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ANÁLISE DA FLUTUAÇÃO ANUAL (2000-2022) NA PRODUÇÃO DE TOMATE NA PARAÍBA

ANALYSIS OF ANNUAL FLUCTUATION (2000-2022) IN TOMATO PRODUCTION IN PARAÍBA

João Henrique Barbosa da Silva
Universidade Federal da Paraíba - UFPB, Brasil
Orcid: https://orcid.org/0000-0002-7673-0953
E-mail: henrique485560@gmail.com

Thiago Jardelino Dias
Universidade Federal da Paraíba - UFPB, Brasil
Orcid: https://orcid.org/0000-0002-7843-6184
E-mail: thiagojardelinodias@gmail.com

João Paulo de Oliveira Santos
Instituto Federal de Rondônia - IFRO, Brasil
Orcid: https://orcid.org/0000-0003-1826-1746
E-mail: jpauloos04@gmail.com

Ramon Freire da Silva
Universidade Federal da Paraíba - UFPB, Brasil
Orcid: http://orcid.org/0000-0002-4465-2006
E-mail: ramonsilvagro@gmail.com

Francisco Helio Alves de Andrade
Instituto Estadual de Educação, Ciência e Tecnologia do Maranhão - IEMA, Brasil
Orcid: https://orcid.org/0000-0002-9699-1413
E-mail: helioalvesuepb@gmail.com

Luís Karlos Pereira da Silva
Universidade Federal da Paraíba - UFPB, Brasil
Orcid: https://orcid.org/0009-0003-3054-448X
E-mail: luiskarlos2@gmail.com

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E-mail para correspondência:
henrique485560@gmail.com

Resumo: O tomate, hortaliça de significativa importância pela sua aceitabilidade e valor nutricional, é cultivado e consumido globalmente desde o século XVI, permanecendo como uma cultura relevante no contexto agrícola do Brasil e, particularmente, no estado da Paraíba. O objetivo deste estudo é avaliar a dinâmica produtiva da cultura do tomate na Paraíba durante o período entre 2000 e 2022. Portanto, para esta análise, foram analisados dados do

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banco de informações da Pesquisa Agropecuária Municipal, disponibilizado pelo Instituto Brasileiro de Geografia e Estatística (IBGE). O Sistema de Recuperação Automática (SIDRA) foi utilizado para extrair informações pertinentes à área plantada, área colhida, quantidade produzida, produtividade média e valor da produção de tomate naquele estado. Os resultados obtidos revelaram variabilidade temporal na produção de tomate, particularmente evidente nas flutuações nas áreas destinadas ao plantio e à colheita. Devido à relevância econômica da cultura do tomate para o estado da Paraíba, faz-se necessário estimular e implementar estratégias que visem à melhoria da produtividade desta cultura.

Palavras-chave: *Solanum lycopersicum* L. Dinâmica produtiva. Culturas temporárias. Semiárido.

Abstract: Tomato, a vegetable of significant importance due to its acceptability and nutritional value, has been cultivated and consumed globally since the 16th century, remaining a relevant crop in the agricultural context of Brazil and, particularly, in the state of Paraíba. This study's objective is to evaluate the productive dynamics of the tomato crop in Paraíba during the period between 2000 and 2022. Therefore, for this analysis, data were analyzed from the Municipal Agricultural Research information bank, made available by the Brazilian Institute of Geography and Statistics (IBGE). The Automatic Recovery System (SIDRA) was used to extract information pertinent to the planted area, harvested area, quantity produced, average yield and value of tomato production in that state. The results obtained revealed temporal variability in tomato production, particularly evident in fluctuations in the areas allocated to planting and harvesting. Due to the economic relevance of tomato cultivation for the state of Paraíba, it is necessary to stimulate and implement strategies aimed at improving the productivity of this crop.

Keywords: Solanum lycopersicum L. Productive dynamics. Temporary crops. Semi-arid.

Introduction

Tomato (*Solanum lycopersicum* L.) is considered the second most cultivated and consumed vegetable in the world, belonging to the Solanum genus within the Solanaceae family. It holds significant importance due to its acceptability and nutritional value [1,2]. The consumption of tomatoes was already a common practice in Central and South America before the arrival of Europeans, with a greater interest observed in the 16th century by colonizers, especially the Spanish, in cultivating them in their home countries. However, its consumption expanded only in the 19th century [3].

A global tomato production in the year 2021, according to FAO (2023), was estimated at 189,133,955.04 tons, cultivated across an area of 5,167,388 hectares. These production figures underscore the significance of this vegetable in the global food matrix. More than half

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of this production is concentrated in the Asian continent (63%), followed by Europe (12.9%), the Americas (12.5%), Africa (11.3%), and Oceania (0.2%). China leads the world in tomato production with 67.5 million tons, followed by India, Turkey, and the USA producing 21, 13, and 10.5 million tons, respectively [4]. In Brazil, the quantity produced in the year 2022 was approximately 3,809,986 tons, with a harvested area of 54,502 hectares and an average yield of 69,905 kg ha^{-1} [5]. In the state of Paraíba, in the same year, the produced quantity was 18,897 tons, harvested from an area of 625 hectares, with an average yield of 30,235 kg ha^{-1} [5].

In the state of Paraíba, certain municipalities have a long history of involvement in the cultivation and processing of tomatoes, such as Congo, Barra de São Miguel, Campina Grande, Sumé, Monteiro, Barra de Santana, Boqueirão, Soledade, Cabaceiras, and Queimadas. Given the socio-economic significance of tomato farming for the state of Paraíba, understanding the production dynamics becomes an important initiative to provide information that can enhance productivity and/or restructure this sector [6]. In this context, the objective was to assess the production dynamics of tomato cultivation in Paraíba during the period between 2000 and 2022, thus enabling an understanding of the factors influencing the performance of this production chain at the local level.

Methodology

The data for this research were obtained from the database of the Municipal Agricultural Survey, made available by the Brazilian Institute of Geography and Statistics (IBGE). The Automatic Recovery System [7] was used to extract data related to tomato production in the state of Paraíba from 2000 to 2022.

In Table 1613 identified by Area intended for harvesting, harvested area, quantity produced, average yield and value of production of permanent crops, the following were evaluated five variables related to tomato production were analyzed: (a) Planted area in hectares (ha), representing the total annual area dedicated to tomato cultivation in the state of Paraíba; (b) Harvested area in hectares (ha), representing the annual extent effectively harvested; (c) Quantity produced in tons (t), corresponding to the annual harvest; (d) Productivity in kilograms per hectare (kg ha^{-1}), calculated by the ratio of the quantity produced

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to the harvested area; and (e) Production value (in thousands of R$), determined by the weighted average of information on quantity and the current average price paid to the producer.

From this selection, the download with generation of an Excel® Table was obtained. The data were organized in tabular format using Microsoft Excel® software. Subsequently, this data matrix underwent Principal Component Analysis (PCA). The analyses were performed using statistical software R® 4.2.0, FactoMineR package version 2.4 for multivariate analysis [8]. Subsequently, the figures and tables included in the Results and Discussion were generated.

Results and Discussion

The productive dynamics of tomatoes in the state of Paraíba showed high variability during the analyzed period, reflecting strong fluctuations in tomato production variables (Figure 1). The years with the largest planted areas coincided with those of the highest harvested areas, particularly in the year 2009 (Figures 1A and C), respectively. It is important to note that, throughout the sample period (2000-2022), the planted area was fully harvested only in the years 2000, 2005, 2006, 2007, 2008, 2009, 2011, 2015, and 2020. This suggests that soil and climatic conditions, along with the management practices employed, played a crucial role in the crop's development, leading to the complete harvest of these areas [9].

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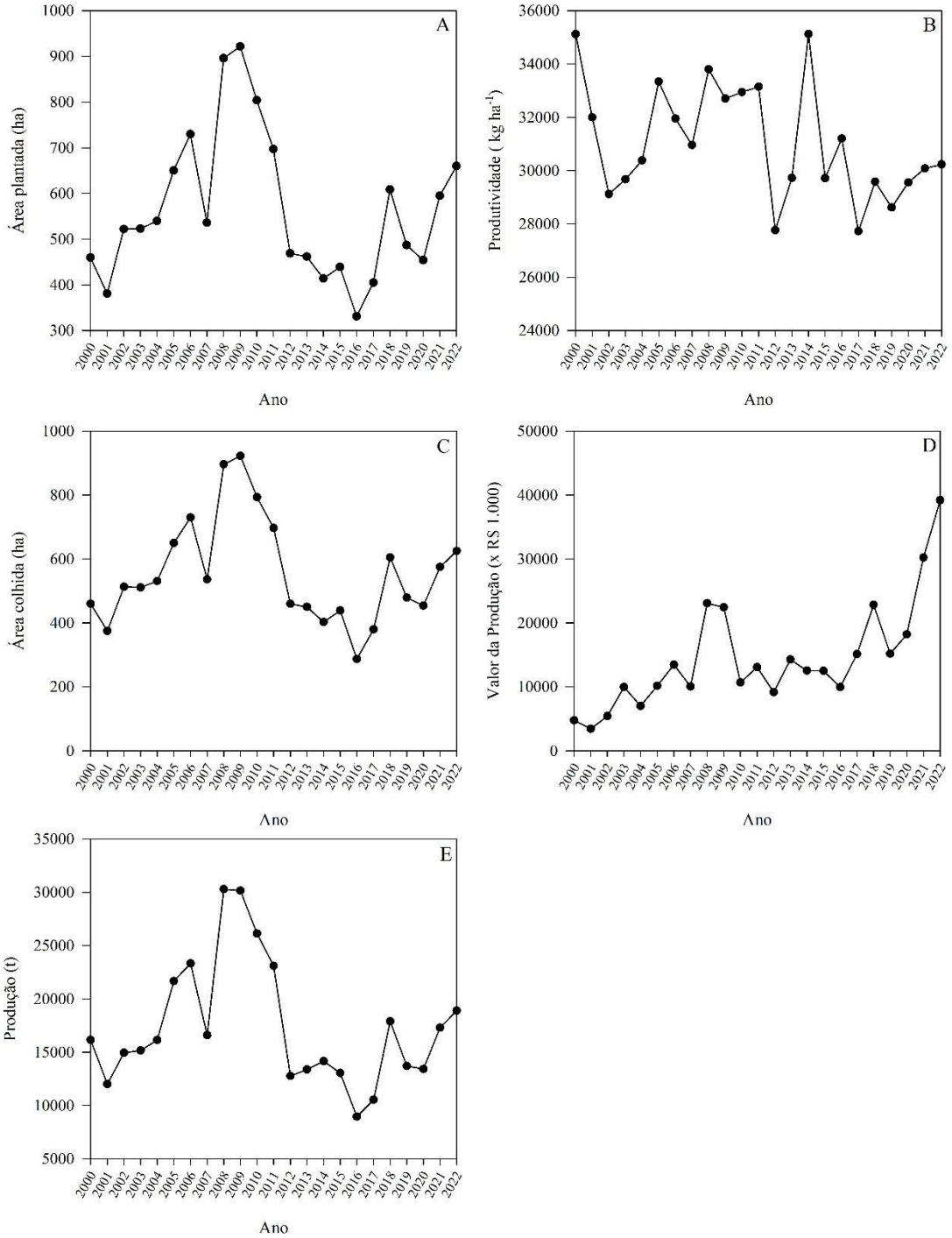
Figure 1 – Planted area (A), harvested area (B), quantity produced (C), productivity (D), and production value (E) of tomato cultivation in the state of Paraíba from 2000 to 2022



Source: Sidra [7], (2023).

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When observing the years with the largest planted and harvested area, especially in 2009, it reinforces the idea that favorable soil and climate conditions, such as adequate rainfall and mild temperatures, optimize the development of tomato crops, reducing losses due to diseases and pests, and encouraging full harvest. Furthermore, in years of high demand and favorable prices, producers tend to maximize the harvest, even in less than ideal conditions.

The results indicate a trend of increase and recovery in the planted and harvested areas with tomato cultivation in the state of Paraíba, notably from the years 2008 and 2009, following previous years of decline in these variables. However, over the years, there has been a gradual reduction in both planted and harvested areas. This reduction may be related to a decrease in precipitation levels and the migration of some areas designated for tomato cultivation to other purposes/crops, given the versatility of the soils in Paraíba [10].

In the year 2008, it stood out as the period with the second-largest planted and harvested areas within the sample range, also recording the highest quantity produced in this crop, totaling 30,289 tons (Figure 1E). However, the most significant productivity indices were achieved in 2000, with an average yield of 35,123 kg ha^{-1} (Figure 1B). These promising results are noteworthy, especially when considering that the average tomato productivity in Paraíba in 2022 was 30,235 kg ha^{-1} [7,5]. The data suggest the need for the implementation of technical and managerial actions to enhance input utilization, increase lines of credit for equipment purchase, reduce losses during the harvest phase, and promote an increase in tomato production efficiency in Paraíba.

In the years 2012 and 2017, the state of Paraíba recorded the lowest average yields of tomatoes, with 27,763 and 27,726 kg ha^{-1}, respectively (Figure 1B). In years of low agricultural production, the impact on rural communities becomes evident, leading to situations of social vulnerability. This jeopardizes a vital sector in income generation, potentially resulting in concerning issues such as more pronounced rural exodus [11]. The low average tomato productivity observed in Paraíba in the time period analyzed can be directly correlated with the historic drought that hit the Brazilian Northeast during this period, which reinforces the importance of drought as a determining factor in the low tomato production in Paraíba [12].

Water stress, resulting from water scarcity, negatively impacts tomato production by compromising physiological processes such as photosynthesis and nutrient absorption, leading to reduced plant growth, a decrease in the number of flowers and fruits, and the production of smaller, lower-quality fruits [13]. In Paraíba, where smallholder farming is

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predominant, dependence on rainfall and limited irrigation infrastructure make producers especially vulnerable to the effects of drought [14]. Decreased tomato production not only reduces farmers' income but also affects local and regional food security.

Additionally, in this context, when comparing the average productivity of Paraíba (30,235 kg ha^{-1}) with all other states in Brazil, it is observed to surpass Amazonas (8,333 kg ha^{-1}), Maranhão (20,292 kg ha^{-1}), Mato Grosso (20,301 kg ha^{-1}), Pará (24,060 kg ha^{-1}), Piauí (24,817 kg ha^{-1}), and Roraima (20,900 kg ha^{-1}) [5]. These results indicate that, while Paraíba stands out compared to some Brazilian states, the productivity of this crop still has room for improvement, especially when compared to the national average productivity (69,905 kg ha^{-1}) [5]. The results also reveal an increase in the production value of this crop, which grew from R$ 4,758,000 in 2000 to R$ 39,193,000 in 2022 (Figure 1D). This significant increase underscores the importance of this crop to the economy of the state of Paraíba.

In the year 2022, the municipality of Congo stood out as the main tomato producer in Paraíba, with a total of 2,800 tons (Table 1). Among the top ten tomato producers in the state, the municipalities of Cabaceiras and Queimadas had the lowest productions for that year, totaling 625 and 600 tons, respectively.

Table 1 – Municipalities with the highest tomato productions in Paraíba in the year 2022

Municipality	Quantity Produced (t)
Congo	2.800
Barra de São Miguel	2.100
Campina Grande	1.800
Sumé	1.500
Monteiro	1.050
Barra de Santana	900
Boqueirão	900
Soledade	700
Cabaceiras	625
Queimadas	600

Source: Sidra [7], (2023).

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Linear correlations between the production variables were summarized by principal component analysis (PCA). To describe/select data, 2 principal components were retained following Kaiser's criteria (eigenvalue >1) and cumulative variances. The principal component analysis explained 90.3% of the original data variance in the first two axes (PC1 and PC2) (Figure 2). On axis 1, which grouped 67.5% of the data explanation, a strong association was observed between planted area ($r = 0.98$; $p<0.01$) and harvested area ($r = 0.98$; $p<0.01$) with the quantity produced ($r = 0.99$; $p<0.01$). On the second axis of PCA, responsible for 22.8% of the data variance, a significant and inverse relationship was evidenced between productivity ($r = -0.72$; $p<0.01$) and production value ($r = 0.70$; $p<0.01$). These results confirm that under tomato production conditions in the state of Paraíba, an increase in planted and harvested areas does not necessarily result in higher productivity rates.

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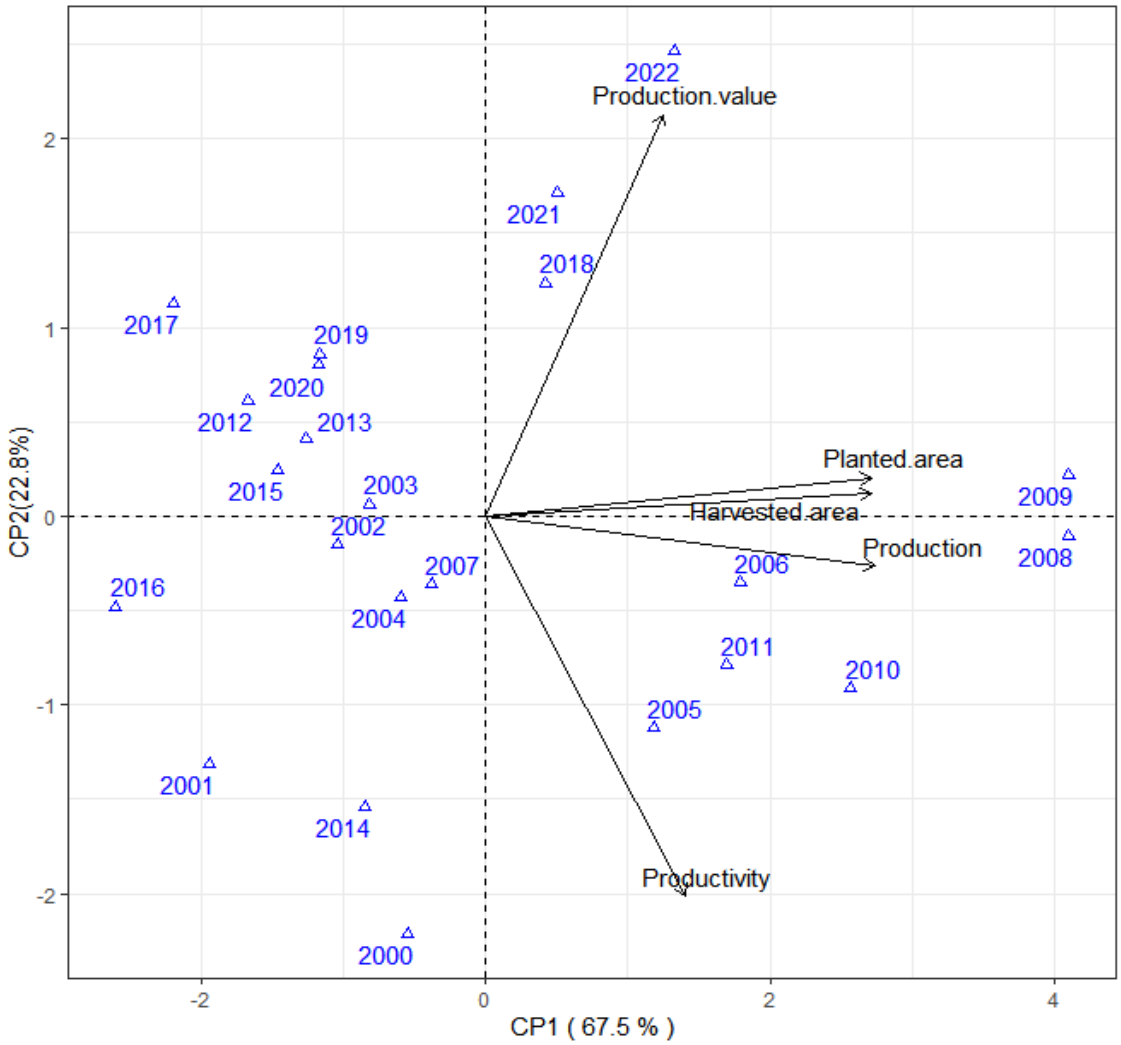
Figure 2 – Biplot graphical dispersion of tomato production in Paraíba, from 2000 to 2022, and based on scores of 5 productive characters, represented by the first two main components



Source: Prepared by the authors, (2024).

It is definitely essential to invest in and improve technological and agricultural practices suitable for tomato cultivation in the state of Paraíba [15] which can result in significant advances in production, deficiencies and agricultural sustainability processes.

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Final Considerations

The analysis of tomato production dynamics in Paraíba reveals significant fluctuations, mainly in planted and harvested areas, and a downward trend in productivity over time. This situation demands special attention, given the economic importance of tomato cultivation for the state. Implementing strategies to boost production is not limited to adopting improved technologies and management practices. It is imperative to consider the complexity of the factors that influence production, such as climate variations, water availability and market fluctuations.

In this context, investment in research and development is suggested to create cultivars that are better adapted to local soil and climate conditions, as well as strengthening technical assistance to disseminate good agricultural practices, optimize the use of inputs and promote the sustainable management of natural resources.

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