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Territorial and temporal dynamics of tangerine (*Citrus reticulata*) production in Brazil between 1970 and 2020

Dinâmicas territoriais e temporais da produção de tangerinas (*Citrus reticulata*) no Brasil entre 1970-2020

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Abstract

The geographical distribution of tangerine (*Citrus reticulata*) plantations in Brazil underwent significant changes between 1970 and 2020, reflecting territorialization, deterritorialization, and reterritorialization. This study analyzes the spatial dynamics of tangerine cultivation in Brazil based on data from the Municipal Agricultural Production survey (PAM/IBGE), using a quali-quantitative approach that focuses on planted area and production volume, and applies decadal averages for each municipality, associated with the construction of thematic maps and the comparison of historical series, which made it possible to identify patterns of continuity and disruption in production and to map the shifts of the main production areas over the decades. The research identified the initial consolidation of citriculture in the state of São Paulo, followed by a decline due to diseases such as greening, and the emergence of new production centers in Minas Gerais, Paraná, and Rio Grande do Sul. The spatial analysis revealed that tangerine production shifts according to environmental, phytosanitary, and economic factors, affecting the permanence of orchards in certain territories. It is observed that production concentration in some regions fosters agricultural specialization but also amplifies sanitary vulnerabilities inherent to the activity. The study concludes that tangerine citriculture in Brazil is marked by a constant cycle of territorial reorganizations, driven both by phytosanitary challenges and by productive strategies aimed at competitiveness and adaptation to new sectoral conditions.

Keywords:
Spatial distribution, Citrus farming, Territorial reconfiguration, Territorialization, Deterritorialization.

Resumo

A distribuição geográfica das plantações de tangerina no Brasil passou por mudanças significativas entre 1970 e 2020, refletindo processos de territorialização, desterritorialização e reterritorialização. Este estudo analisa a dinâmica espacial do plantio de tangerinas (*Citrus*

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Reticulata) no Brasil, a partir de dados da Produção Agrícola Municipal (PAM/IBGE), utilizando uma abordagem quali-quantitativa, enfocando as variáveis área plantada, quantidade produzida e utilizando da média decenal de cada município**,** associada à construção de mapas temáticos e à comparação das séries históricas, o que permitiu identificar padrões de continuidade e ruptura na produção**.** A pesquisa identificou a consolidação inicial da citricultura no estado de São Paulo, seguida de retração em decorrência de doenças como o greening e pela emergência de novos núcleos produtivos em Minas Gerais, Paraná e Rio Grande do Sul. A espacialização revelou que a produção de tangerinas se desloca conforme fatores ambientais, fitossanitários e econômicos, afetando a permanência dos cultivos em determinados territórios. Observa-se que a concentração produtiva em algumas regiões favorece a especialização agrícola, mas também amplifica vulnerabilidades sanitárias inerentes à atividade. Conclui-se que a citricultura de tangerinas no Brasil é marcada por um ciclo constante de reorganizações territoriais, impulsionado tanto por desafios fitossanitários quanto por estratégias produtivas voltadas à competitividade e à adaptação às novas condições do setor.

Palavras-chave:
Distribuição espacial, Citricultura, Reconfiguração territorial, Territorialização, Desterritorialização.

I. INTRODUCTION

Global tangerine production has shown significant growth in planted area in recent decades, more than doubling between 2000 and 2023, from 1,803,980 hectares to 3,893,358 hectares (FAO, 2023). This expansion was driven by the high demand for fresh citrus fruits, particularly in the case of the Ponkan tangerine in Brazil, a variety almost entirely destined for the table market (Neves; Trombin, 2014). China stands out as the world's largest producer, followed by countries such as India, Turkey, Pakistan, Egypt, Spain, and Brazil. Although significant domestically, Brazil accounts for only 2.5% of global production, with production predominantly aimed at domestic supply, as phytosanitary restrictions hinder this fruit export (Koller; Schafer, 2017).

Brazilian *Citrus reticulata* production is predominantly of the Ponkan variety, with supply concentrated between March and September, but especially from May to August (SEBRAE, 2023). This seasonality, combined with the recent reduction in domestic production caused by the advance of Greening, has led Brazil to increasingly import tangerines to meet domestic demand outside the harvest period. Another reason would be the low supply of high-quality fruit in the domestic market, since Brazilian citrus farming has historically prioritized the production of oranges for the manufacture and export of juice, relegating the production of table tangerines to a secondary role (Koller; Schafer, 2017).

The territorialization of tangerines (*Citrus reticulata*) in the West occurred late (Donadio; Mourão Filho; Moreira, 2004). The first descriptions of the fruit date back to 1817, in Rio de Janeiro (Zaragoza, 2016). In Rio

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Grande do Sul, there is evidence of the introduction of tangerines around 1860, due to seeds brought by immigrants. Later, in the 19th century, the first reports of commercial tangerine plantations appear in the state of Rio de Janeiro, where the main tangerine planting center was established for some years (Donadio; Mourão Filho; Moreira, 2004; Koller; Schafer, 2017; Liu, Heying, Tanumihardjo, 2012; Sharma, 2012).

Throughout the 20th century, large-scale planting in Brazil consolidated, with the main axis established near large population centers and production primarily aimed at domestic consumption (Donadio; Mourão Filho; Moreira, 2004). Starting in 1926, the country began exporting to Europe, but climate and phytosanitary crises, such as the "citrus tristeza" disease in the 1930s, caused the sector to decline (Neves et al., 2010). In the 1940s, a reterritorialization occurred, marked by the displacement of orchards from Rio de Janeiro to the interior of São Paulo state, where citrus farming replaced coffee in areas such as Limeira and later expanded to Araraquara and Bebedouro, establishing itself as a relevant agricultural activity in the state (Neves et al., 2010).

Throughout its history, Brazilian citrus production has been marked by cycles of expansion and contraction, with tangerine showing significant variations in both production and spatial distribution (Carvalho et al., 2019; Gravena, 2011; Vasconcelos, 2015; Nascimento, 2010; Alves, 2021; Severo; Pedrozo, 2007, 2008). Between 1995 and 2005, national production practically doubled, reaching 1.2 million tons (Fachinello et al., 2008). However, in recent years, there has been a reduction in the planted area, which decreased from 64,000 hectares in the 2000s to approximately 55,000 hectares in 2023 (IBGE, 2023). This decline over the past two decades is directly related to the incidence of citrus greening (*Huanglongbing* – HLB), one of the most severe citrus diseases, responsible for the eradication of entire orchards in several producing regions. HLB is transmitted by the Asian citrus psyllid (*Diaphorina citri*), a vector that causes the rapid spread of the disease in Brazilian orchards (FUNDECITRUS, 2022).

The state of São Paulo, which plays a key role in the development of tangerine cultivation, has long concentrated the main citrus-producing municipalities, such as Limeira, Taquaritinga, and Araras (Donadio; Mourão Filho; Moreira, 2004). However, the incidence of disease caused a significant reduction in the area planted with tangerines in most of these municipalities. Faced with this scenario, farmers in other states, such as Minas Gerais, invested in the crop, resulting in a spatial reconfiguration of the main tangerine-producing centers in Brazil.

Between 2012 and 2023, the planted area in Minas Gerais grew significantly, consolidating the state, previously not a traditional producer of the fruit, as the state with the largest planted area of tangerines in Brazil and the second-largest producer in the country, with approximately 256,000 tons produced, representing about

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24% of the Brazilian harvest, behind only São Paulo, which represents 30% (IBGE, 2023). The lower incidence of greening, combined with favorable climatic conditions, favored territorialization, transforming the agrarian structure and leading to specialization in citrus farming in the South/Southwest of Minas Gerais. Therefore, it can be observed that tangerine cultivation in Brazil has exhibited complex and varied spatial dynamics in recent decades. Between 1970 and 2020, successive displacements of the main production centers were observed, configuring a geographic pattern of temporality that challenges crop stability in a specific location.

In this context, the notion of territorialization, deterritorialization, and reterritorialization (Haesbaert; Bruce, 2002; Haesbaert, 2013; Alves, 2019) is fundamental to understanding the spatial changes in tangerine production in Brazil. Territory, understood beyond its physical dimension, consists of the power relations established within it. Territorialization occurs when certain spaces consolidate themselves as productive hubs due to favorable climatic and soil conditions, agricultural specialization, labor availability, etc. Deterritorialization, in turn, takes place when these ties weaken, whether due to environmental, economic, or political factors, as in the recent case of the spread of greening (*Huanglongbing* – HLB), which has increased maintenance costs, reduced production and, in some cases, led to the abandonment of contaminated areas. Reterritorialization emerges when new territories are appropriated and reconfigured for the activity, as observed in the displacement of tangerine production centers from the interior of São Paulo to states such as Paraná, Rio Grande do Sul and Minas Gerais, where the lower incidence of HLB and more favorable structural conditions encourage the insertion or sustain the continuity of citrus farming.

Given this scenario, this research aims to analyze the temporality of the geographic distribution of tangerine plantations in Brazil between 1970 and 2020, identifying production shifts and the factors driving these territorial changes. The hypothesis is that such shifts do not occur randomly, but rather express a process of territorialization, deterritorialization, and reterritorialization, primarily driven by phytosanitary, environmental, and economic factors, which have increased production costs and led to changes in the persistence or abandonment of production areas. The central problem guiding this study is to understand the recent deterritorialization of tangerine production in Brazil, marked by the weakening of traditional centers located in the interior of São Paulo. The incidence of diseases such as citrus canker and, more recently, citrus greening (*Huanglongbing* – HLB), associated with the increased use of pesticides and crop maintenance costs, has led to the abandonment of the activity in this region, while also driving the relocation of citrus farming to new areas and players, where the incidence of the disease is non-existent or still relatively low.

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II. Material and Methods

This research adopts a qualitative and quantitative approach, combining statistical data on tangerine production and planted area with a geographic interpretation of their territorial dynamics. The quantitative component is based on data from the Municipal Agricultural Production (PAM/IBGE) on planted area and quantity produced, available annually for all Brazilian municipalities since 1970. Despite minor methodological variations over time, particularly in information collection mechanisms at the municipal level, the PAM maintains standardization criteria that ensure the historical comparability of the series (IBGE, 2023). Data spatialization was achieved by plotting thematic maps using QGIS Desktop 3.28.1 using the decadal average of the collected data.

The choice of the timeframe, covering the 1970s to 2020, is justified by the availability of systematized data on tangerine production in the country. It is worth noting that, until the 1980s, the PAM did not include the planted area variable; thus, for previous years, maps were prepared based on total production expressed in thousand fruits. To minimize annual fluctuations in planted areas and enable a better understanding of the crop territorial dynamics, the average production and planted area were calculated by decade and averages were then standardized by converting them into a percentage of the national total. This method allowed to identify patterns of permanence or displacement of tangerine production areas over time, avoiding distortions due to climatic and seasonal variations that can influence annual production and planted area.

To create the thematic maps, polygons representing production concentration on a national scale were generated. In the 1970s and 1980s, these polygons were constructed based on the percentage of national tangerine production by municipality. Beginning in the 1990s, the polygons began to be defined based on the percentage of the national planted area. In both cases, the ten-year average of production and planted area was used, which made it possible to more consistently highlight the areas of greatest relative importance in each period.

The qualitative part is based on the available bibliographic references on citrus farming in Brazil in recent decades, allowing to interpret the processes of territorialization, deterritorialization, and reterritorialization of tangerine production. The design was exploratory and descriptive: the quantitative variables (production and planted area) were analyzed descriptively and comparatively, and the spatial results obtained were associated with agrarian, phytosanitary, and socioeconomic factors discussed in the specialized literature, ensuring integration between empirical data and theoretical interpretation.

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III. RESULTS AND DISCUSSION

By the 1970s, tangerine planting was concentrated in the state of São Paulo, which accounted for approximately 45% of national production, with Rio Grande do Sul and Rio de Janeiro close behind, with 17% and 8%, respectively (IBGE, 2023). Figure 1 illustrates the concentration of production in the three states, particularly in São Paulo, where the main production hubs were located. Of particular note are Limeira (SP) and Itaborai (RJ), which accounted for 6.1% and 4.6% of tangerine production in the 1970s, respectively.

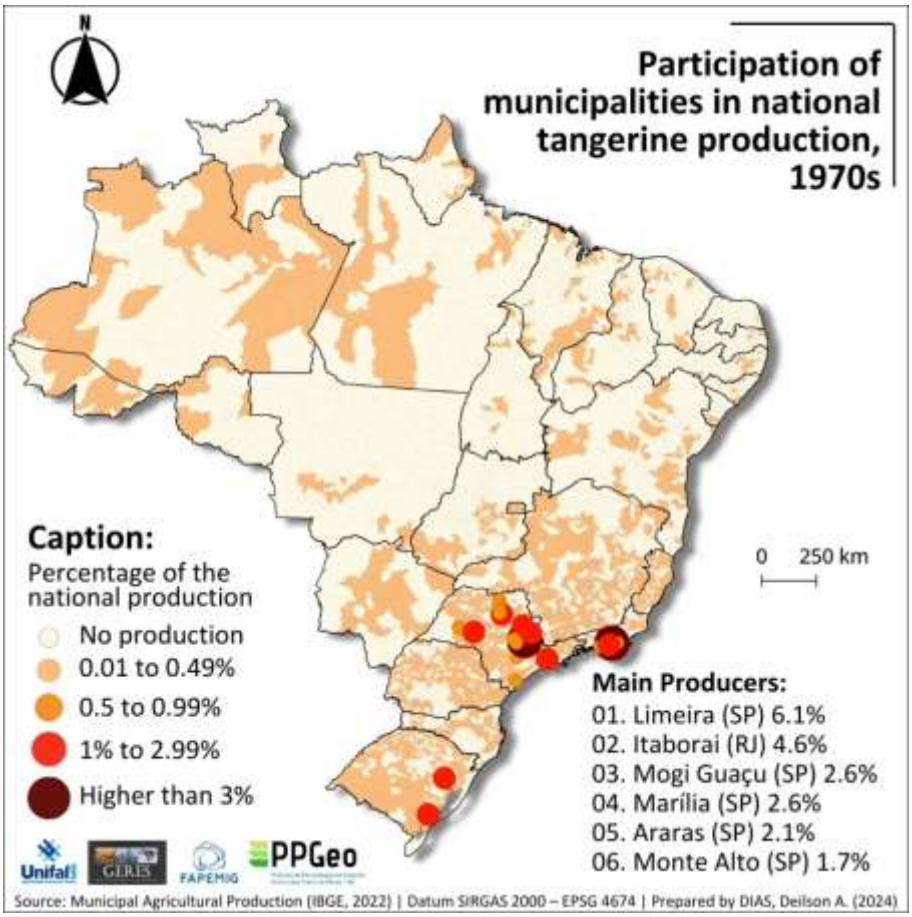

Figure 1 – Map of municipalities that were the territorialization hubs of tangerine production in the 1970s. (Source: IBGE, 2023).

Other important municipalities in the 1970s included Mogi Guaçu, Marília, Araras, and Monte Alto, all located in São Paulo. In general, most producing municipalities contributed less than 0.5% of national production each, with the largest producers concentrated in a few regions, suggesting that these areas had the ideal conditions for the development of this industry.

In the 1980s, we can see from Figure 2 that more states began to have municipalities with a share of more than 0.5% of national production. Notably, Minas Gerais, with the municipalities of Alfenas in the south of the state, and Inhapim in the Vale do Rio Doce Mesoregion. In Paraná, a production hub emerged in the

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northeast. The municipality of Cerro Azul (PR) stands out for its significant increase in tangerine production, jumping from 2,876 fruits in 1980 to 250,000 fruits in 1989, becoming the largest national producer that year.

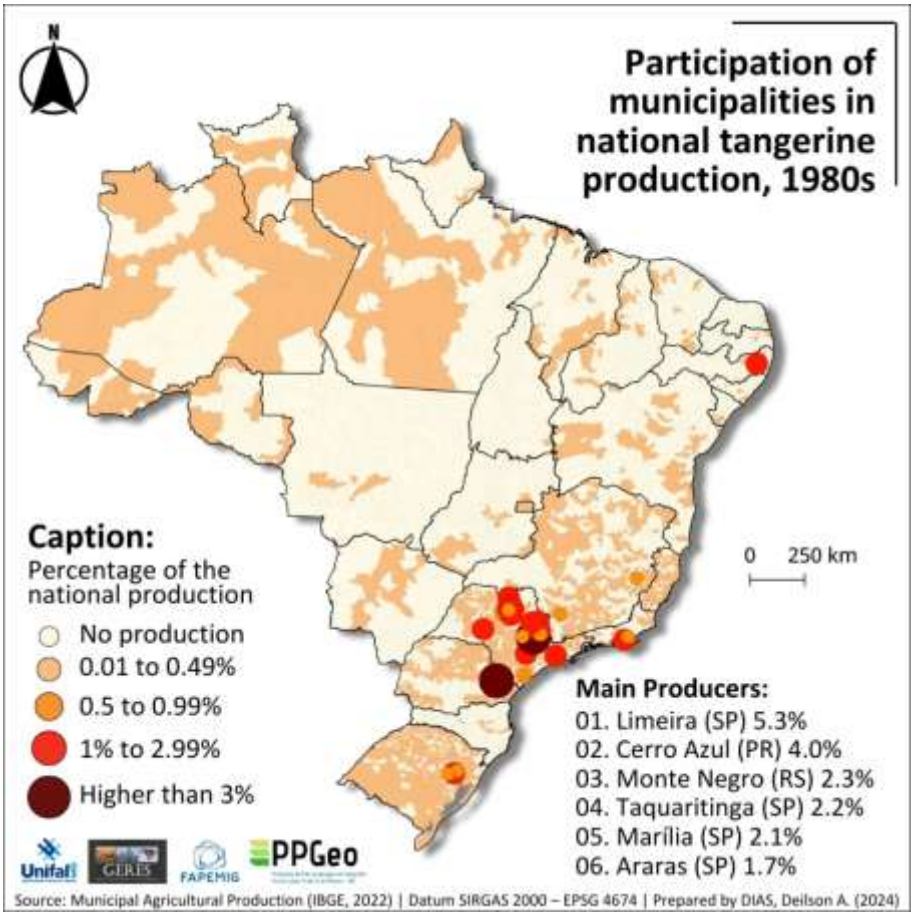

Figure 2 – Map of municipalities that were the territorialization hubs of tangerine production in the 1980s. (Source: IBGE, 2023).

In Pernambuco, the municipality of Sairé emerged as an important tangerine-producing area in this decade, being the first to appear outside the South-Southeast axis. The state of São Paulo continues to concentrate the main production hubs, showing an increase in its share of national production, reaching 53.52% in the 1980s. Other states that experienced considerable growth were Rio Grande do Sul and Paraná, which now represent, respectively, 19% and 7.54% of national production. Among the municipalities, Limeira emerged as the main hub, despite a reduction in its share compared to the previous decade.

Taquaritinga, another municipality in São Paulo, stood out as a major producer, with over 176,000 fruits between 1984 and 1985. However, the municipality suffered a significant drop in production, ending the decade with approximately 39,000 fruits. Other municipalities in the interior of São Paulo that also saw a decline in production during the decade were Marília, which fell from 81,893 fruits to zero; Mogi das Cruzes, which fell

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from 128,000 to 33,000; Bebedouro, which decreased from 51,000 to 20,000; and Barretos, which dropped from 41,400 to 24,000 fruits.

This decline in tangerine production may be associated with the significant restructuring of São Paulo's citrus industry during the decade, which was heavily oriented toward orange production for frozen juice processing industries. Public policies contributed to this expansion, with the state focusing tax incentives on juice exports and investments in research, while reducing subsidized rural credit (Paulillo, 2001). Furthermore, health issues discouraged cultivation in São Paulo in the 1980s and 1990s. Aggressive diseases such as Citrus Canker and Citrus Variegated Chlorosis (CVC) compromised yield and increased management costs in tangerine orchards (Donadio; Mourão Filho; Moreira, 2004; Neves et al., 2010). This context leads us to believe that growing oranges became more profitable and safer than maintaining tangerines, leading São Paulo producers to replace tangerine with orange orchards.

Rio de Janeiro continued to stand out for its declining centrality in tangerine production. The state, which produced an average of over 454,314 million tangerines in the 1970s, ended the 1980s with an average production of approximately 191,194 million tangerines, representing a decrease of almost 10% in its share of national production. Examples of this decline include the municipalities of Itaboraí, which saw its production fall from 81,250 million tangerines at the beginning of the decade to just over 13 million tangerines at the end; Rio de Janeiro, which dropped from 17,900 million tangerines to 250,000 tangerines; and Cachoeiras de Macacu, which saw its production fall from 15,840 million tangerines to 5,530 million tangerines. The constant decline in tangerine production in the state of Rio de Janeiro, as previously mentioned, also stems from phytosanitary problems such as "Citrus Tristeza" (1937), Citrus Canker (1957), and Citrus Decline (1977), which affected orchards in the region, reducing yield and increasing maintenance costs (Donadio; Mourão Filho; Moreira, 2004; Neves et al., 2010). This scenario, combined with the strong pressure of urban expansion on former rural areas, led producers in Rio de Janeiro to migrate to other activities.

In the 1990s, with data availability on the area allocated for planting, an increase in the total area planted with tangerines in Brazil was observed, rising from 45,000 hectares in 1990 to approximately 51,000 hectares in 1999. This increase was largely due to the growth in planting in the states of Rio Grande do Sul, Paraná, and Minas Gerais (see Figure 3). In addition, production centers emerged in Bahia, notably Rio Real, a municipality that experienced a significant increase in planting in the first half of the decade, going from no hectares planted to 3,000 hectares in 1993. However, the crop in the municipality fluctuated, reaching 1999 with only 120 hectares planted.

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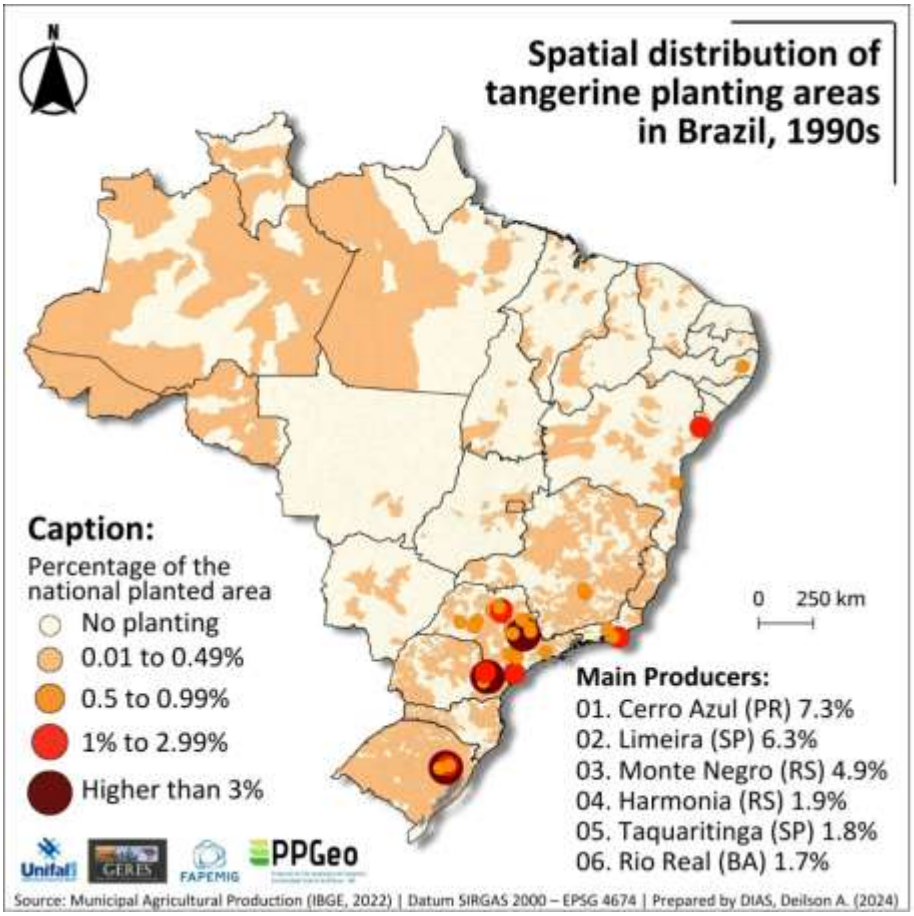

Figure 3 – Map of municipalities that were the territorialization hubs of tangerine production in the 1990s. (Source: IBGE, 2023).

Another municipality in Bahia that suffered a large decrease in planted area was Uruçuca which, despite beginning the decade with 950 hectares planted, saw its plantations reduced to zero in 1993. These two municipalities illustrate the trajectory of the fruit in the state as a whole, which began the decade with 1,541 hectares planted, reached its peak between 1993 and 1995 with more than 3,300 hectares planted, but ended the period with just under 400 hectares planted.

Paraná was the state that experienced the greatest growth in planted area, jumping from 4,796 hectares to 10,184 hectares, increasing the state from 10.65% of the tangerine planted area in Brazil to 17.25%, with a notable expansion in the northeastern region of the state, on the border with São Paulo, as shown in Figure 3. Cerro Azul (PR), a municipality that had already excelled in the previous decade, nearly doubled its planted area, increasing from 3,000 to 5,000 hectares. Neighboring municipalities also experienced significant growth in planted area. Notable among these are Doutor Ulysses (PR), which began cultivation and expanded from zero hectares to 2,600 hectares in 1999, and Itaperuçu (PR), which had no areas designated for tangerine planting and ended the decade with 511 hectares planted.

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These data highlight the territorialization of tangerine production in the Ribeira Valley region of Paraná, where high tangerine production is the result of a combination of geographic, climatic, and cultural factors that favored this territorialization. The humid subtropical climate and altitudes between 200 and 800 meters create ideal conditions for organic, high-quality production, with more juice, intense color, and a sweet flavor. Furthermore, agricultural tradition also plays an important role, with Ponkan tangerine cultivation spanning generations, with entire families dedicated to citrus farming (Koller; Schafer, 2017).

This concentration of plantations in the Cerro Azul region - Ribeira Valley is supported by agroclimatic suitability studies that indicate that the region is highly favorable for citrus cultivation, especially the Ponkan tangerine. The Agroclimatic Risk Zoning (ZARC), established by the Ministry of Agriculture, Livestock, and Supply, identifies the Ribeira Valley of Paraná as an area suitable for citrus farming, as it combines temperature, rainfall, and water regime conditions that reduce climatic and phytosanitary risks (MAPA, 2011).

Furthermore, the technical manuals of IDR-Paraná (formerly IAPAR) highlight that the combination of the humid subtropical climate and the region's altitudes favor the production of high-quality fruits, with characteristics such as higher juice content, intense color, and sweet flavor. This framework explains the insertion and expansion of the activity in the region and reinforces the patterns mapped in this study, since the areas with the highest production concentration coincide with the zones recognized as suitable for citrus cultivation in the state (Leite Júnior et al., 2022).

Rio Grande do Sul established itself as a tangerine producer in the 1990s, with a continuous increase in planted area throughout the decade, reaching approximately 13,000 hectares in 1999, representing 22% of the country's planted area that year. The municipality of Montenegro stands out, doubling its planted area to 3,000 hectares by the end of the decade, being considered as a tangerine production hub. Following Montenegro's trend, farmers in the neighboring municipality of Pareci Novo invested in tangerine cultivation, resulting in a significant increase in planted area, from zero hectares in 1990 to 980 hectares in 1999. Other municipalities in the region also had extensive planted areas, such as Harmonia, São Sebastião do Caí, and Taquari, demonstrating a trend toward concentration and specialization in the Caí Valley region, similar to that observed in Paraná, around Cerro Azul.

This territorialization in the Caí Valley region, such as that in the Ribeira Valley (PR), is the result of an interaction between natural, economic, and sociocultural factors (Panzenhagen et al., 2008; Zulian; Dorr; Sidali, 2014). The production of a local tangerine variety, the Montenegrina bergamot, has become a reference and symbol of citrus farming in this region, maintaining the citrus tradition across generations and consolidating

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tangerine cultivation predominantly among family farmers, with small and medium-sized properties focused on the fresh fruit market (Panzenhagen et al., 2008). Furthermore, the creation of the Cooperative of Ecological Citrus Growers of the Caí Valley (Ecocitrus) in 1994 represented a milestone in strengthening citrus farming in the region. The cooperative emerged as an alternative to the conventional model, encouraging citrus production without the use of pesticides and chemical fertilizers and seeking the verticalization of the production chain, allowing farmers greater access to markets and higher value-added products (Panzenhagen et al., 2008; Zulian; Dorr; Sidali, 2014). This production model and the aggregation of value through agribusiness have ensured the competitiveness and permanence of citrus farming in the region, strengthening the territorial identity of the Caí Valley.

In the state of São Paulo, the area allocated for tangerine planting decreased compared to the previous decade, especially in the municipalities of the Ribeirão Preto Mesoregion, such as Barretos, Bebedouro, Pirangi, Taiuva, Taiaçu, Pitangueiras, and Monte Azul Paulista. In other regions of the state, some municipalities also saw a decrease in planted area, such as Mogi das Cruzes, which fell from 460 hectares at the beginning of the decade to 84 hectares in 1999, as well as Marília and Capela do Alto. In the Limeira region, although the municipality maintained its central position as a producing hub, with 6.3% of the country's planted area in the decade, neighboring municipalities began to experience a decline in plantings, such as Casa Branca, which stopped planting tangerines in 1993, as well as Mogi Guaçu, Araras, and Porto Ferreira, the latter of which had 850 hectares planted in 1990, ending the decade with just over 15 hectares.

Contrary to this trend, other municipalities in the interior of São Paulo state intensified planting which, despite fluctuations throughout the decade, made it possible to maintain the state's tangerine acreage. The municipality of Pariquera-Açu stands out, increasing its planted area from 300 to 1,505 hectares, representing an attempt to migrate citrus farming to the southwest of São Paulo in search of areas less affected by citrus sudden death (CSD) and citrus variegated chlorosis (CVC), which were driving up production costs and requiring greater investment in advanced technologies (Neves et al., 2007).

In this context, the analysis of tangerine production in São Paulo in the 1990s reveals the dynamics of mobility and temporality of cultivation, subject to fluctuations in planted area in different regions, even within the state itself. The deterritorialization of tangerine cultivation in the interior of São Paulo intensified from the 2000s onward, mainly due to the spread of greening. Detected in the state in 2004, HLB rapidly expanded: in just five years, it went from 3.4% of orchards (2004) to 24% in 2009, concentrated especially in the regions of Araraquara and Araras (Belasque Junior et al., 2010). This growth led to a significant increase in maintenance

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costs, increased use of pesticides, and the abandonment of orchards, contributing to the displacement of citrus farming to new areas (Leite Junior et al., 2022). The fact is that, from 2004 to 2011, the planted area in the state of São Paulo increased from 25,254 hectares to 13,664 (IBGE, 2023). In other words, several regions that were previously dominant in production experienced a sharp decline, with producers abandoning the crop.

In contrast, in Minas Gerais, the area designated for tangerine planting more than doubled throughout the 1990s, rising from 2,310 hectares in 1990 to 5,209 hectares in 1999. Municipalities such as Belo Vale, Campanha, and Brumadinho initiated and intensified planting throughout the decade and, by the end, were among the 13 Brazilian municipalities with the largest areas planted with tangerines. Belo Vale, which began planting in this decade, grew from 2 hectares planted to 610 hectares in 1999, a scenario similar to that observed in Campanha, which grew from 20 hectares to 550 hectares. In the case of Brumadinho, there were 150 hectares planted in 1990, an area that increased to 600 hectares in 1999. These are mainly the municipalities that would establish themselves and expand planting in the state in the following decade, placing Minas Gerais firmly on the national scene as an important producer of tangerines from the turn of the century onwards.

Based on Figure 4, we can see the consolidation of these production centers in the state of Minas Gerais, more specifically in the South/Southwest mesoregion of Minas Gerais. Campanha continued to expand its planting area throughout the 2000s, reaching approximately 780 hectares by the end of the decade. In the central region of the state, the neighboring municipalities of Brumadinho and Belo Vale also expanded their planting areas, reaching 1,025 hectares and 972 hectares, respectively, in 2009. These two municipalities emerged as the state's main production centers throughout the decade.

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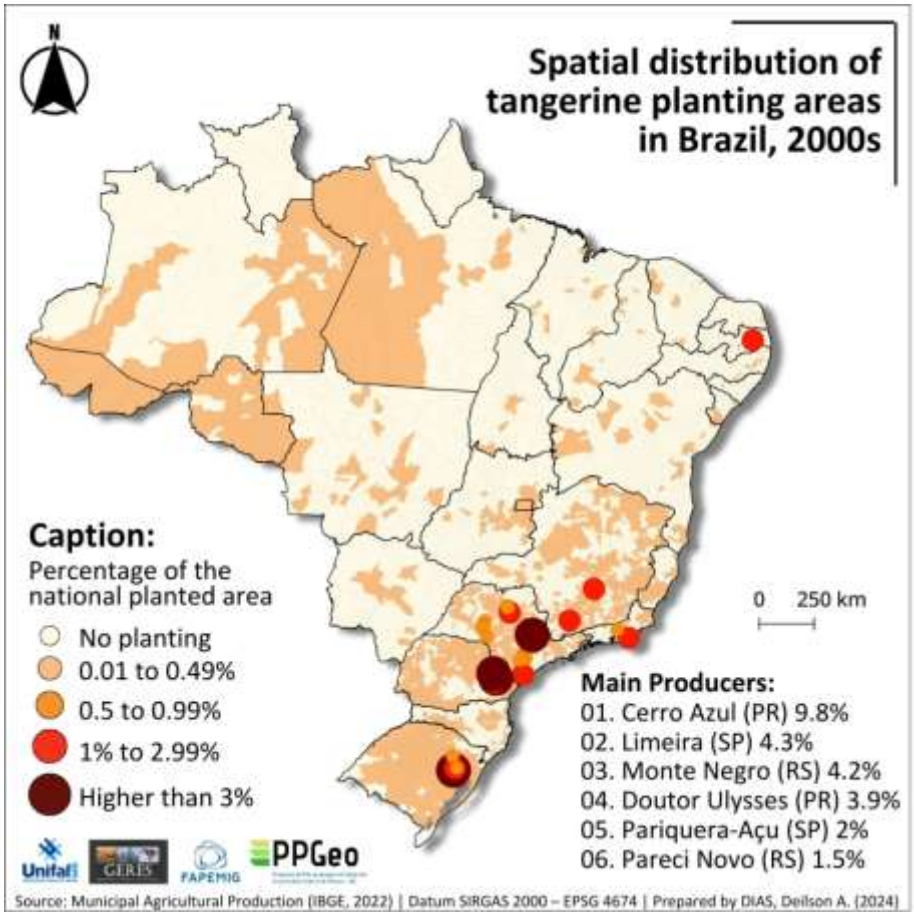

Figure 4 – Map of municipalities that were the territorialization hubs of tangerine production in the 1990s. (Source: IBGE, 2023).

In the main tangerine-producing states, a decline in planted areas was observed in the 2000s. In Rio Grande do Sul and Paraná, despite their importance to national production, particularly in the municipalities of Cerro Azul (PR), Montenegro (RS), and Pareci Novo (RS), planted areas declined. Montenegro lost approximately 1,000 hectares of cultivated area, closing 2009 with just over 2,000 hectares planted. Harmonia, a municipality that stood out in the previous decade with extensive cultivated areas, also saw its planted area decline from 905 hectares to 497 hectares. In the case of Pareci Novo (RS), the planted area remained unchanged. This decline, however, does not indicate a complete abandonment of citrus farming, but rather reflects a productive readjustment in the face of growing cost pressure for orchard maintenance. Paraná experienced a similar situation, with a reduction in planted area in its main producing municipalities. Cerro Azul, which represented 9.8% of the country's planted areas during the decade, had 7,000 hectares planted with tangerines in 2000, a figure that fell to just over 5,600 hectares in 2009. Doutor Ulysses, another production hub during the decade, responsible for approximately 3.9% of the country's planted areas, decreased from 2,600 hectares planted to

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2,343 hectares. By the end of the decade, the state of Paraná had a drop from 12,861 hectares planted to 9,909 hectares in 2008.

The fact is that the spatial concentration of citrus production, combined with a limited variety of rootstocks and canopies used, with 'Rangpur' lime being the rootstock used in 85% of cases, while 'Pêra' orange predominates as a canopy option, eventually facilitates the rapid proliferation of pests and diseases (Almeida; Passos, 2007). The incidence of these diseases, combined with the growing market pressure for increasingly standardized fruits (size, color, skin appearance, etc.), has increasingly influenced the increase in production costs, causing several family farmers to end up giving up the industry once they cannot find ways to sustain themselves in citrus farming (Neves et al., 2010). Between the 2002/03 and 2009/10 harvests, there was a significant increase of approximately 70% in operating costs, rising from R$4.25 per box to R$7.26 per box. This increase was driven by the increase in the price of agricultural inputs, especially fertilizers, insecticides and acaricides (Neves et al., 2010; Pagliuca et al., 2012).

Another reason concerns the increasing labor costs throughout the 2000s. According to Pagliuca et al. (2012), the operational costs of citrus production were significantly impacted by increased spending on labor, phytosanitary management, and harvesting. At the time, harvesting was the main driver of cost increases, as the costs of permanent and temporary workers accounted for up to 38% of out-of-pocket expenses.

In this scenario, municipalities in São Paulo saw a decline in activity in this decade. Examples include Pariquera-Açu, which went from 1,505 hectares planted to 500 hectares; Taquaritinga, which saw a reduction from 1,200 hectares to 500 hectares; São Miguel do Arcanjo, which went from 622 hectares to 62 hectares; Guaimbê, which went from 610 hectares to 32 hectares; and Conchal, São Pedro, and Capela do Alto, which had their planting areas eliminated at the end of the 2000s. The municipality of Limeira, which remained one of the leading municipalities in national tangerine production in the 2000s, suffered a reduction in its area designated for planting of almost 1,000 hectares, going from 3,123 hectares in 2000 to 2,300 hectares in 2009, already showing a downward trend in planting, which will be accentuated in the following decade. Authors such as Neves et al. (2010) understand that since the end of the 20th century, diseases have represented one of the greatest challenges for Brazilian citrus farming, forcing the eradication of plantations to contain their spread. HLB, a disease detected in Brazil in 2004, is the main phytosanitary problem of the 21st century (Koller; Schafer, 2017; Neves et al., 2010). Some studies indicate that tangerine/mandarin orange varieties are highly susceptible to HLB compared to other citrus cultivars (Machado et al., 2025; Cervante Santos et al., 2025). Thus, it is clear

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that the reduction in planted area in the state of São Paulo can be linked to the high incidence of the disease in orchards, with the most effective control being the removal of infected trees.

The downward trend in planted areas in the state of São Paulo continued in the 2010s, reaching 11,085 hectares in 2019 and culminating in a thinning of planted areas, as shown in Figure 5. Limeira, São Paulo, for the first time, does not appear among the country's main production centers. The municipality's plantations declined sharply over the decade, falling from 2,300 hectares in 2010 to just 72 hectares in 2019. With the decline in planted area in the main municipalities of São Paulo, the state was overtaken by Minas Gerais, with 11,433 hectares planted, and Rio Grande do Sul, with 11,758 hectares in 2019.

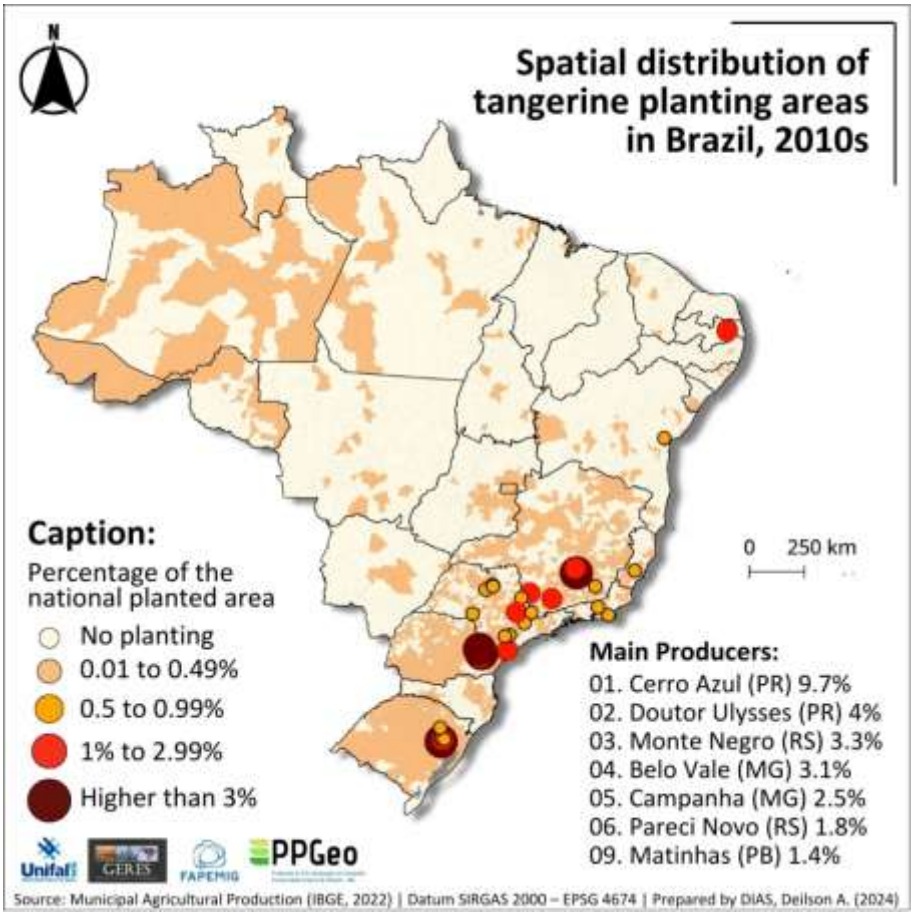

Figure 5 – Map of municipalities that were the territorialization hubs of tangerine production in the 2010s. (Source: IBGE, 2023).

In the state of Rio Grande do Sul, the area allocated for planting did not increase this decade; in fact, it decreased by just under 1,000 hectares. The three main producing municipalities in Rio Grande do Sul — Montenegro, Pareci Novo, and Harmonia — saw a slight reduction in planted area throughout the 2010s. Even so, due to the abrupt decrease in planted area in São Paulo, Rio Grande do Sul already had the largest area allocated for planting nationwide by 2013. Paraná was another state that saw a decrease in its area allocated

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for planting, by just under 2,000 hectares between 2009 and 2019. Nevertheless, the state boasted two major tangerine-growing hubs during the decade: Cerro Azul and Doutor Ulysses.

Both municipalities in Paraná saw a reduction in their planted areas, especially Doutor Ulysses, which fell from 2,343 hectares planted to just over 1,500 hectares, a portion that represented 17% of the state's production in 2019. In the case of Cerro Azul, the municipality reached 5,088 hectares in 2019 for tangerine planting, a reduction of 343 hectares compared to 2010. Even so, this is by far the largest area dedicated to cultivation in Brazil, representing approximately 60% of the state's area designated for planting. This fact highlights a strong concentration of tangerine production in these two municipalities, especially Cerro Azul which, in the decade, accounted for 9.7% of the national planted area.

In Minas Gerais, the area dedicated to tangerine cultivation nearly doubled, rising from 6,879 hectares in 2010 to 11,433 in 2019. Planted areas in Belo Vale and Campanha more than doubled over the decade, reaching 2,000 hectares each in 2019, placing these municipalities as the leading national tangerine growers, second only to Cerro Azul. Other Minas Gerais cities that saw an increase in planted areas over the decade included Bonfim, neighboring Belo Vale, Tocantins, in the Zona da Mata region, and Cambuquira, a municipality neighboring Campanha, which continued to expand its cultivation area along the BR-267 highway.

For the 2020s, the IBGE only has data available for four years, but these appear to indicate a continuation of the trends of the previous decade, as shown in Figure 6. Plantings in the state of Rio de Janeiro are clearly declining and increasingly dispersed across several municipalities. The state of São Paulo has managed to maintain its area dedicated to tangerine cultivation at around 10,000 hectares. This, combined with high production rates and increased planting density, maintains the state as the largest producer of the fruit (Neves et al., 2010), accounting for approximately 34% of the tons produced in the country in 2022, now without the spatial concentration of plantings in a few municipalities, a characteristic of previous decades.

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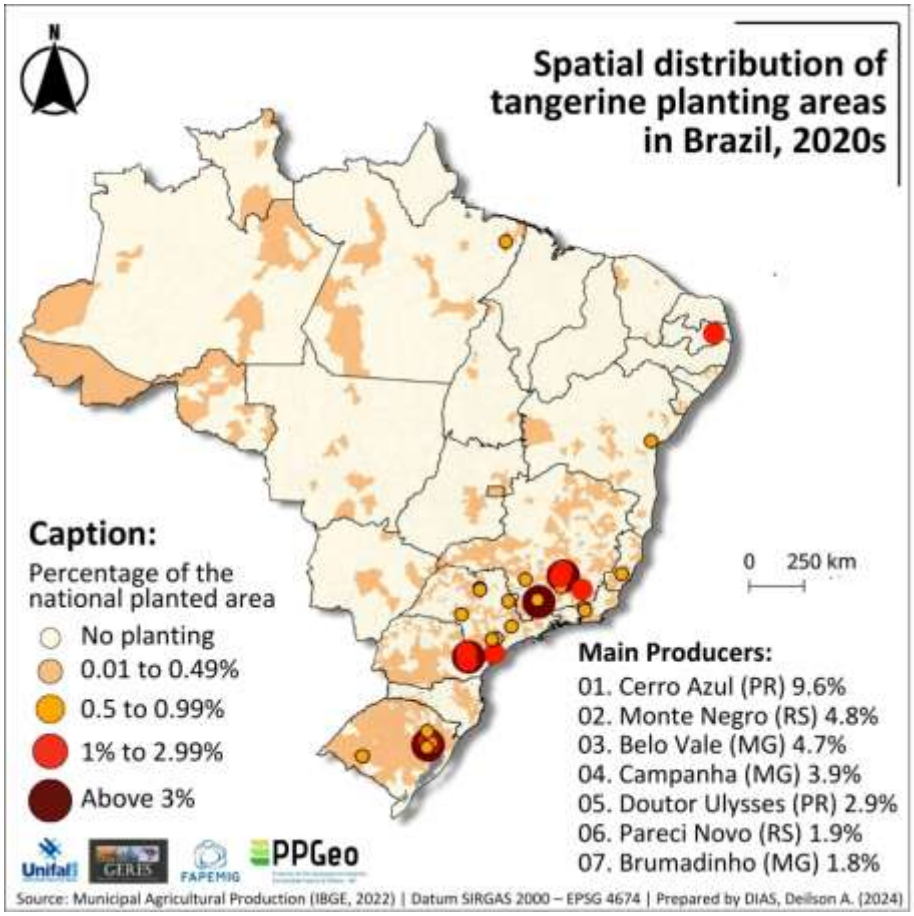

Figure 6 – Map of municipalities that were the territorialization hubs of tangerine production in the 2020s. (Source: IBGE, 2023).

In Rio Grande do Sul and Paraná, the planted area also remained stable, with the state's main producing municipalities — Cerro Azul (PR), Montenegro (RS), Doutor Ulysses (PR), Pareci Novo (RS), São José do Sul (RS), Rio Branco do Sul (PR), and Harmonia (RS) — showing little variation in hectares planted over the three years of this decade. Both states have also seen a concentration of planted areas in municipalities neighboring the main production centers. In Paraná, in the municipalities surrounding Cerro Azul and Doutor Ulysses, in the northeast of the state, and in Rio Grande do Sul, around Montenegro. This raises the hypothesis of a possible productive specialization in these regions, where the convergence of fixed-income instruments aims to provide a high productive and commercial fruit flow.

In Minas Gerais, the planted area increased by just over 1,000 hectares, making it the Brazilian state with the largest area planted with tangerines, according to IBGE data (2023), with plantings predominantly in municipalities in the southernmost part of the state. Municipalities such as Tocantins, Capitólio, and Coronel Xavier Chaves, which had already been expanding their plantings in the previous decade, have established themselves in the cultivation and continued to increase their areas dedicated to tangerine cultivation. The

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municipalities of Campanha, Belo Vale, and Brumadinho also continued to expand plantings, although now at a slower pace due to the presence of HLB in these regions, a fact that worried farmers.

A notable aspect, evidenced by the historical data on Municipal Agricultural Production (PAM/IBGE), is the tendency for plantations to concentrate in a few specific municipalities and neighboring municipalities. While this dynamic favors economies of scale and productive specialization, excessive concentration can also facilitate the proliferation of pests and diseases, such as tangerine greening, posing serious challenges to local producers. This pattern, also highlighted by Neves et al. (2010), is exemplified by municipalities such as Limeira (SP), which has remained among the top producers over the decades, as well as Mogi Guaçu, Marília, Araras, and Monte Alto, all in São Paulo. To summarize the territorial changes analyzed over the decades, a comparative graph was created showing the percentage share of the main producing states in the national total of tangerines. The graph highlights the decline of São Paulo's hegemony and the relative advancement of Minas Gerais, Paraná and Rio Grande do Sul, confirming the deconcentration and spatial reconfiguration of Brazilian citrus farming (Figure 7).

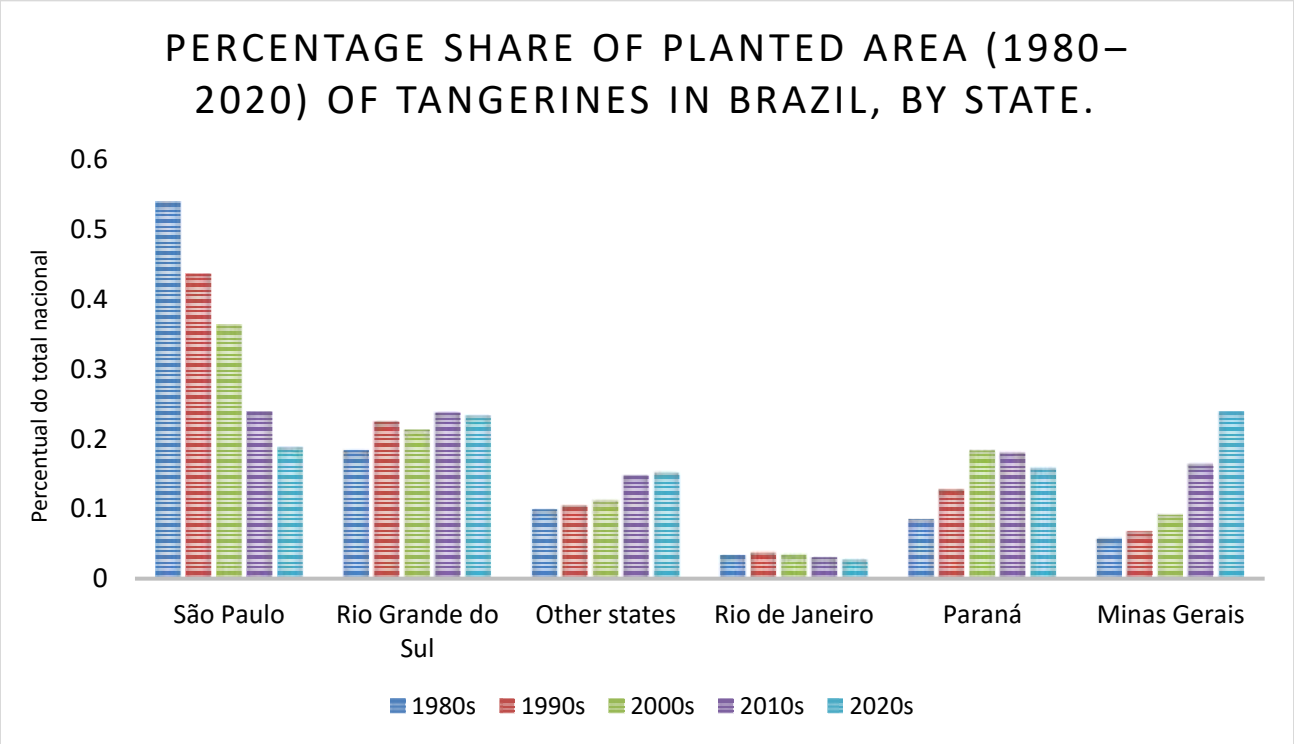

Figure 7 – Percentage share of planted area (1980–2020) of tangerines in Brazil, by state. (Source: IBGE, 2023)

São Paulo remained the leading producer until the 1980s, but its trajectory in the following decades was marked by a sharp decline in share. From the 1990s onward, São Paulo's contribution, which previously

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exceeded half of national production, fell to approximately 24% in the 2010s and below 20% in 2020. This crop deterritorialization in São Paulo stems from multiple factors. First, São Paulo's citrus industry underwent a productive restructuring in the 1980s, when public policies and economic strategies redirected the sector from oranges to the juice industry. Large producers and industries, attracted by tax incentives for the export of concentrated juice, converted tangerine orchards into orange groves (Paulillo, 2001). Simultaneously, phytosanitary challenges undermined the viability of tangerines in São Paulo: aggressive diseases such as citrus canker and citrus variegated chlorosis (CVC) spread through São Paulo's orchards in the 1980s and 1990s, compromising yield and increasing management costs (Donadio; Mourão Filho; Moreira, 2004; Neves et al., 2010). This situation made orange cultivation more profitable and safer than tangerines, leading several São Paulo citrus growers to abandon tangerine production in favor of oranges. In the early 2000s, the situation worsened with the arrival of *Huanglongbing* (HLB, or "greening"), a bacterial disease with no effective cure.

Highly destructive, as defined by Fundecitrus, phytosanitary outbreaks, especially those with Citrus Canker and Huanglongbing, forced the eradication of infected plants, emptying traditional production centers in São Paulo (Donadio; Mourão Filho; Moreira, 2004; Neves et al., 2010). Limeira (SP), for example, which had been a historical center of tangerine production, saw its cultivated area plummet from more than 3,000 hectares in 2000 to just 72 hectares in 2019. As a consequence of this economic and health pressure, São Paulo ended the 2010s behind Minas Gerais and Rio Grande do Sul in planted area, characterizing a loss of territorial centrality in the tangerine chain.

Minas Gerais, on the other hand, experienced its most notable expansion starting in the 1990s, when new centers emerged in the south and southwest of the state, driven by edaphoclimatic conditions, favorable logistics (its proximity to the main consumer centers of the fruit, namely São Paulo and Rio de Janeiro), and the phytosanitary crisis in São Paulo. In the 2000s and 2010s, Minas Gerais practically doubled its cultivated area, surpassing São Paulo in planted area and consolidating its position as the state with the largest tangerine planted area in Brazil. The phytosanitary crisis in São Paulo, marked by the advance of greening, accelerated this shift, attracting investment and producers to less affected areas of Minas Gerais (Dias; Alves, 2024).

In summary, the process reveals a dynamic of territorialization, deterritorialization, and reterritorialization, in which production shifts in search of new comparative advantages, with new actors reorganizing the agrarian space, redefining productive strategies, always seeking added value in the field, which has resulted in a continuous reconfiguration of national *Citrus reticulata* production.

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Despite highlighting clear trends in the territorial shift of tangerine production in Brazil, this study has some limitations that must be considered. First, the data used come from the Municipal Agricultural Production Survey (PAM/IBGE) which, while offering a systematic and comparable basis, does not capture all local nuances. Issues such as methodological differences in collection across municipalities, underreporting, or heterogeneity in statistical detail can lead to variations in the results. Furthermore, until the 1980s, there was no record of planted area, restricting initial analyses to production expressed in terms of number of fruits. Another limitation concerns the methodological scope: the choice of the ten-year average made it possible to minimize annual fluctuations, but at the same time may have masked significant cyclical fluctuations, such as crop crises, extreme weather events, or localized pest outbreaks.

Despite these limitations, the results point to important directions. Prospects for future research include incorporating economic variables (price, profitability, production costs), phytosanitary variables (incidence of HLB, citrus canker, and other diseases), and sociocultural variables (the role of cooperatives, family succession, and territorial organization). It would also be relevant to develop comparative analyses between the tangerine and industrial orange supply chains to understand how distinct dynamics shape the uses of Brazilian citrus-growing territory.

IV. CONCLUSIONS

An analysis of the temporality of the geographic distribution of tangerine plantations demonstrates that fruit production is far from static. On the contrary, it is embedded in a dynamic context of territorial reconfigurations, in which the permanence or displacement of production areas is influenced by various factors. Thus, it is understood that tangerine production in Brazil is subject to cycles of territorialization, deterritorialization, and reterritorialization (Haesbaert, 2013), which are fundamental to understanding the current distribution of plantations.

Initially concentrated in São Paulo, tangerine production in that state declined significantly in the 2000s, marked by the incidence of diseases such as greening and rising production costs. Conversely, new regions have emerged: Rio Grande do Sul, consolidated by the Caí Valley cluster; Paraná, with a focus on the Ribeira Valley; and Minas Gerais in recent decades as an emerging region and, by the end of the period, achieved a similar position among the country's leading producers.

These shifts did not occur randomly, but rather expressed a search for more favorable conditions, whether environmentally, economically, or socioculturally. Although national production remained relatively

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stable, the area planted with tangerines followed a distinct trajectory: after continuous growth between 1988 and 2003, reaching 63,099 hectares in 2004, a decline was observed starting that same year, coinciding with the detection of citrus greening in Brazil, reaching 55,556 hectares in 2023 (IBGE, 2023). This movement reinforces the idea that Brazilian citrus farming did not collapse, but underwent a process of territorial reconfiguration, with contraction in areas pressured by the HLB and rising costs, while simultaneously expanding into new territories with more favorable conditions.

This displacement, evidenced by agricultural specialization, while bringing gains in scale and efficiency, also increases structural vulnerabilities. The concentration of crops in certain regions can accelerate phytosanitary degradation and require constant adjustments by producers, whether through the adoption of new management practices, the introduction of more resistant varieties, or even migration to areas less affected by pests and diseases. The observed reterritorialization, especially in Minas Gerais, points to the search for productive alternatives that balance economic viability and agricultural health, although still at risk of a recurrence of challenges that led to the decline in previous hubs.

Therefore, the results of this research reinforce the need for a close look at the spatial transformations of citrus farming, considering not only the factors driving production expansion and displacement, but also the challenges inherent in maintaining it over time. Understanding these processes can inform more effective public policies capable of mitigating the impacts of diseases and strengthening crop sustainability, resulting in a balanced development that is less susceptible to cycles of abrupt decline.

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