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Productive Dynamics of Sugarcane (*Saccharum spp.*) in the Brejo Paraibano Microregion, Brazil

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A B S T R A C T

This research analyzed the productive dynamics of sugarcane in the Brejo Paraibano Microregion from 2017 to 2022. The objective was to understand the factors influencing the performance of this agricultural culture, emphasizing the importance of efficient management of cultural practices and fertilization for the quality of sugarcane fields. The study methodologically involved data analysis and systematic review of specialized literature. The results indicated variations in planted area, quantity produced, and productivity, influenced by climatic conditions and agricultural practices. In summary, it was possible to conclude that sugarcane agricultural production is a complex and dynamic activity, with strategies and innovations linked to sustainability present in this context, aiming at the economic and social development of the Brejo Paraibano region. Sugarcane activity is a complex and dynamic process in agricultural production, and it is possible to highlight the importance of an integrated and holistic approach to understanding and improving the sector's performance in the specific context of the Brejo Paraibano region.

R E S U M O

O artigo acadêmico analisou a dinâmica produtiva da cana-de-açúcar na Microrregião do Brejo Paraibano no período de 2017 a 2022. O objetivo foi compreender os fatores que influenciam o desempenho dessa cultura agrícola, destacando a importância do manejo eficiente dos tratos culturais e adubação para a qualidade dos canaviais. Para tanto, o estudo envolveu metodologicamente a análise de dados e revisão sistemática da literatura especializada. Os resultados apontaram variações na área plantada, quantidade produzida e produtividade, influenciadas por condições climáticas e práticas agrícolas. Em síntese, foi possível concluir que a produção agrícola canavieira é uma atividade complexa e dinâmica, sendo presente nesse contexto estratégias e inovações atreladas a sustentabilidade, visando ao desenvolvimento econômico e social da região do Brejo Paraibano. A atividade canavieira é uma atividade complexa e dinâmica na produção agrícola, sendo possível destacam a importância de uma abordagem integrada e holística para compreender e melhorar o desempenho do setor no contexto específico da região do Brejo Paraibano.

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Introduction

Sugarcane (*Saccharum* spp.), widely spread in Brazil as well as in several countries on the continent, is an agricultural crop of significant importance to the national economy (DIAS et al., 2021; DUTRAS; TANNÚS, 2019, SILVA et al., 2019). Originating from the south and southeast of tropical Asia, this plant belongs to the taxonomic order Poales, family Poaceae, and subfamily Panicoideae (PEREIRA, CAVICHIOLI, 2021; SOBRINHO et al., 2019; SILVA, 2010). In this perspective, the authors Silva et al. (2019) corroborate by discussing in their studies the good adaptability of the crop to Brazil's climatic variability. Furthermore, its vegetative structures are rich in sucrose, reaching a prominent level in national aquaculture (FIGUEIREIDO et al., 2022). According to the third crop survey for the 2023/24 season, released by (Conab), a 10.9% increase in production is forecasted compared to the previous cycle, reaching 677.6 million tons (CONAB, 2013).

According to Ajala et al. (2021), global sugarcane production exceeds 1.5 billion tons per year, with Brazil being the leading producer, topping the international ranking. Pipitpukdee et al. (2020) add that the crop is widely used for sugar production in over 90 countries worldwide. The researchers also emphasize that internationally, the area dedicated to sugarcane cultivation exceeds 25 million hectares. In this context, the National Supply Company - CONAB (2022) notes an estimated 8,127.7 thousand hectares for the 2022/2023 harvest in Brazil.

Additionally, studies by Cursi et al. (2022) highlight its position as the second-largest producer of the biofuel ethanol. Udompetaikul et al. (2021) emphasize the importance of quality and good average yield per area for sugarcane cultivation. CONAB (2022) also mentions a 2.6% growth in planted area for the 2022/2023 harvest compared to the previous one in the Brazilian Northeast region.

Cherubin et al. (2021) add perspectives on the agricultural potential of sugarcane, noting the growth in planted areas in Brazil over the years, with a 150% increase since the 1980, from 4 to 10 million hectares. They highlight ongoing research, technological advancements, and public policies aimed at reducing national dependence on petroleum-derived fuels (WIESBERG et al., 2021). Gravina et al. (2021) project a Brazilian sugarcane harvest for 2021/22 of over 620 million tons, with expectations of producing 39 million tons of sugar and 27 billion liters of ethanol.

The fact is that sugarcane has a wide range of uses, being not only an important source of sugar but also a crucial raw material for ethanol production (WIESBERG et al., 2021), as well as various other products for human and animal consumption, energy production, among other uses (DOTANIYA et al., 2016). Due to its versatility, the crop plays a fundamental role in the regions where it is planted, generating jobs and significantly contributing to income (PEREIRA, CAVICHIOLI, 2021; SOBRINHO et al., 2019; SILVA, 2010).

In light of the importance of sugarcane culture as a whole, it is essential to highlight the main factors that lead to its successful development. Researchers Tasso Júnior et al. (2007) emphasize efficient cultural practices and fertilization in the quality of sugarcane fields, as proper action tends to prevent pest and disease infestations, with pre-sprouted planting systems being a differential in the phytosanitary management of this agricultural culture (AQUINO et al., 2018).

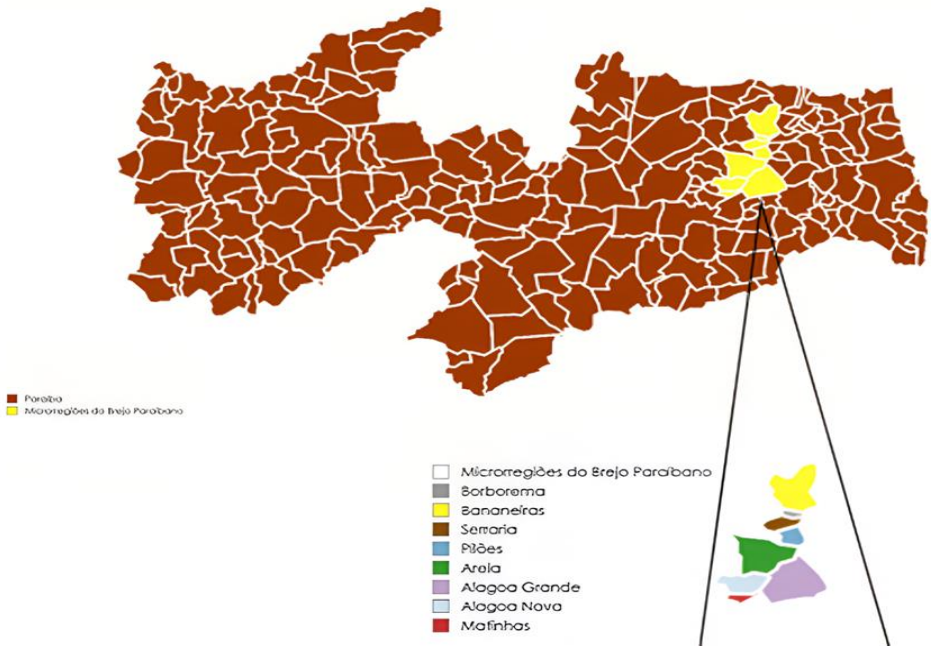
Given the socio-economic significance of the sugarcane industry, understanding production dynamics is an essential measure to guide initiatives aimed at improving productivity or restructuring this sector (DIAS et al., 2021; PESSOA et al., 2021). Therefore, the objective of this study is to evaluate the production dynamics of sugarcane in the Brejo Paraibano Microregion during the interannual period from 2017 to 2022, aiming to understand the factors influencing the local performance of this production chain.

Methodology

The Brejo Paraibano Microregion (Figure 1), comprised of eight municipalities, includes the cities of Alagoa Grande, Alagoa Nova, Areia, Bananeiras, Borborema, Matinhas, Pilões, and Serraria. Furthermore, according to Gondim (1989), the Brejo Paraibano extends 62 km north-south and 40 km east-west, located on the eastern edge of the Borborema Plateau in Paraíba, covering an area of 1,174.168 km².

Figure 1.

Location of the municipalities in the Brejo Paraibano Microregion.



Source: Adapted from MapChart (2024)

Table 1 shows the geographic coordinates, according to municipalities in the Brejo Paraibano Microregion.

Table 1.

Geographic coordinates, according to the municipalities of the Brejo Paraibano Microregion.

Municipalities	Altitude (m)	Latitude – S	Longitude (W. Gr.)
Alagoa Grande	143	07º 09′30″	35º 37′48″
Alagoa Nova	530	07º 04′15″	35º 45′30″
Areia	618	06º 57′48″	35º 41′30″
Bananeiras	520	06º 45′00″	35º 38′00″
Borborema	368	06º 48′12″	35º 34′48″
Matinhas	300	07º 07′30″	35º 46′00″
Pilões	334	06º 42′00″	35º36′54″
Serraria	533	06º 50′00″	35º 37′30″

Source: IDEME – 2013

In terms of climate conditions, its terrain exerts a strong influence on the disparity of rainfall in the respective regions, concentrating primarily in the months of June and July, with an average temperature of 25°C. Its winter months can experience temperatures dropping below 16°C, along with relative humidity ranging from 80 to 85%, contributing to the establishment of a climate particularly unique to this region (MOREIRA, 1989; LIMA, 2008). Additionally, Godim (1999) elaborates on a range of soil qualities found in the area, including latosols, podzols, eutrophic litholic soils, purple earth, and regosols.

As stated by Moreira (1989), the Brejo Paraibano region is characterized by abundant rainfall, with precipitation ranging from 1200 to 1500 mm annually. This is accompanied by mild temperatures and a humid climate, which contribute to the strengthening of agriculture and livestock farming in the area.

For the research, the SIDRA data platform - IBGE (Brazilian Institute of Geography and Statistics) Automatic Retrieval System was utilized to gather information on sugarcane cultivation (*Saccharum* spp.) for the interannual period from 2017 to 2022 in the Brejo Paraibano region. Five variables were considered: planted area in hectares (ha^{-1}), harvested area (ha^{-1}), quantity produced in tons (t), average yield in kilograms per hectare ($kg\ ha^{-1}$), and the production value, given in thousands of Brazilian reais (thousand R$).

After consulting the database, Excel was used to organize the data and weigh their respective interpretations and applications.

At the conclusion of the data tabulation, a systematic review was also conducted regarding sugarcane productivity in the Brejo Paraibano region. This review involved searching for articles, books, dissertations, and manuscripts of high relevance in the respective field of study. The search was performed on academic database platforms such as Scopus, Web

of Science, and Google Scholar, using search terms such as "Brejo Paraibano," "productivity," "sugarcane," "challenges," "advantages," "microregion," "culture," "opportunity," and "sustainability." Subsequently, selected articles were evaluated for relevance, methodological quality, and contribution to understanding the local context, ensuring inclusion only of works pertinent to the review. This process enabled the clear synthesis of a comprehensive view of the proposed theme, highlighting areas that require further investigation and potential directions for future research.

Results and Discussion

The analysis of productive variables in the Brejo Paraibano region over the period from 2017 to 2022 reveals valuable insights into the dynamics of sugarcane in this area. The data presented in (Table 2) allows for a comprehensive understanding of trends and performance in agricultural production, considering five main variables: planted area, harvested area, quantity produced, productivity, and production value.

Table 2.

Productive Variables in the Brejo Paraibano Region (2017 - 2022)

Period	Planted Area (ha^{-1})	Harvested Area (ha^{-1})	Quantity Produced (t)	Productivity (kg/ha^{-1})	Production Value (R$ x 1000)
2017	5.430	4.930	2.549	517	6.240
2018	5.255	5.255	2.236	425	3.715
2019	5.315	5.315	1.810	341	4.149
2020	5.570	5.570	2.844	511	9.297
2021	4.180	4.140	1.426	344	5.338
2022	5.362	5.142	1.917	373	8.513

Source: Adapted from SIDRA (2024)

The planted area and harvested area are fundamental indicators reflecting the extent of agricultural activities in the Brejo Paraibano region. Significant variations were observed in these variables during the analyzed period. In 2020, the region reached its highest planted area, totaling 5,570 hectares, while in 2021, the lowest planted area was recorded, with 4,180 hectares. These fluctuations can be attributed to factors such as climatic conditions, resource availability, and cultivation strategies adopted by producers (FIGUEIREIDO et al., 2008; CARDOSO; SENTELHA, 2013; NELSON et al., 2014). According to researchers Pessoa et al. (2021), agribusiness has a significant influence on these results, due to the increase in the number of mills, as well as the processing of sugarcane, since this microregion has strong cultural and economic ties to this agricultural activity. It is important to emphasize that several other conditions interfere with these respective variables, which consequently affect sugarcane

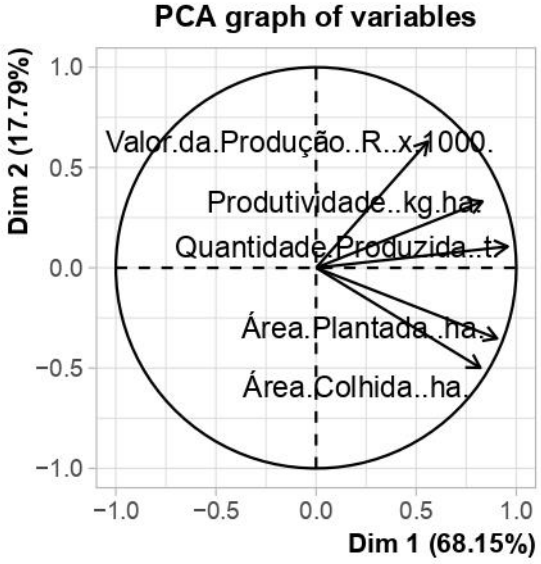
production, such as the cultivar used, cultural practices, management, climatic conditions, or soil fertility (CESAR et al., 1987).

The quantity produced and productivity per hectare are essential metrics for evaluating the efficiency and yield of agricultural activities. Over the years analyzed, variations were observed in the quantity produced and productivity. In 2017 and 2020, the highest quantities produced were recorded, with 2,549 tons and 2,844 tons, respectively. However, productivity per hectare showed variations, reaching its peak in 2017 and 2020, with 517 kg/ha and 511 kg/ha, respectively. According to Blanco et al. (2017), climatic conditions are decisive environmental factors for the good performance of sugarcane, which can interfere at any stage of plant development, harvest, or even in the quality and processing rate. It is important to note that within this context, the variables of quantity produced and productivity are inherent to the advancement and adoption of modern technologies, efficient management practices, and pest control, leading to optimization over time (DESCHÊNES; GREENSTONE, 2007).

Therefore, the production value is a crucial indicator reflecting the economic performance of the agricultural sector. In 2020, the Brejo Paraibano region achieved the highest production value, totaling R$ 9,297 x 1000. This result highlights the significance of that year as a period of high economic yield for the region, driven by the combination of quantity produced, productivity, and market price. The fact is that fluctuations in agricultural product market prices can directly impact the production value each year, and variations in production costs, such as input prices, labor, logistics, technologies, implementation policies in the corresponding sector, production goals, among many other factors, can influence the final product value (MORAES et al., 2015; SATOLO; BACCHI, 2013).

Graph 1.

Principal Component Analysis (PCA) for production variables



Source: researcher data

Graph 1 presents a Principal Component Analysis (PCA) that shows two dimensions with variation of 68.15% and 17.79%, respectively. So, corresponding (Valor da Produção, Produtividade, Quantidade Produzida, Area Planta e Area Colhida) to Production Value, Productivity, Quantity Produced, Planted Area, and Harvested Area. In this way, the variables (planted area, harvested area, productivity, average yield, quantity produced) that are close to each other do not tend to be more correlated, while the more distant variables are less related to each other. The analysis of these dimensions can help identify patterns, trends and possible correlations between the variables studied.

The integrated analysis of productive variables in the Brejo Paraibano region highlights the complexity and importance of the agricultural sector in this area. Variations in planted area, harvested area, quantity produced, productivity, and production value over the years underscore the need for a holistic approach in agricultural management, considering aspects such as sustainability, production efficiency, and market competitiveness (JAMES, 2004; GOMI; SHIMADA; MATSUOKA, 2010; PEREIRA, CAVICHIOLI, 2021; SOBRINHO et al., 2019; SILVA, 2010).

These results provide valuable insights to guide public policies, agricultural development strategies, and sustainable practices in the Brejo Paraibano region. Understanding these variables and their interrelationships is essential for promoting the growth and resilience of the agricultural sector, contributing to the economic and social development of the region.

Final Considerations

that there were significant variations over the years concerning planted area, harvested area, quantity produced, productivity, and production value. These variations can be attributed to a range of factors, including climatic conditions, agricultural technology, market and prices, investment in infrastructure, government policies, and sustainable practices.

that the planted and harvested areas showed some stability over the years, with minor fluctuations, while the quantity produced and productivity showed a trend of increase in some years, reflecting possible improvements in agricultural practices and technologies adopted in the region. On the other hand, the production value varied more significantly, influenced by fluctuations in market prices and production costs.

These results suggest the importance of considering multiple factors when analyzing agricultural production in a given region, highlighting the need for policies and strategies that promote sustainability, innovation, and resilience in the agricultural sector. Future research could delve deeper into the analysis of these factors and how they may impact agricultural

production in the Brejo Paraibano region, contributing to the development and continuous improvement of the sector.

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