governance & Institutions

What institutional arrangements enable or constrain bioeconomic development? How do land tenure, access and benefit-sharing regimes, and multi-level governance interact?

### Health & Biodiversity Nexus

How does biodiversity loss affect human health outcomes? What are the pathways linking ecosystem integrity to disease emergence, nutrition, and pharmaceutical innovation?

### Sustainability Transitions

How do sociotechnical transitions unfold in bioeconomic sectors? What are the barriers and enablers for scaling up low-carbon and biodiversity-positive practices?

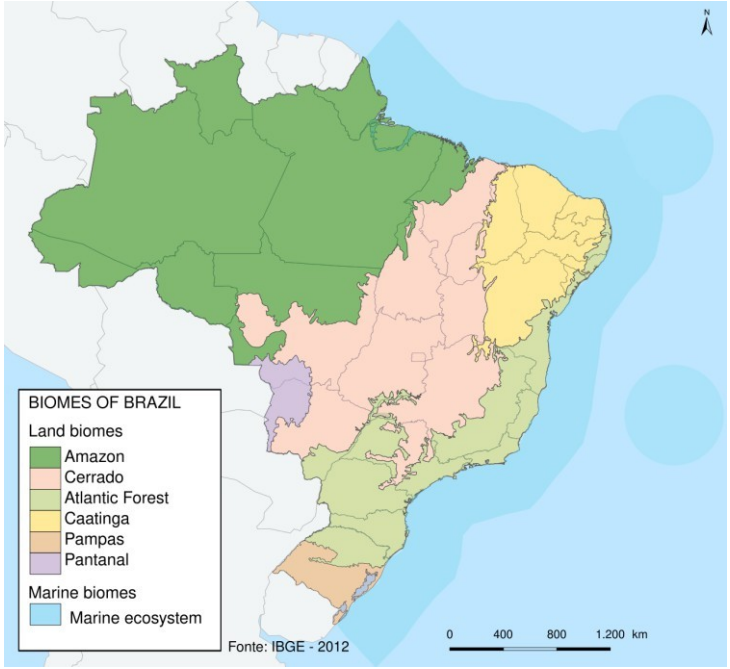
### Policy Design & Inclusion

How can bioeconomy policies be designed to ensure social inclusion, particularly for smallholders, indigenous peoples, and traditional communities? What trade-offs exist between efficiency and equity?



This agenda is inherently interdisciplinary — combining economics, ecology, political science, public health, and innovation studies — and is conducted in partnership with researchers of many institutions in Brazil and abroad.

# Biodiversity and Bioeconomy in Brazil




# Why Is Brazil Difficult to Understand?

Brazil hosts **six major biomes**, each with its own ecological character, social dynamics, and governance challenges. A single narrative cannot capture this complexity.

### Amazon

Conservation vs. local livelihoods — the world's largest tropical forest under pressure from multiple actors.

### Cerrado

Agricultural productivity vs. biodiversity preservation — Brazil's agricultural frontier and a global biodiversity hotspot.

### Caatinga

Resilience vs. poverty — a unique semi-arid biome home to millions living in conditions of chronic vulnerability.

### Pantanal

Water systems vs. land use — the world's largest tropical wetland, critical for water regulation and biodiversity.

Can one concept of biodiversity or bioeconomy explain all these realities across six distinct biomes and their governance regimes?

# One Country, Multiple Bioeconomies?

Brazil does not have one bioeconomy — it hosts **multiple pathways** emerging from different territories, sectors, and social actors. The central question is: *Which bioeconomies are being promoted, by whom, and for whose benefit?*

| Pathway | Examples | Main Challenge |
|---|---|---|
| Forestbased | Amazon socio-biodiversity, NTFP value chains | Market access, value capture |
| Agricultural | Low-carbon agriculture, bioinputs, ILPF systems | Scaling, adoption |
| Health/ Biodiversity | Medicinal plants, traditional knowledge | IP rights, regulation |
| Energy | Biofuels, biomass, sugarcane ethanol | Technologic al transitions |
| Circularity | Waste-to-value, industrial symbiosis | Infrastructure, investment |
| Governance | Payment for ecosystem services, carbon markets | Institutional coordination |

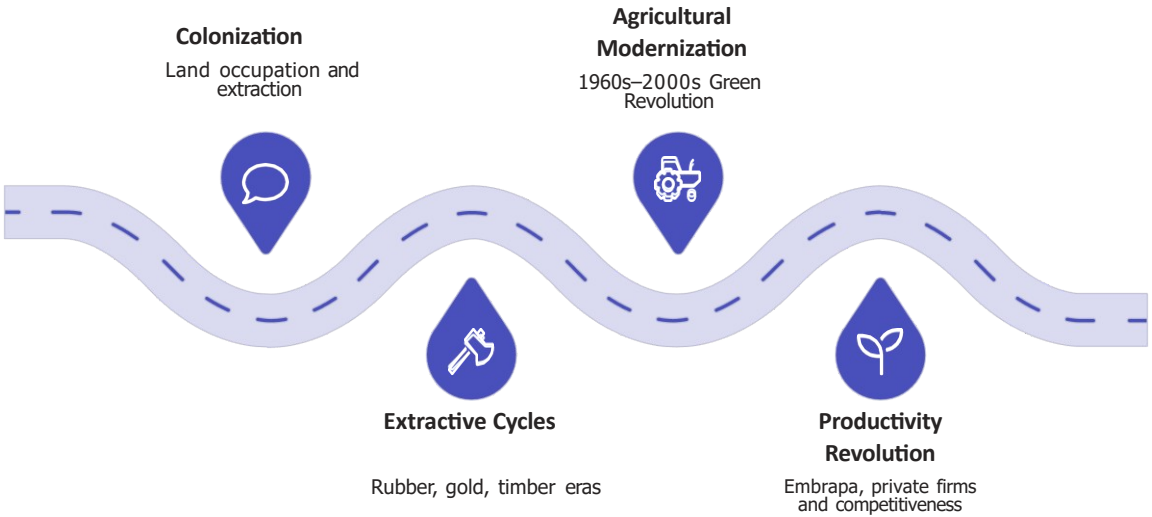



BIOECONOMY

Which bioeconomies are being promoted, by whom, and for whose benefit? Who captures the value generated by Brazil's biological wealth?

# Historical Roots: Agriculture, Biodiversity and Territorial Transformation

Brazil's bioeconomy is historically rooted in centuries of territorial occupation, extraction cycles, and agricultural modernization. Understanding current trade-offs requires this long historical perspective.




This trajectory shaped the institutional landscape, land tenure regimes, and technological capabilities that define Brazil's current position in global debates on biodiversity and development.

## Major Achievements

- Productivity growth in tropical agriculture
- Tropical technology innovation (Embrapa)
- Global agricultural competitiveness
- Biofuel leadership and low-carbon systems

## Persistent Tensions

- Production vs. conservation trade-offs
- Territorial expansion vs. sustainability
- Innovation vs. social inclusion
- Institutional heterogeneity across regions

# Transformation Without Simple Answers: Productivity Gains and Persistent Contradictions

Brazil's agricultural and environmental trajectory defies simple narratives. Both remarkable achievements and deep contradictions coexist within the same territorial and institutional framework.

**✓World-Leading Agricultural Productivity**
Brazil became one of the world's top food exporters through sustained investment in tropical agronomy.

**✓Tropical Technology (Embrapa)**
Embrapa's research transformed the Cerrado into one of the most productive agricultural regions globally.

**✓Low-Carbon Agriculture**
ILPF systems and the ABC Plan represent globally significant innovations in sustainable tropical farming.

**✓ Biofuel Leadership**
Sugarcane ethanol remains one of the most efficient and low-carbon biofuel systems in the world.

**⚠ Deforestation**
Despite legal frameworks, deforestation continues across multiple biomes, particularly the Amazon and Cerrado.

**⚠ Biodiversity Loss**
Habitat fragmentation and land conversion threaten species richness in biomes beyond the Amazon.

**⚠ Rural Inequalities**
Land concentration and unequal access to technology and markets persist across rural Brazil.

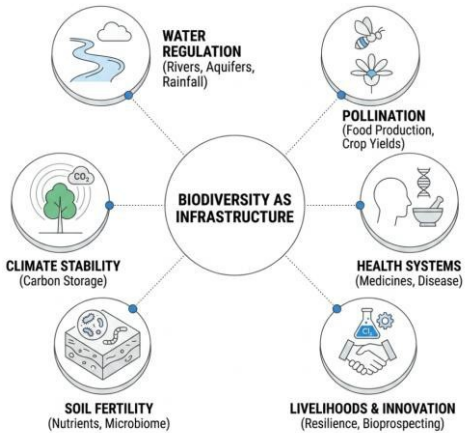
**⚠ Territorial Disparities**
Governance capacity, infrastructure, and market access vary enormously across regions and biomes.

ⓘ Brazil is neither a pure success story nor a case of degradation — both realities coexist. The problem is often **adoption and scaling**, not invention. Solutions exist; the challenge is institutional and political.

# Biodiversity Beyond Conservation: Ecosystem Services and Development

Biodiversity is not only about protecting species — it provides **essential ecosystem services** that underpin agriculture, health systems, livelihoods, and long-term development. It must be understood as **infrastructure**: social, ecological, and economic.






### Food Security

Biodiversity loss directly threatens pollination, soil health, and the genetic diversity underpinning crop resilience.

### Water Security

Forest cover and wetland integrity regulate rainfall patterns and freshwater availability across Brazil's regions.

### Public Health

Ecosystem degradation increases zoonotic disease risk and erodes the natural pharmacopeia of medicinal biodiversity.

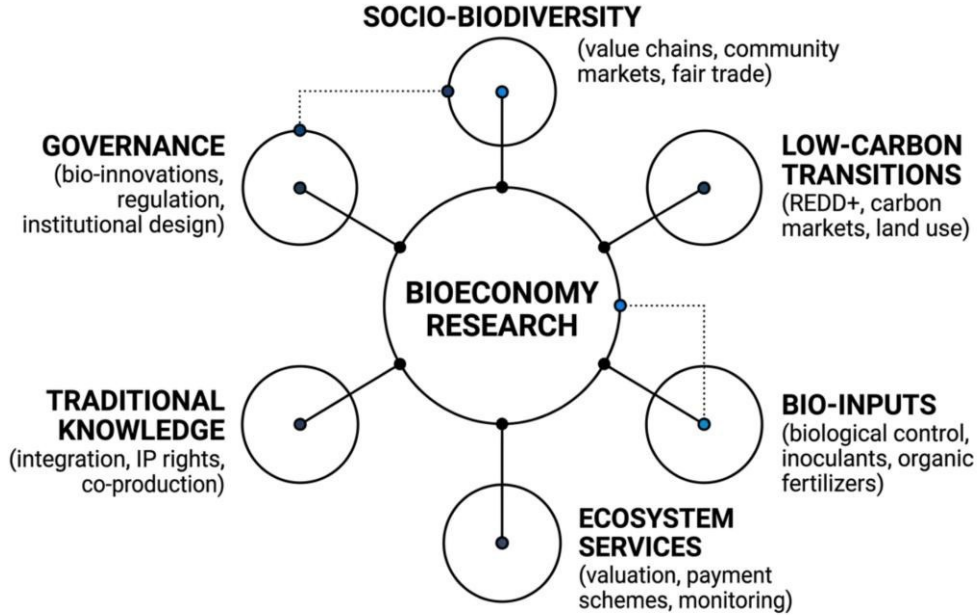
### Economic Resilience

Healthy ecosystems buffer communities against climate shocks and provide the natural capital for bioeconomy development.

What becomes vulnerable — economically, socially, and ecologically — when biodiversity degrades? And who bears the greatest cost of that vulnerability?

# Emerging Research Agendas: Different Questions, Different Approaches

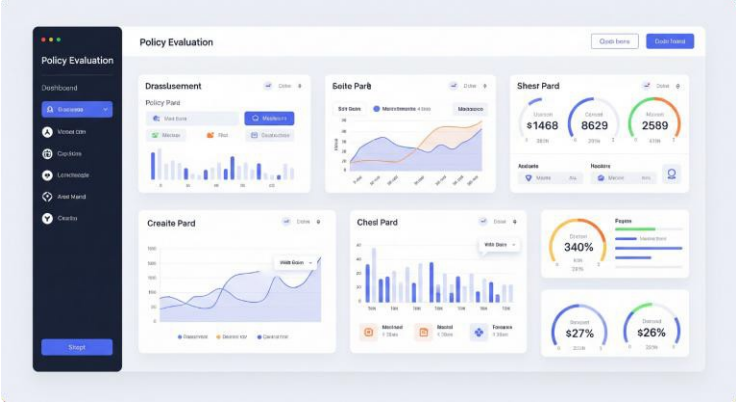
Bioeconomy research in Brazil is expanding beyond traditional agricultural and conservation frames — demanding new methodologies, disciplinary bridges, and collaboration models across six interconnected clusters.




⚠ Key challenge: bridging the gap between academic research and practical application in policy and markets — addressing not only technical viability but social inclusion, territorial equity, and institutional feasibility.

# Measuring Bioeconomy: Evaluation as an Emerging Challenge

Measuring bioeconomy impacts is inherently complex — multiple objectives, pathways, and stakeholders are involved. Traditional metrics capture only part of the picture.




Participatory evaluation approaches can incorporate diverse stakeholder perspectives — recognizing that different actors hold different definitions of "value."

### Economic Viability

GDP, productivity, exports, market competitiveness, and value-added indicators.

### Environmental Sustainability

Carbon stocks, biodiversity indices, land-use change, and ecosystem integrity.

### Social Inclusion & Equity

Income distribution, community participation, gender equity, and labor conditions.

### Territorial Impacts

Regional development, infrastructure access, and spatial justice across biomes.

### Institutional C

Governance quality, regulatory frameworks, and multi-level coordination.

Central question: **How do we evaluate success when different actors have different definitions of "value"?** Multi-dimensional frameworks are essential — moving beyond GDP and exports alone.

# Biodiversity, Health and Public Systems: Medicinal Plants, Traditional Knowledge and Alternative Innovation Pathways

**Brazil's Biodiversity as a Health Asset**

Brazil's biodiversity is a vast reservoir of active compounds with pharmaceutical, cosmetic, and nutritional potential. Traditional and indigenous knowledge systems hold critical insights for bio-innovation — insights that conventional R&D pipelines often overlook.

The Brazilian Unified Health System (SUS) already incorporates medicinal plants and herbal medicines through the **National Policy on Medicinal Plants and Herbal Medicines**, creating a unique institutional pathway for biodiversity-based health innovation.

- Intellectual property rights and benefit-sharing (Nagoya Protocol)
- Biopiracy prevention and community sovereignty
- Bridging traditional knowledge with scientific validation
- Inclusive, lower-cost innovation pathways




Key message: Biodiversity may support health systems and open alternative innovation pathways beyond conventional pharmaceutical models — more inclusive and locally grounded.

# Socio-biodiversity Chains: Conservation, Income Generation and Territorial Challenges

Socio-biodiversity chains — açaí, Brazil nuts, babassu, andiroba, cocoa, carnaúba — link conservation with income generation for traditional communities across the Amazon, Cerrado, and Caatinga. These are concrete bioeconomy models already in operation.



**Açaí**
Pará & Amazon estuary

**B**
Amazon basin

**Babassu**
Maranhão & Piauí

**C**
Bahia & Pará

**Carnaúba**
Piauí & Ceará

## Institutional Challenges — Not Biological Ones

### Market Access & Logistics

Remote communities face high transaction costs and limited infrastructure for reaching formal markets.

### Land Tenure & Territorial Rights

Insecure land rights undermine long-term investment and community governance of natural resources.

### Technical Assistance & Extension

Gaps in rural extension services limit adoption of sustainable management practices.

### Value Capture & Fair Pricing

Communities often receive a small fraction of final product value due to intermediary chains.

Complex sanitary, environmental, and trade regulations create barriers for small producers.

⚠ **Key message:** The main challenge in socio-biodiversity chains is often **institutional rather than biological** — success depends on governance, infrastructure, and institutional support.

# Emerging Transitions: Low-Carbon Agriculture, Bioinputs and Technological Change

Brazil is already undergoing significant low-carbon agricultural transitions. The core challenge is often **adoption and scaling, not invention** — Brazil already has the technology.

## Technologies Available

### ILPF

Crop-Livestock-Forest Integration — over **17 million hectares** adopted across Brazil.

### Bio-inputs

Biological pest control, inoculants, and organic fertilizers replacing synthetic inputs.

### Direct Planting

Plantio direto — no-till system reducing erosion and carbon emissions at scale.

### RenovaBio

Biofuels policy framework and carbon market mechanisms for the energy sector.

## Adoption Barriers

### Technical Assistance Gaps

Insufficient rural extension services to support farmers in transitioning to new practices.

### Risk Perception

Farmers face uncertainty about yields and returns when adopting unfamiliar technologies.

### Path Dependency

Established routines, supply chains, and incentive structures lock in conventional practices.

### Credit Access

Limited financing instruments tailored to low-carbon and agroecological transitions.

### Information Asymmetry

Uneven access to knowledge about available technologies and their proven benefits.

**Key message:** The problem is often **adoption rather than invention**. Bridging the gap between available technology and widespread practice requires institutional, financial, and informational support — not just R&D.

# Beyond the Amazon: Multiple Brazilian Bioeconomies and Neglected Trajectories

The Amazon receives disproportionate attention in bioeconomy discussions, but other biomes have equally important — and often neglected — trajectories. Reducing Brazilian bioeconomy to the Amazon obscures regional diversity and reinforces spatial inequalities.



**C**

Agricultural bioeconomy, bio-inputs, native fruits (pequi, buriti), and expanding carbon markets across Brazil's vast interior savanna.



Restoration economy, native species cultivation, ecotourism, and water ecosystem services in Brazil's most densely populated biome.



**Caatinga**

Adaptation economy, native biodiversity, climate resilience, and medicinal plants in Brazil's unique semi-arid biome.



Sustainable livestock, ecotourism, and water system services in the world's largest tropical wetland.



Natural grasslands, biodiversity-friendly production, and sustainable grazing systems in Brazil's southernmost biome.

⚠ **Key message:** Reducing Brazilian bioeconomy to the Amazon **obscures important trajectories and reinforces regional inequalities**. A truly national bioeconomy agenda must recognize and invest in all six biomes.

# Persistent Tensions: Why Trade-offs Remain Central

Despite progress, fundamental trade-offs persist in Brazil's bioeconomy landscape. These tensions cannot be eliminated — only managed with intellectual honesty and sound policy design.

### Conservation vs. Production

Biodiversity protection in tension with agricultural expansion and land-use demands.

Technological sophistication versus access for smallholders and traditional communities.

### Global Markets vs. Territorial Governance

International demand versus local control over resources and decision-making.

Immediate economic returns versus sustainability investments and ecological resilience.

Trade-offs evolve over time but rarely disappear — they shift form and scale. Acknowledging trade-offs is not pessimism; it is intellectual honesty necessary for sound policy design.

**Key Message:** Trade-offs evolve — they rarely disappear.

# An Unfinished Development Agenda: Biodiversity, Inequality and Inclusion



Brazil's development remains unfinished — impressive aggregate indicators mask deep inequalities. Biodiversity and bioeconomy cannot be separated from social inclusion.

### Who benefits?

Who captures value from bioeconomy value chains — and who is excluded?

### Who bears the costs?

Conservation burdens often fall disproportionately on local and traditional communities.

### Who participates?

Land tenure, technical assistance, and market access shape who can engage.

Conservation without inclusion becomes fragile — protected areas without local support face constant pressure. The central question: **How to expand inclusion while preserving ecological systems?** Bioeconomy offers potential pathways, but only if designed with equity as a core objective — not an afterthought.

**Key Message:** Conservation without inclusion may become fragile.

# Open Questions: Emerging Research Agendas

As bioeconomy research matures, questions multiply — and productive uncertainty drives innovation. These questions are not gaps to be filled; they are invitations to collaborative inquiry.

How to evaluate bioeconomy impacts across economic, social, and environmental dimensions simultaneously?

How to scale socio-biodiversity initiatives without losing their territorial and cultural specificity?

3

**G** **B**

How to balance intellectual property rights with the protection of traditional knowledge?

### International Cooperation

How to design cooperation that generates new questions — not only model replication?

**B**

How to align Brazil's multiple bioeconomies with global sustainability goals without reproducing inequalities?

**Key Message:** Questions may currently be more valuable than premature certainties.

# Opportunities for Collaboration: Why International Cooperation Matters



Brazil offers a unique laboratory for studying bioeconomy transitions at scale — continental size, multiple biomes, advanced agricultural research, and rich traditional knowledge. International cooperation should go beyond model replication.

**C**

Across different bioeconomy pathways and biomes.

**Impact Evaluation**

Methodological innovation in multi-dimensional metrics.

**G**

Knowledge exchange on institutional design.

**B**

Joint research on health and ecosystem services.

**Key Message:** Brazil is not only a case to be studied — it may also become a partner in producing new questions.

# Opportunities for UK–Brazil Research Cooperation

Brazil and the United Kingdom bring complementary strengths to the global challenge of biodiversity governance and bioeconomic development. The synergies between Brazil's unparalleled living laboratory of ecological and socioeconomic complexity and the UK's deep tradition in governance research, policy evaluation, and sustainability transitions create a uniquely fertile ground for joint inquiry.

### BR What Brazil Offers

An unmatched laboratory of biodiversity and bioeconomic experiments — from Amazonian community forestry to São Paulo's biological inputs industry — generating real-world evidence on what works, what fails, and why, at continental scale.

### GB What the UK Offers

World-leading expertise in sustainability transitions theory, environmental governance, policy evaluation methodologies, and institutional economics — frameworks that can help interpret and generalize Brazil's complex experiences for global audiences.

### Joint Research Programs

Co-designed research projects on bioeconomy measurement, governance innovation, and transition pathways — leveraging FAPESP's funding instruments and UK Research and Innovation (UKRI) partnerships.

### Researcher Mobility

Structured exchange programs for early-career and senior researchers between São Paulo institutions and UK universities — building long-term collaborative networks across disciplines.

### Policy Dialogue

Bridging academic research and policy communities in both countries — informing COP negotiations, CBD implementation, and national bioeconomy strategies with rigorous, comparative evidence.

### Capacity Building

Joint training initiatives in sustainability economics, biodiversity valuation, and governance assessment — strengthening the next generation of researchers in both countries and in the Global South more broadly.

> Brazil's contradictions are not obstacles to cooperation — they are its most valuable scientific asset. The country's simultaneous experience of biodiversity richness, deforestation pressure, agroindustrial dynamism, and social inequality makes it an irreplaceable site for generating knowledge that matters globally.

# Final Reflections: Biodiversity, Tensions and Unfinished Futures

Brazil's bioeconomy is not a single story — it is a mosaic of multiple pathways, tensions, and possibilities. The future will be shaped by the questions we ask, the collaborations we build, and the trade-offs we are willing to confront.

### B

Not a constraint on development — but a fundamental condition for it. Ecological systems underpin every productive pathway.

They are inherent to complex socio-ecological systems and must be managed honestly — not denied or minimized.

Conservation without equity is fragile. Bioeconomy without inclusion reproduces the very inequalities it seeks to transcend.

> **Final Message:** Brazil is not waiting for answers — it is generating new questions.