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Productive performance of tomato cultivation (*Solanum lycopersicum*) using staking in the semi-arid region of Paraíba and its mesoregions

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Abstract. The productive performance of tomato cultivation (*Solanum lycopersicum*) using staking in semi-arid conditions in the Paraíba region is of utmost importance for establishing sustainable and high-quality agriculture, driving various socio-economic aspects of the region. This study aims to evaluate tomato productivity using staking in the semi-arid region of Paraíba and its mesoregions. The methodology involves data analysis from the 2017 Agricultural Census and research in highly relevant academic databases. Results for the studied mesoregions demonstrate the significant role of family farming in agricultural production across all mesoregions of Paraíba, with particularly strong presence in the Sertão Paraibano, Agreste Paraibano, and Mata Paraibana. Total tomato production using staking amounted to 2,336 tons in the Sertão Paraibano, 813 tons in the Borborema, 208 tons in the Agreste Paraibano, and 90 tons in the Mata Paraibana. The quantity sold was 2,321 tons in the Sertão Paraibano, 811 tons in the Borborema, 204 tons in the Agreste Paraibano, and 86 tons in the Mata Paraibana. Total production value reached 2,356 thousand reais in the Sertão Paraibano, 562 thousand reais in the Borborema, 381 thousand reais in the Agreste Paraibano, and 181 thousand reais in the Mata Paraibana. In summary, these findings are crucial for understanding the dynamics of the staked tomato market and can guide marketing strategies and economic development across different mesoregions.

Keywords: Family farming. Productivity. Sustainability.

Introduction

The tomato (*Solanum lycopersicum*) is cultivated in various regions of Brazil, representing a

cosmopolitan crop deeply rooted in the heritage of the Aztec peoples (FURQUIM et al., 2024). According to Dahlke et al. (2019), tomatoes offer

numerous benefits, being rich in organic acids and vitamins, thus forming a nutritious and balanced diet essential for human nutrition, leading to health benefits.

Despite its undeniable importance, conventional cultivation often involves the use of pesticides, which can leave residues on fruits and compromise consumer health (DAHLKE et al., 2019). Therefore, studies on crop management systems and post-harvest techniques are essential to improve fruit quality and reduce the grey water footprint (GWF) (LÉDO et al., 1995; FURLANETO et al., 2022).

Within this context, the grey water footprint is defined as the volume of freshwater required to dilute pollutants incorporated into the soil's surface and subsurface layers due to pesticide emissions in agricultural production (OLIVEIRA et al., 2019). Its development under the conditions imposed by the semi-arid region of Paraíba requires caution, as long periods of drought and irregular rainfall afflict the region, necessitating the refinement of techniques and means to optimize the capture, consumption, and appropriate and efficient use of water resources, making a significant difference in tomato cultivation, agricultural systems, livestock, and overall utilization for survival (NASUTI et al., 2013).

Oliveira et al. (2016) emphasize the importance of evaluating tomato productivity under different water conditions, as the Brazilian semi-arid region is characterized by pronounced water deficit, which is a limiting factor for agricultural practice. Furthermore, the researchers report on a study that evaluated the productive performance of sweet sorghum cultivated in underground dams in the semi-arid region, showing higher development and productivity compared to cultivation outside the dam.

Dahlke et al. (2019) add that protected cultivation and agroecological practices bring many benefits to tomato productivity under semi-arid conditions, offering organic agriculture without pesticides compared to conventional systems, which often leave residues compromising plant health and even consumer health. It also reduces water consumption and increases productivity since the protected system reduces evapotranspiration, minimizing water loss, a milestone considering it is one of the major limitations of agriculture in the semi-arid region of Paraíba.

In summary, the productive performance of tomato cultivation under semi-arid conditions in the Paraíba region is of extreme importance, as tomatoes are a cosmopolitan crop essential for human nutrition. Studies on crop management systems and their relationship with water needs concerning productive performance are essential to

improve fruit quality and optimize cultivation systems, as well as to contribute to the implementation of positive actions towards understanding water consumption challenges. Thus, this study aims to evaluate the productive performance of staked tomato cultivation and provide information for the implementation of sustainable practices in agriculture.

Material and Methods

O semi-arid region of Paraíba (Map 1) is characterized by a range of natural variables that influence its climate, ecosystems, and natural resources, including: Irregular precipitation; High temperatures; Arid and infertile soil; Adapted vegetation; Periodic droughts; Limited water resources; Vulnerability to desertification; and Unique biodiversity. Despite these adverse conditions, the semi-arid region harbors distinct biodiversity, with a variety of plant and animal species adapted to extreme conditions.

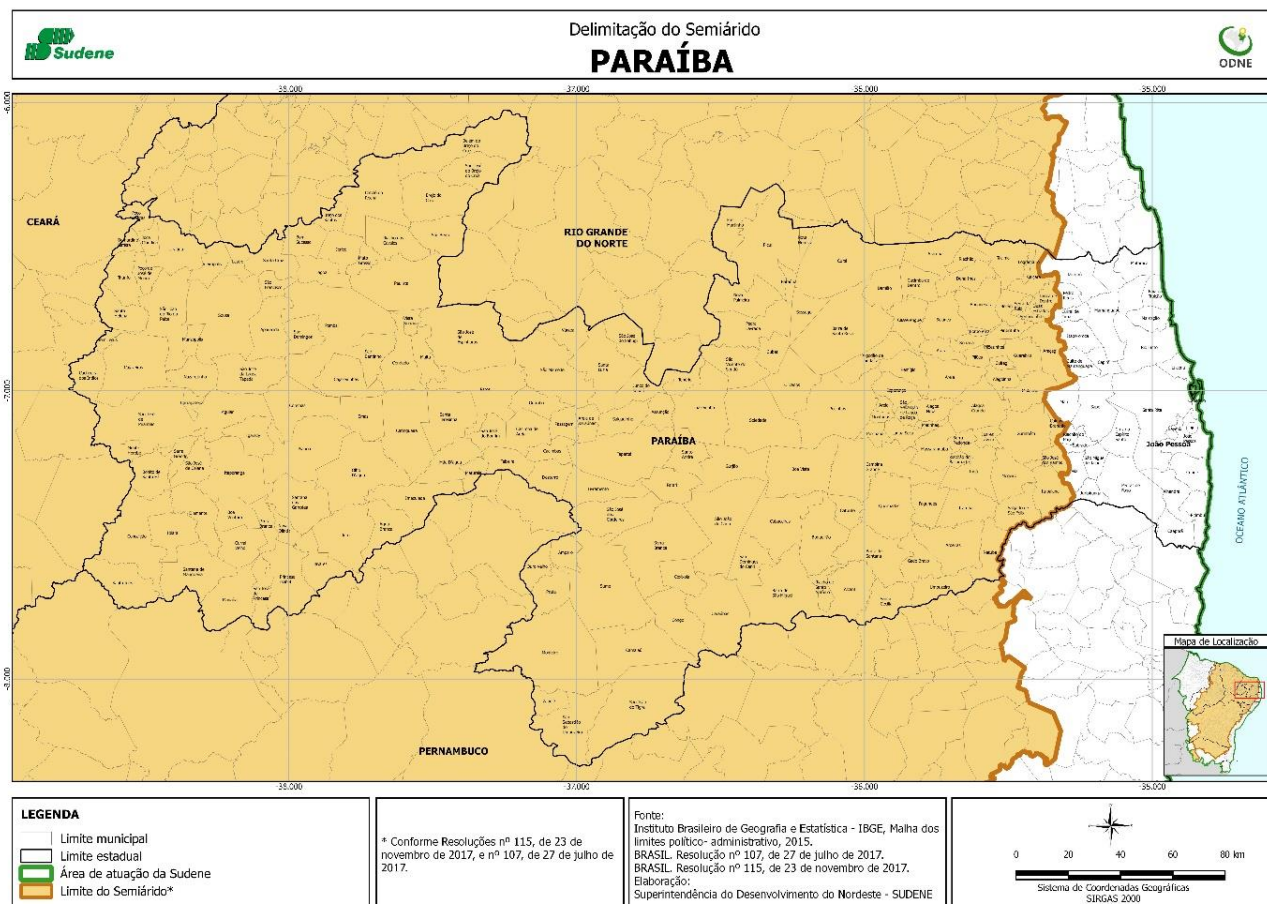
These natural variabilities of the semi-arid region profoundly influence the lives of people and ecosystems inhabiting this area, requiring specific adaptations and strategies to deal with its challenges.

For this purpose, the present research utilized the SIDRA database - IBGE (Brazilian Institute of Geography and Statistics) Automatic Retrieval System, based on the latest Agricultural Census (2017) for staked tomato cultivation in the semi-arid region of Paraíba.

In addition to this database, searches were also conducted for documents on platforms such as Google Scholar, PubMed, Scopus, and Web of Science, using keywords such as: Tomato, *Solanum lycopersicum*, Staked cultivation, Semi-arid, Cultivation conditions, Productive performance, Paraíba region, Rainfed agriculture, Water management, Agricultural sustainability, Water footprint, Sustainable agriculture, and Agricultural productivity.

Based on this information, it was possible to compile a spreadsheet and analyze the main manuscripts, conducting a thorough analysis and verifying their compatibility with the study's proposed objective. Furthermore, with the assistance of Microsoft Office Excel (2016) software, information was cross-referenced to determine staked tomato production in the semi-arid region of Paraíba and its main mesoregions (Sertão Paraibano, Borborema, Agreste Paraibano, Mata Paraibana), obtained from SIDRA for variables such as: number of agricultural establishments, quantity produced, quantity sold, and production value, categorized as resulting from family farming or not.

Figure 1. Delimitation of the Paraíba Semi-Arid Region



Source: SUDENEa (2017)

Results and discussion

Table 1 presents relevant data on tomato production in the semi-arid region of Paraíba, with a focus on family farming. The scenario presented reveals essential aspects of agricultural production in this specific region. The analysis of the results indicates that out of the 172 agricultural establishments considered, the majority (142) are linked to family farming, highlighting the importance of this modality for tomato production in the region.

Observing the quantity produced and sold of tomatoes, it is noted that, despite a significant production of 3.362 tons, most of this quantity (2.431 tons) comes from establishments not belonging to family farming. This may indicate a significant participation of non-family farmers in tomato production in the semi-arid region of Paraíba. Furthermore, the quantity sold of 3.340 tons indicates a seemingly healthy demand for this product in the region.

In terms of economics, the values presented in the table demonstrate that family farming contributes a considerable portion of the tomato production value. According to the data, the production value reaches the mark of 3.306 thousand Reais, of which 1.143 thousand Reais come from establishments linked to family farming. This information highlights the socio-economic

importance of family farming in the context of tomato production in the semi-arid region of Paraíba, significantly contributing to income generation and local development.

Therefore, the analysis of the results from the table not only underscores the relevance of family farming in tomato production in the semi-arid region of Paraíba but also points to the complex interaction among different actors and variables in this specific agricultural context.

The results provided by Figure 1 depict the distribution of staked tomato production across the mesoregions of Paraíba, distinguishing between agricultural production units categorized as family farming (yes) and those that do not fall under this category.

In the Sertão Paraibano, a total of 67 agricultural production units were identified, of which 54 are classified as family farming and 13 as non-family farming. This suggests a predominance of family farming in the region, with a significant contribution to local agricultural production.

In the Borborema (PB), the distribution of agricultural production was 21 units in total, with 15 units belonging to family farming and 6 units to non-family farming. These numbers indicate a relatively strong presence of family farming in the region,

although on a smaller scale compared to the Sertão Paraibano.

In the Agreste Paraibano (PB), there were a total of 82 agricultural production units, of which 71

are attributed to family farming and 11 to non-family farming. These results show a clear predominance of family farming in this region, with a significant share in total agricultural production.

Table 1 - Variables discussed on tomato production in the semi-arid region of Paraíba

| Variables | Family Farming | YES Family Farming | Total |
|---|----------------|--------------------|-------|
| | YES | NO | |
| Number of agricultural establishments (units) | 142 | 30 | 172 |
| Quantity produced (tons) | 930 | 2.431 | 3.362 |
| Quantity sold (tons) | 911 | 2.429 | 3.340 |
| Production value (thousand Reais) | 1.143 | 2.163 | 3.306 |

Source: SIDRA/IBGE/CensoAgro (2017)

Finally, in the Mata Paraibana (PB), the distribution of agricultural production was 89 units in total, with 72 units belonging to family farming and 17 to non-family farming. This suggests a substantial contribution of family farming to agricultural production in the Mata Paraibana region.

In summary, the results indicate that family farming plays an important role in agricultural production in all mesoregions of Paraíba, with a particularly strong presence in the Sertão Paraibano, Agreste Paraibano, and Mata Paraibana. This distribution may have significant implications for agricultural policies and rural development programs, highlighting the importance of supporting and strengthening family farming to promote food security and sustainable development throughout the state.

We can observe the total production of staked tomatoes in each mesoregion, expressed in tons (t). In the Sertão Paraibano, the total production of staked tomatoes was 2.336 t, of which 517 t were produced by family farmers and 1,818 t by non-family farmers.

In the Borborema (PB), the total production of staked tomatoes was 813 t, with 237 t coming from family farmers and 576 t from non-family farmers. In the Agreste Paraibano (PB), the total production was 208 t, with 171 t produced by family farmers and 37 t by non-family farmers. Finally, in the Mata Paraibana (PB), the total production was 90 t, with only 34 t coming from family farmers and 55 t from non-family farmers.

We observe the total quantity of staked tomatoes sold in each mesoregion. In the Sertão Paraibano, for example, a total of 2.321 t of staked tomatoes were sold, with 503 t from family farmers and 1,818 t from non-family farmers. In the Borborema mesoregion, the total quantity of staked tomatoes sold was 811 t, with 235 t from family farmers and 576 t from non-family farmers. In the Agreste Paraibano, the total quantity sold was 204 tons, with 168 tons from family farmers and 36 tons from non-family farmers. Finally, in the Mata Paraibana, the total quantity of staked tomato sold was 86 tons, with 31 tons coming from family farmers and 55 tons from non-family farmers. We

can observe in Figure 4 the total monetary value of staked tomato production in different mesoregions of Paraíba, expressed in thousands of reais (R\$). In the Sertão Paraibano, the total production value was 2.356 thousand reais, of which 630 thousand reais are attributed to family farming and 1.725 thousand reais to non-family farming.

In the Borborema, the total production value was 562 thousand reais, with 156 thousand reais coming from family farming and 406 thousand reais from non-family farming. In the Agreste Paraibano, the total production value was 381 thousand reais, with 349 thousand reais from family farming and 32 thousand reais from non-family farming. In the Mata Paraibana, the total production value was 181 thousand reais, with 84 thousand reais from family farming and 97 thousand reais from non-family farming.

These pieces of information are important for understanding the dynamics of the staked tomato market and can guide marketing strategies and economic development in the different mesoregions.

The increase in the number of family farming establishments in the semi-arid region and in Paraíba can be attributed to a series of factors and trends that have occurred in recent decades. Here are some reasons that may have contributed to this increase: Public policies of encouragement, Recognition of the importance of family farming, Increased interest in sustainable agricultural practices, Diversification of economic activities, Access to information and technology, and Resilience to climate change (SOUTO et al., 2011; ANDRADE et al., 2019).

Family farming plays a significant role in providing food for the Brazilian population (MAPA, 2022). According to César et al. (2020), family farming goes beyond economic barriers, standing out significantly in social and environmental aspects. Moreover, its contributions are invaluable, as according to FAO (2019), this activity is closely related to the Sustainable Development Goals (SDGs) for combating poverty and hunger worldwide.

Researchers Marcelino et al. (2017) further emphasize that sustainable agriculture has a

relationship of many benefits between producers and consumers, as in this mode of trade, trust is established between both parties, since products are mostly sold directly. Furthermore, they are healthy products compared to those marketed by large industries.

Buriti et al. (2010) highlight that despite the large production of food, it is necessary to reflect, as secure access must be ensured, either physically or economically. Assad and Almeida (2004) corroborate by highlighting the ability of sustainable agriculture to provide healthy food in line with environmental concerns. More than just producing, it is about achieving productivity with quality.

Final considerations

The results reveal the crucial importance of family farming in tomato production in the semiarid region of Paraíba. This form of agriculture not only significantly contributes to the total quantity produced and sold but also plays a fundamental role in income generation and local economic development.

Furthermore, the data show an unequal distribution of staked tomato production among the different mesoregions of Paraíba, with a predominance of family farming in some regions such as the Sertão Paraibano, Agreste Paraibano, and Mata Paraibana. This underscores the need for agricultural policies and rural development programs that support and strengthen family farming throughout the state.

The analysis of the results also highlights the complexity and interdependence of various factors, such as public policies, sustainable agricultural practices, and resilience to climate change, which influence the increase in the number of family farming establishments in the region.

Considering the socioeconomic, environmental, and health benefits associated with family farming and sustainable food production, it is essential to continue investing in research and policies that promote this agricultural model.

In summary, this study provides valuable insights into the dynamics of staked tomato production in the semiarid region of Paraíba and underscores the importance of family farming as a fundamental pillar for food security, economic development, and environmental sustainability in the region.

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