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THE AMBIGUITIES OF AGRIBUSINESS: POTENTIALS AND CHALLENGES FOR BRAZIL

Abstract: Agribusiness is a contentious topic in Brazil, both conceptually and in terms of its functions and externalities across the economy, environment, and society. While this discussion is grounded in facts and data, it is occasionally shaped by varying interest or viewpoints. This essay aims to contribute to the ongoing debate by presenting data and information about Brazilian agribusiness, supporting discussions on its economic and social roles, as well as its inherent ambiguities. To this end, the essay undertakes an exploratory analysis from recent periods, emphasizing both the positive and negative findings from the literature and selected databases. The goal is to encourage discourse on potential pathways for economic, social, and environmental improvement. The broader aim is to foster a well-informed discussion, dispel certain misconceptions about agribusiness, and identify key issues and externalities requiring attention.

Keywords: AGRICULTURE, PUBLIC POLICIES, HETEROGENEITY, SUSTAINABILITY, PRODUCTIVITY

Introduction

The history of agriculture in Brazil reflects large economic, social, and environmental transformations, evolving from rudimentary and subsistence practices to a highly mechanized and competitive agribusiness sector on the international stage. However, this sector is characterized by significant economic, social, and environmental disparities (Silva & Vian, 2021; Silva & Lisbinski, 2023), which pose various challenges to the country.

During the colonial period, Brazilian agriculture was primarily based on the production and export of sugarcane, tobacco, and coffee, established on large farms and slave labor. This phase was marked by intense deforestation and environmental degradation, particularly in the Atlantic Forest, to make way for plantations (Dean, 1996). In the 19th century, Brazil became the world's largest coffee producer, further intensifying deforestation in the Southeast. The expansion of coffee monocultures, driven by international demand, led to soil degradation, erosion, habitat fragmentation, and social problems, exacerbated by the absence of sustainable practices and the continued use of slave labor (Dean, 1996; Schwarcz & Starling, 2018). In the second half of the 20th century, Brazilian agriculture underwent a process of modernization, rooted in the principles of the Green Revolution, introducing technologies such as chemical fertilizers, pesticides, and agricultural mechanization (Goodman, Sorj & Wilkinson, 2008). While these innovations increased productivity, the indiscriminate expansion of agriculture exacerbated soil degradation, water contamination, and biodiversity loss, often neglecting long-term sustainability. Agricultural expansion in the Midwest, particularly in the Cerrado biome (Brazilian Savanna), was driven by government policies promoting the occupation of these lands within a context of national integration, leading to habitat destruction and increased greenhouse gas emissions (Jepson, 2005).

Building on this process, by the late 20th and early 21st centuries, Brazil had become one of the world's largest producers and exporters of agricultural commodities such as soybeans, corn, beef, and sugar (Hosono, Rocha & Hongo, 2016). However, this agribusiness expansion increased pressure on ecosystems, particularly in the Amazon rainforest and Cerrado, where deforestation driven by livestock and soybean production has become a major global environmental concern (Fearnside, 2005).

Agribusiness is a widely discussed topic in Brazil, both for its analytical breadth, which examines the interrelationships between agriculture and downstream and upstream sectors, as well as for its capacity to represent specific social groups. In Brazil, the term is extensively used in academic and market debates within research institutions, universities, companies, and government bodies that develop scientific research and public policies related to agriculture.

The concept of agribusiness encompasses not only agriculture as an economic activity but also the activities that supply inputs, the industries that process agricultural products, and the support services such as storage, transportation, distribution, and financial intermediation. Therefore, it represents a value chain that integrates various sectors, covering the production and commercialization of both raw and processed agricultural goods. The scope of agribusiness activities, when measured in terms of value added, employment creation, and political influence, surpasses the representativeness of agriculture in its strict sense. The main advantage of using this analytical term is its ability to provide a more comprehensive view of economic relations between agriculture and other related sectors.

However, the term agribusiness is often used in Brazil from a political standpoint, in the relationships between its agents (producers, input suppliers, processors, and distributors) and the state, aiming to defend specific economic and political interests before the population and its representatives. Although the analytical concept of agribusiness is broad and does not discriminate between large or small producers, suppliers of fresh food or commodities, family farmers or large-scale producers, political representation is unequal (Pompeia, 2020).

The diversity of production methods and ways of life in rural Brazil fuels this debate, contrasting the perspective of agribusiness as an analytical category with that of a political association around the concept. From these perspectives, academia, rural producers, politicians, and other agents position themselves and defend their interests concerning the formulation of public policies related to the topic.

This debate requires considering the different realities of farmers and their productive activities, reflecting conceptions present in other contexts (such as in Europe), which encompass small-scale production, inclusive policies, sustainability, and the multifunctionality of farms (Bonnal, Cazela & Maluf, 2008; Schneider & Cassol, 2014). This includes understanding the diversity of productive realities and living conditions of the rural population (Santos & Silva, 2022), considering: i) rapid urbanization – the portion of the population living in rural areas decreased from 80% in 1970 to 10% in 2017 (IBGE, 2019); ii) the significance of the rural population - 10% of the economically active population is involved in agriculture, compared to 3% in OECD countries; iii) the concentration of means of production; iv) public policies focused on non-inclusive agricultural credit; v) regional imbalances and disparities between types of producers (family farms and large-scale producers).

Understanding agribusiness in Brazil requires considering three structural aspects: i) representations and forums for debate, including producer entities, social movements, and the National Congress; ii) the structure of public policies related to activities, diversity, production, and commercialization of goods; and iii) the outcomes of agribusiness, its contributions, and limitations for the national economy in productive, social, and environmental aspects. Analyzing these three points allows for a better understanding of the reality of agribusiness in Brazil, its potentials, and challenges. This work aims to discuss the term agribusiness and its developments, focusing on the analytical concept to explore its main characteristics and ambiguities,

which permeate both the analytical and political aspects within the Brazilian context.

The paper is divided into four additional sections. Section 2 reviews the literature on the analytical concept of agribusiness, its relevance for research and Brazil's economic position, while also discussing the appropriation of the concept by political and organized groups within agribusiness. Section 3 addresses the structure of public policies for different producer profiles. Section 4 analyzes the recent evolution of agribusiness in Brazil, discussing economic, social, and environmental aspects. Section 5 offers final considerations.

Agribusiness: economic measurement and political representation

This section focuses on the first of the three points highlighted earlier: the representations, agendas, and forums of debate that influence decision-making in agribusiness, distinguishing between the analytical concept and the political conception of the term. This section is based on a literature review on the topic, differentiating the technical aspects and outcomes of the agribusiness concept from its political representativeness.

The term agribusiness was coined in the United States in the 1950s by Davis and Goldberg to rationalize and measure the increasing connections between the food industry and agriculture (Pompeia, 2020). The concept encompasses all sectors related to rural activities, integrating upstream and downstream segments of agriculture and their interrelationships. Davis and Goldberg (1957, p. 136) define agribusiness as "The sum of all operations involved in the manufacture and distribution of farm supplies, production operations on the farm, and the storage, processing, and distribution of farm commodities". Based on Wassily Leontief's Input-Output Matrix studies, Davis, and Goldberg (1957) quantified these relationships, proposing methods to measure this system.

Analytically, this approach is broader than viewing agriculture as an independent sector, highlighting the interconnections between the segments of the productive system (Zylbersztajn, 2017). Moreover, it does not distinguish between small or large, family, or corporate, encompassing all profiles of producers, suppliers, manufacturers, and distributors involved. This presumes an economic connection between the various agents in agribusiness, disregarding political and distributive conflicts among them (Pompeia, 2020). However, Davis and Goldberg recognized that individually, farmers had little power in an economy dominated by agribusiness (Hamilton, 2016).

In Brazil, the term agribusiness ("agronegócio") gained prominence with the work of Araújo, Wedekin, and Pinazza (1990), bringing the concept into the academic and market context and proposing an integrated view of agriculture (Pompeia, 2020). Since then, macroeconomic statistics on agribusiness have been researched and analyzed by institutions as the Center for Advanced Studies in Applied Economics

at the University of São Paulo (CEPEA - ESALQ/USP), which publishes data on the GDP and employment in agribusiness.

Numerous studies measure these macroeconomic aggregates for Brazil and its regions[1]. These analyses underscore the significance of agri-food and energy functions, including their environmental impacts, employment, income generation, international currency, and inflation control. Furthermore, encompasses discussions on family succession, production and management technologies, and the heterogeneity of agriculture (Silva & Vian, 2021; Santos & Silva, 2022). Thus, the analytical use of the agribusiness concept defines the interconnections between sectors linked to agriculture without politically representing a specific group.

Brazilian rural areas are characterized by various distinct realities, some more aligned with subsistence farming and others more connected to the principles of the Green Revolution (high-scale production, capital/technology intensity, high productivity, and market integration). Public policy arenas reflect these different realities, their representations, alliances, and converging or diverging forces. Therefore, while it is recognized that the agendas, research, and policies focused on agribusiness are concentrated on aspects like technology, productive efficiency, economies of scale, and capital intensity, the concept itself does not prevent analyses, studies, and debates on the contradictions of agribusiness.

On the other hand, the use of the term "agribusiness" as a form of political legitimacy and representation often allows specific groups, though involved in agribusiness, to appropriate the term to promote their economic interests, for example, through media campaigns, aiming to influence public opinion and, especially, the state in the formulation and approval of public policies that benefit them.

In this context, Pompeia (2020) highlights that entities linked to workers, such as the National Confederation of Rural Workers and Family Farmers (CONTAG) and the Movement of Small Farmers (MPA), are not part of the nucleation of recognized entities in the context of agribusiness, such as the Brazilian Agribusiness Association (ABAG), the Brazilian Confederation of Agriculture and Livestock (CNA), the Institute for Agro Thinking (IPA), and the Parliamentary Front of Agriculture (FPA), due to their divergent interests, even though family farms represents 76.8% of the farms.

Similarly, the differing interests between small agriculture family in Brazil and corporate farmers reflect the contradiction in political representation, with frequent conflicts between these classes, despite both being part of the analytical concept of agribusiness. An example of this divergence is the existence of two ministries related to agriculture in Brazil: the Ministry of Agriculture and Livestock (MAPA), representing corporate agriculture, and the Ministry of Agrarian Development and Family Agriculture (MDA), focused on the demands of family farming. Given the divergent interests between producer groups, the MDA seeks to balance the

1 See Sesso Filho et al. (2022); Luz & Fochezatto (2023); Barros & Castro (2017); Sesso et al. (2023); Guilhoto et al. (2007); Nascimento, Figueiredo & Miranda (2018); Araújo Neto & Costa (2005); Cruz, Teixeira & Gomes (2009); Montoya & Finamore (2001)

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insufficient political representation of small family farmers in Federal Government institutions and in Parliament[2].

Two key conclusions emerge from this discussion. First, agriculture has relations of varying intensity with other sectors of the economy, legitimizing the importance of the analytical concept of agribusiness to measure this productive system. Second, although the analytical concept establishes a vision that aggregates upstream and downstream activities of agriculture, the actors involved in agribusiness are not represented in a balanced way before the state and public opinion.

Structure of agricultural policies

This section focuses on the second of the three key points mentioned earlier: the description of the structure, function, and focus of current public policies in agribusiness. This discussion covers the last 20 years, addressing: i) the structure and types of initiatives based on implemented laws; ii) the identification of the central aspects that these initiatives aim to modify or improve, as well as the key divergences in the debate.

Beyond local specificities, directives from the FAO and the European Union have shaped agricultural and rural policies in Brazil (Santos and Sant'Anna, 2022). These policies, in addition to addressing the traditional economic functions of agriculture, have incorporated issues such as environmental conservation, regional development, and rural development (Santos and Sant'Anna, 2022; Lowe, Buller, and Ward, 2002; OECD, 2020; Glauber and Effland, 2016). Governments thus aim to meet the demands of all segments in the productive chain while also addressing agrarian, environmental, innovation, and social issues.

Despite the numerous public policies aimed at providing structural support for agricultural establishments, the budgetary and credit resources controlled by the government represent approximately one third of the total required for funding and investment in annual agricultural production. Additionally, the budgetary resources allocated to small-scale agriculture are more limited compared to those for large-scale activities. The diversity of agricultural activities, the multifunctionality, and the farm pluriactivity require multiple programs that make up agricultural policy, which is the responsibility of the Federal Government, with complementary actions from the states. However, for decades, the Federal Government expenditures have been concentrated in: i) credit and insurance; ii) administrative expenses; iii) stock formation, minimum price policies, and commercialization; iv) agricultural defense. Table 1 presents the main budgetary actions, excluding those of an administrative nature.

2 For more details on these political conflicts, see Pompeia (2020).

Table 1. Federal Government disbursements for key agricultural policy actions in Brazil

Year	BUDGETARY ACTION	Amount (R$ MM)
2000	Interest equalization for extension of debts originating from rural credit	7,508
	Federal public debt issuance of agrarian debt bonds	2,592
	Financing and price equalization for Federal Government purchases and formation of regulatory and strategic stocks	2,483
	Formation of public stocks	2,061
	Financing and interest equalization for family agriculture - Pronaf	1,667
	Loan amortization for public stock formation	1,1
	Financing for voluntary stock retention	1,088
	Financing for coffee crop maintenance	687
	Construction of common use irrigation infrastructure	442
2010	Financing for coffee production and sales investment	2,664
	Formation of public stocks	2,625
	Financing of productive sector projects under the Northeast Development Fund (FDNE)	2,454
	Price guarantee and support in the commercialization of agricultural products	2,368
	Interest equalization in agricultural costing operations	733
	Interest equalization for family agriculture - Pronaf	544
	Financing of productive sector projects under the Amazon Development Fund (FDA)	393
	Support for agricultural sector development projects	385
	Contribution to the Garantia-Safra Fund (FGS)	366
2020	Support for school feeding in basic education	4,316
	Financing for agribusiness in the coffee sector	3,669
	Economic subsidy for operations under the national program for strengthening family agriculture – Pronaf	2,275
	Compensation and restitution under the agricultural activity guarantee program - Proagro	1,941
	Economic subsidy for rural insurance premium	881
	Support for the agricultural sector	861
	Contribution to the Garantia-Safra Fund (FGS)	468
	Economic subsidy for operations resulting from the extension of debts originating from rural credit	457
	Economic subsidy for rural and agro-industrial investment operations	431

Source: Adapted from Santos and Sant'Anna (2022), using data from the Integrated System of Planning and Budgeting of the Federal Government (SIOP).

****Values deflated to December 31, 2020, by the National Consumer Price Index (INPC).***

In 2000, most of the resources allocated by the Federal Government to agriculture were directed towards production support: interest rate equalization for rural credit, issuance of agrarian debt securities (with the funds intended for agrarian reform), and price policies for Federal Government acquisitions and stockpiling. In 2010, credit continued to be the main expenditure, with the National Program for Strengthening Family Agriculture (Pronaf) gaining prominence. In 2020, in addition to credit, expenditures expanded to include the National School Feeding Program (PNAE) and agricultural insurance, such as Proagro. The top 10 actions in 2000, 2010, and 2020 were directed towards agricultural production, representing 82%, 75%, and 65% of the total disbursement, respectively.

This concentration of resources limits the ability of policies to alter the structural conditions and heterogeneity present in Brazilian agriculture, limiting policies aimed at access to land, water, and technical support services, and reproducing the concentration of production factors in a small portion of agricultural establishments. Table 2 presents the allocated amounts for selected years, identifying the main policies and programs, grouped into structural and support categories for agriculture. The oscillations on the Structural support for rural life/productive organization and low values in essential policies such as Support for other activities/environmental care are evident.

Table 2. Allocated values for agricultural policies in Brazil in 2000, 2010, and 2020

Description / Total	R$ MM*		
	2000	2010	2020
Structural management, agricultural defense, other supports, and operational costs	286 .6	2,026 .7	359 .7
Structural support for goods supply/consumption, food, and nutrition security (SAN)	7,075 .4	5,297 .3	4,658 .7
Structural support for rural life/ productive organization	1,375 .5	1,030 .4	255 .0
Support for other activities/ environmental care	43 .8	20 .4	1 .5
Production support	14,981 .5	8,958 .0	13,158 .1
Support and promotion of R&D and technologies	272 .7	445 .5	265 .4
Total	24,035 .4	17,778 .3	18,698 .3

Source: Santos and Sant'Anna (2022), using data from IBGE (2019) and the Integrated System of Planning and Budgeting of the Federal Government (SIOP).

****Values deflated to December 31, 2020, by the National Consumer Price Index (INPC).***

Dualism of Brazilian agribusiness

This section focuses on the third of the three points highlighted in the introduction: the outcomes of agribusiness, its contributions, and limitations to the national economy in terms of productive, social, and environmental aspects. Data were gathered on income generation, employment, number of agricultural establishments, planted area, production value, and the concentration of both production and land ownership.

Social and economic issues

Several studies employ the concept of agribusiness as defined by Davis and Goldberg (1957) to quantify its economic value and employment generation. The CEPEA has been publishing historical series of the Brazilian agribusiness GDP since 1996, disaggregated into four segments: inputs, agriculture, industry, and services.

Agribusiness is one of the main driving forces of the Brazilian economy, significantly contributing to GDP, employment generation, and trade surplus. In 2023, agribusiness accounted for 23.8% of Brazil's GDP, equivalent to R$ 2.58 trillion, with the services segment contributing the most (43.4%), followed by agricultural activity (27.6%), agroindustry (23.4%), and inputs (5.6%) (CEPEA, 2024). Activities related to vegetable production have historically contributed about 70% of the agribusiness GDP, generating R$ 1.86 trillion, while livestock-related activities contributed around 30%. According to Sesso Filho et al. (2022), Brazil had the fifth largest agribusiness GDP globally.

A huge portion of production value is concentrated in commodities such as soybeans, corn, sugarcane, and beef, making Brazil one of the world's largest exporters (FAO, 2021). Brazil led global exports of soybeans, coffee, beef, and poultry, and was the third-largest exporter of corn in 2023. In that year, agribusiness exports totaled US$ 166.55 billion, representing 49% of Brazil's total exports (Ministry of Agriculture and Livestock, 2024). Soybeans accounted for 23% of total Brazilian exports, with sugar and beef contributing 4.8% and 3.3%, respectively (MDIC, 2024). Soybeans, corn, sugarcane, and coffee led Brazil's agricultural production value, representing 42%, 17%, 11%, and 6% of the total in 2022 (PAM IBGE, 2024).

Agricultural commodity exports strengthen Brazil's trade balance and contribute significantly to its GDP. According to the FAO (2021), Brazil is one of the world's largest food exporters, consolidating its importance in global supply chains and enhancing its trade and diplomacy. Participation in the international market also drives technological development and innovation in Brazilian agribusiness. Global competition pushes producers to adopt more efficient and sustainable practices, increasing productivity and product quality while attracting foreign investments for economic growth (Leite, 2018).

The sector's competitiveness is fueled by the availability of arable land, favorable climate, and advanced technology. Although exports are concentrated in a few products, trade surplus contributes to exchange rate stability, benefiting the overall economy. Additionally, high productivity and low prices in agriculture reduce the cost of raw materials for other sectors, lowering food prices and helping to control inflation.

In terms of employment, agribusiness accounted for about 26% of total employment in Brazil in 2023, employing approximately 28 million people, with 47% engaged in agricultural activities (28% in commercial production and 19% in subsistence production) and 37% in the service sector, which includes commercialization, financial intermediation, transportation, and storage (Cepea, 2024).

Despite agribusiness's contributions to income generation, employment, and foreign exchange, significant inequalities persist in rural areas. Land concentration is a striking example: in 2017, 32.8% of agricultural land (114.5 million hectares) was controlled by just 0.3% of establishments (16,865 farms), while 90.7% of establishments occupied only 20.4% of the total agricultural area (IBGE, 2019). This concentration leads to land conflicts, particularly affecting small farmers and Indigenous communities, exacerbating social inequality, and hindering sustainable development (Souza Ferreira Filho, 2013; Pacheco and Carvalho, 2019). Land concentration and dependence on commodities also expose the country to international price volatility (Graziano da Silva, 2010; Pompeia, 2022).

Of the seventy-two products tracked by the IBGE's Municipal Agricultural Survey, the shares of soybeans (45%), corn (23%), and sugarcane (11%) together accounted for 79% of the crop land 2022. In terms of production value, soybeans accounted for 42% of the total in 2022. Both soybeans and sugarcane are concentrated in the South-Central region, indicating that the direct economic benefits of agribusiness are unevenly distributed across the country, posing a challenge to be addressed.

The expansion of monocultures can compromise long-term economic and environmental sustainability, leading to soil and water contamination, biodiversity loss, and depletion of water resources (Strand et al., 2018; Galford, Soares-Filho, and Cerri, 2013). The lack of crop rotation depletes soil nutrients, increasing the risk of erosion and reducing agricultural productivity (Lal, 2015; Pimentel, 2006), while the loss of genetic diversity makes crops more vulnerable to pests and diseases (Tscharntke et al., 2012; Tilman et al., 2002; Altieri & Nicholls, 2020) and harms local fauna that rely on diverse plant species for food and habitat (Perfecto and Vandermeer, 2010).

Access to technology is also unequal. While mechanization has increased agribusiness competitiveness (Daum, 2023; Bustos, Caprettini, and Ponticelli, 2016), small farmers and traditional communities often lack access to technology, credit, and technical assistance, exacerbating social inequality and hindering their market competitiveness (Carter, 2015).

Despite the economic benefits, agribusiness growth exposes Brazil to significant infrastructure challenges. Poor transportation, storage, and logistics result in substantial losses and increased costs. Poor road conditions and lack of investment in infrastructure delay the flow of goods, affecting producers' ability to meet international demand efficiently, and causing product deterioration, which reduces the quality and value of exports (Araújo et al., 2024). According to the FAO (2019), up to 20% of agricultural production is wasted due to logistical deficiencies, such as poor roads, port congestion, and inadequate rail infrastructure (Pontes, Carmo & Porto, 2009; Soliani, 2015; 2022). Improving logistics infrastructure is essential to mitigate losses, reduce costs, and increase the competitiveness of Brazilian agribusiness, particularly for the small farmers. These challenges can be addressed through public-private policies that encourage infrastructure investment and promote public-private partnerships (Soliani, 2015; 2022).

These data reflect the diversity and duality of Brazilian agribusiness, which presents economic, social, and environmental contrasts. On the one hand, a significant part of the modern agriculture has become more efficient and sustainable, adopting practices such as no-till farming, crop rotation, and biotechnology to reduce agrochemical use (MAPA, 2021). Agribusiness also generates millions of jobs, drives rural development, and supports small local businesses (Schneider, 2010). On the other hand, the conversion of forests into agricultural lands increases deforestation, especially in the Amazon rainforest and Cerrado, leading to biodiversity loss and increased greenhouse gas emissions (Brando et al., 2020). Small producers face precarious conditions, low wages, and lack of access to resources, technology, technical support, and financing for efficient production (Carter, 2015), reproducing the cycle of poverty and inequality in rural areas (Carter, 2015; Lin, 2011; Kiani et al., 2021).

This dualism underscores the need for public policies that promote a more equitable distribution of agribusiness's economic benefits by providing small farmers with greater access to credit, technology, technical assistance, and training, as well as reducing land concentration and improving logistics infrastructure (Pacheco, 2009). It is also necessary to balance production for export with domestic food supply, promoting sustainable food security (Marengo et al., 2022). Diversifying agricultural production and encouraging sustainable practices are ways to increase economic resilience and ensure a stable and diversified food supply for the population (Birthal and Hazrana, 2019; Chonabayashi, Jithitikulchai, and Qu, 2020).

Graeub et al. (2016) and Aquino, Alves, and Vidal (2021) highlight the importance of income supplementation for rural families, particularly for smallholder agriculture, which faces difficulties integrating into the market. Structural and support policies for farms have not been effective in distributing resources, leading to difficulties in accessing markets, credit, insurance, and extension services, as well as poor land and water distribution (Santos and Sant'Anna, 2022; Grisa et al., 2014; Schneider and Cassol, 2014; Belik, 2021).

Environmental issues

Brazil's agribusiness is a crucial sector for the economy, with a grain harvest estimated at 300 million tons over 80 million hectares of planted area (CONAB, 2023; Cepea, 2024; Brasil, 2024). However, agribusiness also has negative environmental impacts due to the diversity of techniques and production practices employed. In recent years, Brazil has adopted more sustainable agricultural practices, aiming to reconcile high productivity with environmental preservation. Among these practices are conservation agriculture, no-till farming, crop rotation, and integrated crop-livestock-forestry (ICLF) systems.

Conservation agriculture, which includes no-till farming, crop rotation, and permanent soil cover, aims to conserve natural resources, improve input use efficiency, and increase the resilience of production systems. These practices have been shown to improve soil health, increase organic matter, and reduce erosion (Embrapa, 2022).

No-till farming, which involves seeding without prior plowing, is widely used in Brazil, covering approximately 32 million hectares. This technique preserves soil structure, increases organic matter, and reduces erosion, while also improving water infiltration and reducing soil compaction (Derpsch et al., 2014).

Crop rotation, which alternates different crops on the same land over time, helps disrupt pest cycles, improve soil fertility, and increase agricultural biodiversity, reducing dependence on chemical inputs and increasing productivity (Franzluebbers, 2007). Brazil's agricultural sector has also invested in technologies to reduce greenhouse gas emissions, promoting practices like recovering degraded pastures and integrated crop-livestock-forestry systems (ICLF). The ICLF system, used on approximately 15 million hectares, has shown promising results in recovering degraded areas and sustainably increasing productivity (Balbino et al., 2011).

Despite these advances, Brazil's agribusiness faces significant environmental challenges, particularly deforestation in the Amazon rainforest and Cerrado, driven by agricultural expansion. Pendrill at al., 2019 pointed more than 8 million hectares of forest were converted to agricultural land annually between 2011 and 2015, with 90% to 99% of this deforestation related to agriculture, though only 45% to 65% resulted in effective agricultural production expansion (Pendrill et al., 2019). From 2008 to 2023, the Amazon rainforest lost 123,982 km² of forest, with the highest deforestation peak occurring in 2022, totaling 12,479 km² (INPE, 2024). The state of Pará leads in deforestation with 42.26% of the total deforested area, followed by Mato Grosso (19.07%), Amazonas (13.52%), Rondônia (13.15%), and Acre (5.50%). Outside the Amazon rainforest, deforestation totaled 8,555 km², with a peak of 729 km² in 2022. Mato Grosso, Roraima, Pará, Rondônia, and Amazonas were the most affected states. Agricultural expansion, particularly for pasture and soybean cultivation, was the main cause of this deforestation.

Mato Grosso is the leading Brazilian state in grain production, but it is also among the states with the highest deforestation rates in 2023. This exemplifies the pressure that agriculture exerts on forested areas, highlighting the need for stricter environmental monitoring. The conversion of forests into agricultural areas in Brazil is driven by land demand, lack of enforcement, land grabbing, illegal deforestation, and flexible government policies. The lack of effective monitoring and impunity in protected areas and Indigenous lands exacerbate the situation, allowing illegal activities to expand (CNJ, 2024).

Fires in the Amazon rainforest and other biome are also a critical issue. Between August 2019 and May 2024, 474,012 fire outbreaks were recorded in the Amazon, with Pará state leading (36.54%), followed by Mato Grosso (17.58%), Amazonas (17.50%), Rondônia (10.83%), and Acre (9.04%). In the Cerrado, there were 290,201 fire outbreaks during the same period, concentrated in Maranhão (23.63%), Tocantins (18.32%), and Mato Grosso (15.09%) (INPE, 2024). In the same way, Pantanal biome was devasted in 2022 and 2024. These data highlight the severity of the fires and the urgent need for effective prevention and control policies to mitigate their impacts (Fearnside, 2005).

Intensive monoculture and cattle pastures in Brazilian agribusiness also significantly contribute to soil degradation. According to the FAO, 30% of the world's agricultural lands face some degree of soil degradation (UN, 2021), compromising long-term agricultural production and increasing dependence on fertilizers and other chemical inputs (Pimentel, 2006).

Additionally, the extensive use of agrochemicals in Brazil is a serious environmental problem. As one of the world's largest consumers of agrochemicals, the country faces soil and water contamination and biodiversity loss. Some studies show that 50% of drinking water samples collected in selected agricultural areas contained pesticide residues (Gil et al., 2012; Moreira et al., 2012; Vieira et al., 2017), requiring continuous studies, comprehensive monitoring, and strict application of national laws. This contamination may cause severe impacts on human health and fauna, affecting aquatic and terrestrial ecosystems (Van der Werf, 1996).

To promote more sustainable agribusiness in Brazil, it is crucial to intensify environmental law enforcement to combat illegal deforestation and protect ecosystems (Fearnside, 2005). Financial and technical incentives for farmers who adopt sustainable practices can accelerate the transition to low-impact agriculture (Cohn et al., 2014). Additionally, education and training programs on sustainable agricultural practices and agrochemical management are essential to improve field practices (Pretty, 2008). Investing in research and development of modern technologies that increase productivity without harming the environment is vital to ensuring long-term sustainability (Tilman et al., 2002).

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Final considerations

This study discusses the complexity and contradictions of Brazilian agribusiness. On one hand, the sector has played a crucial role in the GDP, employment, food safety, strengthening the country's trade balance, and labor market. This success is supported by the availability of arable land, favorable climatic conditions, and the use of advanced technologies, which together position Brazil as one of the world's largest food exporters. However, this economic expansion has been accompanied by significant challenges, particularly in terms of social and environmental inequalities, such as land concentration and natural resource degradation.

Although the country has adopted more sustainable agricultural practices and public policies to mitigate these impacts, deforestation, - an indirect step that has made new lands viable for agribusiness -, especially in the Amazon and Cerrado biomes, remains a severe problem, exacerbated by weak enforcement and flexible government policies. This situation threatens not only the environment but also the long-term sustainability of the agricultural sector itself, which is formed by a significant portion of small and large producers that are efficient and do not need to deforest.

The future of Brazilian agribusiness depends on a balanced approach that harmonizes economic growth with environmental sustainability and social justice. More effective public policies are needed to promote a more equitable distribution of economic benefits, support small farmers, and reduce land concentration. Additionally, investments in infrastructure and sustainable agricultural practices are essential to ensure that Brazil continues to be a global leader in the agricultural sector without compromising its natural resources and the welfare state of its rural population.

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НЕЈАСНОСТИ АГРОБИЗНИСА: ПОТЕНЦИЈАЛИ И ИЗАЗОВИ ЗА БРАЗИЛ

Апстракт: Агробизнис је спорна тема у Бразилу, и концептуално и у смислу његових функција и екстерних ефеката у економији, животној средини и друштву. Иако је ова дискусија заснована на чињеницама и подацима, повремено је обликована различитим интересовањима или гледиштима. Овај есеј има за циљ да допринесе текућој дебати презентовањем података и информација о бразилском агробизнису, подржавајући дискусије о његовој економској и друштвеној улози, као и његовим нејасноћама. У том циљу, есеј обухвата истраживачку анализу из новијих периода, наглашавајући како позитивне тако и негативне налазе из литературе и одабраних база података. Циљ је да се подстакне дискурс о потенцијалним путевима за економско, и социјално побољшање животне средине. Шири циљ је да се подстакне дискусија са добрим информацијама, да се разбију одређене погрешне представе о агробизнису и да се идентификују кључна питања и екстерналије које захтевају пажњу.

Кључне речи: ПОЉОПРИВРЕДА, ЈАВНЕ ПОЛИТИКЕ, ХЕТЕРОГЕНИЧНОСТ, ОДРЖИВОСТ, ПРОДУКТИВНОСТ