



Progress towards a more sustainable and equitable food system in Brazil?

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Introduction: Brazil's agri-food sector, traditionally being a low productivity sector, has evolved towards significant investment in technology-driven large-scale agribusiness, making Brazil a major food exporter. An increase in intensive large-scale agriculture production, while benefiting Brazil's economy and export revenues, has also resulted in significant social and environmental externalities. With the aim to improve food security and more equitable access to food, Brazil's federal government has intervened with a range of policies and initiatives to eliminate hunger and incentivize more sustainable practices for improved environmental outcomes. **Objective:** The paper provides an overview of the agri-food policy landscape, and policy innovations since the early 2000s intending to drive a transition towards a more sustainable and equitable agri-food system. **Results and Discussion:** It also highlights the challenges in implementing policies and programmes in the context of Brazil's agrarian structures, vested interests and political conflicts surrounding the allocation of public assets. Successful implementation will require further innovation, collaboration and inclusive partnerships to foster food system transformation pathways towards the achievement of the Sustainable Development Goals.

Keywords: Food and nutrition security, Food system, Agro-ecology, Public policy, Brazil.

Transição para um sistema alimentar mais sustentável no Brasil?

Introdução: O setor agroalimentar do Brasil evoluiu de um campo predominantemente agrícola tradicional e de baixa produtividade para um investimento significativo no agronegócio de grande escala impulsionado pela tecnologia, tornando o país um grande exportador global de alimentos. Os resultados de uma agricultura mais intensiva em grande escala resultaram em externalidades sociais e ecológicas significativas. Com o objetivo de melhorar a segurança alimentar, bem como os resultados sociais e ambientais do setor agro-alimentar, o governo interveio, implementando uma série de políticas e iniciativas para regular o referido setor e incentivar práticas mais sustentáveis. **Objetivo:** O presente trabalho fornece uma visão geral do panorama da política agroalimentar e das inovações políticas desde o início da década de 2000, as quais foram formuladas para impulsionar uma transição para um sistema alimentar mais sustentável e equitativo. **Resultados e Discussão:** Os resultados mostram políticas inovadoras visando melhorias na saúde e meio ambiente, mas conflitos políticos que envolvem a alocação de ativos públicos e mudanças nas políticas progressistas relacionadas aos direitos ambientais e sociais foram também identificados. O documento também destaca os desafios na implementação de políticas e programas para

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promover uma produção alimentar mais equitativa, sustentável e saudável no contexto das estruturas agrárias do Brasil e das diversas partes interessadas. A implementação bem-sucedida exigirá mais inovação, colaboração e parcerias inclusivas para promover caminhos de transformação do sistema alimentar rumo à realização da Agenda 2030 para o Desenvolvimento Sustentável.

Palavras-chave: Segurança alimentar nutricional, Sistema alimentar, Transição sustentável, Políticas públicas, Brasil.

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INTRODUCTION

Globally, the agri-food sector is facing multifaceted challenges. It depends heavily on natural resources, particularly land, biodiversity, fresh water, nitrogen and phosphorus – all becoming scarce or depleted^{1,2}. Yet it has resulted in major environmental degradation worldwide, including widespread land contamination and soil depletion, biodiversity loss, the degradation of forest and fishery resources and a significant share of greenhouse gas emissions. Additionally, there is growing evidence that industrial food systems are directly correlated with rising global health challenges such as the pandemic of obesity and overweight and diet-related non-communicable diseases (NCDs)^{2,3,4}.

The importance of transforming food systems to achieve the Sustainable Development Goals is now well accepted, with momentum building in the international, state and local spheres of influence towards creating more ecologically sustainable and equitable food systems to meet human needs and planetary goals⁵.

A sustainable food system is understood to integrate nutritional, health, environmental, economic and social considerations² in order to generate food security and nutrition for all⁶ while protecting the capacity of future generations to feed themselves, and therefore deliver positive environmental outcomes¹.

The adoption of the United Nations' Agenda 2030 further reinforces the imperative to shift towards sustainable food systems, that deliver

concomitantly food security and positive health, environmental and socio-economic outcomes.

An important mission for dedicated public agencies is to develop coherently, and align, policies in such a way that they can contribute to win-win scenarios for people, the economy and the environment, and create sustainable food systems². Encouraging solely agricultural production for food security or economic development can generate unintentional environmental damage, while environmental policies may have negative impacts on food security and/or the communities that rely on agriculture as a source of income³. Policy coherence and synergies are crucial to ensure food security for present and future generations, and to achieve all the other SDGs.

Brazil is an emerging economy that belongs to the BRICS with continental dimensions (27 sub-national and 8,514,876 km²), more than 210 million inhabitants⁷, contrasting climates and population distribution and varied economic and social development. Brazil is one of the most inequitable nations in the world, with great disparities of wealth and unequal agrarian structure. In 2017, a census showed that inequalities in access to land persist, and land ownership concentration has increased⁸. Most holdings are significantly large and held by a small minority – the landowning elite. Roughly 1% of landowners control almost 50% of the land in rural Brazil, while half of all rural landowners have holdings that are less than 10 hectares. These gigantic land estates, known as *latifúndios*, have their roots in the Portuguese occupation in the 16th century, and are also associated with monocultures for export⁸.

Through the modernization of its agricultural system in the 20th Century, and government support, Brazil has become one of the leading producer and exporter of sugar, coffee, beef, tobacco, soybean and sugar cane⁹. This has come with ecological and social costs, including the deforestation of vast areas of high ecological value, and the displacements of local agricultural communities. In contrast, family farms (mainly small-scale) that supply the domestic market have received less government support¹⁰. The model resulted in economic growth from commodities exports, with however major negative impacts on natural resources and in terms of people's access to productive land resources and food¹¹.

From the 2000s, in order to address these structural issues, the Brazilian government rolled out a set of initiatives and programs to address food security issues while also encouraging agro-ecological farming and organic food production¹².

In 2014, Brazil was for the first time removed from the United Nations Food and Agriculture Organization's (FAO) Hunger Map, with significantly reduced hunger and food insecurity. This achievement was mainly the result of decisive food security policies, that sought to improve access to nutritious food for all and support small-scale family farms.

The paper presents a general account of Brazil's initiatives aimed at enhancing food and nutrition security and making the agri-food sector more sustainable from an environmental perspective.

Brazil's food security and agri-food policy innovations

In Brazil, the change from a traditional and low productivity agricultural sector to a global powerhouse in agricultural commodities and trade

was possible due to different factors. Paula and Delgado¹³ mention that agribusiness became crucial for the economy and the leading economic sector in foreign trade relations since the early 1990s, when the Brazilian government pursued monetary stabilization and adopted neoliberal policies with a deeper integration into the world economy. Paulino¹⁴ claims that increased productivity of the agricultural sector is related to privileges wrested from the state, such as access to arable land and financial resources, both placed at the disposal of powerful landlords. Government incentives and support to agricultural research and development also contributed to this process. Additionally, macroeconomic stability, favorable international prices, and investments in agricultural technologies set a new era for Brazilian agribusiness¹⁵.

However, what has been hailed as the "modern agricultural model" has caused significant environmental, social and health impacts and affected food security for the people of Brazil¹⁶. Agricultural modernization led farmers to specialize in the production of some commodity crops for exports and intensively use pesticides and other chemical inputs, which has exposed farming communities to economic, social and health hazards. The use of chemical pesticides, fertilizers and herbicides is high on large farms in Brazil¹⁶ and has intensified, as evidenced by an increase in their per hectare use in main crops¹⁷, as well as transgenic seeds¹⁸.

Diversified and agro-ecological systems are often hailed as an alternative model to industrial agriculture⁴. Agro-ecology, as a discipline and practice, is seen to offer an interdisciplinary perspective, and a toolkit to create more sustainable and equitable food systems¹⁸.

Table 1 presents a comparison between industrial agriculture (also-called "agribusiness" model) and agro-ecological systems.

Table 1. Key characteristics of industrial agriculture (agribusiness) and agro-ecology⁴

	Agribusiness: Specialized Industrial Agriculture	Agroecology: Diversified Ecological Approach
Definition	Agribusiness, an industrial agriculture, refers to modes of farming that are analogous to industrial processes in their scale and task segregation, and seek to derive productivity gains from specialization and intensification of production.	Agro-ecology is the science of applying ecological concepts and principles to the design and management of sustainable food systems. It encompasses various approaches to maximize biodiversity and stimulate interactions between different plants and species, as part of holistic strategies to build long-term fertility, healthy agro-ecosystems and secure livelihoods.
Diversification	Crop monocultures (or production of a handful of select crops) at the level of farms or landscapes; Concentrated Animal Feeding Operations (CAFOs) and specialization, which refers to a socio-economic paradigm whereby producers specialize in the production of a single item (or few items) that they are most efficient at producing, or of a single stage of that item's production.	Temporal diversification (e.g. crop rotation) and spatial diversification (e.g. intercropping; mixed farming); diversification employed at various levels, including plot, farm and landscape. Diversification refers to maintaining multiple sources of production, and varying what is produced across farming landscapes and over time.
Variety	Use of genetically uniform varieties or breeds selected mainly for high productivity, wide adaptability to favorable environments, and ability to respond to chemical inputs.	Use of wide range of species and less uniform, locally-adapted varieties/breeds, based on multiple uses (including traditional uses), cultural preferences, taste, productivity and other criteria.
Production	Vertical and horizontal segregation of product chains, e.g., animal feed production and animal rearing in separate farms, value chains and regions. Highly mechanized, labour-saving production systems.	Natural synergies emphasized and production types integrated (e.g. Mixed crop-livestock-tree farming systems and landscapes). More labour-intensive systems.
Input	Intensive use of external inputs, e.g. fossil fuel, chemical fertilizer, pesticides and antibiotics.	Low external inputs; recycling of waste within full nutrient cycling and circular economy approaches.
Output	Maximization of yield/economic returns from a single product or limited number of products. Production of large volumes of homogenous products for national and international markets, typically within long value chains.	Maximization of multiple outputs. Production of a wide range of less homogeneous products often destined for short value chains; multiple sources of production, income and livelihood.

Source: Created by authors.

A policy shift from industrial modes of agriculture towards diversified agro-ecological farming will however become noticeable from the early 2000s. The beginning of the re-democratization process in late 1980s contributed to this transition, which marked the beginning of a period of deep social and political change in Brazil, as well as the interaction between civil society and the state at different levels of governance. In this new democratic context, social movements, especially those linked to rural and land issues such as the Movement of the Landless (MST – *Movimento dos Trabalhadores Rurais Sem Terra*, in Portuguese), which was fighting for agrarian reform, gained significant

strength. For the first time, large agribusiness became the target of criticism, with public recognition that poverty and food insecurity were the results of inequalities in terms of access to land and agricultural credit¹⁹. Nevertheless, the sustainable agriculture movement presented little influence in government decisions during the 1980s and 1990s, since large-scale agribusiness was crucial for the economy and the leading economic sector in foreign trade relations¹². The few political gains in this period were partially influenced by the international conferences on sustainable development¹⁰.

In the early 1990s, the Brazilian government started to regulate and incentivize the organic food sector due to pressure from activists and farmers' organizations, as well as businesses attracted by emerging global market opportunities for organic products²⁰.

Since the mid-2000s, greater focus has been placed on policies and programs to eliminate hunger and undernutrition¹⁵ and the adoption of new technologies and sustainable agricultural practices¹⁷. With a new administration in 2003, and the determination of newly-elected President Luiz Inácio Lula da Silva (commonly known as "Lula") to eradicate hunger in Brazil, an increase in initiatives occurred, which was marked by the establishment of dedicated councils and social participation commissions, such as the National Council for Food and Nutrition Security (Consea), the National Council for Sustainable Rural Development (Condraf) and the National Commission for the Sustainable Development of Traditional Peoples and Communities (CNPCT)²¹. These initiatives, that encompassed enhanced participation of agro-ecological organizations in public policies and programs¹³, new types of credit, territorial development approaches, seed and biosecurity policies, represented a major advance. For the first time, agro-ecology was incorporated into public policies¹⁰.

Initiated in 2003, a substantial social welfare program, the Zero Hunger Program (*Fome Zero*, in Portuguese) was designed to reduce hunger and malnutrition and improve food security for all people. Some of the most important components of this program are conditional cash transfers through the Family Fund Program (Programa Bolsa Família), the National School Feeding Program (PNAE), the National Program for Strengthening Family Farming (PRONAF) and the Food Acquisition Program (PAA)²². Through some of these programs, small-scale family farming was also promoted via subsidized agricultural credits, crop insurance, and technical assistance, as a means to raise rural incomes and increase the quantity and quality of food supply¹⁵.

The federal Food Acquisition Program (PAA) was launched in 2003 as tool to promote market access for family farms engaged in ecological

agriculture. The PAA sought to promote a shift towards more sustainable food production practices by providing incentives, such as price premiums and targeted agricultural extension programs for agro-ecological and organic production²³. The PAA encourages crop diversification, the commercialization of niche local food products and the exchange or purchase of traditional seed varieties with the aim to promote sustainability of farming practices that preserve biodiversity and increase farmers' autonomy. The program pays up to 30% more to agro-ecological production in relation to products from conventional agriculture²⁴ and aims to secure a source of income for small-scale farmers, ensure a price floor and increase marketing capacity, while also increasing public food stocks for public nutrition programs²³.

Federal regulations pertaining to organic food production also occurred at the same time due to pressures from importing countries for the organic certification of products, as well as increasing demand from the local market¹². Normative Instruction (IN) 07/99 was the first Brazilian standard in the sector, but the first national law was enacted in 2003 (Law 10831/2003), complemented by Decree 6323/2007 and Decree 7794/2012. Decree 6323/2007 has become the most important norm of organic production in Brazil, due to detailing aspects relating to conceptualization, objectives, productive aspects, certification, marketing, institutional structuring, sanctions and control mechanisms. Besides that, the National Plan for Agroecology and Organic Agriculture (PLANAPO), one of the instruments of National Policy Agroecology and Organic Production, was launched in 2013 by the federal government¹². The actions are related to the sustainable use of water, soil and forest management technologies, innovative practices for primary production and environmental regularization²⁵. Recently, Ordinance 52/2021 updated the technical regulation on organic agriculture methods of production, describing production practices to avoid contamination by different production units and listing the substances that are authorized for organic agriculture.

PRONAF launched in 2005 its Agroecology Program, providing investment in environmentally sustainable agricultural systems and organic production. In 2007, PRONAF's Eco-program

provided finance for the construction of mini biofuel plants, energy generation from renewable sources and conservation, and for the restoration of soils. Non-reimbursable financing is also available from the Amazon Fund. Although it is not directed exclusively towards agriculture, it may finance a broad range of agriculture-related environmental activities, such as the integration of forestry, crop farming and cattle-raising, and the preservation of biodiversity. Established in 2011, the Program for the Promotion of Social-Biodiversity Products and the *Bolsa Verde Program* sought the integration of environmental objectives into programs designed to combat poverty. Sustainable farming practices, for example, related to reducing water pollution and a variety of other environmental issues, are also supported through state-level and municipal projects¹⁷.

In 2006, the Organic Law of Food and Nutritional Security (LOSAN), Law 11346/2006, created the National Food and Nutritional Security System, with the aim, and some allocated resources, to guarantee the human right to adequate food¹⁶. LOSAN integrates the objectives of food and nutrition security – as the right to permanent and adequate access to food in sufficient quantity and quality- and sustainability from an environmental, cultural, economic and social perspective²².

Significantly, in 2009, a special parliamentary commission approved the Constitutional Amendment Proposal (PEC) 047/2003, which was transformed into Constitutional Amendment 64/2010 and includes the right to adequate food amongst constitutionally recognized human rights in Brazil. The same year, the Brazilian Climate Change Law was adopted seeking to recover millions of hectares of degraded land and promote integrated crop-livestock systems, no-till planting, biological nitrogen fixation, and planted forests¹⁵. The ABC Program (an acronym for low-carbon agriculture, in Portuguese) was introduced in 2011 as part of the National Plan on Climate Change and provides low-interest loans for sustainable agricultural practices such as no-till agriculture; restoration of degraded pasture; integration of crops, livestock and forest; planting of commercial forests; biological nitrogen fixation; and treatment of animal wastes. The program's ambitious goals (2020-2030) include rehabilitating 30 million ha of degraded pastures, 10

million ha of integrated crop-livestock-forest, planting 4 million ha commercial trees, and treating 208,4 million cubic meters of animal waste. The target is to reduce greenhouse gas emissions by 1.042, 41 million Mg of carbon dioxide equivalent annually by 2030²⁶. Buller et al.²⁷ argue that Brazil could play a large role in the global food, fibers and energy production through the ABC Program, as well as helping to mitigate GHG global emissions, since integrated farming systems have important environmental advantages when compared to conventional monoculture practices, like soil health and water conservation, livestock well-being and increased agro-biodiversity²⁸.

In 2013, Law 12805 was enacted, establishing the National Integrated Crop-Livestock-Forestry Policy. This initiative aims to sustainably improve productivity, product quality and agricultural income by adopting integrated systems to exploit crops, livestock and forests in deforested areas as an alternative to monoculture cropping; to mitigate deforestation and contribute to the conservation of Permanent Preservation Areas and allocated Legal Reserves; to foster new land use models combining sustainable agribusiness and environmental conservation. The Policy includes different integrated systems: integrated production of grains, grasses and animals; integrated production of grasses, animals and trees; integrated production of grains and trees; and integrated production of trees, grains, grasses and animal²⁸. Pacheco et al.²⁹ findings demonstrated that integrated cropping, livestock, and forestry systems are economically and technically feasible in the Cerrados region, a vast savanna covering almost one quarter of Brazil's land area. The application of this integrated system is strategic for intensifying agriculture sustainably while reducing GHG emissions³⁰ and producing food of high biological value with environmental benefits, including long-term ground cover, carbon fixation and increases in soil organic matter content²⁹.

Additionally, Brazil has developed financial services for both export-oriented agribusiness and smallholder family farming. Nowadays, the country sees a range of commercial banks, cooperative banking networks, leasing companies, dedicated boutique lenders and investors, and development banks providing services to supply chain actors, including inputs financing, long-term investment

finance, equity participation, and trade and commodity finance. The segmentation in Brazilian agriculture is well-reflected in the business models of these financiers through “rural banking” and equipment lease for large-scale farmers and through cooperatives and regional banks for medium and small-scale producers¹⁵. Brazil is in a good position to maximize the efficacy of its existing substantial rural credit resources to ensure that producers are offered the right financial incentives and technical support to progressively adopt sustainable agricultural practices³¹.

Appendix A. Supplementary data presents the legal framework analyzed. The laws and programs are related to food security and sustainable agriculture that has been launched and designed for both the industrial and family farm segments in Brazil.

In summary, the impact of public policies has been critical in enabling the transition towards a more sustainable food system that sought to reduce hunger in Brazil³². However, although decisive public support for the agro-ecological transition and reducing hunger, social programs and income redistribution, large-scale agribusinesses remain politically powerful and influential in policy making circles¹³. Transitioning towards a more sustainable food system presents varied and significant challenges, as discussed in the next section.

Challenges to create a more sustainable food system in Brazil

The challenge is momentous for Brazil to feed its population sustainably and equitably, while preserving its rich biodiversity, and pursuing agricultural commodities export growth³³. Many contradictions at the policy level, polarized between defenders of large-scale agribusiness and defenders of sustainable localized agriculture, were identified in the literature.

Despite the important role of the family farm sector in terms of GDP, rural employment and food production for domestic consumption, the sector receives significantly lower levels of government support when compared to the export-oriented agribusiness sector²³. While family farm organizations have tried to influence the political

decisions, landlords on behalf of large-scale agribusiness, have historically used their power to influence the executive, legislative and judiciary branches to prioritize its interests. Initiatives that have arisen due to social mobilization were mainly discarded during the period of domination of the agro-industrial sector¹⁴. Policy priorities and public investments have mainly focused on encouraging the modernization of agriculture, increasing the production of commodities for export^{10,12}.

Government support to large-scale mechanized agricultural production has resulted in concentration of land ownership¹⁰. According to the National Agricultural Census (2006) 4,3 million of family farms produce 70 percent of the total domestic food consumption on less than 25 per cent of the agricultural land²³, while 80’000 farms that provision export markets concentrate the other 75%²⁴. Paula and Delgado¹³ highlight that, even though economically enfeebled and squeezed by a long lasting process of land ownership concentration, family farmers have been strategic for the stability and diversity of the domestic food market. Vilpoux³⁴ adds that the preservation of family farms also helps to prevent greater disequilibria in the urban environment due to the reduction of rural exodus, which is an important issue in Brazil.

The existence of two ministries involved in agriculture issues confirm inequalities in the agrarian structure of Brazil¹³. On one hand, the Ministry of Agriculture, Livestock and Supply (MAPA), that represents large-scale agribusiness interests, has historically had significant political and economic power¹². It deals with large scale farming¹³ and provides targeted support for the agribusiness sector in the form of low-interest loans, grants and capital investment projects²¹. On the other hand, the Ministry of Agrarian Development (MDA), created in 2000 to lead social actions in rural areas¹², deals with social security, supporting local communities and implementing programs towards small-scale family farming, food production and distribution, preservation of social, economic and cultural diversity, environmental sustainability, among others¹³.

The National Policy for Agroecology and Organic Production (PLANAPO), for example,

establishes the Interministerial Chamber of Agroecology and Organic Production (Ciapo), the National Commission for Agroecology and Organic Production (Cnapo) to manage the Policy. PLANAPO clearly seeks to integrate the various policies and programs carried out by each of the ten ministries participating in its execution²⁵. Interministerial management is a progress in terms of governance, but also a challenge, as it involves various political and sectoral interests (productive, economic, environmental and social) seeking to influence public policies¹².

In terms of organic farming, Wienke¹⁸ presents data from the Ministry of Agriculture, Livestock and Supply (MAPA) related to the National Register of Organic Producers. In January 2014, 6,719 producers were recorded, and with a significant growth over the years, since there was a record of 11,207 registrations in August 2015 and 24,955 in 2023³⁵. According to the 24th edition of "The World of Organic Agriculture", published by the Research Institute of Organic Agriculture FiBL and IFOAM – Organics International, Brazil has the largest market for organic products in Latin America, and is in the eleventh position in the world with regard areas dedicated to organic agriculture, with about 1.5 million hectares (approximately 0.6% of Brazil's agricultural area) in 2023³⁶.

Despite the new generation of public policies that started in the early 2000s, and efforts to promote integrated sustainable agricultural and rural development³⁷, which enable Brazil's removal from FAO's Hunger Map in 2014, indicators of food insecurity started rising again after 2015, due to many internal and external challenges, spanning political, economic, and environmental sectors, exacerbated by the COVID-19 pandemic³⁸. According to the State of Food Security and Nutrition in the World (SOFI) Report 2023, 1.9 percent of Brazilians faced severe food insecurity and 18.3 experienced moderate food insecurity during 2014–16. Numbers from 2020–22 showed that there was an increase: 9.9 percent of Brazilians faced severe food insecurity and 32.8 experienced moderate food insecurity³⁹.

Currently, efforts are underway to change this scenario by revisiting and updating policies and programs³⁸. For instance, in 2021, the PAA (Food Acquisition Program) was replaced by the Food

Brazil Program (Law 14.484/2021, and Decree 10.880/2021). Despite being conceived as an important strategy to combat hunger and malnutrition, the government drastically reduced the budget allocated to the purchase of food from family farming during the 2019–2022 administration. In 2012, the program received an allocation of R\$ 586 million from the federal budget. In 2021, it was only R\$ 58.9 million, and as of May 2022, it was only R\$ 89,000⁴⁰. In 2023, the newly elected administration under President Lula relaunched the PAA through Law 14.628/2023, and Decree 11.476/2023, increasing the individual value that can be marketed by family farmers, indigenous peoples, and traditional communities. The relaunch of the PAA marks an important moment in the revival of the federal government's key food security programs.

According to Gil et al.³⁰, integrated crop-livestock systems (iCL), although presented as a promising strategy to increase agricultural production and rehabilitate degraded pastures while mitigating GHG emissions, still occupies a small share of the country's total agricultural areas. Findings originated from a study centred in Mato Grosso, the largest agricultural producing state in Brazil, which found that the main factors influencing the early stages of iCL diffusion are access to information, education, culture, supply chain infrastructure and historical land use patterns³⁰.

Also, although family farming is commonly associated with sustainable organic agriculture, it is not always the case in practice. The hegemonic attraction of modern technologies can explain why most farmers prefer to adopt the latest genetic, chemical or mechanical innovation instead of agro-ecological approaches^{14,20}. Blanc and Kledal²⁰ analyzing groups of smallholders converting to organic practices and selling their produce through an alternative food system, found that some farmers were not satisfied with the 'trade off' between the huge amount of time they invested in shifting to organic practices and the income they received in return. High costs for certification and the harsh conditions imposed by a global market - price volatility and strong competition -, must be taken into account. Zanella and Cardoso⁴¹ mention that the incentives farmers have to switch to organic agriculture is strongly defined by market forces,

farmers own personal values and technical, information and knowledge restrictions.

Consumers' attitudes and expectations for social justice and ecological outcomes have increased demand for organic foods, providing a larger consumer base for agro-ecological products, and influencing a shift towards more socially and environmentally sustainable methods of production and supply chains⁴². However, in parallel, general food consumption habits (preference for ultra-processed foods associated with industrialization, use of agro-chemicals, and genetically modified organisms (GMOs), presents another challenge to consolidate the organic sector.

Lamine et al.³² state that there is a risk of political discontinuity in Brazil. Economic and political crises since 2015/16 and the COVID-19 pandemic led to falling government support for family farmers, cutbacks in social protection and the minimum wage, and dismantling of other progressive government policies⁴³. Paes de Barros¹¹ cites that although the Brazilian government has presented an ambitious plan to reduce carbon emissions, it does not seem determined to implement an effective environmental policy, maintaining a weak budget for environmental agencies in order to sustain agricultural development. Candiottto¹² mentions the federal government budget cuts that occurred in 2015 and the Brazilian political instability in 2016, resulting in a reduction of the entire amount of funds released on PLANAPO 2013-2015 (R\$ 2.9 billion, i.e., just 33% of what was planned). The current PLANAPO (2016-2019) indicates the strategies for strengthening organic agriculture and agroecology in Brazil, but not the budget allocation for meeting the established goals.

From 2019 to 2022, Brazil' federal government under the leadership of President Bolsonaro minimized support for sustainable agricultural practices and instead increased incentives for conventional agriculture through credits and the approval of new pesticides and genetically modified organisms¹², representing a cause of concern regarding the transition towards a more sustainable food system in Brazil. In 2019, CONSEA, the advisory body to the Brazilian Presidency on food and nutritional security, was dismantled.

The political transition currently underway in Brazil since President Lula re-gained office in January 2023 is indicative of a new positive trend, with priority being placed again on zero hunger and protecting the human right to adequate food and nutrition^{43,38}. Reinstatement of the National Food and Nutrition Security Council-CONSEA and the Ministry of Agrarian Development-MDA as well as re-development of policies on food and nutrition security (eg. Family Fund Program, Food Acquisition Program, the Family Agriculture Harvest Plan, and the National School Feeding Program), are some examples of some commitments in response to the rise in hunger and food insecurity in the last five years^{43,44}. Institutional and market strengthening and coordination with other other development priorities can benefit from firmer policy directions and enhanced linkages across stakeholders involved in agricultural and food innovation (public sector, farmers, industry, NGOs, researchers, educators, consumers and others)¹⁷.

CONCLUSION

Since the early 2000s, Brazil has implemented forward-thinking policies towards food system transformation, including policies for food and nutritional security, small-scale family farming, organic food production, investments in agricultural research and development. All these achievements are the result of a longstanding process of broad social mobilization and, in response, public sector intervention that has involved a variety of stakeholders. The broader national strategies presented in Appendix A show that Brazil has managed to have both agricultural modes (large-scale monocultures largely directed towards exports and small-scale family farming) coexist, often however when tensions and trade-offs.

Public investments have also been directed towards large-scale agribusiness, which may impede the gradual shift towards a more sustainable food system, given the continuous use of agro-chemicals, genetically modified organisms, and technologies. Moreover, access to information, education, culture, farmers own personal values, hegemonic attraction of modern technological, supply chain infrastructure, high costs for certification and historical land use patterns are some of the difficulties faced to improve

Brazil's position in terms of organic farming and food security.

Brazil's journey in promoting food security and sustainable agriculture, though marked by challenges, demonstrates the country's firm commitment to address the structural causes of food insecurity. Despite the political conflicts surrounding the allocation of public assets and changes in progressive policies regarding environmental and social rights in the late 2010s, there are reasons for hope with the new political agenda, which is focusing on climate, hunger, food security, and international engagement. Challenges remain, which will require further innovation, collaboration, dialogue between government and civil society and inclusive partnerships to sustain and further improvements in creating a sustainable food system and achieving the SDGs.

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CONFLICTS OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

AUTHOR CONTRIBUTIONS

IKEMATSU, P. conducted the literature review, led the data collection and assisted in interpreting the findings. She took the lead role in writing the original manuscript.

MAURIN, C. contributed to the interpretation of the results, supervised the literature review; and reviewed the findings. All authors have read, reviewed, and approved the final version of the manuscript.

REFERENCES

- 1- Healthy people depend on healthy food systems. Sustainable food systems for food security and nutrition [Internet]. Rome: FAO, 2013 [cited 2018 Apr 15]. Available from: http://www.fao.org/fileadmin/templates/getinvolved/images/WFD_issues_paper_2013_web_EN.pdf.
- 2- United Nations Environment Programme. Food Systems and Natural Resources: A Report of the Working Group on Food Systems of the International Resource Panel. UNEP, 2016. Number: DTI/1982/PA. UNEP. ISBN: 978-92-807-3560-4.
- 3- Food and Agriculture Organization of the United Nations. Towards the future we want. End hunger and make the transition to sustainable agricultural and food systems [Internet]. Rome: FAO, 2012 [cited 2018 Apr 15]. Available from: <http://www.fao.org/docrep/015/an894e/an894e00.pdf>.
- 4- International Panel of Experts on Sustainable Food systems. From uniformity to diversity: a paradigm shift from industrial agriculture to diversified agro ecological systems [Internet]. IPES-FOOD, 2016 [cited 2018 Apr 15]. Available from: http://www.ipes-food.org/_img/upload/files/UniformityToDiversity_FULL.pdf.
- 5- Miles S. Stakeholder Theory Classification: A Theoretical and Empirical Evaluation of Definitions. *J Bus Ethics*. 2017;142(3):437–59. Available from: <https://link.springer.com/article/10.1007/s10551-015-2741-y> DOI: <https://doi.org/10.1007/s10551-015-2741-y>.
- 6- High Level Panel of Experts. Food losses and waste in the context of sustainable food systems. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security [Internet]. Rome: HLPE, 2014 [cited 2018 Apr 15]. Available from: <http://www.fao.org/3/a-i3901e.pdf>.
- 7- Instituto Brasileiro de Geografia e Estatística. Estimativas da população residente para os municípios e para as unidades da federação brasileiros com data de referência em 1º de julho de 2017 [Internet]. Rio de Janeiro: IBGE, 2017 [cited 2018 Apr 15]. Available from:

- <https://biblioteca.ibge.gov.br/visualizacao/livros/liv100923.pdf>.
- 8- Institute for Social Research. Popular agrarian reform and the struggle for land in Brazil. Dossier nº 27. [Internet]. Tricontinental: Institute for Social Research. April, 2020. [cited 2023 Oct 28]. Available from: <https://thetricontinental.org/dossier-27-land/>.
 - 9- The Nature Conservancy. Sustainable Agriculture: Efficient and Responsible Use of Natural Resources in Brazil [Internet]. Rio de Janeiro: TNC, 2016 [cited 2018 Apr 15]. Available from: <https://www.nature.org/media/brasil/sustainable-agriculture-brazil.pdf>.
 - 10- Sambuichi RHR, Silva APM, Oliveira MAC, Savian M. Políticas agroambientais e sustentabilidade: desafios, oportunidades e lições aprendidas [Internet]. Brasília: Ipea, 2014 [cited 2018 Apr 15]. Available from: http://www.ipea.gov.br/portal/images/stories/PDFs/livros/livros/livro_politicasagroambientais.pdf.
 - 11- Paes de Barros D. A transição para as políticas agroambientais no Brasil. The Transition to agri environmental policies in Brazil [Internet]. Cuiabá; 2012 [cited 2018 Apr 15]. Available from: <http://www.publicadireito.com.br/artigos/?cod=4764f37856fc727f>.
 - 12- Candiottto LZP. Organic products policy in Brazil. Land use policy [Internet]. 2018;71:422–30. Available from: <https://www.sciencedirect.com/science/article/abs/pii/S026483771730176X?via%3Dihub> DOI: <https://doi.org/10.1016/j.landusepol.2017.12.014>.
 - 13- Paula N, Delgado N. Fragmentation of Brazilian Food System Between Global Markets and Food Security. *J Food Secur.* 2016;4(5):120–25. Available from: <https://pubs.sciepub.com/jfs/4/5/3/index.html>.
 - 14- Paulino ET. The agricultural, environmental and socio-political repercussions of Brazil's land governance system. *Land use policy.* 2014;36:134–44. Available from: <https://www.sciencedirect.com/science/article/pii/S0264837713001464?via%3Dihub> DOI: <https://doi.org/10.1016/j.landusepol.2013.07.009>.
 - 15- International Food Policy Research Institute. Food System Transformations: Brazil, Rwanda, and Vietnam. World Economic Forum (WEF) and Global Agenda Council (GAC) on Food and Nutrition Security [Internet]. IFPRI; 2016 [cited 2018 Apr 15]. Available from: https://reliefweb.int/sites/reliefweb.int/files/resource_s/WEF_NVA_Food_System_Transformation_Case_Studies.pdf.
 - 16- Leonel Júnior G. The right to agroecology. Using the law to support sustainable farming in Brazil [Internet]. Brussels: FERN; 2018 [cited 2018 Apr 15]. Available from: <http://fern.org/report/RightToAgroecology>.
 - 17- The Organisation for Economic Co-operation and Development. Innovation, Agricultural Productivity and Sustainability in Brazil. OECD Food and Agricultural Reviews. Paris: OECD; 2015. Available from: DOI: <http://dx.doi.org/10.1787/9789264237056-en>.
 - 18- Wienke FF. As políticas de Pagamento por Serviços Ambientais direcionados à Agroecologia: da emergência da experiência europeia e da inexistência de mecanismos no Brasil. *Rev Direito Agrár Agroambient.* 2016;2(2):59–78. Available from : <https://indexlaw.org/index.php/rdaa/article/view/1247>.
 - 19- Sonnino R, Torres CL, Schneider S. Reflexive governance for food security: The example of school feeding in Brazil. *J Rural Stud* [Internet]. 2014;36:1–12. Available from: <https://www.sciencedirect.com/science/article/abs/pii/S0743016714000709?via%3Dihub> DOI: <http://dx.doi.org/10.1016/j.jrurstud.2014.06.003>.
 - 20- Blanc J, Kledal PR. The Brazilian organic food sector: Prospects and constraints of facilitating the inclusion of smallholders. *J Rural Stud.* 2012;28(1):142–54. Available from: <https://www.sciencedirect.com/science/article/abs/pii/S0743016711000921?via%3Dihub> DOI: <https://doi.org/10.1016/j.jrurstud.2011.10.005>.
 - 21- Sambuichi RHR., Spínola PAC, Mattos LM, Ávila ML, Moura IF, Silva APM. Análise da construção da Política Nacional de Agroecologia e Produção Orgânica no Brasil. Texto para discussão [Internet]. Rio de Janeiro: IPEA; 2017 [cited 2018 Apr 15]. Available from: <http://ainfo.cnptia.embrapa.br/digital/bitstream/item/161371/1/td-2305.pdf>.
 - 22- Rocha C. Developments in national policies for food and nutrition security in Brazil. *Dev Policy Rev.* 2009;27(1):51–66. Available from: <https://onlinelibrary.wiley.com/doi/10.1111/j.1467-7679.2009.00435.x> DOI: <https://doi.org/10.1111/j.1467-7679.2009.00435.x>.
 - 23- Wittman H, Blesh J. Food Sovereignty and Fome Zero: Connecting Public Food Procurement Programmes to Sustainable Rural Development in Brazil. *Journal of Agrarian Change.* 2017;17(1):81–105. Available from: <https://onlinelibrary.wiley.com/doi/abs/10.1111/joac.12131> DOI: <https://doi.org/10.1111/joac.12131>.
 - 24- Maluf RS, Burlandy L, Santarelli M, Schottz V, Speranza JS. Nutrition-sensitive agriculture and the promotion of

- food and nutrition sovereignty and security in Brazil [Internet]. *Cien Saude Colet.* 2015;20(8):2303–12 [cited 2018 Apr 15]. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/26221795>.
- 25- Brazil. Organization of Ministries Chamber of Agroecology and Organic Production. National Plan for Agroecology and Organic Production [Internet]. Brasília: MDA; 2016 [cited 2018 Apr 15]. Available from: http://www.mda.gov.br/sitemda/sites/sitemda/files/user_arquivos_19/Mont_cartilha_planapo_ingles.pdf.
- 26- Ministry of Agriculture, Livestock and Food Supply - MAPA. ABC - Brazilian Agricultural Policy for Climate Adaptation and Low Carbon Emission (2020-2030). 2022. [cited 2023 Aug 09]. Available from: <https://www.gov.br/agricultura/pt-br/assuntos/sustentabilidade/agricultura-de-baixa-emissao-de-carbono/publicacoes/abc-sumario-executivo-2022-ingles.pdf/view>
- 27- Buller LS, Bergier I, Ortega E, Moraes A, Bayma-Silva G, Zanetti MR. Soil improvement and mitigation of greenhouse gas emissions for integrated crop–livestock systems: Case study assessment in the Pantanal savanna highland, Brazil. *Agric Syst* [Internet]. 2015;137:206–19 [cited 2018 Apr 15]. Available from: <https://www.sciencedirect.com/science/article/abs/pii/S0308521X14001589?via%3Dihub> DOI: <https://doi.org/10.1016/j.agsy.2014.11.004>.
- 28- Gil JDB, Siebold M, Berger T. Adoption and development of integrated crop–livestock–forestry systems in Mato Grosso, Brazil. *Agric Ecosyst Environ* [Internet]. 2015;199:394–406. Available from: <https://www.sciencedirect.com/science/article/abs/pii/S016788091400471X?via%3Dihub> DOI: <https://doi.org/10.1016/j.agee.2014.10.008>.
- 29- Pacheco AR, Chaves RQ, Nicoli CML. Integration of crops, livestock, and forestry: a system of production for the Brazilian Cerrados [Internet]. 2013:51–61. In: Hershey CH, Neate P. (Ed.). *Eco-efficiency: from vision to reality*. Cali: CIAT; 2013 [cited 2018 Apr 15]. Available from: <http://ainfo.cnptia.embrapa.br/digital/bitstream/item/84508/1/52.pdf>.
- 30- Gil JDB, Garrett R, Berger T. Determinants of crop–livestock integration in Brazil: Evidence from the household and regional levels. *Land use policy.* 2016;59:557–68. Available from: <https://www.sciencedirect.com/science/article/abs/pii/S0264837715300594?via%3Dihub> DOI: <https://doi.org/10.1016/j.landusepol.2016.09.022>.
- 31- Lopes D, Lowery S. Rural Credit in Brazil: Challenges and Opportunities for Promoting Sustainable Agriculture [Internet]. 2015 [cited 2018 Apr 15]. Available from: http://www.forest-trends.org/documents/files/doc_5016.pdf.
- 32- Lamine C, Maréchal G, Darolt M. Ecological transitions within agri-food systems: a Franco-Brazilian comparison [Internet]. 8th AESOP-Sustainable Food Planning Conference, Nov 2017, Coventry, United Kingdom; 2017 [cited 2018 Apr. 15]. Available from: <https://halshs.archives-ouvertes.fr/halshs-01579748/document>
- 33- Boddey RM, Xavier DF, Alves BJR, Urquiaga S. Brazilian Agriculture: The Transition to Sustainability. *J Crop Prod.* 2003;9:593–621. Available from: https://www.tandfonline.com/doi/abs/10.1300/J144v09n01_10 DOI: https://doi.org/10.1300/J144v09n01_10.
- 34- Vilpoux OF. Agrarian reform and cooperation between settlers in the Midwest of Brazil: An institutional approach. *Land use policy.* 2014;39:65–77. Available from: <https://www.sciencedirect.com/science/article/abs/pii/S0264837714000611?via%3Dihub> DOI: <https://doi.org/10.1016/j.landusepol.2014.03.011>.
- 35- Ministry of Health of Brazil. Secretariat of Health Care. National Register of Organic Producers [Internet]. Brasília: Ministry of Health of Brazil; 2023 [cited 2023 Aug 30]. Available from: <https://www.gov.br/agricultura/pt-br/assuntos/sustentabilidade/organicos/cadastro-nacional-produtores-organicos>.
- 36- Willer H, Schlatter B, Trávníček J (Eds.) [Internet]. *The World of Organic Agriculture. Statistics and Emerging Trends 2023*. Research Institute of Organic Agriculture FIBL, Frick, and IFOAM – Organics International, Bonn. Online Version 2 of February 23, 2023 [cited 2023 Aug 30]. Available from: <https://www.fibl.org/fileadmin/documents/shop/1254-organic-world-2023.pdf>.
- 37- Niederle P, Grisa C, Picolotto E, Soldera D. Narrative disputes on family farming public policies in Brazil: conservative attacks and restricted counter movements [Internet]. Conference Paper N. 12. The 5th International Conference of the BRICS Initiative for Critical Agrarian Studies. Moskou; 2017 [cited 2018 Apr 15]. Available from: <https://www.iss.nl/sites/corporate/files/2017-11/BICAS%20CP%205-12%20Niederle%20et%20al.pdf>.
- 38- Ceolin, AS, Nogueira, LCK. Brazil's return: Towards zero hunger (again). [Internet]. OPINION: Institute of Development Studies, 2023 [cited 2023 Aug 30]. Available from:

<https://www.ids.ac.uk/opinions/brazils-return-towards-zero-hunger-again/>.

- 39- FAO, IFAD, UNICEF, WFP, WHO. 2023. The State of Food Security and Nutrition in the World 2023. Urbanization, agrifood systems transformation and healthy diets across the rural–urban continuum. Rome, FAO. Available from: <https://www.fao.org/documents/card/en/c/cc3017en>
DOI: <https://doi.org/10.4060/cc3017en>.
- 40- Turtelli C. Com escalada de fome no Brasil, governo destrói programa alimentar [Internet]. UOL: Brasília 06/06/2022 [cited 2023 Aug 30]. Available from: <https://noticias.uol.com.br/politica/ultimas-noticias/2022/06/06/com-escalada-de-fome-no-brasil-governo-destroi-programa-alimentar.htm>.
- 41- Zanella MA, Cardoso LV. Agri-environmental Policies in Brazil and Perspectives for Evaluation. OECD Workshop on the Evaluation of Agri-environmental Policies 20-22 June 2011 [Internet]. The Johann Heinrich von Thünen Institute, Bundesallee. Braunschweig, Germany; 2011 [cited 2018 Apr 15]. Available from: <http://www.oecd.org/tad/sustainable-agriculture/48169582.pdf>
- 42- Ministry of Health of Brazil. Secretariat of Health Care. Primary Health Care Department. Dietary Guidelines for the Brazilian population [Internet]. Brasília: Ministry of Health of Brazil; 2014 [cited 2018 Apr 15]. Available from: <https://www.foodpolitics.com/wp-content/uploads/Brazilian-Dietary-Guidelines-2014.pdf>.
- 43- Devereux S, Maluf, RS. Brazil's return: Food security and social protection. [Internet]. OPINION: Institute of Development Studies, 2023 [cited 2023 Aug. 30]. Available from: <https://www.ids.ac.uk/opinions/brazils-return-food-security-and-social-protection/>.
- 44- Cabral, L, Sauer, S, Pomeroy, M. Brazil's return to international development under Lula 3.0 [Internet]. OPINION: Institute of Development Studies, 2023 [cited 2023 Aug 30]. Available from: <https://www.ids.ac.uk/opinions/brazils-return-to-international-development-under-lula-3-0/>.