
**A proposal for the periodization of the Brazilian sugar-energy sector:
interpretations based on the technical phenomenon**

**Una propuesta de periodización del sector sucroenergético brasileño:
interpretaciones a partir del fenómeno técnico**

**Uma proposta de periodização do setor sucroenergético brasileiro: interpretações à
partir do fenômeno técnico**

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Abstract

This article presents a proposal for the periodization of the Brazilian sugar-energy sector based on the relationship between the technical phenomenon and politics that, in each historical moment, establish the basis for spatial transformation. This analytical effort is justified because it is in the relationship between technique and politics that time is understood as a reality that is also geographical. Based on these method suppositions, four distinct periods were defined based on the possibilities of using the territory for sugarcane activities in Brazil, since the colonial period. While sugarcane activities are mixed with the Brazilian territorial formation itself, it is expected that this proposal can contribute to demonstrate the importance of temporal analysis from the perspective of Geography.

Keywords: Periodization; sugar-energy sector; use of territory; technique.

Resumen

Este artículo presenta una propuesta de periodización del sector sucroenergético brasileño basada en la relación entre el fenómeno técnico y la política que, en cada momento, conforman las bases para la transformación del espacio. Este esfuerzo analítico se justifica en la medida en que es en la relación entre técnica y política donde se comprende el tiempo como una realidad que es, también, geográfica. A partir de estos supuestos, se delinearon cuatro períodos distintos, que se diferencian

por las posibilidades de uso del territorio por parte de las actividades relacionadas con la caña de azúcar en Brasil, desde el período colonial. En la medida en que las actividades cañeras se entrelazan con la propia formación socioespacial brasileña, se espera que esta propuesta pueda contribuir a demostrar la importancia del análisis temporal desde la perspectiva de la Geografía.

Palabras clave: Periodización; sector sucroenergético; uso del territorio; técnica.

Resumo

Este artigo apresenta uma proposta de periodização do setor sucroenergético brasileiro com base na relação entre o fenômeno técnico e a política que, em cada momento histórico, conformam as bases para a transformação do espaço. Justifica-se esse esforço de análise pois é na relação entre técnica e política que se compreende o tempo como realidade que é, também, geográfica. Com base nesses pressupostos, foram delineados quatro períodos distintos que se diferenciam pelas possibilidades de uso do território pelas atividades da cana-de-açúcar no Brasil, desde o período colonial. Ao passo em que as atividades da cana-de-açúcar se mesclam à própria formação socioespacial brasileira, espera-se que essa proposta possa contribuir para demonstrar a importância da análise temporal sob a ótica da Geografia.

Palavras-chave: periodização; setor sucroenergético; uso do território; técnica.

Introduction

A comprehensive analysis of a phenomenon from a geographical perspective must consider time and space as historical realities where human society is realized (Santos, 2014). Thus, considering the realization of human society—which occurs on a material basis—also allows us to consider "[...] space and its use, time and its use; materiality and its various forms, actions and their various features" (Santos, 2013, p. 39). Thus, geographic space is understood to be shaped by the inseparable relationship between the set of objects and the set of actions that, established as systems, are dialectically conditioned, establishing the dynamics of transformation of space itself (Santos, 2012; 2013).

This dynamic of spatial transformation occurs through the relationship between its elements, which are established as systems, and therefore interdependent, and cannot be understood in isolation, but rather within the social process itself. This means that concrete data from spatial reality, such as a sugarcane

plant or a sugarcane field, for example, cannot be analyzed in and of themselves or as a "thing in itself," but rather in their relationship to the whole: "The value of a variable is not a function of itself, but of its role within a whole. When this whole changes its meaning, content, rules, or laws, the value of each variable also changes" (Santos, 2014, p. 22).

But how can we understand this totality, the geographic space that, despite constituting reality, is difficult to grasp theoretically and empirically? (Santos, 2014, p. 13)

An abstract-concrete perspective of analysis appropriate for understanding the dynamics and transformations of space is that of used territory (Santos, Silveira, 2016, p. 19). Analysis through used territory allows us to move away from the restricted use of the word "territory," often understood only as a designation of a country's political-administrative space. It allows for an understanding that takes into account the intentions, agents, social dynamics, and materiality that govern the process of territorial use in each socio-spatial formation, thus recovering the notion of spatial totality. In this way, it is possible to understand the movement of elaboration and re-elaboration of material geographic forms (systems of objects), but also of social, legal, and political forms (systems of actions) that, at each historical moment, present themselves in a certain way (Santos, 2012; 2013). The historical component of the analysis allows us to understand space as a process that constitutes, in each period – "[...] fragments of time subject to the same historical law" (Santos, 2013, p. 67) – specific configurations that are the basis for their subsequent reproduction. Thus, if the proposal is to seek totality in the analysis of phenomena, it is not possible to consider them without considering their spatiotemporal dimension, which structures the historical dimension of geographical studies. In turn, this historical dimension can be analyzed through the relationships established between technique (materiality) and politics (immateriality) that, in each historical moment, reveal the uses of territory and the conformation of geographic space (Santos, 2012; 2014).

Thus, considering these theoretical assumptions, this article demonstrates an effort to understand the spatiotemporal dimension through the relationships established, in each historical moment, in the formation of the Brazilian sugar-energy sector. The importance of this study lies in its concretization, through analysis, of the methodological assumptions of periodization, as suggested by Santos (2012; 2014), and to indicate the intrinsic relationship between technique and politics in shaping the uses of territory effected by sugarcane activities at each historical moment of Brazil's socio-spatial formation.

The article is divided into five parts, in addition to this introduction and concluding remarks. The article first outlines the theoretical assumptions that guided the proposed periodization of sugarcane activities in Brazil. The article then argues in favor of this organized proposal, defining each of the periods. The following four parts cover more general discussions that characterize each of the proposed periods.

The importance of periodization for understanding spatial phenomena

Time, as a historical reality, can be analyzed from a geographical perspective through the relationship between technology and geographic space. From an epistemological perspective, technology allows for the union between time, made material, and space, understood in its temporal context, enabling a totalizing approach. But after all, what can be understood as technology?

Technology can be understood as a solidary system of instrumental (technical objects) and social (action, processes, and norms) means that constitute a productive arrangement indispensable to social reproduction. From the perspective of materiality, it is a set of plural and overlapping objects with equally plural functions and values, and from the perspective of immateriality, a set of uses, actions, procedures, and norms that give life and content to these objects (Silveira, 2019, p. 9). Thus, in addition to instruments and machines (technical objects), the technical phenomenon also encompasses knowledge, methods of doing things, forms of

business and institutional organizations, intentions of use, and other actions understood, from this perspective, within the idea of politics. This analytical perspective allows us to understand the dialectical relationships between materiality and politics and to think about geographic space beyond its tangible nature (Perrin, 1992; Picon, 1994 apud Silveira, 2019, p. 10). María Laura Silveira (2019) highlights the importance of considering technology as a “technical phenomenon”—technical objects, their location and modes of use, and their political dimension—for the operationalization of the category of geographic space. This allows for an understanding of its uses at each historical moment, moving away from a perspective of abstract interpretation, whether of space or technology: “[...] addressing the technical phenomenon would allow us to understand how society uses territory or, more concretely, how, where, why, by whom, and for what purpose the territory is used” (Santos, Silveira, 2001 apud Silveira, 2012, p. 30). In this way, it is possible to understand the social dimension of geographic space, as well as the imperatives of each historical moment that drive it in its constant process of transformation.

It is the technical objects and actions that allow, at each historical moment, to recognize how the processes of production of the space that constituted the totality occurred (Silveira, 2019). This totality of the space we have access to is incessantly transformed, along with history, constituting its uninterrupted dynamics (Santos, 2013). Thus, the development of history is also the development of techniques: “(...) what distinguishes economic epochs from one another is not what is done, but how it is done, with what instruments of work” (Marx, 1867 apud Santos, 2012, p. 56). In each historical moment, techniques constitute an authorization of doing, expressing a rationality specific to their time and are active elements in the organization of socio-spatial relations (Santos, 2012; Akrich, 2014).

But it's important to emphasize that this dynamic doesn't just occur through objects; it's dialectical, as the very existence of the object presupposes intention. When we talk about technology, all objects are constructed to fulfill a function,

which, even if deviated, responds to an intended use, an action, and therefore, a human action: "It is, after all, through technology that the 'progressive objectification of rational activity toward an end' is achieved" (Habermas, 1968, p. 13 apud Santos, 2012, p. 298).

Hence the importance of understanding technology as a phenomenon, therefore, in its entirety, also considering the economic, sociocultural, and political dimensions that enable its installation and use (Winner, 1980; Benakouche, 2005; Antas Jr, 2005).

Thus, it becomes possible to understand the geographic space in its historicity, that is, to date its materiality, to empiricalize it, because at each historical moment, the techniques of production, transport, communication, politics, control, sociability, etc., imprint a spatial configuration and reveal a mode of organization and regulation specific to their time (Kahil, 2012; Santos, Silveira, 2016).

Recognizing the centrality of technology in understanding geographic space allows us to periodize, that is, to explain eras based on the technical phenomenon. What was technically possible and what was actually achieved at each moment in history and in each place? What is the nature of the technical phenomenon in this period, and what geographic environment was configured? (Silveira, 2012, p. 31, own translation).

Since these questions guide the proposed periodization of the Brazilian sugarcane industry argued here, it is necessary to question the phenomenon itself: what techniques and policies authorized sugarcane activities at each historical moment? Thus, it becomes clear that, when it comes to understanding the forms of land use by the sugarcane industry, the analysis focuses on hegemonic modes of production, since historically, it has been a sector largely immersed in the hegemonic rationality of global capitalist accumulation, with characteristics unique to each historical moment.

Once the object of periodization has been identified, it is then necessary to understand how the definition of periods is established. The proposal for the

periodization of space based on technical phenomena situates the segments based on a set of variables that established, at each historical moment, diverse forms of territorial use, composed of particular manifestations that evolve together, obeying the global and local logics of each moment (Santos, Silveira, 2016, p. 20).

In this sense, Santos and Silveira (2016) point out that, due to the impossibility of any variable in space evolving in isolation or without interfering with the others in its movement, the objective of periodization is not to reach a particular element, but rather to understand its global evolution (Santos, Silveira, 2016, p. 24).

If the goal is to understand the general movement and dynamics that define each period, revealing new geographic situations specific to the phenomenon under study, it is therefore impossible to establish rigid divisions. Therefore, between each period there will always be a transitional moment that marks, through a significant evolution capable of disrupting the previous arrangement of variables and characteristics, the end of one period and the beginning of another.

Understanding the uses of the territory used by sugarcane activities in Brazil, through the proposed method, is by no means an easy task and cannot be achieved through an analysis of the activity itself. Therefore, we sought to understand the constitution of these activities within their historical and spatial context. This entailed understanding how their actions, at each time point, contributed to the social and political constitution of the Brazilian territory itself.

But there is a primary difficulty that arises when proposing a periodization scheme through technology and politics, which is the overlapping forms of territorial use (different social and territorial divisions of labor and regional inequalities), that is, multiple characteristics to be considered. However, the variables that shape space, despite being unequal and asynchronous, function symmetrically and organically as a whole. Thus:

The question is to choose the key variables that, in each segment of time, will command the system of variables, this system of events that we call a period. This is the principle from which we can value

processes and recognize historical novelties (Santos, Silveira, 2016, p. 23).

To periodize means to choose constitutive elements of our object, which are not immutable, but rather variable in the future and which will have different capacities to govern history. Meanwhile, these elements do not vary in isolation, but in conjunction with the process by which one totality becomes another (Silveira, 2019, p. 12, own translation).

Thus, it is worth noting that, for Santos (2014, p. 13), the larger the scale of the phenomenon under study, the simpler the periodization will be. Conversely, for smaller phenomena, the levels and external determinants that influence it are so numerous and diverse that they create a greater complexity of key variables that constitute it.

It is noteworthy that the periodization presented here also includes the definitions of transitional moments between these periods, where technical and political transformations occurred and began to shape the characterization of the subsequent period. The periods are, therefore, a manifestation of a general change in social relations (Santos, 2012, p. 299) that determined the dynamics of land use by the sector.

Thus, the proposed periodization recognized four distinct periods in the space-time configuration of the Brazilian sugarcane-energy sector based on a few key variables—the development of production techniques and sets of standards—as defining the forms of land use by the sector throughout its history in Brazil. The first period (from the 16th to the 19th centuries), characterized by an incipient technical environment, was followed by a transitional period (marked by the transformations of the late 19th and early 20th centuries) and succeeded by the second period (from 1930 to 1975), notably marked by a consolidated technical environment, with technical productive innovations and new intentions and territorial expressions of activities in Brazil, with the consolidation of the sugarcane productive axis in the present-day Southeast region. The third period

(from 1975 to 2000) was shaped by a technical-scientific environment that allowed for the intensification of mechanization and the improvement of motor alcohol production techniques. After another period of transition, notably marked by the dissolution of the production planning instruments put into practice in the 20th century, the fourth and current period constitutes a technical-scientific-informational environment that authorizes new dynamics for the sector, which is significantly denationalized and increasingly inserted into the dynamics of financialization.

Thus, considering the theoretical assumptions that underpin this analysis effort and this synthesis presented that demarcates the periods analyzed, the following highlights the more general discussions about the periodization presented here.

Sugarcane activities in Brazil in an incipient technical environment

A coherent set of techniques and standards was considered to establish the beginning of sugarcane activities in Brazil, delimiting a first and long period that stretches from the installation of the first sugarcane mill in 1532, the Engenho São Jorge dos Erasmos, in the captaincy of São Vicente (Andrade, 2006, p. 61; Schwarcz; Starling, 2015, p. 53), until the mid-19th century. This period was characterized by an incipient technical environment, with rudimentary production techniques concentrated in the portion that now corresponds to the Northeast region of the country.

It is known that sugar production in Brazil dates back to the beginning of the colonial period and established itself as an important means of territorial occupation (Moraes, 2009; Schwarcz; Starling, 2015). In this context, sugar established itself for the Portuguese Crown as a profitable agricultural activity, an alternative to the

simple exploitation of raw materials, while simultaneously fostering effective occupation of the newly appropriated territory (Ferlini, 1994).

The main technical objects established in the territory for production during this period were the sugar mill and sugarcane fields. Both the production techniques and their standardization shaped a primary-export economic structure in Brazil, driven by external demands, based on large estates (*latifundia*) and monocultures produced by enslaved labor (Bastide, 1976; Prado Jr., 1987; Schwarcz; Starling, 2015).

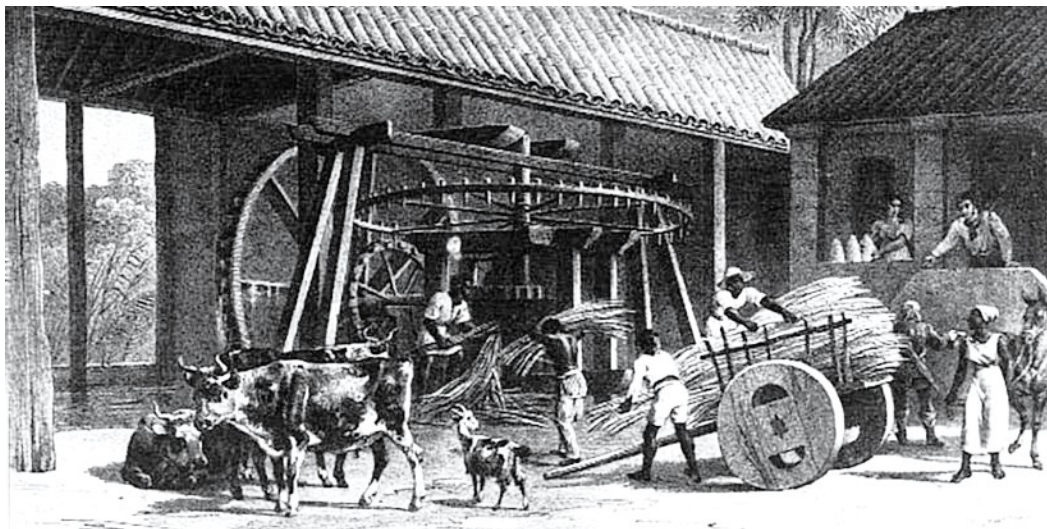
One of the main characteristics of this incipient technical environment was the *latifundia*, which allowed, in the case of sugarcane monoculture, the replacement of cultivated land with new land, thus eliminating the need for investment in soil reclamation and fertilization technologies (Ferlini, 1994). In fact, the land preparation technique was limited to the felling and burning of native vegetation, followed by soil disturbance. This cultivation was highly dependent on specific soil and climate conditions found primarily in the Pernambuco Forest and Bahian Recôncavo regions, the main sugarcane and sugar-producing areas until the 17th century (Andrade, 2006).

The harvest was done manually, and the sugarcane was transported to the mill by oxcart or by river—where the waterways were favorable for this type of transport—for final milling. The sugar plantation estates were cultivated using enslaved labor, initially Indigenous and later Black—which even constituted a dynamic and lucrative market (Prado Jr, 1987). Because of simple production techniques, enslaved labor was required on a large scale, making sugar production an expensive endeavor and therefore only feasible for the financially able. The lands where sugarcane was cultivated and processed were primarily controlled by the sugar mill owner and, in some cases, by farmers who leased the owner's land (Ferlini, 1994).

There were few technical advances in the layout of the mills and plantations in this early period. Until the 17th century, sugarcane was ground using a mill consisting of two horizontal wooden cylinders rotating in a single direction, through which the enslaved worker passed the sugarcane to extract the juice. This mill was powered primarily by human and animal power, but also by hydraulics on properties with watercourses. From a technological point of view, this type of mill had limitations, such as the rapid wear of the wood and the impossibility of supplying from both sides, thus reducing productivity (Ferlini, 1994).

In the 17th century, a technical innovation was introduced into the sugar production process: the entrosas or stick mill (Figure 1). This type of mill consisted of three rotating metal-coated cylinders, allowing sugarcane to be fed in both directions, reducing the number of enslaved workers required and increasing production. This technical innovation remained dominant until the 19th century (Castro, 1980).

Photo 1 - Illustration of a entrosas mill - 1835



Source: Rugendas, Johann Moritz. Moulin á sucre. Engraving, 1835

Even with the innovation of the entrosas mill, as well as other technologies that emerged during this period—such as the centrifuge for separating sugar crystals from honey or the vacuum boiler, which replaced the copper boiler and allowed sugarcane juice to be cooked at lower temperatures, preventing it from burning (Canabrava, 1971; Gama, 1979 apud Rodrigues; Ross, 2020, p. 55)—a sufficiently

strong conjuncture did not emerge to constitute changes in the social, economic, or geographic structure. This occurred because the new technologies did not become hegemonic or perpetuated—they occurred, more often than not, in isolation—which is due both to their lack of awareness and to the operational and financial difficulties of installation and maintenance (Rodrigues; Ross, 2020, p. 55). Thus, these innovations did not alter the key variables that defined this long period, such as dependence on physical and natural factors, large estates, enslaved labor, and production for export.

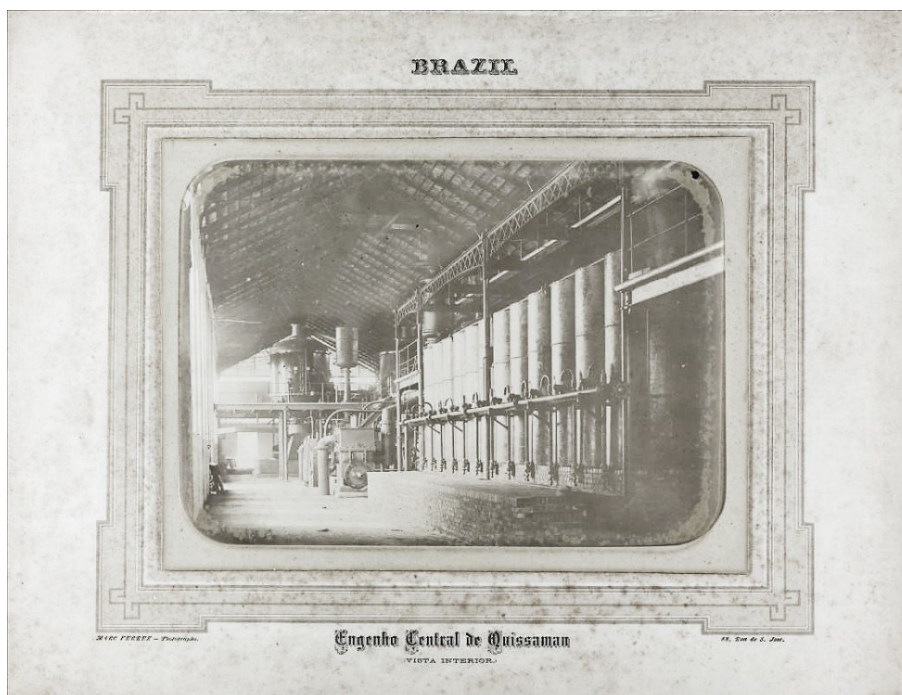
With the discovery of gold in Minas Gerais in the 18th century, a process began, albeit slow, of production shifting from what is now the Northeast region to what is now the Southeast region of Brazil, driven by increased demand. At this time, mining assumed a central role in the interests of the Crown and, to a certain extent, marginalized the Portuguese state's actions focused on sugar production (Andrade, 2006). This shifted production materialized in small mills that produced sugar and cachaça for local supply, which essentially operated under the same technical and regulatory system, and were also unable to constitute a new period.

The transition to a new period only occurred in the late 19th and early 20th centuries, when significant political and economic transformations (actions) and the renewal of the production process occurred through technical innovations (objects) that impacted the uses of the territory for sugar production and laid the foundation for the formation of a new period.

A milestone in the transformation of the technical system of sugar production occurred in the late 19th century, with support from the Empire, with the construction of the first central sugar mills (Dunham; Bomtempo; Fleck, 2011). The central sugar mills (Figure 2) corresponded to the industrial sector where sugarcane, purchased by weight from producers, was processed (Meira, 2007). This marked the beginning of the separation between the agricultural production stage and industrial processing for the production of sugar and now also ethanol, since many sugarcane producers lacked the capital necessary to modernize their old mills (Ramos, 1991).

From a normative perspective, the enactment of the Lei Áurea (Golden Law) (1888) brought about transformations in the organization of work, replacing the slave labor used for centuries in sugar production in Brazil. Thus, it can be summarized that the technical changes concentrated in the central sugar mill and the modifications in the organization of work occurred concomitantly with important political transformations in Brazil, indicating a moment of transition to a new era for sugar production.

Photo 2- Quissamã Central Sugar Mill Company in Macaé, RJ-1877



Source: Ferrez, Marc. Brazil: Engenho Central de Quissaman. b&w, 1877.

Following the establishment of the First Republic, the shift in the productive axis from the present-day Northeast to the Southeast intensified, fueled by the boom in the coffee economy and the urbanization processes that established a domestic consumer market. This period also marked the establishment of the centrality of state power in the São Paulo and Minas Gerais oligarchies, which relegated the sugarcane sector to a secondary role in the national political project (Prado Jr, 1987; Szmrecsányi, 1988; Furtado, 1999).

This scenario underwent little change until the creation of the Sugar and Alcohol Institute (IAA) in 1930, which marked the beginning of the second period, characterized primarily by the centrality of the state in controlling and organizing production, focusing on the emerging domestic market, and the industrial modernization of the production process.

The technological advancement of sugarcane activities

The transformations that characterize the second period of this proposed periodization are part of a larger context of the Brazilian state's ongoing efforts to intentionally create a model of urban-industrial accumulation and the technological advancement of its territory, with the goal of national integration (Santos, Silveira, 2016; Oliveira, 2003).

In this context, a new way of structuring sugar and ethanol production emerged, combining a more modern industrial unit with land ownership dedicated to sugarcane cultivation, guaranteeing the production of the necessary raw materials.

The mill began a new cycle, a new civilization—that of the machine. That of industrial rationalization, concentration, and standardization. In short, it realized the modern ideal of tailoring. And by looking more closely, one can perceive the mill's psychological meaning. The central mill gives us the impression of a factory dependent on raw materials supplied by farmers outside the industry. The mill has a sense of absorbing raw materials, of the "planting farm," of intensive production, of rationalizing agricultural labor, of guaranteeing a minimum harvest. It is, therefore, the approximation of the state long desired by the industrialist to be the producer of raw materials, eliminating the intermediary, that is, the sugarcane supplier (Dé Carli, 1943, p. 17 apud Meira, 2007, p. 28).

This way of structuring the production process allowed the sector to advance from a rustic production system, which for a time defined specific modes of production and social relations, to a "modern," industrial one, which from then on defined other forms of production and social relations, with a rationality different from that of the central sugar mills.

Within the scope of sugarcane activities, the rationality of this new period permeated, with its central characteristics being the advancement of industrialization

ideals, the centrality of the industrial unit in conjunction with land ownership, the end of enslaved labor, the consolidation of the sugarcane production axis in what is now the Southeast, and the concentration, in the figure of the State, of the power to direct the sugarcane production dynamics in Brazil (Szmrecsányi, 1979, 1988; Prado Jr, 1987; Furtado, 1999).

Regarding the State's role in coordinating activities, it is also important to highlight the intentionality of promoting the production of fuel alcohol, especially as a way to overcome the problems arising from overproduction of sugar and the consequences of the First World War and the 1929 financial crisis (Szmrecsányi, 1979, p. 173). The first experiments with alcohol-powered engines in Brazil date back to 1925, at the Experimental Station for Fuels and Minerals (EECM) (Camelini, 2011). In 1931, Decree No. 19,717 of February 20, 1931, determined, for example, that all imported gasoline must, from then on, contain at least 5% alcohol of national origin, and that all vehicles belonging to or serving the Union must use gasoline with at least 10% alcohol of national origin. Furthermore, this decree also stipulated that, until March 31, 1932, all machinery required for the construction of alcohol distillation plants would be exempt from import taxes and duties.

The promotion of fuel alcohol production brought about further transformations in sugarcane production in Brazil, which, until then, had been largely focused on sugar production. Thus, the IAA played a central role in adapting and promoting motor alcohol production techniques. Among the Institute's main initiatives are: the installation of large central distilleries under its control to produce alcohol with collected surpluses; incentives and financial assistance to cooperatives, companies, or producers wishing to establish alcohol production plants or adapt existing units for this purpose; promotion of improved production through the provision of technical resources and the dissemination of more efficient processing methods; approval of standard formulas for alcohol, attested through certificates and inspections, necessary for its integration into the market; and installation of motor

alcohol pumps for sale to the public wherever necessary or convenient (Brazil, 2021 [1933], Art. 4 and 5).

Thus, it can be seen that in this second period, the technical transformations were centered on the actions of the Brazilian State, which at that time was committed to promoting the technological development of production and the beginning of the production of motor alcohol. As a reflection of these transformations in land use, production was consolidated in new areas, effectively shifting the productive axis of sugarcane activities to the southeast of the country, with the state of São Paulo assuming the position of leading producer (Szmrecsányi, 1979).

The period between the civil-military coup in 1964 and the early 1970s marked the transition from this second period to a new one, in which there was a centralization of activities and an intensification of state action in consolidating alcohol production, encouraging the expansion of production to new areas, mechanizing the agricultural stage, and incorporating scientific content into the production process.

The technical-scientific period and the consolidation of the motor alcohol industry in Brazil

The State's actions during this period were directed toward intensifying capitalist expansion in the Brazilian countryside, which also affected sugarcane activities. In this sense, the 1964 coup d'état represented a new step in the internationalization and rationalization of the Brazilian economy, favoring the concentration of capital (Santos, Silveira, 2016, p. 46; Marini, 2000, p. 47). The introduction of new techniques and new scientific content into agricultural spaces allowed a significant advance of the agricultural frontier into the cerrados during this period, especially in the Central-West region, which also favored the expansion of sugarcane-energy activities in this region. In this sense, the creation of the National Sugarcane Improvement Program (1971) and the implementation of the Sugar Agroindustry Support Program (1973) defined a scenario of rationalization of

Brazilian sugarcane production, with incentives for the merger, incorporation, and relocation of mills, in addition to improving production through the construction of sugar terminals in the main ports (Szmrecsányi, 1979). This meant, in addition to incentives for the oligopolization of activities, the exclusion of small mills and sugarcane suppliers from the planning of the sugarcane agroindustry, under the pretext of concentrating efforts on the most profitable ventures (Szmrecsányi; Moreira, 1991).

In 1975, the National Alcohol Program (Proálcool) was created, encouraging the production of fuel alcohol primarily from sugarcane, with the aim of reducing external dependence on petroleum by modifying Brazil's energy matrix (Safatle, 2011). Thus, the initial efforts to produce motor alcohol in the preceding period laid the foundation for the consolidation of sugarcane fuel production at an industrial level.

Proálcool's actions allow us to consider the relationship between norms and materiality, since the program's institutionalization enabled a series of transformations in land use. Proálcool stipulated, for example, that motor alcohol production in the country should be encouraged through the expansion of raw material production and the modernization and expansion of plants, which occurred through the creation of credit lines by the Brazilian government (Legislative Chamber, 2020 [1975]). In the first five years of the program, there was a 530% increase in ethanol production and a 30% increase in sugar production (Safatle, 2011).

During this period, the State's role in promoting and developing research stands out, reinforcing and integrating science into sugarcane activities in Brazil. This can be seen in the efforts of the Agronomic Institute of Campinas (IAC) and the Sugarcane Technology Center, which developed sugarcane varieties with higher sucrose content and greater resistance to pests and diseases (Dunham, Bomtempo, Fleck, 2011). Another characteristic that Proálcool conferred on Brazilian production was the consolidation of industrial fuel alcohol production, which in turn promoted

transformations in the automobile industry. By adapting and creating technologies for the use of the new fuel, it created a new market for the sector (Dunham, Bomtempo, Fleck, 2011; Paul, Fuck, Dalsin, 2012). According to Kohlhepp (2010), in 1984, 94.4% of new cars sold in Brazil were fueled by alcohol and benefited from incentives and easy credit for purchase.

It can be seen, then, that this third period was marked by the intensification of the Brazilian government's actions not only in controlling and promoting production, but also in the technical and scientific development of the sector's methods, with implications beyond production itself, but also for other sectors, such as the automobile industry, and for society as a whole.

The transition from the third to the fourth period of this proposed periodization is marked by political and economic transformations that occurred in Brazil after redemocratization, with economic liberalization and efforts at economic deregulation, including the dissolution of the Proálcool (in 1989) and the IAA (in 1990) programs, marking the end of the planned agricultural and production phase of the sector.

From a political perspective, this represents a transition from a period marked by the direct presence of the State in the political and economic management of the sector and in the planning of sugarcane and energy activities, to one in which these activities began to rely on State actions that indirectly fostered them, without direct coordination. This process paralleled the political and economic transformations that occurred in Brazil after redemocratization, with economic liberalization and efforts to deregulate economic activities previously heavily coordinated by the State. In this sense, the dissolution of Proálcool (in 1989) and IAA (in 1990) marked the end of the planned agricultural and production phase of the sector.

Regarding production, the return to an international climate favorable to the use of oil and the prioritization of macroeconomic strategies that anticipated the

creation of surpluses through commodity exports, which was established at the turn of the century (Delgado, 2012, p. 77), pushed the intention of national autonomy in relation to oil to the background, which led to the gradual reduction of incentives and subsidies for the production of motor alcohol, with production stagnation (Safatle, 2011, p. 65-66).

The recent expansion of the Brazilian sugar-energy sector in the context of globalization

This fourth and current period, which began at the turn of the century, is marked by recent dynamics in the sector related to the consolidation of globalization, financialization, and neoliberalism. In this context, the recent expansion of activities accompanied the significant increase in the prices of agricultural and mineral commodities after 2000, caused by an overlapping of factors, including the growth in demand from the Asian continent for agricultural goods and raw materials for industry—mainly China; the devaluation of the dollar against the euro and the yen, favoring imports and stimulating the futures market for these goods; pent-up supply due to low investment in previous decades—characterized by the low price of agricultural commodities relative to manufactured goods—and supply shocks due to climate change (Prates, 2007; Carneiro, 2012; Oliveira, 2016). This situation helped to consolidate for Latin America as a whole, and therefore also for Brazil, a political, economic and ideological order, called by Svampa (2013) the “commodities consensus”, as well as the strategies of the new pact of the political economy of agribusiness at the national level, which focused on strengthening the primary sector as a strategic driver for the economy and, consequently, reinforcing the reprimarization of the export agenda (Delgado, 2012). What emerges new in this fourth and current period for agricultural sectors as a whole, but also for the sugar-energy sector, is that with economic liberalization and deregulation, as well as the significant growth in commodity production, such as sugar, supported by increased

demand in the international market and public policies, broad participation by foreign agents and capital became possible, which was expressed through the increase in mergers and acquisitions that occurred during the period (Verdi, Aoun, 2009; Siqueira, Castro Junior, 2010).

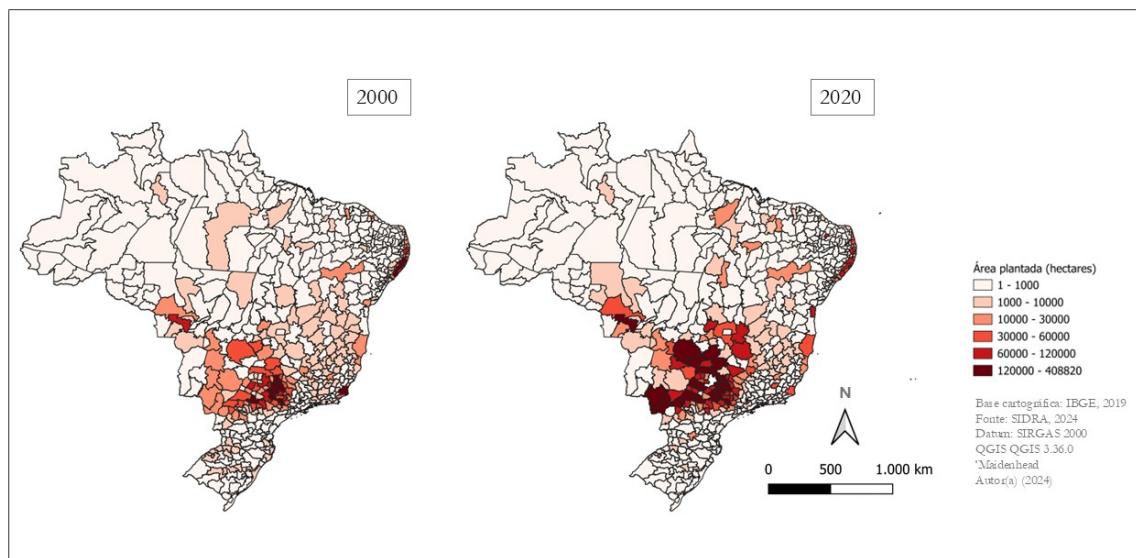
It is noteworthy that, beyond the positive expectations established by the international scenario and the actions of the Brazilian government, the flexibility of sugarcane—understood as a flex crop (Borras et al., 2016), crops that can be directed to different types of uses using diverse production techniques, thus being highly adaptable to market demands—also appears to be a factor of attraction for international investors.

The environmental issue is an important factor in understanding the sector's recent movements, especially regarding marketing strategies that use the environmental and sustainability narrative as a factor in attracting agents and legitimizing themselves in society (Silva, Souza, 2024). There is an effort on the part of agents in the sugar-energy sector to build a psychosphere (Santos, 2012) associating the activity as a solution to the global environmental crisis, a characteristic of our time.

Regarding the support offered by the Brazilian State to the sector, it is important to highlight that, at this moment, its actions appear different from those established in previous periods, acting as: "[...] a driver of the sector's movements, through investments in transportation infrastructure, granting credit, and establishing public policies compatible with the needs of investors [...]" (Camelini; Castillo, 2012, p. 10). This induction is well exemplified by the effort to promote biofuels in national energy policy – including the maintenance and reinforcement of the mandatory ethanol percentage in gasoline, currently at 25% (MAPA Ordinance No. 7 of January 11, 2010) – anchored by the discourse of sustainability and independence from fossil fuels (Castillo, Sampaio, 2019), or with the significant increase in public funds allocated to the sector via the National Rural Credit System

(SNCR) and the National Bank for Economic and Social Development (BNDES), which provide subsidized credit for financing, research, adaptation for energy cogeneration, logistics, planting and reforming sugarcane fields, and even working capital (Central Bank, 2021; Silva, 2017). This situation led to significant production growth, rising from more than 4.8 million hectares and 326 million tons of sugarcane in 2000 to more than 10 million hectares and 757 million tons in 2020 (IBGE, 2022). This expansion of activity (Map 1) represented transformations in the uses of Brazilian territory, subordinating new areas to the logic of sugar-energy production, with two main vectors of expansion from the state of São Paulo, the country's main producer: one toward the state of Goiás, also encompassing the Triângulo Mineiro/Alto Paranaíba region in Minas Gerais, and the other toward Mato Grosso do Sul and northern Paraná (Castillo, 2015).

Map 1 - Sugarcane planted area, in hectares, by microregion (selected years)



Source: Silva(2024).

This expansion was accompanied by significant changes—the creation of new sugarcane fields and production units, adaptations of existing production units, logistical infrastructure for inputs and production flow, etc.—largely enabled by government actions through public funds. These ultimately formed a set of geographic objects created with well-defined purposes and intentions, access to which is uneven among stakeholders.

Also noteworthy in this recent and current period are changes in sugarcane production techniques, with an emphasis on the modernization of plants, enabling the production of second-generation ethanol, gas production, and the expansion of cogenerated electricity production. Also noteworthy are the technical transformations that enabled the consolidation of flex-fuel engines, which boosted ethanol production and significantly impacted activities in the sector.

In general terms, these are the technical and political transformations that allow us to recognize a new period, which began at the end of the last century and continues until the moment of this analysis, in which the territorial dynamics of the Brazilian sugar-energy sector began to be guided by processes and agents inserted in a new context, that of financialization.

Final considerations

The periodization exercise presented in this article allowed us to relate the process of establishing the Brazilian sugarcane-energy sector to the dynamics of territorial use within the context of Brazil's socio-spatial formation.

Two important conclusions emerge from this interpretative effort. The first is that analyzing spatial phenomena based on the intertwined relationships between technology and politics presents a concrete epistemological path toward recognizing the space-time relationship from a geographical perspective. This allows us to understand the dialectical relationships between materiality and immateriality, which, at each moment, function simultaneously as conditioning factors and conditioned factors, dictating the dynamics of transformation in territorial use.

Moreover, more specifically, the exercise demonstrates the existence of aspects and processes that perpetuate themselves over time in the national sugarcane-energy sector, albeit with new guises, such as: the role of the Brazilian state, which, at different historical moments, acted as a sustainer of production, demonstrating the sector's dependence on state support; international demands and prices as principles

for organizing production, shaping other aspects of dependence and vulnerability; and the presence of barbarity, which has accompanied the sector throughout its historical development, beginning with the use of over 300 years of enslaved Black and Indigenous labor.

Thus, the sugarcane-energy sector was used as a means of practicing the methodological path of periodization and advocating for the historicity of geographical analyses, highlighting the potential for understanding the dialectical relationships between systems of objects and systems of action—understood through technology and politics—as the driving force behind the transformation of geographic space over time.

References

- AKRICH, Madeleine. Como descrever os objetos técnicos. **Boletim Campineiro de Geografia**. Campinas, v. 4, n. 1. 2014. DOI <https://doi.org/10.54446/bcg.v4i1.147>
- ANDRADE, Manuel Correia de. **Formação territorial e econômica do Brasil**. Recife: Fundação Joaquim Nabuco, Editora Massangana, 2006. 310 p.
- ANTAS JR., R. M. **Território e regulação: espaço geográfico, fonte material e não formal do direito**. São Paulo: Humanitas/Fapesp, 2005.
- BANCO CENTRAL. **Crédito Rural**. Disponível em: <<https://www.bcb.gov.br/estabilidadefinanceira/creditorural>> Acesso em set. 2021.
- BASTIDE, Roger. O litoral da cana-de-açúcar. In: _____. **Brasil, terra de contrastes**. São Paulo/Rio de Janeiro: DIFEL, 1976., p. 51-67.
- BENAKOUCHE, Tamara. Tecnologia é sociedade: contra a noção de impacto tecnológico. In: DIAS, Leila Christina; SILVEIRA, Rogério Leandro Lima (org.). **Redes, sociedades e territórios**. Santa Cruz do Sul: EDUNISC, 2005. p. 79-107.
- BORRAS, Saturnino M. et al. The rise of flex crops and commodities: implications for research. **The Journal of Peasant Studies**. v. 29, n. 1, p. 93-115, 2016. DOI <https://doi.org/10.1080/03066150.2015.1036417>
- BRASIL. **Decreto nº22.789 de 1º de junho de 1933**. Página na internet. Disponível em: <http://www.planalto.gov.br/ccivil_03/decreto/1930-1949/d22789.htm> Acesso em jun. 2021.
- CÂMARA LEGISLATIVA. **Decreto nº 76.593, de 14 de novembro de 1975**. Página na Internet. Disponível em: <<http://www2.camara.leg.br/legin/fed/decret/1970-1979/decreto-76593-14-novembro-1975-425253-norma-pe.html>>. Acesso em fev. 2020.

CAMELINI, João Humberto. Regiões competitivas do etanol e vulnerabilidade territorial no Brasil: o caso emblemático de Quirinópolis, GO. **Dissertação (Mestrado)** – Instituto de Geociências, Universidade Estadual de Campinas, Campinas. 2011.

CAMELINI, João Humberto; CASTILLO, Ricardo. Etanol e uso corporativo do território. **Mercator**. Fortaleza, v. 11, n. 25, p. 7-18, 2012. Disponível em: <<http://www.mercator.ufc.br/index.php/mercator/article/viewFile/722/414>>. Acesso em nov. 2019.

CARNEIRO, Ricardo de Medeiros. Commodities, choques externos e crescimento: reflexões sobre a América Latina. **CEPAL - Serie Macroeconomía del desarrollo**. Santiago: Publicações nas Nações Unidas. 2012.

CASTILLO, Ricardo. Dinâmicas recentes do setor sucroenergético no Brasil: competitividade regional e expansão para o bioma cerrado. **Geographia**, Niterói, v. 17, n. 35, 2015, p. 95-119. DOI <https://doi.org/10.22409/GEOgraphia2015.v17i35.a13730>

CASTILLO, Ricardo; SAMPAIO, Mateus de Almeida Prado. Reestruturação produtiva e regionalização do agronegócio canavieiro no Brasil no século XXI. In: BERNARDES, Júlia Adão; CASTILLO, Ricardo (Org). **Espaço geográfico e competitividade: regionalização do setor sucroenergético no Brasil**. Rio de Janeiro: Lamparina, 2019. p. 235-252.

CASTRO, Antônio Barros de. Brasil, 1610: mudanças técnicas e conflitos sociais. **Pesquisa e Planejamento Econômico**. Rio de Janeiro: IPEA, 1980, n. 10 (3), p. 679-712.

DELGADO, Guilherme Costa. **Do capital financeiro na agricultura à economia do agronegócio: mudanças cíclicas em meio século (1965-2012)**. Porto Alegre: UFRGS, 2012.

DUNHAM, F. B.; BOMTEMPO, J. V.; FLECK, D. L. A Estruturação do Sistema de Produção e Inovação Sucroalcooleiro como Base para o Proálcool. **Revista Brasileira de Inovação**, Campinas, SP, v. 10, n. 1, p. 35-72, 2011. DOI <https://doi.org/10.20396/rbi.v10i1.8649009>

FERLINI, Vera Lúcia Amaral. **A civilização do açúcar**. São Paulo: Brasiliense, 1994. 105 p. (Tudo é história).

FERREZ, Marc. Brasil: Engenho Central de Quissaman. p&b, 1877. In: **Biblioteca Digital Luso-Brasileira**. 2021. Disponível em: <<http://acervo.bndigital.bn.br/sophia/index.html>> Acesso em jan. 2021.

FURTADO, Celso. **O longo amanhecer: reflexões sobre a formação do Brasil**. Rio de Janeiro: Paz e Terra, 1999.

KAHIL, Samira Peduti. Usos do território: uma questão política. **Estudos Geográficos**. Rio Claro, v.10, n.11, jul./dez 2012.

KOHLHEPP, Gerd. Análise da situação da produção de etanol e biodiesel no Brasil. **Estudos Avançados**, [s. l.], v. 24, n. 68, p.223-253, 2010. UNIFESP (SciELO). DOI <https://doi.org/10.1590/S0103-40142010000100017>

MARINI, Ruy Mauro; **Dialética da dependência**; Petrópolis, Editora Vozes, 2000

MEIRA, Roberta Barros. A gênese da modernização do setor açucareiro: os engenhos centrais no Brasil. **Simpósio Nacional de História**, 2007, São Leopoldo. Anais.... São Leopoldo: Unisinos, 2007. Disponível em: <<http://anpuh.org/anais/wp-content/uploads/mp/pdf/ANPUH.S24.0011.pdf>>. Acesso em jan. 2020.

MORAES, Antônio Carlos Robert. **Geografia histórica do Brasil**: cinco ensaios, uma proposta e uma crítica. 1ª. ed. São Paulo: Annablume, 2009. v. 1. 152 p.

OLIVEIRA, Francisco de. A economia política da social-democracia. **Revista USP**. São Paulo: 1993

OLIVEIRA, Ariovaldo Umbelino. **A Mundialização da Agricultura Brasileira**. São Paulo: Iánde Editorial, 2016. v. 1. 545p.

PAUL, Nilson Maciel de; FUCK, Marcos Paulo; DALCIN, Rafael Barreto. Trajetórias tecnológicas do etanol: do Proálcool à alcoolquímica. **Revista Espacios**. V. 33, n. 29, 2012. n.p.

PRADO JR., Caio. **História Econômica do Brasil**. São Paulo: Ed. Brasiliense, 1987.

PRATES, Daniela Magalhães. A alta recente dos preços das commodities. **Revista de Economia Política**. São Paulo, v. 27, n. 3, p. 323-344, Sept. 2007. DOI <https://doi.org/10.1590/S0101-31572007000300001>

RAMOS, Pedro. **Agroindústria canavieira e propriedade fundiária no Brasil**. 1991. 331 p. Tese (Doutorado em Administração), Fundação Getúlio Vargas, São Paulo, 1991. Disponível em:< <https://bibliotecadigital.fgv.br/dspace/handle/10438/4550>>. Acesso em: jun. 2025.

RODRIGUES, Gelze Serrat de Souza Campos; ROSS, Jurandyr Luciano Sanches. **A trajetória da cana-de-açúcar no Brasil**: perspectivas geográfica, histórica e ambiental. Uberlândia: EDUFU, 2020.

RUGENDAS, Johann Moritz. **Moulin à sucre**. Gravura, 1835. In: **Biblioteca Digital Luso Brasileira**. 2022. Disponível em: < <https://bdlb.bn.gov.br/acervo/handle/20.500.12156.3/19986>> Acesso em mar. 2022.

SAFATLE, Fernando Netto. **A economia política do Etanol**: a democratização da agroenergia e o impacto na mudança do modelo econômico. São Paulo: Alameda, 2011.

SANTOS, Milton. **Natureza do espaço**: técnica e tempo, razão e emoção. São Paulo: Editora da Universidade de São Paulo, 2012.

SANTOS, Milton. **Técnica, espaço e tempo**. São Paulo: Editora da Universidade de São Paulo, 2013.

SANTOS, Milton. **Espaço e método**. São Paulo: Editora da Universidade de São Paulo, 2014.

SANTOS, Milton; SILVEIRA, Maria. Laura. **O Brasil**: território e sociedade no início do século XXI. Rio de Janeiro: Record, 2016.

SCHWARCZ, Lilia Moritz; STARLING, Heloisa Maria Murgel. Tão doce como amarga: a civilização do açúcar. In: _____. **Brasil**: uma biografia. São Paulo: Companhia das Letras, 2015. p. 50-79.

SILVA, L. R. O BNDES e a sustentação do setor sucroenergético no Brasil: implicações territoriais no contexto neoliberal e de financeirização. 2017. **Dissertação** (Mestrado em Geografia. Área de Concentração: Geografia e Gestão do Território)-Programa de Pós-Graduação em Geografia da Universidade Federal de Uberlândia (PPGEO/UFU), Uberlândia, 2017.

SILVA, L. R.; SOUZA, G. V. A. Psicofera de sustentabilidade ambiental: o setor sucroenergético e a política nacional de biocombustíveis (RenovaBio). **Geografia**. Rio Claro: v. 49 n. 1 (2024), p. 186-211.

SILVEIRA, Maria Laura. Território usado y fenómeno técnico em el período de globalización. **Párrafos Geográficos**. V. 11, n. 02, 2012. Disponível em: <<https://www.revistas.unp.edu.ar/index.php/parrafosgeograficos/article/view/680>> Acesso em jun. 2025.

SILVEIRA, María Laura (2019). Espacio geográfico y fenómeno técnico: cuestiones de método. **Punto Sur**, (1), 6-20. DOI <https://doi.org/10.34096/ps.n1.6910>

SIQUEIRA, Paulo Henrique de Lima; CASTRO JÚNIOR, Luiz Gonzaga. Fusões e aquisições produtivas e da agroindústria de cana-de-açúcar no Brasil e nas distribuidoras de álcool hidratado etílico. **Revista de economia e sociologia rural**. Brasília, v. 48, n. 4, out.-dez. 2010. DOI <https://doi.org/10.1590/S0103-20032010000400009>

SVAMPA, Maristella. Consenso de los commodities, giro ecoterritorial y pensamiento crítico en América Latina. **Revista del Observatorio Social de la América Latina**, Buenos Aires, ano XVIII, n. 32, p. 15-38, 2012.

SZMRECSÁNY, Tamás. **O planejamento da agroindústria canavieira do Brasil (1930 – 1975)**. Campinas: Hucitec; Unicamp, 1979.

SZMRECSÁNY, Tamás. Crescimento e crise da agroindústria açucareira do Brasil, 1914-1939. **Revista Brasileira de Ciências Sociais**, v. 7, n. 5, jun., p. 32-68, 1988. Disponível em: <http://www.anpocs.org.br/portal/publicacoes/rbcs_00_07/rbcs07_02.htm>. Acesso em: jun. 2015.

SZMRECSÁNYI, Tamás; MOREIRA, Eduardo Pestana. O desenvolvimento da agroindústria canavieira do Brasil desde a Segunda Guerra Mundial. **Estudos Avançados**, [s. l.], v. 5, n. 11, p. 57-79, 1991. FapUNIFESP (SciELO). DOI <https://doi.org/10.1590/S0103-40141991000100006>

VERDI, Adriana Renata; AOUN, Samira. O agronegócio brasileiro na globalização financeira: estratégia e dinâmica dos principais grupos. **Revista de economia agrícola**. São Paulo, v. 56, n. 1, p. 103-118, jan./jun. 2009. Disponível em: <<ftp://ftp.sp.gov.br/ftpiea/publicacoes/rea/rea7-n1-09.pdf>>. Acesso em set. 2016

VIAN, Carlos Eduardo Freitas. **Agroindústria Canavieira: estratégias competitivas e modernização**. Campinas: Ed. Átomo. 2003.

WINNER, Langdon. Do artifacts have politics? **Daedalus**, v. 109, n.1., 1980, p. 121-136. Disponível em: <<https://www.cc.gatech.edu/~beki/cs4001/Winner.pdf>> Acesso em fev. 2020.

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