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EVOLUTION OF THE AREA, PRODUCTION AND PRODUCTIVITY OF THE COMMON BEAN IN BRAZIL: REGIONAL ANALYSIS FROM 2000 TO 2024

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Abstract: Common beans (*Phaseolus vulgaris* L.) are a staple food in the Brazilian diet and play a strategic role in food security and income generation, especially among family farmers. However, it faces challenges such as a reduction in the area planted, price instability, competition with more profitable crops and the impact of climate change. This study analyzed the dynamics of the cultivated area, production and productivity of beans in Brazil's five regions between 2000 and 2024. It used data from the National Supply Company (CONAB), organized into historical series and represented by interpretative graphs. The results show that although the area planted has decreased significantly, especially since 2012, national productivity has grown. This progress is attributed to the adoption of improved cultivars, management technologies and conservation practices. The Midwest, Southeast and South regions had the highest production rates, while the Northeast and North maintained the lowest, reflecting the strong dependence on rainfed agriculture and structural limitations. The conclusion is that public policies that promote the modernization of production, expand technical assistance and encourage the adoption of technologies are essential to guarantee the sustainability of bean cultivation and food security in Brazil.

Keywords: *Phaseolus vulgaris*. Agricultural production. Brazilian regions.

INTRODUCTION

Common beans (*Phaseolus vulgaris* L.) are one of the most essential foods in the Brazilian diet and play a fundamental role in the country's food security. It is grown in all regions of Brazil and can be planted on its own or in consortium with other agricultural crops (Silva 2021).

The crop accounts for 16.9% of total protein production in Brazil and is responsible for 31.4% of the country's daily protein intake,

playing a key role in the population's diet (Wander 2018).

The common bean is highly adaptable and is produced in all regions of Brazil. It is grown in three annual cycles, with the first crop known as "das águas" (summer), the second as "das secas" (dry) and the third as the winter crop. Brazil stands out in both the production and consumption of this grain, ranking among the world's largest producers and consumers (Mapa 2018).

According to data from CONAB (2024), the projection for the 2024/25 harvest indicates that, considering the three grain harvests, production should reach approximately 3.3 million tons, representing an increase of 1.8% in relation to the volume recorded in the 2023/24 harvest.

Wander & Chaves (2011) analyzed the per capita consumption of beans in Brazil and found that, between 2008 and 2010, the average annual intake per inhabitant was 17 kg, highlighting the importance of beans as a fundamental food in the national diet. The study pointed out that annual apparent per capita consumption was higher than annual household per capita consumption, suggesting an increase in the frequency of meals eaten outside the home or in the use of beans for other purposes. In a more recent period, between 2018 and 2020, the average annual consumption of the legume fell to approximately 14 kg per inhabitant. Specifically in 2020, this figure was 15.2 kg per capita (EMBRAPA 2021).

According to FAO data (2021), Brazil is among the world's top three bean producers, alongside India and Myanmar. In 2020, production in these countries was approximately 5.46 million tons in India, 3.035 million tons in Myanmar and 3.05 million tons in Brazil. Despite Brazil's significant production, it still relies on grain imports in some periods, depending on the performance of the harvest, to ensure supply to the domestic market.

Due to its wide adaptation to edaphoclimatic conditions, common beans are grown in Brazil in different production systems, ranging from small farms with limited use of technology to medium and large highly-technified agricultural enterprises (Souza et al. 2017). This productive diversity reinforces the need for research aimed at developing techniques that promote significant gains in productivity and improve the quality of this crop's grains (Soratto et al. 2005).

Given the socio-economic importance of the common bean, it is essential to understand its evolution over recent years in Brazil. In this context, this study aims to analyze the growth and changes in the production of this crop in the country, covering the period from 2000 to 2024.

MATERIAL AND METHODS

A survey was carried out of the historical series regarding the harvested area, production and productivity of the common bean (*Phaseolus vulgaris* L.), considering the three annual harvests (first, second and third) in the five Brazilian macro-regions (North, Northeast, Midwest, Southeast and South), as well as the national total. The data was obtained from the National Supply Company (CONAB), based on available crop year estimates from 2000/01 to 2023/24.

The data was organized in electronic spreadsheets and tabulated to consolidate the time series. Illustrative graphs were then generated using Microsoft Excel® 2010 software, with the aim of making it easier to see the trends and variations that occurred over the period analyzed.

RESULTS AND DISCUSSION

Between 2000/01 and 2011/12, there was an increase in the area planted to the total common bean crop in practically all regions of the country, despite the fluctuations observed, there is a general upward trend (Figure 1). This increase can be attributed to the growing adoption of agronomic practices that promote improvements in soil quality, such as soil correction and fertilization, as well as advances in genetic improvement. These advances have made it possible to develop and disseminate cultivars with higher productivity, better adaptability to regional conditions and resistance to pests, diseases and climatic variations

An assessment of the historical series of the area under common bean cultivation in Brazil indicates a trend towards expansion in most regions, with the exception of the North. The Northeast stands out as the region with the largest area under bean cultivation; however, this predominance in terms of planted area is not followed production.

suggesting the influence of factors such as productivity, the technology used and soil and climate conditions.

During the period analyzed of the evolution of the planted area of the total common bean crop in the country's regions, from 2012/13 to 2023/24 (Figure 2), there was a reduction in the extent of the planted area in practically all regions, and according to CONAB's monthly report of October 2022, the cultivation of beans, although of great relevance to Brazilian agriculture, has shown a reduction in the planted area in recent years. This phenomenon is mainly due to growing competition with soybean and corn crops, which offer greater profitability and resistance to environmental adversities.

In addition, the bean plant is highly susceptible to climatic variations and the incidence of pathogens, including fungi, bacteria, viruses and nematodes (Steinhauser 2016). The

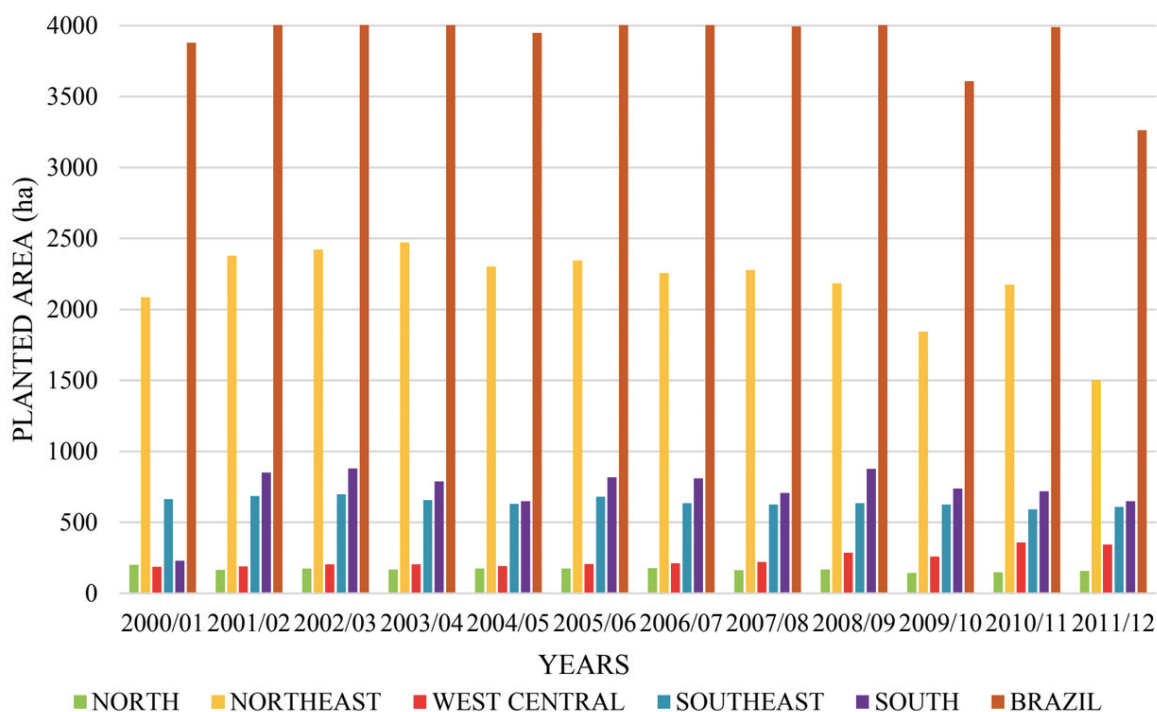


Figure 1 - Evolution of the planted area of the total common bean crop in the regions of Brazil from 2000/01 to 2011/12

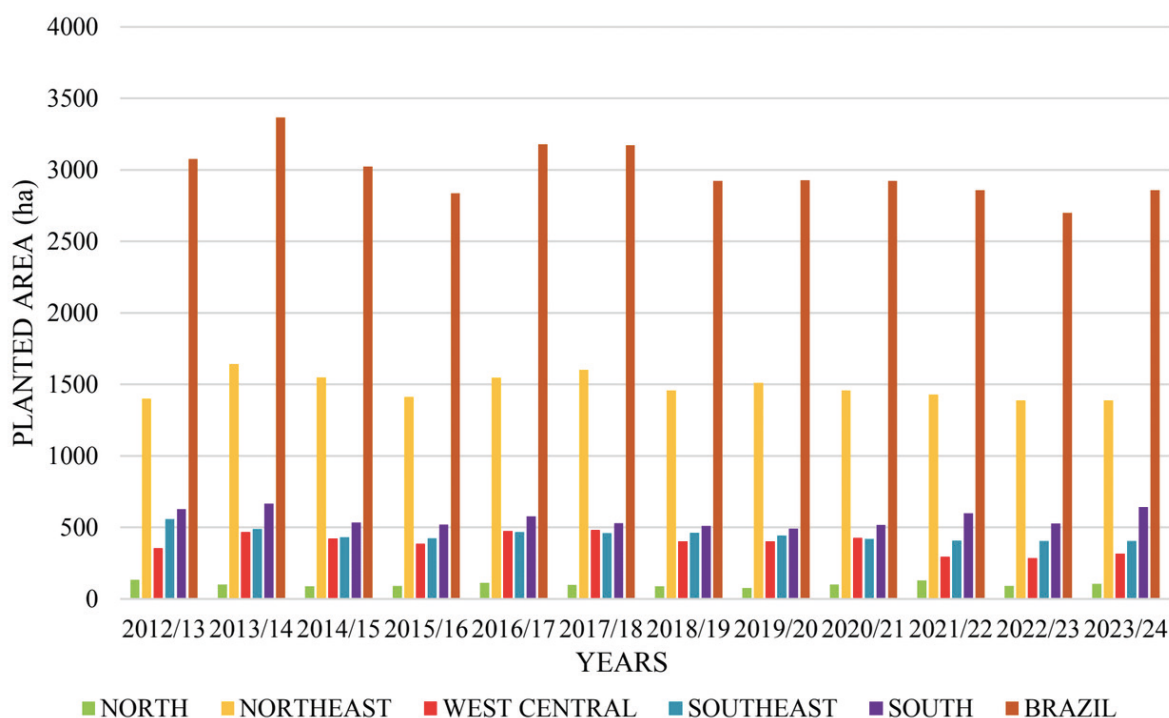


Figure 2: Evolution of the planted area of the total common bean crop in the regions of Brazil from 2012/13 to 2023/24

interaction of these factors, combined with the devaluation of the product on the market, increased production costs and instability in marketing, has contributed significantly to the reduction in the area planted.

Analysis of the historical series of bean production in Brazil, made available by CONAB, indicates a significant reduction in the area cultivated over the last few decades. Between the 1981/1982 and 2022/2023 harvests, the area used to grow the crop went from 6,155.3 thousand hectares to 2,699.5 thousand hectares, respectively, showing a significant decline (CONAB 2023).

Over this period, it can be seen that the Northeast still has the largest area planted with beans, while the North has the smallest. This behavior is associated with the fact that in the North, beans are predominantly grown in a single annual crop and often in consortium systems with other crops, which limits the expansion of the planted area (Oliveira and Wander 2023)

Analysis of the historical series from 2000/01 to 2011/12 (Figure 3) reveals a trend towards balance in production between the country's regions, with the exception of the North and Midwest, which maintain a lower level of production. The other regions are converging, gradually getting closer in terms of production volume.

According to Wander & Silva (2013), the predominance of the South and Southeast regions in the production of common beans in Brazil results from the interaction between climatic, technological and structural factors, which ensure greater stability and productivity throughout the harvests.

The authors point out that the common bean crop is highly sensitive to climatic variations, especially in relation to the availability of water throughout its phenological development. In this scenario, the North and Midwest regions have the lowest common bean pro-

duction rates (Figure 3) and face considerable challenges, since productivity is impacted by both scarcity and excess rainfall, factors that compromise the stability of the crop

In the North, high rates of rainfall and humidity, combined with low soil fertility, make it difficult to expand large-scale cultivation. In the Midwest, where the tropical climate prevails with prolonged periods of drought, production viability depends on the adoption of irrigation systems, an essential factor in guaranteeing production stability.

On the other hand, the South and Southeast have a more balanced rainfall regime, which favors cultivation, especially during the first harvest, providing more suitable environmental conditions for the crop's development.

Bean production in the Northeast is strongly associated with subsistence farming, where most of the crop is grown for family consumption and the surplus is only sold when production exceeds local demand. This production model gives relative stability to the total volume produced, even in the face of seasonal variations (Figure 3).

In addition, the predominance of domestic consumption reduces dependence on large-scale transport and distribution logistics, minimizing operating costs and facilitating marketing. This factor, combined with the strong regional demand for the grain, guarantees continued production, even during periods of drought (Wander & Silva 2013).

Figure 4 shows the evolution of common bean production in Brazil over the 2012/13 to 2023/24 harvests, segmented by region. Analysis of the data shows distinct variations in terms of growth and stability. Although national production has shown relative constancy over this period, there is a heterogeneous distribution between regions, with some consolidating their relevance in the production scenario, while others have maintained a more restricted contribution

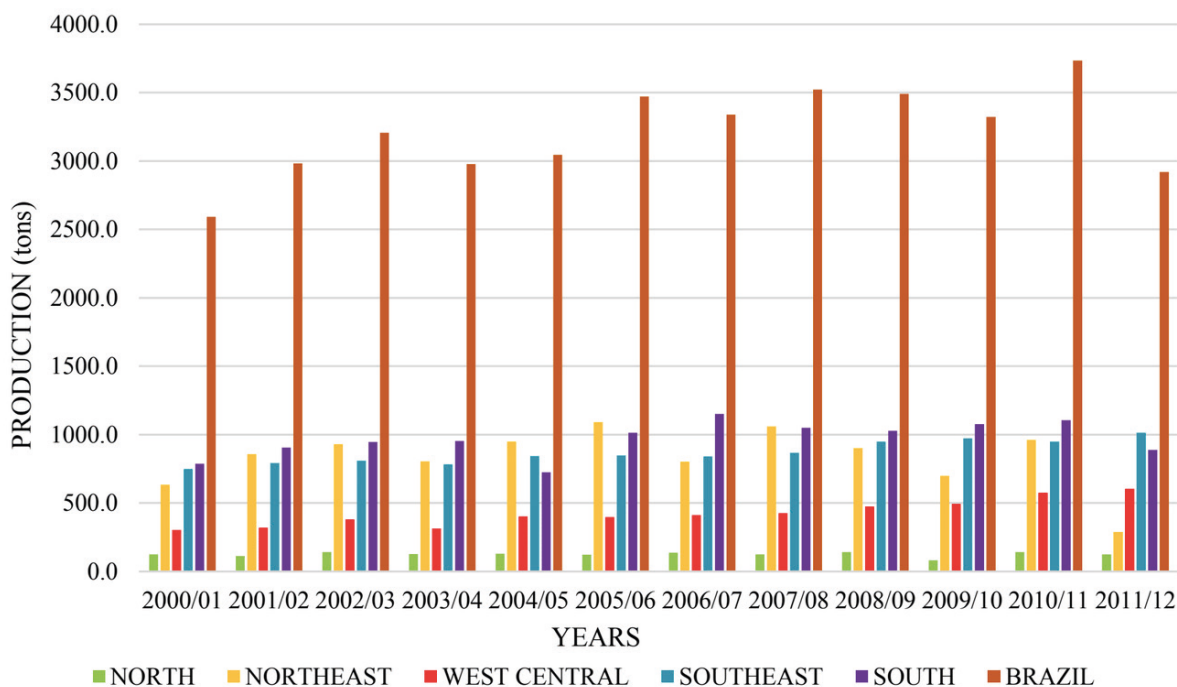


Figure 3: Production trends of the total common bean crop in Brazil's regions from 2000/01 to 2011/12

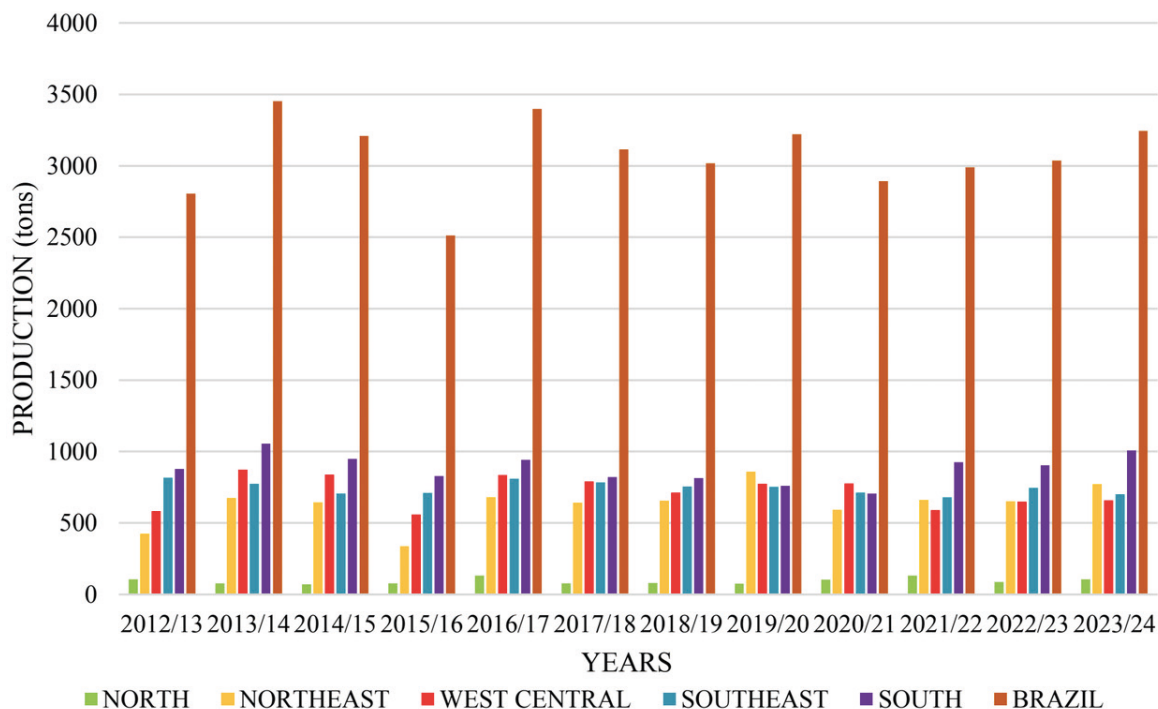


Figure 4: Evolution of production of the total common bean crop in the regions of Brazil from 2012/13 to 2023/24

Over the period analyzed, total bean production in Brazil varied between 2.5 and 3.5 million tons per year (Figure 4). This relative stability can be attributed to the incorporation of technological innovations in the agricultural sector, the implementation of policies to encourage production and the growing use of improved cultivars that are more tolerant of climate fluctuations and have greater production potential.

Bean production in Brazil is concentrated in the South, Southeast and Northeast regions, while the Midwest and North have relatively low volumes. According to IBGE data (2022), the South stands out as the main producer, accounting for approximately 29% of national production. Within this context, the state of Paraná leads both regional and national production, with the municipality of Irati ranking as the state's largest producer.

The Northeast has seen significant growth (Figure 4), driven above all by targeted policies and government incentives aimed at family farming. During the period from 1990 to 2010, production in the region was characterized by greater instability, directly influenced by rainfall variability. However, analyses of studies indicate that programs such as the National Program to Strengthen Family Farming (PRONAF), along with other government initiatives, played a key role in recovering and strengthening production, especially after the severe drought of 2012 (Salustiano & Nascimento 2019).

Productivity data over the period analyzed shows significant variations between the different regions of Brazil (Figure 5). The Midwest has established itself as the region with the highest productivity, reaching peaks of over 2000 kg/ha in certain harvests, such as 2004/05, as a result of the widespread adoption of genetically improved cultivars, agricultural mechanization and soil conservation practices, such as no-till farming (Gomes et

al. 2012). In contrast, the Northeast and North had the lowest production rates, often below 1000 kg/ha, reflecting the greater dependence on rainfed agriculture and the lower availability of advanced agricultural technologies (Moraes & Menelau 2017).

The South and Southeast maintained intermediate productivity, consistently above the national average (Figure 5). These regions, characterized by the predominance of family farming, have benefited from public policies aimed at modernizing the sector, especially the financing of inputs and technology via government programs such as PRONAF (Almeida 2021). However, adverse climatic events, such as severe droughts, have significantly impacted productivity in specific years, such as 2008/09 in southern Brazil (Coutinho et al. 2014).

Between 2007 and 2010, productivity fluctuated considerably due to adverse climatic factors. In southern Brazil, the drought of 2008/09 significantly reduced crop yields, demonstrating the vulnerability of this region to water variability (Coutinho et al. 2014). In the Midwest and Southeast, productivity remained relatively stable, sustained by the widespread adoption of irrigation.

In the last few years of the period analyzed, there was consistent growth in national productivity, driven by the intensified use of agricultural technologies. The national average productivity exceeded 1600 kg/ha (Figure 5).

However, the Northeast continued to present structural challenges, with yields of less than 900 kg/ha. The lack of irrigation infrastructure and dependence on rainfall limited production gains, making the region more vulnerable to crop failures. In order to overcome these difficulties, public policies aimed at expanding irrigation and technical support for family producers are fundamental to ensuring greater production stability in the long term (Gomes et al. 2012).

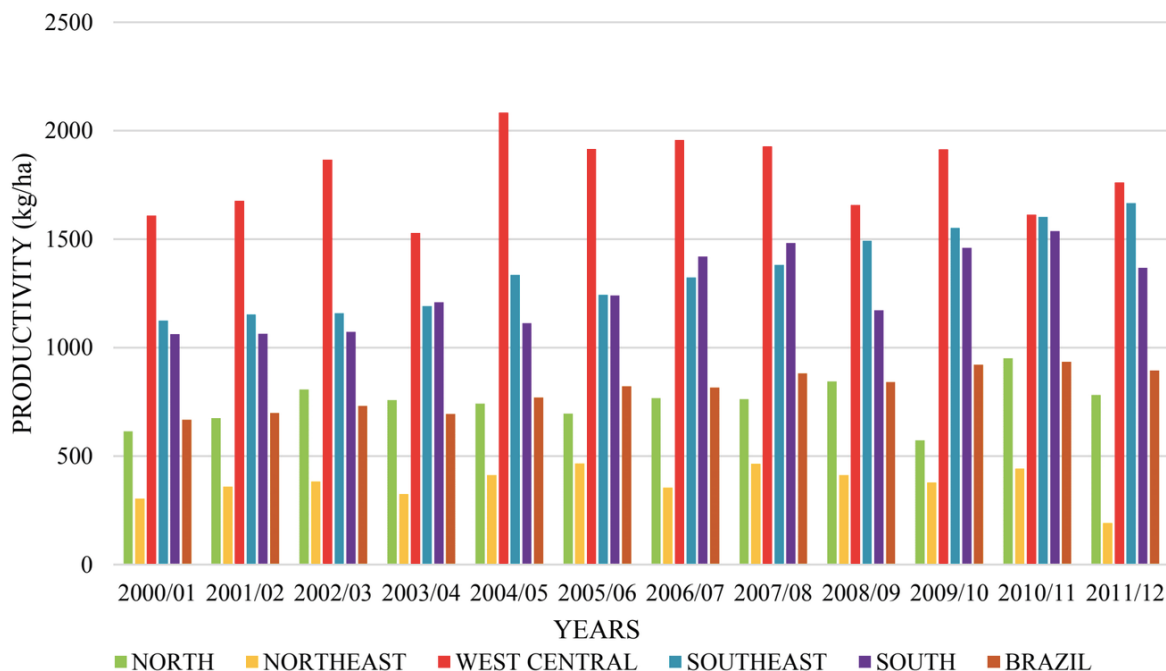


Figure 5 - Productivity trends of the total common bean crop in Brazil's regions from 2000/01 to 2011/12

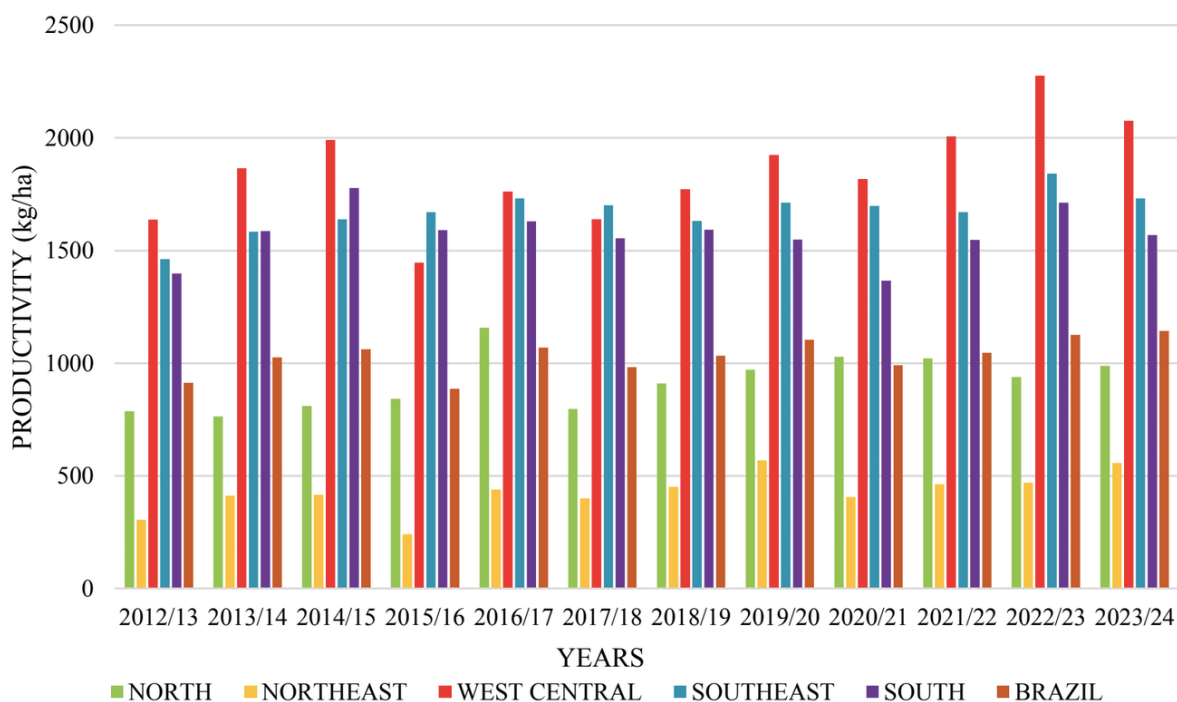


Figure 6 - Evolution of the productivity of the total common bean crop in the regions of Brazil from 2012/13 to 2023/24

Productivity data from the total common bean harvests show the Midwest as the most productive region (Figure 6), often exceeding 2,000 kg/ha, due to the increased flexibility in growing the crop, a factor that has led to an average 20% increase in productivity over the period. The Southeast and South maintained intermediate levels of productivity, varying between 1,500 and 1,800 kg/ha (Figure 6), driven by the predominance of family farming and the diversification of production systems. However, these regions proved vulnerable to extreme weather events, such as the droughts recorded in 2016/17 and 2019/20, which had a negative impact on the performance of bean crops, especially in rainfed areas (Almeida et al. 2021). In contrast, the Northeast and North saw yields below 1,000 kg/ha, due to the low adoption of technologies, water restrictions and the predominance of rainfed crops, with oscillations in several years of extreme drought, such as 2015/16 and 2017/18, despite the modest increases provided by the expansion of irrigation and the development of more drought-tolerant cultivars in some semi-arid areas.

The national average productivity fluctuated between 1,200 and 1,800 kg/ha, reflecting sustained growth, driven by the dissemination of conservation practices, expanded use of bio-inputs and improved efficiency in water use, especially from 2020 onwards. The years 2021/22 and 2022/23 recorded historic productivity records, driven by advances in genetic improvement, intensified adoption of sensors to monitor soil moisture and greater efficiency in

nutrient management, while 2023/24 showed production fluctuations associated with extreme weather events and increased costs of agricultural inputs, reinforcing the need for more robust strategies to adapt to climate variability (Costa et al. 2024). Faced with climate projections and the growing demand for food, it is imperative that Brazil invests in strategies that guarantee not only increased productivity, but also food security and the long-term sustainability of bean cultivation.

CONCLUSION

The historical analysis of the planted area, production and productivity of common beans in Brazil between 2000 and 2024 shows that, despite the reduction in the cultivated area, technological advances have sustained the growth in average national productivity, especially in the Midwest, South and Southeast regions, where there has been greater investment in irrigation, mechanization and improved cultivars. On the other hand, the Northeast and North maintained the lowest yields, reflecting their dependence on rainfed agriculture and structural limitations. The impact of climate change, competition with more profitable crops and price instability in the bean market were determining factors in the dynamics of the crop. For the future, policies to encourage modernization, expansion of water infrastructure and sustainable management will be essential to guarantee sustainable production and national food security.

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