SUSTAINABLE TROPICAL AGRICULTURE

CULTIVATING SOLUTIONS FOR FOOD, ENERGY, AND CLIMATE

EXECUTIVE SUMMARY

BRAZILIAN FORUM ON TROPICAL AGRICULTURE

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The 30th United Nations Climate Change Conference (Conference of the Parties) – COP30, to be held in November in Belém, Pará, is not a COP for Brazil, nor for agriculture. It is yet another COP focused on seeking mechanisms to prevent global warming.

For this reason, it is common to question the "benefits" that Brazilian agriculture and/or agribusiness could gain from taking part in the discussions that will take place during the event.

This is a much deeper issue than it appears, and several points should be highlighted. The first one has to do with the loss of prominence of multilateral organizations, which has caused a certain loss of values and direction for humanity.

Without punishment for provocations that lead to wars or undermine democracy around the world, a situation of general uncertainty about the future is taking shape — a sense of geopolitical insecurity and even the feeling of a new international "disorder."

There is no shortage of voices warning that this scenario poses a threat to world peace.

And this is a cause that should unite all peoples: the fight to safeguard global peace.

There can be no greater challenge for the contemporary world.

Ensuring peace is the highest ambition that every citizen, in every corner of this vast world, should pursue!

Peace for today and for the future.

No one should even entertain the idea: our children and grandchildren without peace? Unthinkable!

This should be the main focus for leaders at all levels and positions.

Indeed, there is an unmistakable element in this quest: peace cannot exist where hunger persists.

Universal history is full of evidence that hunger has triggered wars. Therefore, food security is an essential prerequisite for preventing conflict. At the same time, the pursuit of a renewable energy matrix with a lower impact on greenhouse gas emissions has been ongoing for some time. Meanwhile, social inequality has become a source of despair on every continent, fueling waves of migration and increasing public insecurity.

It is essential to tackle this issue with the same vigor and determination with which climate change is being addressed. The four points are interconnected.

For peace to be fully realized, humanity must unite decisively around ensuring food security for all, advancing the energy transition toward greater sustainability, generating jobs and income in the poorest regions to reduce social inequality, and accomplishing all of this through agricultural activities guided by science and technological innovation.

This vision will reach its full potential within the planet's tropical belt. Latin America, sub-Saharan Africa, and parts of Asia are regions with available land to expand cultivation and where technological standards are still relatively low. It is across this vast territorial expanse that the largest sustainable tropical agricultural production is set to take place, helping to prevent fratricidal wars of any kind.

Brazil has developed sustainable tropical technologies that can be replicated across the region. This is why COP30 is so important for both Brazilian and global agriculture: the world will be watching Brazil, and this remarkable technological expertise must be showcased to its fullest. Everything developed here over the past 50 years—from a country that imported 30% of its domestic food in the 1970s to one that now exports agricultural products to over 190 countries—must be presented, explained, and its applicability to the tropical belt clearly demonstrated

In doing so, Brazil can leave an invaluable legacy for humanity: its replicable agricultural production will serve as a safeguard against insecurity—the price of Peace, with a capital P! Another key aspect of the COP's agenda is the determination of its President, Ambassador André Correa do Lago, to implement the decisions of this COP and previous ones in defense of the sovereignty of peoples. Throughout his full year in office leading up to COP31, he will pursue every possible means to ensure this implementation.

With these two points, Brazil's potential legacy from COP30 becomes clear: to emerge as a champion of world peace.

Roberto Rodrigues
Special Envoy for Agriculture at COP30

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This publication was prepared with the collaboration of leading institutions in Brazilian agribusiness, including industry associations, research centers, and experts from a wide range of areas within the sector.

ABAG – Brazilian Agribusiness Association

ABCA – Brazilian Academy of Agronomic Science

ABCZ – Brazilian Association of Zebu Breeders

ABIA – Brazilian Food Industry Association

ABIEC – Brazilian Association of Meat Exporting Industries

ABIMAQ – Brazilian Association of Machinery and Equipment Manufacturers

ABIOGÁS – Brazilian Biogas Association

ABIOVE – Brazilian Association of Vegetable Oil Industries

ABISOLO – Brazilian Association of Plant Nutrition Technology Industries

ABPA – Brazilian Animal Protein Association

ABRAMILHO – Brazilian Association of Corn and Sorghum Producers

ABRAPA – Brazilian Association of Cotton Producers

ABRASEM – Brazilian Association of Seeds and Seedlings

AGROICONE

ANDA – National Association for Fertilizer Distribution

ANDAV – National Association of Agricultural and Veterinary Input Distributors

ASBRAER – Brazilian Association of Technical Assistance and Rural Extension Entities, Agricultural Research, and Land Regularization

CEBDS – Brazilian Business Council for Sustainable Development

CNA – Confederation of Agriculture and Livestock of Brazil

BRAZIL CLIMATE, FORESTS AND AGRICULTURE COALITION

CROPLIFE BRAZIL

EMBRAPA

FAESP – Federation of Agriculture and Livestock of São Paulo

FEBRAPDP – Brazilian Federation of No-Till Farming

FIESP – Federation of Industries of the State of São Paulo

DOM CABRAL FOUNDATION

GETÚLIO VARGAS FOUNDATION (FGV Agro and FGV Bioeconomia)

IAC – Agronomic Institute

IBÁ – Brazilian Tree Industry

Insper Agro Global

Arapyaú Institute

Equilibrium Institute

IPA – Agricultural Thinking Institute

IPAM – Amazon Environmental Research Institute

IPEA – Institute of Applied Economic Research

MAPA – Ministry of Agriculture and Livestock

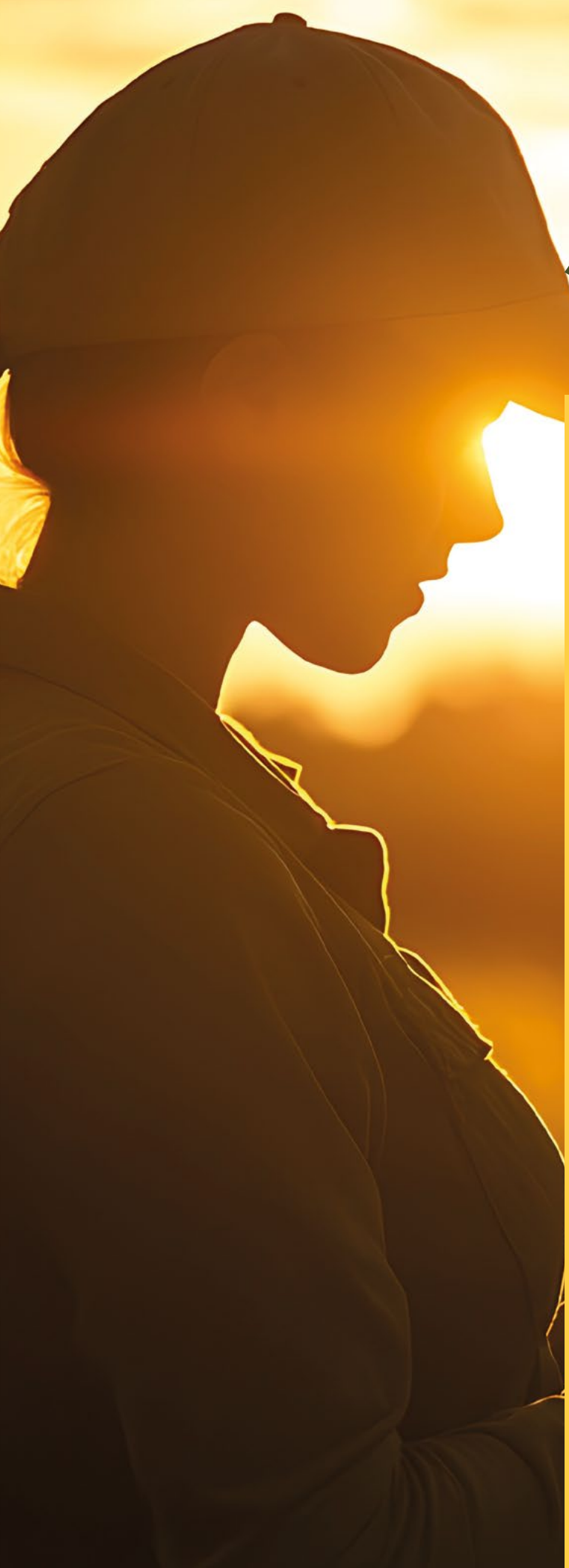
MBPS – Brazilian Roundtable on Sustainable Livestock

OCB – Organization of Brazilian Cooperatives

SINDIRAÇÕES – National Union of Animal Feed Industry

SRB – Brazilian Rural Society

UNICA – Sugarcane Industry Union



WHAT IS THE BRAZILIAN FORUM ON TROPICAL AGRICULTURE?

An initiative that unites research centers, leading institutions, representatives of the productive sector, and experts from various fields to **position tropical agriculture as a cornerstone of global climate solutions at the 30th United Nations Climate Change Conference (COP30) and beyond.**

Proposed by **FGV Agro** and **FGV Bioeconomia**, the Forum is a **space for technical coordination, interinstitutional dialogue, and proposal formulation**, with a focus on **positioning tropical agriculture as a structural axis of global solutions for the climate crisis, food security, and energy transition**, recognizing the uniqueness, innovation, and sustainability of tropical production systems.

Although created for COP30, **the Forum operates on an ongoing basis**, supporting public policies, regulatory frameworks, and **Brazil's leadership in sustainable tropical** agriculture — low-carbon, resilient, and inclusive.

SUSTAINABLE TROPICAL AGRICULTURE: CULTIVATING SOLUTIONS FOR FOOD, ENERGY, AND CLIMATE

Where there is no food, there is no peace. This idea sums up the essence of this document, which recognizes agriculture as the foundation of political, economic, and social stability. When it thrives, it strengthens communities, markets, and nations. When it fails, it weakens structures, deepens inequalities, and generates social and political tensions. In the 21st century, in the face of climate crises, energy pressures, and persistent inequalities, **tropical agriculture occupies a central place in delivering solutions to these major global challenges.**

Tropical agricultural systems connect food, energy, and climate in a strategic agenda that requires integrated and coordinated solutions. Food security, energy transition, climate action, and social justice do not advance in isolation: they are interdependent dimensions of the same transition.

The **tropical region**, which accounts for around **40% of the planet's arable land** and **52% of its water resources**[1], also boasts one of **the world's** greatest **levels of biological diversity**, giving it **enormous productive potential**. In this context, **tropical agriculture** can play a strategic role on a global scale by reconciling **food security**, **socio-environmental sustainability**, and **economic competitiveness.**[2]

At the same time, the tropics are among the regions' **most vulnerable to climate risks**, facing structural problems such **as low soil fertility, high incidence of pests and diseases, limited irrigation infrastructure, compaction of fragile soils, loss of biodiversity**, and increasing **pressure on land and water use**. To respond to these challenges, it is essential to adopt **production models based on science and innovation**, with a focus on **regenerative practices, efficient use of land and water resources, recovery of degraded areas, and integrated territorial planning. International cooperation** is a key factor in leveraging development in these regions.

The diversity of experiences in tropical regions shows that there is no **single model of agricultural production**. In **Latin America**, especially in Brazil, **large-scale** production predominates, while in **Asia, small, labor-intensive, and irrigation-intensive farms** prevail. These different paths indicate that building **sustainable tropical agriculture** requires **continuous investment in scientific research, rural extension, and coordinated public policies.**

In this scenario, **promoting resilient and sustainable tropical models** is a fundamental strategy for addressing the challenges posed by **climate change** in an integrated manner, while ensuring **food and energy security**. This approach reinforces the importance of **robust agricultural policies adapted to regional specificities**, capable of **mitigating climate impacts, increasing production efficiency**, and **consolidating a resilient and environmentally responsible agricultural system.**[3]

Given the diversity of local realities, specific solutions adapted to the socio-environmental conditions of each territory are necessary. There is no single model for tropical agriculture—its full development depends on advances in technological adaptation, sustainable management, and regionalized innovation.

TROPICAL BELT OF THE WORLD

Sustainable Tropical Agriculture: Cultivating Solutions for Food, Energy, and Climate presents a proactive vision: transforming the potential of tropical production systems into structural actions capable of strengthening global food security, accelerating the energy transition, reducing inequalities, and promoting climate mitigation and adaptation solutions. To this end, it proposes a common vision for the tropics, anchored in science, innovation, public policies, and productive practices that favor adaptation, respecting the characteristics of each region and reconciling economic development, environmental conservation, and social justice.

The Brazilian experience is a central element of this proposal. Over five decades, Brazil has built a unique tropical model, combining **scientific research, public policies, rural entrepreneurship, and cooperativism. This trajectory shows that sustainable agricultural transformations are feasible and replicable. It is not a question of imposing a single model, but of affirming the capacity of tropical countries to lead the construction of their own solutions, appropriate to their territories and realities.**

The Forum proposes and articulates the repositioning of tropical agriculture as a structuring axis for global solutions, contributing to a future in which food security, energy security, climate action, and social justice go hand in hand. By focusing on tropical agriculture, COP30 can pave the way for a new framework for international cooperation, stimulating scalable and more equitable solutions.

THE TRAJECTORY OF BRAZILIAN TROPICAL AGRICULTURE

From colonial exploitation to institutional strengthening, Brazilian agriculture has undergone profound transformations until consolidating a national agricultural policy capable of integrating innovation, credit, rural extension, and sustainability to the country's tropical conditions.

Until the mid-20th century, Brazilian agriculture still bore the marks of its colonial heritage. **Extensive systems, low productivity, deep regional inequalities, and heavy dependence on imports of inputs and staple foods defined the sector.** The Cerrado, with its 204 million hectares, was considered unsuitable for cultivation due to soil acidity, excess aluminum, and low natural fertility. The rapid urbanization of the 1960s increased the demand for food, leading the country to frequently resort to the foreign market to meet basic needs.[4-6]

It was in this context that Brazil began to structure its first modern agricultural policies. The creation of **the National Rural Credit System (SNCR) in 1965** introduced subsidized interest rate financing instruments, laying the foundations for a national agricultural policy. **In 1973, the founding of the Brazilian Agricultural Research Corporation (Embrapa)** marked the beginning of a scientific revolution focused on the tropics, inheriting about 70 experimental stations and quickly consolidating its presence in the country. During the same period, cooperativism gained national prominence with the creation **of the Organization of Brazilian Cooperatives (OCB) in 1969 and the Brazilian Technical Assistance and Rural Extension Company (Embrater) in 1975**, while the **National Alcohol Program (Proálcool), launched in 1975**, positioned Brazil as a pioneer in biofuels, anticipating debates on energy transition decades before they became global.[4,7]

The 1980s marked the beginning of the Tropical Revolution, a period when Brazilian science began delivering tangible results. Technologies such as large-scale liming, phosphate fertilization, biological nitrogen fixation (BNF), genetic improvement, and the adaptation of plants and animals to tropical conditions transformed the Cerrado from an unproductive region into a powerhouse of national production.[8]

This trajectory contrasted with other tropical regions. In **sub-Saharan Africa**, the absence of research institutions and structured policies maintained extensive systems of low productivity, aggravated by erosion and loss of soil fertility.[2] The limited reach of the Green Revolution in the region is evidenced by the **stagnation of total agricultural factor productivity since the 1960s**, in contrast to the well above-average global evolution observed in Latin America and Asia—with Brazil at the forefront of this process. In **Asia**, the Green Revolution focused on irrigated rice and wheat, crops adapted to fertile soils and existing irrigation systems, conditions very different from those faced in the Brazilian Cerrado.

In the following decades, a unique model of tropical agriculture was consolidated in Brazil, **the result of a profound and unprecedented transformation, shaped by a combination of tropical science, public policies, and the entrepreneurial spirit of rural producers.** This modernization process turned the country into an agro-environmental powerhouse, capable of combining high productivity, technological innovation, and sustainability on a large scale. The productive occupation of the Cerrado, driven by agricultural research and the adaptation of crops to the tropical environment, was a water-

shed moment. The expansion of soybeans, corn, and livestock revealed the potential of the tropics to produce in harmony with the environment.

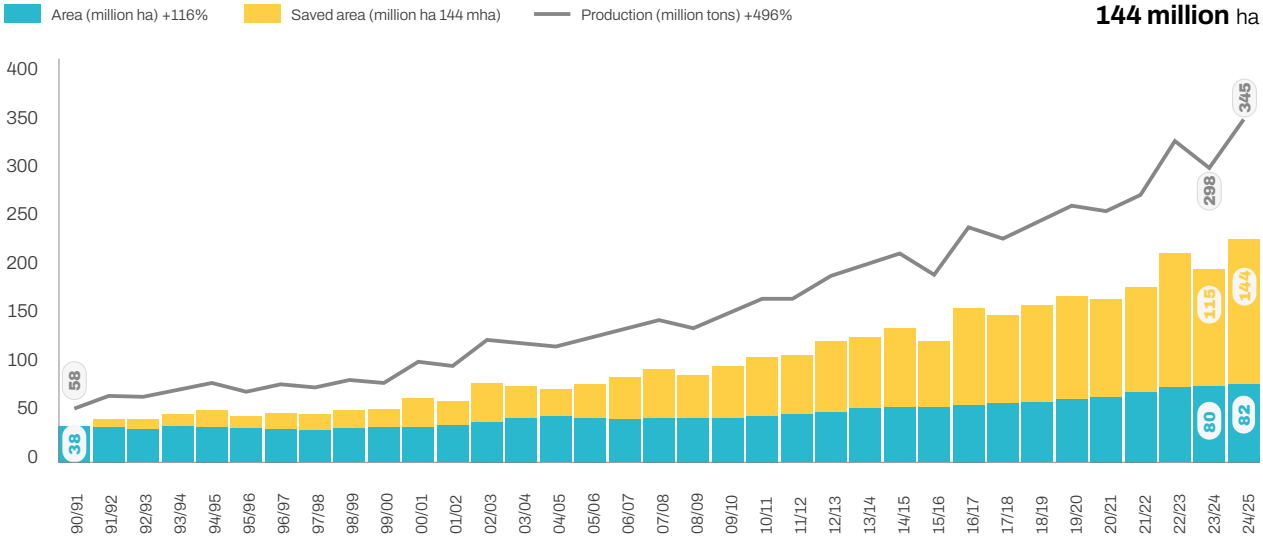
The distinguishing feature of Brazilian agriculture, however, lies in **its productive diversification**, expressed in the wide variety of crops, systems, and agricultural biomes. Today, Brazil produces **hundreds of foods**, ranging from large commodities to high value-added chains, such as fruits, vegetables, fibers, oilseeds, coffee, cocoa, and forest products. This plurality is not only an economic asset but also a strategy for the future: the path to resilient, innovative, and sustainable tropical agriculture.

The result of this trajectory of transformation is remarkable. In the last three decades, grain production in Brazil has grown **494.8%**, from **58 to 345 million tons**, while the cultivated area has increased **115.8%**, from **38 to 82 million hectares**, considering the planted area that includes first, second, and third harvests, depending on the product. This progress reflects **significant productivity gains**, which have allowed for an estimated **"area savings" of 144 million hectares** — equivalent to **1.8 times** the current area cultivated with grains[9].

EVOLUTION OF GRAIN PRODUCTION IN BRAZIL

Source: CONAB, FGV Agro

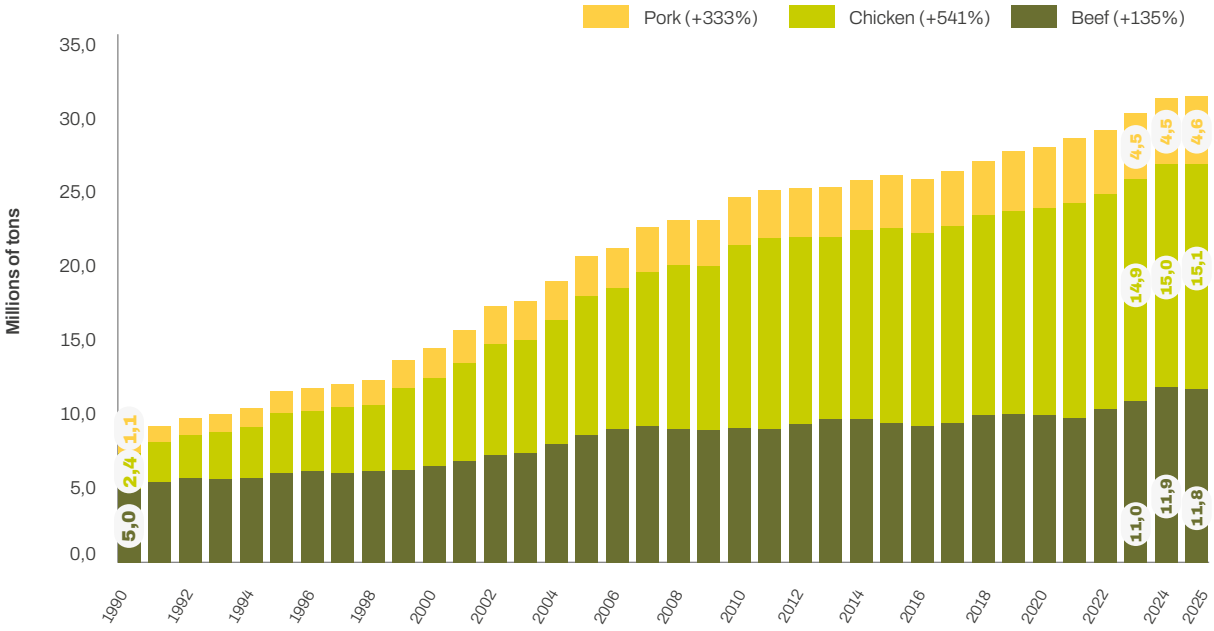
Productivity gains enables savings of **144 million** ha



Improvements in Zebu cattle breeds and pastures have allowed the cattle herd to **more than double in four decades** without significantly expanding the area occupied, consolidating Brazil as **the world's second largest producer and leading exporter of beef**. In **poultry farming**, the country has seen a significant jump in production, achieving **global leadership in chicken meat exports**. **Pig farming** has also advanced with genetic and management innovations, **positioning Brazil as the world's fourth largest producer and exporter.** [10]

EVOLUTION OF MEAT PRODUCTION IN BRAZIL

Source: USDA, FGV Agro

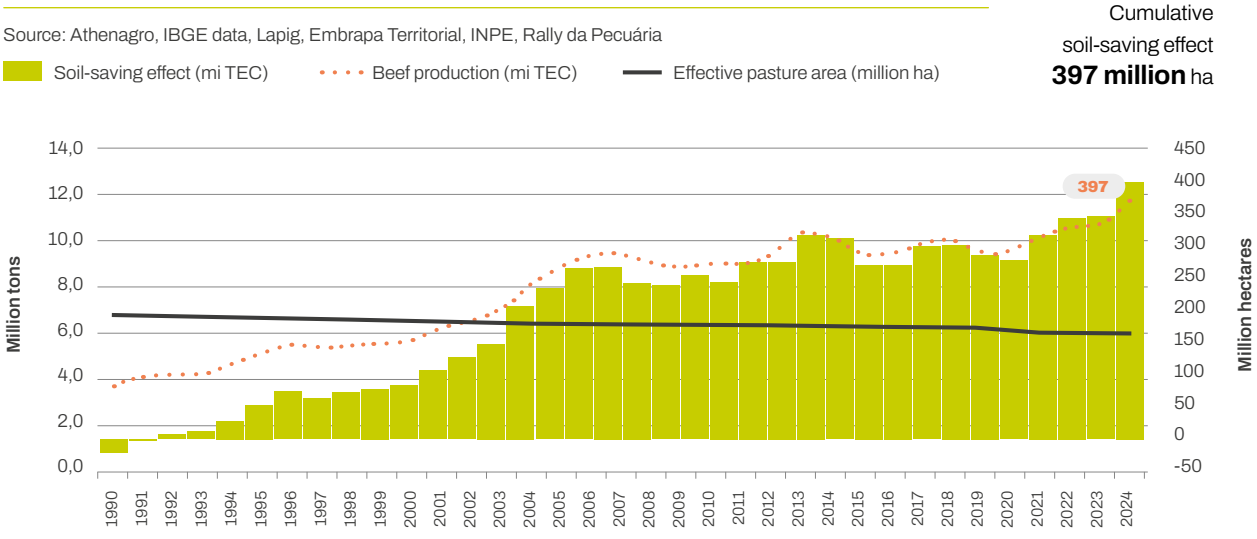


In livestock farming, even with the pasture area remaining relatively stable between **160 and 190 million hectares**, beef production increased by more than **240%**, from about **3.5 million to 12 million tons of carcass equivalent (TEC)**. The so-called "cumulative **land-saving effect**" reaches **397 million hectares**, an area that would have been necessary to sustain current production levels if productivity had remained at 1990 levels — equivalent to approximately **2.5 times** the country's current pasture area.

EVOLUTION OF PASTURE AREA, BEEF PRODUCTION, AND LAND ECONOMICS IN BRAZIL

Source: Athenagro, IBGE data, Lapig, Embrapa Territorial, INPE, Rally da Pecuária

Cumulative soil-saving effect **397 million** ha



Today, one in every four agricultural products sold globally originates from Brazil. This level of relevance positions the country as a global benchmark for solutions that reconcile productivity with sustainability, innovation with social inclusion, and economic growth with the energy transition. Brazil ranks among the world's leading producers and exporters of food, fiber, and bioenergy, holding dominant positions in key markets such as soybeans, sugar, coffee, orange juice, and pulp. This remarkable productive capacity is underpinned by a highly diverse agricultural structure — encompassing small family farms, medium-sized producers, and large-scale, technologically advanced enterprises that are deeply integrated into global markets.

BRAZILIAN AGRIBUSINESS ACCOUNTS FOR

Source: CEPEA, IPEA, MAPA, and MDIC, 2024

23%
of GDP

26%
of jobs

49%
of exports

One out of four agribusiness products in circulation worldwide is Brazilian

In 2024, the Gross Domestic Product (GDP) of agribusiness reached R$ 2.72 trillion, with R$ 1.9 trillion coming from agriculture and R$ 819.26 billion from livestock, accounting for 23.2% of the national economy[11] . Between January and November of the same year, exports from the sector totaled US$ 152.63 billion, corresponding to 48.9% of the country's total exports, led by the soybean complex (US$ 52.19 billion), meat (US$ 23.93 billion), and the sugar-alcohol complex (US$ 18.27 billion).

BRAZIL'S ROLE IN THE GLOBAL AGRICULTURAL MARKET

Source: USDA, Ibá, 2024

PRODUCT	INDICATORS	PROD.	EXPORT.
Soybean (mi ton)	World	370	173
	Brazil	155	103
	Ranking	1º	1º
	Share	39%	59%
Corn (mi ton)	World	1.230	202
	Brazil	124	52
	Ranking	3º	2º
	Share	10%	26%
Sugar (mi ton)	World	183	67
	Brazil	41	32
	Ranking	1º	1º
	Share	22%	48%
Cotton (mi bales 480lb)	World	113	44
	Brazil	14	12
	Ranking	3º	3º
	Share	13%	28%

PRODUCT	INDICATORS	PROD.	EXPORT.
Coffee (mi bags 60kg)	World	171	142
	Brazil	66	43
	Ranking	1º	1º
	Share	39%	31%
Cellulose (mi ton)	World	187,5	238,7
	Brazil	25,5	18,6
	Ranking	2º	3º
	Share	12%	8%
Orange juice (mi ton)	World	1,5	1,3
	Brazil	1,1	1,0
	Ranking	1º	1º
	Share	74%	76%
Beef (mi ton)	World	59	11
	Brazil	10,5	2,9
	Ranking	2º	1º
	Share	18%	24%

Brazilian agriculture is also decisive for energy sustainability: the Brazilian matrix maintains 49% of renewable sources, an index three times higher than the global average of 15%, with about 30% coming directly from agribusiness. The integration between food and bioenergy chains strengthens production and expands joint benefits, avoiding competition for land use. This synergy projects Brazil as a global leader, articulating food, climate, and energy security in the same strategic agenda.[1,2]

BRAZILIAN ENERGY MATRIX

Source: Bioeconomy Observatory, FGV 2025

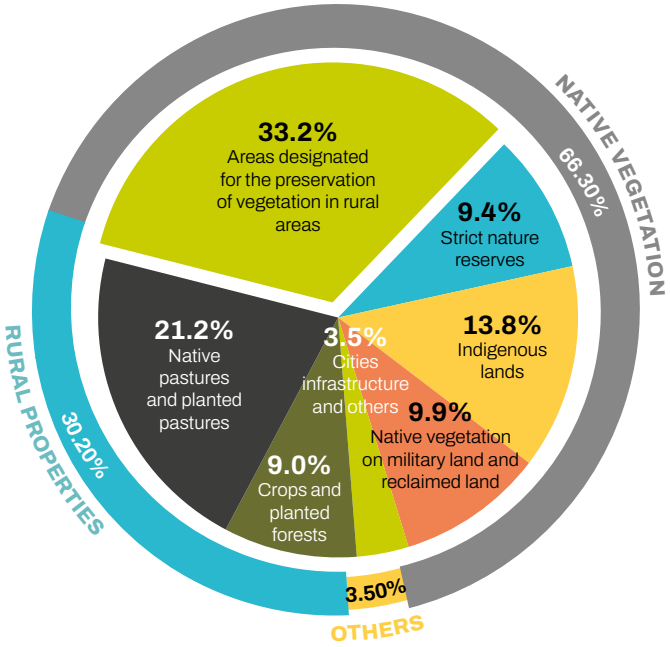
ORIGIN		ENERGY SOURCE	PARTICIPATION (%)*
Non-renewable		Oil and oil products	35,10%
		Natural gas	9,61%
		Other non-renewables	0,60%
		Coal and coke	4,40%
		Nuclear (Uranium)	1,23%
		Total – Non-renewables	**50,94**
Renewable	Bioenergy from Agribusiness	Sugarcane biomass	16,87%
		Firewood and charcoal (energy forestry)	5,20%
		Leach-Black liquor	3,39%
		Vegetable oils	1,97%
		Other biomass	1,63%
		Biogas from agricultural and forestry	0,04%
		Subtotal	**29,09%**
	Renewable energy not related to agricultural activities	Firewood (natural vegetation)	3,49%
		Biogas from urban solids waste	0,11%
		Subtotal	**3,60%**
	Other renewable sources	Hydric	12,01%
		Aeolic	2,62%
		Solar	1,73%
		Subtotal	**16,36%**
		Total – renewables	**49,06%**

Brazil has established itself as one of **the world's largest agricultural producers**, using only about one-third of its territory for agricultural production. Currently, **30.2% of the national area** is dedicated to agriculture and livestock, distributed between **native and planted pastures (21.2%)** and **crops and planted forests (9.0%)**.

The **remaining 66.3% of Brazilian territory** remains covered by **native vegetation**, with **33.2%** protected within **rural properties**, **9.4%** in **integral conservation units**, **13.8%** on **indigenous lands**, and **9.9%** in **military areas and vacant lands**. The **remaining 3.5%** is used for **cities, infrastructure, and other purposes.**

LAND OCCUPATION AND USE IN BRAZIL

Source: EMBRAPA Territorial based on data from MMA, FUNAI, EMBRAPA, TERRACLASS, IBGE, SICAR/MGI, and FGV Agro



Currently, the **Brazilian agricultural sector is undergoing a new transformation**, driven by the adoption of r**egenerative technologies and practices** that combine **agroforestry systems and integrated food and energy production systems**. More than just increasing productivity, this transition seeks **to restore soil health**, conserve biodiversity, and **strengthen the resilience of production systems**, enabling them to operate with **low or neutral carbon emissions** and, in many cases, **remove more carbon from the atmosphere than they emit**.

National priorities also include integrated landscape management, which considers the relationships between **deforestation, biodiversity conservation, and agricultural production**, and recognizes that **climate adaptation depends directly on the preservation of natural ecosystems**. Forests and native vegetation play an essential role in **regulating microclimates, maintaining precipitation patterns**, and **sustaining agricultural productivity**, highlighting that **effective adaptation strategies** must be deeply linked to **the conservation of ecosystem services and the integration of forests, climate, and production.**

SUSTAINABILITY AS A JOURNEY FOR BRAZILIAN AGRICULTURE

The trajectory of Brazilian agriculture has been marked by a continuous journey toward **sustainability**, guided by public policies that, at different times, have consolidated this commitment as a strategic axis of the sector.

A fundamental milestone in this trajectory is the **Forest Code**, established in 1965 and updated in 2012. Considered one of the most comprehensive environmental legal frameworks in the world, the Code establishes instruments such as **Permanent Preservation Areas (APPs), Legal Reserves, and the Rural Environmental Registry (CAR)**, which align agricultural production with the conservation of natural resources. By defining clear rules for the protection of native vegetation and environmental regularization mechanisms, the Forest Code has become an international benchmark in reconciling productive land use and preservation, consolidating a legal framework that has guided Brazilian agriculture for more than half a century.

In the wake of this regulatory framework, the **ABC Plan** and its successor, **ABC+**, consolidated the **low-carbon agenda in the countryside**, encouraging sustainable practices such as the **recovery of degraded pastures, biological nitrogen fixation, crop-livestock-forest integration (ILPF)**, and **no-till farming**. In the same vein, the **National Bioinputs Program** has been promoting the use of **innovative biological solutions** that reduce **production costs** and **environmental impacts**, strengthening the transition to more efficient and regenerative agriculture.

In integrating agriculture with bioenergy, the **National Biofuels Policy (RenovaBio)** promotes production certification, including environmental eligibility criteria for biomass that include zero deforestation, traceability, and measurement of sustainability indicators for the production system, generating the carbon footprint throughout the biofuel life cycle.[1,3]

The Payment for Environmental Services Program (PSA), in turn, represents an important step forward in **recognizing the economic value of ecosystem conservation**, including by **traditional communities** that play an essential role in maintaining biodiversity. **Agro + Sustentável** reinforces this agenda by promoting **responsible management, traceability**, and **certification of good agro-environmental practices**. This set of policies is complemented by the **National Plan for Adaptation to Climate Change**, which aims **to prepare the agricultural sector for extreme weather events**, and the **National Program for the Conversion of Degraded Pastures into Sustainable Agricultural and Forestry Production Systems (PNCPD)** — later renamed "Green Path Brazil", **focused on the productive restoration of degraded areas** and the **enhancement of resilience in agricultural systems**.

This journey is also **a social one**. Programs such as **Pronaf**, **agricultural insurance**, and t**echnical assistance** strengthen **family farming**, which accounts for **76.8% of rural establishments** and **23% of the Gross Value of Agricultural Production**, in addition to playing a strategic role in chains such as **cassava, milk, tropical fruits, and horticulture**.[14]

In this context, **cooperativism** stands out as one of the main forces for **integration and inclusion in the countryside**. By coordinating **credit, technical assistance, and market access**, the cooperative model expands opportunities, reduces inequalities, and strengthens the **resilience of rural communities**. More than an economic structure, it represents a **social, environmental, and productive**

lever that combines **efficiency with equity** and **growth with** sustainability—a true institutional asset of Brazil and an inspiring example of how unity can transform realities.

In turn, **larger-scale**, highly technical **producers** expand **Brazil's international presence** and complement **domestic supply**. Together, family farming, cooperatives, and large producers form a **mosaic of coexisting production systems**, which gives **dynamism, competitiveness, and resilience** to the Brazilian agricultural sector.[14]

By recognizing its plurality and investing in science, innovation, and consistent policies, Brazil demonstrates that it is possible to reconcile **competitiveness, environmental conservation, and social inclusion** in a unique tropical agricultural model. More than meeting domestic and foreign demand, this experience offers the world **low-carbon tropical solutions** capable of inspiring agriculture that combines **productivity, sustainability, and human development**.

CONTEMPORARY CHALLENGES OF TROPICAL AGRICULTURE

Tropical agriculture is at the heart of the great challenges of our time—from food and energy security to climate stability and social justice.

Tropical agriculture faces a set of structural and interconnected challenges that define the 21st century. **Although global food production is sufficient to feed all of humanity, 673 million people live in a situation of food insecurity,** not because of scarcity, but because of unequal distribution, systematic waste, and the intensification of climate events.[15]

In tropical countries, this paradox takes on even more dramatic contours: a strong export vocation coexists with the urgency of ensuring food sovereignty for local populations, while **dependence on fossil fuels** exposes the entire production chain to fluctuations in energy prices, making fertilizers, transportation, and storage more expensive.[2]

Climate change disproportionately exacerbates these vulnerabilities. Prolonged droughts, changes in rainfall patterns, extreme temperature fluctuations, soil degradation, and intensified pests hit hardest precisely those regions and people who already live in the most fragile situations.

These environmental pressures are intertwined with deep structural inequalities. Land concentration, unequal access to credit and technology, and the historical exclusion of family farmers, women, youth, traditional communities, and indigenous peoples limit the collective capacity for adaptation. Without addressing these asymmetries, there will be no just transition or lasting solutions.

THE ABC PLAN AS A MILESTONE IN THE TRANSITION TO LOW-CARBON AGRICULTURE

Brazil has established itself as a global benchmark in low-carbon agriculture by structuring pioneering policies such as the ABC Plan and ABC+, which combine science, innovation, and public policies to reduce emissions, restore degraded areas, and strengthen climate resilience in rural areas.

Given this interconnected scenario, the Brazilian experience demonstrates that it is possible to build integrated and transformative responses. By aligning productivity, environmental conservation, and social inclusion, Brazil has consolidated a model in which **adaptation and mitigation go hand in hand**. Adaptation to climate change plays a central role in ensuring productive stability, food and energy security, and reducing social vulnerabilities. **Mitigation becomes a direct consequence of well-structured adaptive systems:** practices that strengthen productive resilience also reduce emissions and increase carbon sequestration, consolidating the contribution of tropical agriculture to global climate goals. **This trajectory consolidates the strategic role of tropical countries in building global solutions, articulating food, energy, climate, and social security in a single horizon of a sustainable future.**

A decisive milestone in this process was the **Sectoral Plan for Climate Change Mitigation and Adaptation** for the Consolidation of a Low Carbon Economy in Agriculture (ABC Plan), a pioneering initiative that structured strategic actions for the adoption of sustainable technologies. The plan established guidelines aimed at reducing GHG emissions and strengthening the resilience of the agricultural sector without compromising productivity. [1,6]

The ABC Plan was structured around seven main programs, six focused on mitigation and one on adaptation. These included: the recovery of degraded pastures (RDP); crop-livestock-forest integration (ILPF) and agroforestry systems (SAF); no-till farming (NTF); biological nitrogen fixation (BNF); expansion of planted forests (PF); animal waste treatment (AWT) and targeted actions to adapt to climate change.

Between 2010/2011 and 2019/2020, the plan achieved virtually all of its expansion and mitigation targets, **resulting in 53.76 million hectares under sustainable technologies and estimated mitigation of 192.65 million tons of CO_2 equivalent between 2010 and 2020.**[17]

TARGETS AND RESULTS ACHIEVED BY THE ABC PLAN (2010 TO 2020)

Source: Morandi *et al*, 2024, Manzatto *et al*, 2020 and Brazil, 2021

		RPD	ILPF	NTF	BNF	PF	AWT	TOTAL
TARGETS	Commitment (Mha)	15.0	4.0	8.0	5.5	3.0	4.4	35.5
	Estimated mitigation potential (million Mg CO_2eq)	83 a 104	18 a 22	16 a 20	10	NE	6.9	132.9 a 162.9
RESULTS	Increased adoption in the period	26.80	10.76	14.59	11.78 a 6	1.88	38.34	53.76
	Computed expansion for mitigation	9.50	NE	NE	NE	NE	NE	–
	Exceeding the target achieved in relation to the estimated goal (%)	179	269	182	214	63	871	276
	Emission factor Mg CO_2 -1 ha^{-1} $year^{-1}$	3.79	3.79	1.83	1.83	4.69	1.56	–
	Mitigation (million Mg CO2 -1 ha^{-1} $year^{-1}$)	36.01	39.76	26.70	21.56	8.82	60.00	192.65
	Exceeding the target achieved in relation to the estimated target (%)	35	185	133	216	–	867	118

RPD | Recovery of Degraded Pastures
ILPF | Crop-livestock-forest integration
NTF | No-till farming
BNF | Biological Nitrogen Fixation
PF | Planted Forests
AWT | Animal Waste Treatment

NE | Non-existent

The results demonstrate the effectiveness of this public policy and reinforce Brazil's potential to implement national commitments to reduce net emissions. Areas with RPD grew by 66% and with ILPF by 86%, with average annual expansion rates of 7.5% and 9.2%, respectively.

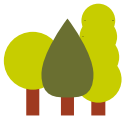
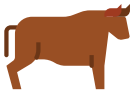
The success of the ABC Plan led to the launch of the ABC+ Plan (2020-2030), which expands and improves this sectoral policy, reinforcing Brazil's commitment to sustainable, resilient, and low--carbon agriculture. The new plan aims to increase the efficiency of production systems, promote climate adaptation, and control GHG emissions through an integrated landscape approach.

Its strategic goals include: expanding the adoption of **Sustainable Production Systems (SPS-ABC)** by 72.68 million hectares; increasing the treatment of animal waste by 208.4 million m^3; encouraging the use of bio-inputs and water and nutritional efficiency practices; and intensifying the slaughter of 5 million cattle in intensive finishing.[16]

ABC+ adopts a differentiated approach by biome, covering all producer profiles, from family farmers to large agribusinesses. The plan introduces innovative concepts such as the **Integrated Landscape Approach (ILA)**, Sustainable Production Systems (SPS-ABC), and certified low-carbon products, all based on scientific evidence and periodic reviews. **The practices recommended by the ABC+ Plan have the potential to mitigate up to 1 gigaton of CO_2 equivalent by 2030, strengthening the transition to low-carbon agriculture through the dissemination of sustainable systems, practices, products, and processes.**[16]

ABC+ PLAN TARGETS FOR THE PERIOD FROM 2020 TO 2030

Source: Manzatto *et al*, 2024

	**PASTURES RECOVERY** Agricultural practices to restore the vigor of forage crops and increase ground cover. **Target – 30 million ha | Potential – 113.70 million of Mg CO_2 eq**
	**NO-TILL SYSTEM** Techniques to avoid soil disturbance, maintaining mulch or plant cover. **Target – 12.5 million ha | Potential – 12.990 million od Mg CO_2 eq**
	**INTEGRATION SYSTEMS** Integrated production systems involving the production of grains, fibers, wood, energy, milk, or meat in the same area. **Target | 10.10 million ha | Potential – 72.10 million of Mg CO_2 eq**
	**PLANTED FORESTS** Reforestation with native or exotic species for environmental or commercial purposes. **Target – 4 million ha | Potential – 510 million of Mg CO_2 eq**
	**BIO-INPUTS** Beneficial microorganisms and plants to improve water efficiency and add nutrients to agricultural crops. **Target – 13 million m3 | Potential – 23.4 million of Mg CO_2 eq**
	**ANIMAL RESIDUES MANAGEMENT** Reduces external dependence on fertilizers and energy. It is a complementary source of income. **Target – 208.4 million ha | Potential – 277.8 million of Mg CO_2 eq**
	**IRRIGATED SYSTEMS** Reduce the vulnerability of production systems to periods of drought and the risk of crop loss. **Target – 3 million ha | Potential – 50 million of Mg CO_2 eq**
	**INTENSIVE TERMINATION** Promote the best use of forage resources and reduce slaughter time. **Target – 5 million ha | Potential – 16.25 million of Mg CO_2 eq**

PROTECTING ECOSYSTEM SERVICES TO PRODUCE WITH RESILIENCE

Brazilian tropical agriculture recognizes that sustainable productivity depends entirely on ecosystem services. Conservationist soil management, which includes practices such as no-till farming, terracing, and permanent cover, **strengthens water retention capacity, reduces erosion, and increases biological activity**, making agricultural systems more resilient to extreme weather events. **Efficient water management** complements this progress. **Precision irrigation** technologies, **moisture sensors, and digital platforms optimize water use**, increase productivity, and reduce risks during periods of drought, consolidating food security without the need to expand frontiers. [18-22]

The protection of forests and biodiversity completes this conservation triad. Instruments such as the **Forest Code, the Action Plan for the Prevention and Control of Deforestation in the Amazon (PPCDAm), and the National System of Conservation Units (SNUC)** have established robust territorial governance. Indigenous Lands and

Conservation Units have proven effective in curbing deforestation. This strategy is reinforced by **climate finance and international mechanisms such as REDD+** (Reducing Emissions from Deforestation and Forest Degradation), which **places economic value on forest conservation**. **The traceability of production chains and zero deforestation criteria consolidate the integration between production and conservation**, strengthening the contribution of tropical agriculture to global climate stability.[6]

SUSTAINABLE PRODUCTION SYSTEMS: INTENSIFY WITHOUT EXPANDING

By integrating technology, genetics, and intelligent management to increase productivity without expanding the agricultural frontier, sustainable intensification preserves ecosystem services, strengthens the resilience of production systems, reduces emissions, and consolidates agriculture as a strategic vector for food security and climate action.

Sustainable intensification has become a central strategy for expanding production without putting pressure on natural ecosystems. Precision agriculture, genetic improvement, and biotechnology **increase efficiency per hectare**, while **integrated production systems**, which can combine crops, livestock, and forests in the same area, restore degraded soils, diversify income, and sequester carbon.[16]

Regenerative livestock farming transforms liabilities into productive assets: the recovery of degraded pastures can double or triple productivity, while intensive finishing accelerates animal fattening, reduces time to slaughter, and decreases methane emissions per kilogram of meat produced. Animal waste, when treated in biodigesters, generates biogas and biofertilizers, connecting food production to clean energy generation and the circular economy.

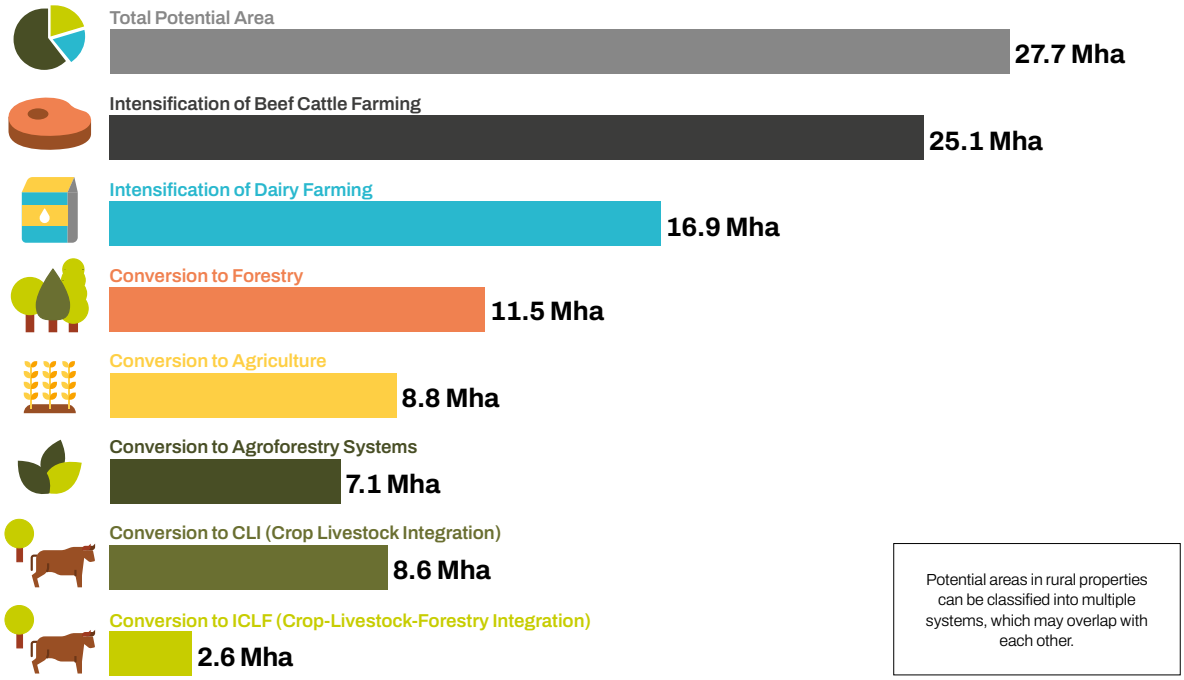
Bioenergy consolidates this integration between agriculture and energy transition. Brazilian agribusiness accounts for about 30% of the domestic energy supply, transforming biomass, waste, and sugarcane into ethanol, biodiesel, biogas, and bioelectricity.[23,24] In the tropical environment, the possibility of using agricultural soils more efficiently by planting a second crop and keeping the soil covered all year round ensures sustainable intensification with a substantial increase in FAOSTAT's *cropping frequency* indicator. [25]

Bio-inputs complete this cycle of innovation: Biological Nitrogen Fixation has replaced synthetic fertilizers on more than 40 million hectares of soybeans, generating savings of billions of dollars and avoiding millions of tons of emissions.[26]

Planted forests provide renewable raw material for pulp, energy, and construction, without putting pressure on native biomes. This portfolio of solutions demonstrates that productivity, decarbonization, and the bioeconomy can advance together, consolidating **tropical agriculture as a driver of the green transition.**[27-29]

POTENTIAL AREA FOR CONVERSION IN EACH AGRICULTURAL AND FORESTRY SYSTEM

Source: IICA, Croplife Brasil, MAPA, 2025



Potential areas in rural properties can be classified into multiple systems, which may overlap with each other.

GREEN RURAL CREDIT: DRIVERS OF TRANSFORMATION AT SCALE

The climate transition in the countryside depends on financial instruments that enable the adoption of sustainable practices on a large scale. Rural credit, which has been a cornerstone of Brazilian agriculture since 1965, has gained prominence by prioritizing low-carbon practices through the ABC+ Plan. Financing lines aimed at pasture recovery, integrated systems, efficient irrigation, and adaptive technologies not only increase mitigation but also the productive resilience of millions of farmers.[17]

Cooperativism strengthens this movement by integrating credit, technical assistance, and market access, democratizing opportunities and transforming resources into shared prosperity. With more than **17.3 million members and a presence in more than 57% of Brazilian municipalities, cooperatives have established themselves as an essential link between public policies and producers**, expanding the reach of low-carbon agriculture and promoting financial and productive inclusion. Together, **rural credit and cooperativism accelerate the sustainable transformation of the countryside**, demonstrating that the green transition requires not only technology, but also instruments that guarantee equitable access to climate solutions.[30]

CHALLENGES AND PATHS TO SCALING UP THE TRANSFORMATION

Brazilian tropical agriculture has consolidated a robust repertoire of solutions that simultaneously respond to food, energy, climate, and social challenges. **However, transforming these advances into systemic and large-scale change requires overcoming structural challenges that still limit their expansion.**

Financing is the first bottleneck: although policies such as the ABC+ Plan encourage sustainable practices, the public resources available do not match the scale of the transition required. **Innovative financial mechanisms, such as *blended finance*, green bonds, payments for environmental services, and low-carbon certifications**, are essential to expand access to capital and enable the recovery of millions of hectares of degraded pastureland. **Land governance is also a decisive fator.** The lack of land tenure regularization increases legal uncertainty, land grabbing, and illegal deforestation, challenges that must be addressed to ensure a just and lasting transition[16].

The social dimension cannot be neglected. Small producers, who are responsible for a significant part of food security and local economies, face structural limitations in accessing credit, technical assistance, and markets. Including them in decisions about agriculture and climate strengthens adaptive capacities and balances the distribution of the benefits of the green transition. Valuing ecosystem services by incorporating natural assets into property balance sheets facilitates access to credit and encourages conservation practices, requiring improved methodologies, effective PES (Payment for Environmental Services) mechanisms, and traceable, deforestation-free supply chains. [16]

Science, innovation, and the reduction of regulatory barriers accelerate the adoption of productive solutions, expand opportunities via the carbon market and international cooperation, and consolidate bioenergy as a vector for integration between agriculture and clean energy. **When addressed in a coordinated manner, these challenges become drivers of transformation**, expanding the contribution of tropical agriculture to global agendas for mitigation, adaptation, food security, and sustainable development.

AGRICULTURE AND FOOD SYSTEMS ON THE GLOBAL CLIMATE AGENDA

From production to consumption, food systems determine the security of billions of people—and their transformation is crucial to eradicating hunger, combating poverty, and addressing climate change. These systems are vulnerable to climate change, geopolitical instability, and socioeconomic inequalities. **Making them more sustainable and resilient requires coordinated action by farmers, governments, industries, financial institutions, and consumers.** This transformation must integrate production, the environment, and nutrition to ensure healthy food, respect the planet's limits, and advance the Sustainable Development Goals.[31]

T**ropical agriculture can lead this transformation.** Based on science, technology, innovation, regenerative practices, robust public policies, and international cooperation, the tropics can lead a model that combines food production, bioenergy, and climate action. Extreme weather events already compromise crops, raise prices, and intensify food insecurity, which affects 730 million people globally.

Brazilian initiatives such as the **National School Feeding Program (PNAE) and the Food Acquisition Program (PAA) demonstrate that public procurement policies can strengthen family farming, increase income, and promote healthy eating. Traceability strengthens this agenda:** the **National Plan for Individual Identification of Cattle and Buffalo** and the **Agro + Sustentável** program reinforce transparency and compliance with international regulations such as the European Union Deforestation-Free Regulation (EUDR).[32]

The trajectory of climate negotiations has progressively recognized the importance of agriculture and food systems. The Koronivia Joint Work on Agriculture (KJWA), adopted at COP23 in 2017, inaugurated a specific space for the sector in multilateral discussions. The Sharm el-Sheikh Joint Work (SJWA), established at COP27 in 2022, guided the debate toward the implementation of concrete actions, prioritizing holistic approaches and access to climate finance. COP28 consolidated this agenda with the *Emirates Declaration on Sustainable Agriculture, Resilient Food Systems, and Climate Action*, which was endorsed by more than 150 countries and mobilized at least $7 billion. Initiatives such as the *FAST (Food and Agriculture for Sustainable Transformation) Partnership* and *Harmoniya* reinforce international cooperation by connecting governments, the private sector, and civil society around climate finance, technical knowledge, and political dialogue. [33,34]

The challenge now is to implement concrete actions at scale: access to financing, technical training, innovation, recognition of ecosystem services, land regularization, and inclusion of small producers are essential steps to turn commitments into reality. COP30 in Belém represents a historic opportunity to consolidate this movement.

With a focus on transforming agriculture and food systems, the conference can bring together public, private, and civil society actors. The **focus should be on strengthening food resilience, promoting renewable energies, including sustainable biofuels, and reducing emissions from deforestation.** It is also essential **to promote the recovery of degraded areas and foster sustainable trade** that avoids unilateral measures harmful to food security.

PROPOSED ACTIONS

TROPICAL AGRICULTURE AND THE CHALLENGE OF GLOBAL CLIMATE ACTION

Throughout the latest UNFCCC Conferences of the Parties (COPs), agriculture has remained a sensitive issue, permeated by controversy and political resistance, especially with regard to its relationship with greenhouse gas (GHG) emissions, deforestation, and environmental externalities.

Historically, the debate has been dominated by narratives focused on mitigation and land use conversion, with strong regulatory pressure on agricultural and tropical countries. However, in more recent COPs, especially since the *Koronivia Joint Work Program on Agriculture* (COP23–COP27), the *Sharm el-Sheikh Joint Work on Implementation of Climate Action on Agriculture and Food Security* (COP27), the *Food and Agriculture for Sustainable Transformation* (FAST) Partnership (COP27), the *UAE Declaration on Sustainable Agriculture, Resilient Food Systems and Climate Action* (COP28), and, more recently, the *Baku Harmoniya Climate Initiative* for Farmers (COP29), **there have been concrete advances in recognizing the strategic role of adaptation in agriculture to strengthen food security and climate resilience.**[33,34]

However, robust, predictable, and binding mechanisms for climate finance specific to the sector in developing countries have not yet been consolidated. In addition, COP29 established, through the *Baku Adaptation Roadmap*, a clear path for the development of adaptation indicators applicable to agri-food systems, as well as reinforced the commitment that the *New Collective Quantified Goal for Climate Finance* (NCQG) (agreed by developed countries with a target of US$ 300 billion annually by 2035 and aiming to reach US$ 1.3 trillion/year from 2030 with global contributions) should include special attention to the needs of agri-food systems and vulnerable rural communities. This understanding was reinforced by *the Food and Agriculture Organization* (FAO, 2025) when it pointed out that 94% of Nationally Determined Contributions (NDCs) mention agri-food systems as a priority for adaptation, and 91% for mitigation.

The success of COP30 for agriculture transcends sectoral or reactive advocacy. It is a historic opportunity to reposition agriculture, especially in the tropical region, as a structuring axis of global climate solutions, reconciling food security, energy security, sustainable rural development, and low-carbon technologies under an approach based on productive inclusion, innovation, mitigation, adaptation, and recognition of the diversity of tropical production systems.

The 30th Conference of the Parties (COP30) to the United Nations Framework Convention on Climate Change (UNFCCC) in Belém (PA) arrives with a clear message and a firm purpose to demonstrate that **tropical agriculture is central to the global climate solution**. At a time when the world demands proven solutions, this event inaugurates the transition from the "era of negotiation" to the "era of implementation," as guided by the results of the first *Global Stocktake* (GST-1) of the Paris Agreement.

A PROPOSAL FROM THE TROPICS TO THE WORLD

Regenerative agriculture and livestock practices represent the forefront of climate action in the agri-food sector. They go beyond traditional mitigation by integrating soil health restoration, biodiversity conservation, efficient land use, and productive inclusion. This new paradigm combines environmental sustainability, economic profitability, and climate resilience, forming one of the central axes of the transition to sustainable tropical agriculture.

Brazil already has a wide range of technologies and public policies that embody this vision. The ABC+ 2020–2030 Plan, the main instrument for adaptation and mitigation in the agricultural sector, aims to expand sustainable practices to more than 72 million hectares by 2030, consolidating low-carbon agriculture as the basis for decarbonization in the countryside.

This transition will not happen spontaneously. It requires an institutional, economic, and technological environment capable of accelerating the adoption of already available solutions. **Its success depends on three interdependent pillars: adequate financing, functional markets, and cooperative governance.** Together, these elements transform climate goals into concrete investments, measurable results, and tangible benefits for producers, communities, and ecosystems.

The combination of tropical science, integrated systems, and innovation has generated an ecosystem of solutions that combines productivity and conservation. From no-till farming to bioenergy, from crop-livestock-forest integration to biological nitrogen fixation, **tropical agriculture has turned ecological limitations into competitive and climatic advantages. These advances transcend national borders and form part of a collective proposal from the tropics for the new phase of the Paris Agreement, Mission 1.5, a global effort to keep warming below 1.5 °C.**

This mission calls for a global implementation effort, a central concept advocated by the COP30 Presidency, in which tropical countries share practical solutions that combine mitigation, adaptation, and economic prosperity. Tropical regenerative agriculture is the concrete expression of this vision. By integrating nature, science, and productive inclusion, it promotes soil regeneration, diversification of productive landscapes, and the enhancement of ecosystem services, shaping a new generation of economic and social development agenda.

The future of global food and climate security depends on the recognition and appreciation of these tropical solutions, which emerge from living systems, local knowledge, and applied scientific innovation. From the tropics, the world receives more than food: it receives a vision of the future in which production and regeneration go hand in hand, and in which prosperity is measured by the ability to nourish and restore the planet.

TRANSFORMATION OF AGRICULTURE AND FOOD SYSTEMS: FINANCING AND A JUST TRANSITION TOWARD FUNCTIONAL AND COOPERATIVE MARKETS

CLIMATE FINANCE AS A BRIDGE TO ACTION

Climate finance has established itself as the main historical bottleneck in negotiations and as the decisive enabler of the implementation of the Paris Agreement's Nationally Determined Contributions (NDCs). COP30 in Belém represents an opportunity to transform this barrier into an effective bridge to action.

Climate finance is not only a pillar of the UNFCCC and the Paris Agreement, but also the axis that connects ambition to the reality of the new implementation phase. The Baku–Belém Roadmap and the NCQG provide the global framework, but their success will depend on multisectoral engagement in a true collective implementation effort to align agricultural production, forest conservation, and economic development through innovative climate finance.

National experience with low-carbon agriculture, bioeconomy, and renewable energy proves that sustainability can be a driver of competitiveness and prosperity. Belém's legacy will be measured by its ability to unlock concrete financial flows, ushering in a decade of real transformation. COP30 has the potential to be remembered as the conference that transformed the "global effort" into a historic turning point, producing tangible and lasting results for the climate, people, and our common future.

The transition to a low-carbon economy requires the development of innovative instruments and the overcoming of structural barriers that limit developing countries' access to climate resources.

For the agriculture and forestry sector, this agenda means making climate finance accessible, low-cost, and targeted toward the low-carbon transition. Reducing the cost of capital is equivalent to reducing the price of money. Sustainable rural projects need credit with reduced interest rates and extended terms. This transformation is made possible by public guarantees, insurance, venture funds, and *blended finance* mechanisms, in which public and philanthropic resources attract private investment and increase the total volume of capital mobilized.

The global financial architecture needs to evolve to support the urgency of climate action, expanding its scale, flexibility, and risk-taking capacity, as guided by the CMA.6 and the *IMF–World Bank Joint Statement on Scaling Climate Action* (2024). In this sense, it is essential to strengthen the role of financial agents.

Mobilizing US$ 1.3 trillion annually by 2035 for mitigation and adaptation actions will depend on the creation and expansion of innovative financial instruments capable of leveraging private capital and mitigating risks. Developing countries continue to face structural obstacles that restrict access to climate finance, including high capital costs, limited fiscal space, unsustainable debt levels, high transaction costs, and complex access conditions.

EXAMPLES OF FINANCIAL MECHANISMS THAT CAN LEVERAGE INVESTMENTS IN THE AGRICULTURAL SECTOR

FINANCIAL INSTRUMENT	ROLE IN MOBILIZING CLIMATE CAPITAL
Blended Finance 	A financing structure that combines public, concessional, or philanthropic capital with private investment, reducing the risk of climate projects and making them more attractive to commercial investors. This approach is recognized by the OECD (2024) as fundamental to mobilizing flows at scale.
Guarantee Schemes 	Risk mitigation instruments (credit enhancement and risk-taking facilities) that partially cover investment losses, reducing perceived risk and encouraging banks and funds to finance sectors that are more vulnerable to climate change.
Green bonds 	Fixed income instruments whose proceeds are directed exclusively to projects with proven environmental benefits, in accordance with the ICMA Green Bond Principles (2024 revision). They have become the main channel for raising global sustainable capital.
Green Rural Product Note (Green CPR) 	Brazilian experience, with a title that remunerates rural producers for environmental services and sustainable practices, allowing the commercialization of environmental assets. Regulated by Law No. 14,130/2021 and Decree No. 11,075/2022 (SINARE), it is part of the national green finance infrastructure.

In addition to public and multilateral funds, market mechanisms are essential for attracting private investment. Among the key catalysts are the **bioeconomy** and **carbon markets**, which convert mitigation actions and sustainable use of natural resources into measurable economic value and create direct economic incentives for decarbonization.

The **bioeconomy**, based on the sustainable use of biological resources, is recognized as a priority investment area for megadiverse countries. In the case of Brazil, it is part of both the Brazil 2050 Climate Plan and the *G20 Bioeconomy Initiative: Sustainable Growth through Biodiversity*, launched by the Brazilian Presidency of the G20 (2024). This agenda promotes a development model that integrates conservation, value generation, and social inclusion, aligning the valuation of standing forests with economic competitiveness. The tropical bioeconomy is, therefore, a key vector for expanding climate finance and consolidating the just transition to a low-carbon economy.

The operationalization of **carbon markets**, provided for in Articles 6.2 and 6.4 of the Paris Agreement, emerges as an essential instrument for attracting private investment and directing it cost-effectively toward adaptation and mitigation. Advances in this market are preconditions for tropical sectors, such as soils, agriculture, and bioenergy, to generate cooperation with environmental integrity. By pricing emission reductions, Article 6 allows countries and companies to invest in low-carbon actions in a cost-effective manner. Brazil, with its potential in sectors such as bioenergy and agriculture, is in a privileged position to benefit from these mechanisms.

In the Brazilian experience, according to the guidelines established in public policies related to agriculture, the priorities are:

1. **Accessible Credit:** strengthening rural credit lines, such as the Safra Plan and the ABC+ Program, to finance low-carbon practices, including Crop-Livestock-Forest Integration (ILPF), precision agriculture, and the recovery of degraded pastures
2. **Rural Insurance:** expanding parametric and climate insurance coverage, protecting small and medium-sized producers against losses from extreme events and ensuring production continuity.
3. **Payment for Environmental Services (PSE):** implementation and strengthening of instruments provided for in Law No. 14,119/2021 and regulated by Decree No. 11,075/2022 (SINARE), remunerating rural producers for conservation, sustainable management, and maintenance of biodiversity.
4. **Traceability and MRV:** investment in Measurement, Reporting, and Verification (MRV) systems and traceability of agro-environmental products, ensuring legal certainty and climate integrity for financial flows.
5. **"Tropicalization" of Metrics:** The carbon dynamics in tropical soils and areas, especially through the agricultural practices used, have particularities that need to be considered in carbon quantification and verification methodologies. Importing models developed for temperate climate regions without proper adaptation can compromise the international comparability and scientific credibility of national credits, which limits their direct application to Brazilian tropical systems. It is therefore essential to develop methodologies based on tropical science, incorporating regional factors such as soil and vegetation type, water seasonality, biomass dynamics, and specific biogenic emissions. This *tropicalization* ensures methodological robustness, predictability for producers, and investor confidence.

These actions form the basis for unlocking low-cost financing and ensuring that climate capital reaches the end users, especially small producers and cooperatives. The consistency and predictability of public policies are the foundation of producer and investor confidence. The **ABC+ 2020–2030 Plan and the Forest Code (Law No. 12,651/2012) provide the regulatory and technical basis for sustainable agriculture in Brazil**. Full implementation of these policies ensures legal certainty, traceability, and international recognition of Brazilian adaptation and mitigation efforts.

JUST TRANSITION TO FUNCTIONAL AND COOPERATIVE MARKETS

Just Transition has established itself as the pillar that ensures that global decarbonization moves forward without leaving people, regions, or sectors behind. For COP30, the relevance of this principle is central: translating climate goals into shared prosperity, ensuring that productive transformation is also social.

The cooperative model represents one of the country's greatest socioeconomic forces, capable of transforming climate ambition into territorial action. Inspired by the spirit of "mutirão" (collective effort), highlighted in the COP30 Presidency Letters, cooperativism represents what Brazil has closest to a networked social governance system: horizontal, supportive, and oriented toward the collective creation of value.

Brazilian agricultural cooperatives are central actors in this transition. With more than one million associated producers, they have a unique capacity to disseminate sustainable technologies among small and medium-sized producers, who face greater barriers to access to credit and innovation. Due to their capillarity and organizational structure, cooperatives act as vectors for productive inclusion, in-

come generation, and the dissemination of climate knowledge, making the low-carbon agenda socially scalable and territorially fair.

Cooperativism asserts itself as an institutional instrument for economic inclusion and social justice, articulating the productive base and climate agenda with territorial legitimacy. While other economic models prioritize returns on capital, cooperativism prioritizes returns to the community, promoting a balance between productive efficiency and social justice.

This structural character makes it an operative instrument of Just Transition: an organized network of producers, entrepreneurs, and workers who share benefits, divide risks, and transform climate action into real value in the territory.

The size and scope of Brazilian cooperativism is an economic force with social impact on a national scale. For Brazil, with more than 4,500 active cooperatives and around 23.5 million cooperative members, 1,200 of which are in the agricultural sector alone, cooperativism is the most tangible foundation for implementing climate policies with capillarity, local governance, and social legitimacy. The more than 1 million rural producers organized in cooperatives account for a significant portion of agribusiness GDP and food exports, in addition to generating more than 550,000 direct jobs, not to mention the millions of indirect jobs in the countryside and in industry.

This structure already constitutes a socioeconomic network capable of operationalizing adaptation and mitigation goals in the territory, channeling resources, technologies, and knowledge directly to producers who implement climate action on the farm.

The coherence between cooperativism and the climate agenda stems from its seven founding principles: voluntary membership, democratic management, economic participation of members, autonomy, education, intercooperation, and commitment to the community.

These principles are directly aligned with the Sustainable Development Goals (SDGs) and the ILO's Just Transition principles, which stipulate that economic transformation must be inclusive, participatory, and based on decent work.

By putting people at the center of decisions and prioritizing local reinvestment, the cooperative model ensures that the financial, technological, and environmental gains of the transition are distributed equitably, benefiting small and medium-sized producers. At COP30, this experience positions Brazil as a provider of concrete solutions with the potential to guide global agriculture and climate policies.

For tropical agriculture and cooperativism to fulfill their role in the just transition, it is necessary to recognize their strategic role in articulating political, financial, and technical pillars capable of translating climate ambition into concrete action on the ground. Sustainable and cooperative agriculture is an essential component of the global climate solution. This recognition implies integrating it transversally into decisions. This strategic repositioning is consistent with the *Sharm el-Sheikh Joint Work on Agriculture and Food Security* (SJWA) and with the COP30 Presidency's vision of transforming the "global task force" into an effective implementation movement.

Strengthening the cooperative model in Climate Governance is essential to reflect the diversity of the actors who implement it. Agricultural cooperatives represent the direct link between climate policy and the productive reality of farmers. COP30 should recognize cooperativism as an institutional instrument for implementing Just Transition, promoting its integration into UNFCCC committees, platforms, and mechanisms and strengthening its

role in national decision-making spaces. This strengthening ensures grassroots governance, participatory transparency, and social capillarity, transforming climate action into development policy.

The just transition must also balance technological innovation and traditional knowledge. The cooperative agenda proposes integrating scientific research, business innovation, and local knowledge to boost the tropical bioeconomy, generating added value and inclusion.

These proposals structure a realistic and measurable implementation agenda that translates the Just Transition discourse into operational mechanisms with impact.

Brazilian cooperativism, with its capillarity, legitimacy, and self-governance, demonstrates that effective climate action stems from cooperation. It is a model in which solidarity and productive efficiency converge for the same purpose: to regenerate the planet and empower people.

PROPOSED AXES: AGRICULTURE AND CLIMATE ACTION

The **Brazilian Forum on Tropical Agriculture** consolidates and presents strategic proposals from key players in the Brazilian economy and society. The analyses and recommendations gathered here reflect multisectoral views that together form a pragmatic and ambitious roadmap for Brazil to lead by example at COP30.

The Forum brings together a wide range of actors and translates into a single voice what Brazil offers the world: a **development model that reconciles productivity, conservation, and social inclusion**, supported by scientific evidence. This model, built over five decades of tropical innovation, proves that it is possible to produce more with fewer emissions, restore degraded ecosystems, and generate prosperity in balance with the climate.

Tropical agriculture is a point of convergence between **food security, energy transition, and climate stability**, playing an essential role in the global equation of climate change adaptation and mitigation. It feeds populations, provides raw materials for clean energy, and protects soils and forests that regulate ecosystem services and preserve biodiversity, with direct impacts on the sustainable development of developing countries.

Recognizing this interdependence, Brazil invites the international community to take a fresh look at agriculture in the tropics, an essential belt for ensuring sustainable development for a planet with a growing population. The experience presented is applicable to multiple tropical realities beyond Brazil and could represent a historic advance for the transformation of agriculture and food systems.

In this context, the following **strategic axes** are proposed:

1. Political and diplomatic repositioning[2]

- Recognize the strategic importance of tropical agriculture as a pillar of global climate, food, and energy solutions in the context of adaptation, mitigation, and co-benefits, with an emphasis on the need to deepen scientific knowledge about the climate risks to which it is exposed and to secure climate finance from various sources to drive climate action in agriculture and food security.
- Overcome the fragmented view that separates agriculture, forests, and climate, in favor of an integrated approach to land use that combines conservation and restoration of native vegetation, food systems, renewable energy, and the bioeconomy, with benefits in mitigation and adaptation.
- Include agriculture in loss and damage mechanisms, recognizing it as one of the activities most impacted by extreme weather events such as droughts, floods, frosts, heat waves, etc., which compromise production, income, and food security.

2. Adaptation and Resilience as guiding elements[35]

- Consolidate the adaptation agenda as a priority axis of tropical agriculture's contribution, associated with mitigation as a co-benefit of adopting sustainable practices, incorporating elements of tropical technological innovation, diversified agricultural systems, healthy soils, and intact ecosystems, as well as models with clear economic and social benefits.
- Adapting agriculture to the effects of climate change means building new production models that incorporate the regeneration of degraded areas and innovate in the relationship with nature, promoting resilience. True adaptation needs to be comprehensive: from genetics to soil, from biodiversity to landscape management, integrating technical knowledge, local knowledge, and effective public policies.

3. The centrality of science, technology, and innovation

- Adopting production models based on science and innovation, with a focus on regenerative practices, efficient use of land and water resources, recovery of degraded areas, and integrated territorial planning. The tropics are among the regions´ most vulnerable to climate risks, facing structural problems such as low soil fertility, high incidence of pests and diseases, limited irrigation infrastructure, compaction of fragile soils, loss of biodiversity, and increasing pressure on land and water use. International cooperation is a key factor in leveraging development.
- Developing technologies for the transition to adapted, resilient, low-carbon agriculture and food systems requires continuous investment in scientific research, rural extension, and coordinated public policies. The diversity of experiences in tropical regions demonstrates that there is no single model of agricultural production.

- Promoting resilient and sustainable tropical models is a fundamental strategy for addressing the challenges posed by climate change in an integrated manner, while ensuring food and energy security. This approach reinforces the importance of robust agricultural policies adapted to regional specificities, capable of mitigating climate impacts, increasing production efficiency, and consolidating resilient and environmentally responsible agricultural systems.
- Promoting investment in research, development, and innovation to advance low-carbon agriculture, the bioeconomy, and adaptation and mitigation technologies, especially in public-private partnerships and national and international cooperation networks, is crucial to consolidating a transition in agriculture that promotes resilience, food security, and reduced emissions from food systems.

4. Advance climate finance commitments[36] for sustainable agriculture integrated with the preservation of native vegetation

- Include agriculture in post-2025 climate finance mechanisms, with an explicit link between part of the NCQG and direct support for a low-carbon, resilient, and regenerative agricultural transition.
- Propose a global financing *roadmap* for low-carbon, sustainable, and resilient agricultural transition, focusing on tropical innovation, adaptation, bioenergy, food systems, and the bioeconomy.
- Promote innovative financial instruments such as payment for agricultural environmental services, carbon pricing associated with agricultural production, financial compensation for avoided deforestation and regeneration of degraded pastures, *blended finance* and dedicated agricultural climate funds, commercial recognition of the positive externalities of tropical agriculture in international markets, linking these initiatives to existing initiatives for climate finance in agriculture, such as the *Food and Agriculture for Sustainable Transformation (FAST) Partnership*, among others.
- Expand financial mechanisms to support productive native forests and agroforestry systems, including REDD+ mechanisms and the TFFF fund.
- Strengthen the strategic role of forests as a climate solution. Land use change, the main source of national emissions, also concentrates the country's greatest mitigation potential. It should include rigorous combating of deforestation and associated emissions; large-scale ecological and productive restoration; and promotion of a forest-based bioeconomy that values standing forests and biodiversity as economic assets.

5. Directing Financing to Key Sectors and Critical Needs[36]

- Direct resources to the most vulnerable sectors, ensuring that each resource invested generates multiple benefits: emissions reduction, increased resilience, food security, and climate justice. Resource mobilization will only be effective if guided by **prioritization**. CMA.6 (Baku, 2024) recommends that climate finance be aligned with national plans for just transition, food security, and adaptation. This convergence is essential to transform COP30 into a framework for effective implementation, consolidating agriculture, the bioeconomy, and natural systems as structural drivers of the new global climate economy.

6. Integration of food and energy security agendas[37]

- Strengthen the role of tropical agriculture as the basis of food and energy security for the world, especially in times of growing geopolitical and climate crises. This model of agro-energy synergy is now considered critical for the global energy transition, as it demonstrates that it is possible to produce food, generate renewable energy, and reduce emissions simultaneously.
- Recognize that any sustainable global transition depends on efficient, adapted, technologically advanced food systems that are integrated with renewable energy production, consolidating the vision of food and energy security as a structuring axis of the global climate agenda.

7. Coexistence of diverse sustainable production models in specific contexts[38-40]

- Recognize the legitimate and necessary coexistence of different production models, valuing their specific contributions to adaptation, mitigation, food and energy security, and social inclusion—as reaffirmed by the G20 Ministerial Declaration on Agriculture (2024) and the *Sharm el Sheikh Joint Work on Agriculture* guidelines.
- Promote policies that value and meet the needs of different agricultural models and scales in a complementary manner to build resilient and sustainable agricultural systems in accordance with local circumstances, adopting an integrated landscape approach as a relevant connecting element.

8. Bio-revolution in agriculture

- Consolidate the generation and use of biological solutions in agriculture. Brazil is currently the world's largest producer and consumer of biofertilizers, inoculants, and biological pesticides, a direct result of decades of investment in applied research, tropical science, and cooperative innovation. This transformation has direct and measurable climate impacts. Replacing fossil-based nitrogen fertilizers with biological solutions drastically reduces emissions of nitrous oxide (N_2O), a gas with a global warming potential almost 300 times greater than CO_2. The widespread adoption of Biological Nitrogen Fixation (BNF) already covers almost 100% of Brazilian soybeans and is rapidly expanding to corn, cotton, and sugarcane. It is estimated that this replacement prevents the emission of tens of millions of tons of CO_2 equivalent per year, while improving soil health and structure.

SUSTAINABLE TROPICAL AGRICULTURE:

Cultivating solutions for food, energy and climate

By combining productivity, social inclusion, and climate action, tropical agriculture is consolidating itself as a pillar of global stability, ensuring affordable food, renewable energy, and climate resilience. Adapting agriculture to this new context goes beyond resisting extreme events. It means transforming production systems, regenerating territories, and renewing our relationship with nature. This transition depends on the integration of science, local knowledge, and public policy—from soil to landscape and from genetics to biodiversity.

Brazilian agricultural science is at the forefront of this transformation, driving a new rural economy that is innovative, inclusive, and low-carbon. By developing solutions that reduce emissions, strengthen resilience, and ensure food security, Brazil reaffirms, at COP30, its commitment to leading the transition to sustainable tropical agriculture, capable of feeding the world and protecting the planet.

The Brazilian Forum on Tropical Agriculture reinforces this purpose by repositioning tropical agriculture as an essential part of climate solutions in the international political and diplomatic arena. **The Forum reaffirms the centrality of adaptation, advocates for the strengthening of climate finance, and encourages the development of lasting international cooperation mechanisms.**

The recommendations presented in this document guide the **strengthening of international cooperation, the improvement of financing mechanisms, and the consolidation of public policies** that integrate agriculture and food systems into global adaptation and mitigation strategies. Thus, Brazil reaffirms its proactive leadership and demonstrates that **science, innovation, public policies, and international cooperation can guide the development of global solutions with local roots**, capable of repositioning the tropics at the center of the climate agenda.

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