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# Agronomic perspective: exploring the diversity and potentialities of banana cultivation (*Musa* spp.)

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**Abstract.** This article addresses the importance of banana cultivation (*Musa* spp.) in Brazil, focusing on its genetic diversity, economic potential, and challenges faced by producers. The bibliographic review conducted highlights the socio-economic relevance of bananas, their role in job creation and income generation, and their contribution to food security. Banana genetic diversity is a key point, offering varieties with distinct characteristics adapted to different environmental conditions. However, banana production faces significant challenges, such as pest and disease control, ensuring food quality and safety, and the need to promote sustainable agricultural practices. Collaboration among different actors in the production chain, including governments, research institutions, the private sector, and civil society, is essential to address these challenges and explore opportunities for sustainable development. Investing in research, innovation, and producer training is recommended, as well as promoting diversification of banana-derived products to add value to production and create new business opportunities. In summary, this article provides a comprehensive overview of banana cultivation in Brazil, highlighting its potential and challenges, and providing valuable insights for researchers, farmers, and policymakers.

**Keywords:** Family farming. Production challenges. Economic sustainability.

## Contextualization and analyses

Banana cultivation (*Musa* spp.) represents a significant component of Brazilian agriculture,

playing a fundamental role in the economy and subsistence of many rural families. The state of São Paulo stands out as a prominent producer of this

fruit due to favorable climatic and geographical factors, along with the active engagement of family farmers in its production. The state holds considerable potential for banana production, both for the domestic market and export, as highlighted by Baptistella, Coelho, and Ghobril (2019). The diversity of cultivated varieties, including Prata, Apple, Nanica, and Nanicão, reflects the adaptability of this crop to different local conditions, with over 700 known varieties of the genus *Musa*, according to the Ministry of Agriculture, Livestock, and Supply (MAPA, 2007), as noted by ASMAR et al. (2013).

In addition to its economic potential, banana cultivation plays a significant role in food and nutritional security. According to Rosso (2013), it is an accessible source of essential nutrients, providing carbohydrates, potassium, vitamins, and dietary fiber. This nutritional importance is particularly relevant considering the socioeconomic profile of many rural communities in the state, where bananas are a fundamental part of the daily diet. However, despite its significance, banana cultivation faces significant challenges, including issues related to production management and marketing, as observed by Nantes and Scarpelli (2001).

The connection between family farming and food markets, both domestic and international, is a crucial aspect to consider when exploring the importance of banana cultivation. According to data from the 2017 Agricultural Census, cited by Gilio and Renno (2018), family farming plays a predominant role in production in the state, contributing significantly to the local economy and job creation in rural areas. This integration between family producers and markets, while essential, also presents challenges, especially in terms of management and adaptation to market demands, as pointed out by Cordeiro (2000).

The economic and social importance of banana cultivation is undeniable, especially for family farming, which finds in this activity a significant source of income and subsistence, playing a crucial role in regional development and promoting economic growth, mainly through fruit farming (SOUZA et al., 2019).

However, banana production faces various challenges, from issues related to its delicate nature during harvest and post-harvest phases to the need to adapt to the demands of both domestic and international markets (LIVRAMENTO; NEGREIROS, 2017; BAPTISTELLA; COELHO; GHOBRI, 2019). The diversity of cultivated varieties and the cultivation techniques used reflect the complexity of this agricultural activity (MARTINS; FURLANETO, 2008).

The insertion into the domestic market is mediated by a variety of agents, including retailers, supermarkets, street markets, and supply centers, highlighting the importance of regional networks of production, distribution, and consumption (CORDEIRO, 2000). Despite the economic potential of banana cultivation, exports still represent a small portion of the total production, with the domestic

market being the main consumer (BAPTISTELLA; COELHO; GHOBRI, 2019).

In this context, it is fundamental to explore strategies and initiatives aimed at strengthening banana production and marketing, ensuring its long-term economic and social sustainability. The analysis of production chains, food markets, and regional development policies can provide valuable insights for the formulation of more effective policies and practices in the sector, as suggested by Moraes and Amaral (2013). Therefore, this research aims not only to highlight the diversity and importance of banana cultivation but also to identify opportunities and challenges for its sustainable development, exploring different agronomic, economic, commercial, social, and cultural aspects related to this important agricultural crop.

## Material and methods

The methodology adopted in this review article was carefully designed to ensure a comprehensive and detailed approach to banana cultivation. Initially, major academic databases, including PubMed, Scopus, Web of Science, and Google Scholar, were consulted. These platforms provide access to a wide range of scientific articles, theses, dissertations, and technical reports related to the subject matter. Additionally, books and other relevant literary sources were explored to enrich the review with diverse and complementary information.

When searching for relevant articles and materials, specific keywords were used to effectively direct the research. Terms such as "banana," "*Musa* spp.," "banana cultivation," "agriculture," "agricultural economics," "production chains," "food trade," "social impact," "regional development," and "future perspectives" were employed to cover different aspects of banana cultivation and ensure broad coverage of relevant topics.

The significance of this study lies in the need to deeply understand banana cultivation and its implications in various areas such as food security, agricultural economics, and sustainable development. A detailed analysis of these aspects can provide valuable insights for the formulation of more effective agricultural policies, production practices, and marketing strategies, thus contributing to the advancement of the agricultural sector as a whole.

The justification for conducting this review stems from the scarcity of comprehensive and up-to-date studies on banana cultivation. While there are many isolated research studies on the topic, an integrated and systematized review can fill gaps in existing knowledge, providing a more complete and holistic view of the subject. This is essential to guide researchers, farmers, and policymakers in making informed decisions and implementing more sustainable practices.

Furthermore, this review has significant potential for innovation by identifying areas for future research and developments in banana cultivation. By highlighting the challenges faced by the sector

and the emerging opportunities, it can inspire new approaches and solutions to complex issues related to production, marketing, and utilization of this versatile fruit.

In summary, it is expected that this review article will make a substantial contribution to the academic community by providing a comprehensive and updated overview of banana cultivation. By serving as a reliable source of information and insights, it can inspire new research, debates, and initiatives in the fields of agriculture, agricultural economics, and rural development.

#### *History and Origins of Bananas*

The history and origins of bananas date back centuries of cultivation and adaptation to various environmental and social conditions. Embedded in family agricultural practices, bananas stand out as one of the main agricultural crops in tropical and subtropical regions (WANDERLEY, 2010; FRANÇA et al., 2009; AQUINO & SCHNEIDER, 2011). Their socio-economic importance is evidenced by references highlighting the relevance of family agriculture in the production of commercial fruits like bananas (ANDRADE, 1986; SOUZA et al., 2007). Moreover, nature preservation is emphasized as an essential condition for conserving these natural spaces, which are crucial for sustainable food production, as highlighted in studies on family agriculture and its environmental challenges (LAMARCHE, 1993; SCHNEIDER, 2003; SCHNEIDER, 2006). Over time, bananas have become a predominant commercial product, encouraging local processing initiatives such as dehydration for the production of "banana chips," which seeks to add value to the product and expand income-generating opportunities for family farmers (CRUZ, 1990; TRAVAGLINI ET AL., 2002).

The origins of the fruit trace back to ancient periods of agriculture, representing one of the earliest cultivated crops by humanity (AVANITOYANNIS; MAVROMATIS, 2009). Originating from Southeast Asia, it is an ancestral fruit, with over 700 varieties and approximately 30 cataloged species (ASMAR et al., 2013). Its presence dates back to historical records that span millennia, indicating its cultural and economic importance over time. The domestication and dissemination of bananas were significant milestones in agricultural history, marking the transition from collecting wild foods to systematically practicing agriculture (NASCIMENTO et al., 2020).

Over the centuries, bananas spread across different continents, adapting to varied climates and soils found in each region (NASCIMENTO et al., 2020). Through ancient trade routes like the Silk Road and the exploration voyages of European navigators, it was introduced to new territories, becoming a globally disseminated crop (ASMAR et al., 2013). This dissemination not only influenced agricultural practices but also played a crucial role in cultural interaction and the formation of diets in

different societies around the world (AVANITOYANNIS; MAVROMATIS, 2009).

Its arrival in the American continent occurred during the colonial period, when European colonizers introduced it to their colonies in the Americas (NASCIMENTO et al., 2020). Initially cultivated on a small scale for local consumption, with time, the development of transportation and storage technologies allowed for large-scale commercialization (ASMAR et al., 2013). Rising as a commercial crop had a profound impact on the economy of various tropical regions, shaping social and economic relations and altering the agricultural landscape (NASCIMENTO et al., 2020).

The history of banana cultivation is closely linked to exploitation and colonialism, with the establishment of large-scale plantations by multinational companies in tropical regions (NASCIMENTO et al., 2020). This expansion led to significant production concentration in specific countries, such as Ecuador, Costa Rica, and the Philippines, making them the world's leading exporters (ASMAR et al., 2013). However, this history is also marked by social and environmental challenges, including issues of labor rights, environmental impacts, and land concentration (AVANITOYANNIS; MAVROMATIS, 2009).

Bananas have become not only an important food source but also an integral part of the culture and identity of many communities around the world (ASMAR et al., 2013). Its culinary versatility, combined with its nutritional value and accessibility, has made it an essential food in many traditional diets. Additionally, it also plays symbolic and ritual roles in various cultures, being associated with celebrations, festivals, and religious ceremonies (AVANITOYANNIS; MAVROMATIS, 2009). Thus, history and origins are not limited to its agricultural and commercial context but also encompass social, cultural, and even spiritual aspects, highlighting its multifaceted importance over time.

#### *Banana Varieties in Brazil*

Banana varieties exhibit a wide diversity, reflecting the genetic richness of this fruit. According to Asmar et al. (2013), the *Musa* genus encompasses about 30 species and over 700 varieties, highlighting the extensive variety within the group. This genetic diversity is essential not only for species preservation but also for adaptation to different climatic conditions and market demands.

In Brazil, the most common banana varieties are the Prata, Maçã, Nanica, and Nanicão, mainly cultivated on small farms. According to the Ministry of Agriculture, Livestock, and Supply (MAPA, 2007), these varieties are predominant in the country due to their adaptation to local conditions and market demand, emphasizing the importance of the most popular varieties in Brazilian agriculture.

The differentiation among banana varieties extends beyond physical characteristics to encompass their agronomic and commercial properties as well. As highlighted by Avanitoyannis

and Mavromatis (2009), different varieties show variations in pest resistance, tolerance to adverse weather conditions, and ripening time, which directly influence producers' and consumers' choices.

In addition to well-known varieties, there are also regional and traditional varieties, which play an important role in local culture and the preservation of agricultural biodiversity. As emphasized by Folegatti and Matsuura (2008), these varieties can be exploited by small agribusinesses for the production of products like dried bananas, sweets, and jams, adding value to production and promoting gastronomic diversity.

Understanding banana varieties is fundamental for sustainability and innovation in agriculture. As highlighted by Moraes and Amaral (2013), the genetic diversity of banana varieties offers opportunities for developing new cultivars with desirable traits such as disease resistance and adaptation to new environments, contributing to food security and the resilience of agricultural systems.

#### *Agronomic Aspects of Banana Cultivation*

Banana cultivation (*Musa* spp.) is characterized by a series of agronomic aspects that influence its production and development. As emphasized by Avanitoyannis and Mavromatis (2009), the fruit is one of the earliest crops in agricultural history, demonstrating its relevance and long trajectory in agricultural practice. This history confirms bananas' continued importance as a fundamental crop over the centuries, influencing agronomic practices adopted in its production.

In the agronomic context, variety diversity plays a crucial role. Varieties such as Prata, Maçã, Nanica, and Nanicão, highlighted by Baptitella, Coelho, and Ghobril (2019), have distinct characteristics in terms of size, taste, and disease resistance. This diversity requires specific agronomic strategies for each type, from planting to harvesting, aiming to optimize fruit production and quality.

One of the most important agronomic aspects in banana cultivation is phytosanitary management. As mentioned by Embrapa (2000) and Alves (1997), proper treatment is essential to control pests and diseases affecting the crop, ensuring its health and productivity. This includes the responsible use of pesticides and integrated pest management practices, aiming to minimize crop damage and promote sustainable production.

Moreover, water management is a crucial aspect in agriculture. According to Folegatti and Matsuura (2008), bananas require a significant amount of water for their proper growth and development. Therefore, efficient irrigation practices are essential to ensure adequate water supply to plants, especially during periods of water stress. Another relevant agronomic aspect in cultivation is fertilization. As emphasized by Rosso (2013), proper application of fertilizers is fundamental to provide the necessary nutrients for healthy plant growth and high-quality fruit production. This involves balanced

use of macro and micronutrients according to the specific needs of each growth stage.

These agronomic aspects highlight the complexity and importance of banana cultivation in agriculture, demonstrating the need for careful and specific practices to ensure sustainable and high-quality production.

#### *Economics and Trade of Bananas*

The economy of banana-producing regions is intrinsically linked to the various production chains that sustain this crop. These chains encompass production on farms to commercialization in local and international markets (MORAES; AMARAL, 2013). The economic progress of these areas often depends on the performance of these chains, highlighting the importance of bananas as a crop of significant socioeconomic relevance.

The competitiveness and socioeconomic development of cities, municipalities, and regions are closely linked to the existence and performance of banana production chains. These chains not only generate employment and income but also drive local economic growth (ROSSO, 2013). Active participation of producers, especially those in family agriculture, is essential for strengthening these chains and promoting regional development.

Banana production plays a crucial role in the economy of family agriculture, providing profitable activities and a vital source of income, especially for small-scale producers (SOUZA et al. 2019). This crop not only sustains rural families but also positively influences regional development and economic growth through fruit growing.

Trade, both in domestic and international markets, plays a significant role in the Brazilian economy. In 2018, the country exported a substantial quantity, especially to South American countries, demonstrating the importance of this product in regional markets (BAPTISTELLA; COELHO; GHOBIL, 2019). However, a large portion of production is still destined for the domestic market, highlighting its relevance in the national diet and local supply.

For producers, agribusiness represents an opportunity to add value to production and minimize post-harvest losses. Transformation into processed products such as candies, jams, and chips offers alternatives to maximize profitability and cater to different market segments (SALLES; MENDES NETO; GUSMÃO, 2006). This diversification of supply contributes to strengthening the local economy and expanding business opportunities.

#### *Social and Cultural Impact of Bananas*

Banana production plays a fundamental role in the social and cultural context, being an important source of employment and income, especially for small producers and rural communities. This activity significantly contributes to social inclusion and local development, providing work opportunities and strengthening community bonds (SOUZA et al. 2019).

Beyond its economic impact, bananas are deeply rooted in food culture and consumption habits of the Brazilian population. Present in open-air markets and regional markets, this fruit is consumed in various forms and integrates traditional recipes of the national cuisine, reflecting its relevance in the country's diet and customs (LIMA, 2017; SILVA, 2016).

Its presence goes beyond food aspects, permeating social and festive spheres as well. In events like parties and celebrations, it promotes sociability and community interaction, being an essential element in the traditions and cultural rituals of various regions of Brazil (ANDREATTA; WICKLIFFG, 2002).

It is interesting to observe how bananas transcend culinary and social aspects, marking their presence in various cultural manifestations of the country. Mentioned in songs, poems, and popular expressions, this fruit becomes a symbol of Brazilian cultural identity, enriching the nation's artistic and symbolic repertoire (LIMA, 2017; SILVA, 2016).

Furthermore, the cultivation and traditions associated with this crop are passed down from generation to generation, strengthening family ties and preserving ancestral knowledge about the management and use of this fruit. This transmission of knowledge and practices contributes to maintaining cultural identity and valuing local traditions (SOUZA et al. 2019).

In summary, bananas are not just a fruit of economic value but also an essential element in building identity and cultural expression of the Brazilian people. Its social and cultural impact transcends the boundaries of agricultural production, leaving profound marks on the history and lives of the communities where it is cultivated.

#### *Challenges and Future Perspectives*

Faced with the challenges of banana cultivation, the need to address fundamental issues related to its environmental sustainability and the preservation of natural resources becomes evident. As highlighted by Souza et al. (2019), proper management of agricultural waste and conservation of water resources emerge as priority challenges in this context. It is essential to develop and implement more sustainable agricultural practices, such as adopting agroforestry systems and employing precision agriculture techniques, aiming to mitigate negative impacts on the environment (EMBRAPA, 2000; ALVES, 1997).

In addition to environmental concerns, banana cultivation also faces challenges related to food safety and security. The need to control pests and diseases, as well as to ensure the quality and safety of food products, is an urgent issue that demands attention and investments from producers and institutions responsible for sector regulation and oversight (ASMAR et al., 2013).

In addressing these challenges, research and development of new banana varieties more resistant to diseases and adapted to local growing

conditions play a crucial role. Borges and Souza (2004) highlight the importance of investing in more efficient and sustainable production technologies capable of increasing productivity and reducing the environmental impacts of banana cultivation.

Moreover, it is essential to promote the training and access of rural producers to information and technologies that can help them address current and future market challenges. In this regard, Soto Ballesteros (1992) emphasize the importance of providing technical support and financial assistance to farmers, enabling them to adopt more sustainable and efficient practices in their activities.

Finally, it is fundamental for governments, research institutions, non-governmental organizations, and the private sector to collaborate and coordinate efforts to address challenges and seize opportunities for sustainable development of banana cultivation. Cooperation and integration among different actors in the production chain are essential to ensure a promising future for this important agricultural activity (BORGES; SOUZA, 2004).

#### **Conclusion**

First and foremost, the diversity and importance are evident, highlighting its economic, social, and cultural relevance across various regions of the world. Through the analysis of cultivated varieties, a wide range of types is observed, each with specific characteristics that cater to different market demands and consumer preferences. This aspect underscores the importance of genetic diversity and the preservation of biodiversity to ensure food security and sustainable development in the region.

Regarding agronomic aspects, there is a need to address issues related to sustainable management of natural resources and pest and disease control. Investments in research and development of new technologies and practices are essential to increase productivity, reduce environmental impacts, and ensure the economic viability of producers. Additionally, farmer training and access to technical information are essential to promote the adoption of more efficient and sustainable cultivation methods.

Concerning the economy and trade, the importance of the domestic market as a potential for expanding exports to other markets is evident. Diversification of derivative products, such as purees, sweets, and jams, can contribute to adding value to production and opening new business opportunities for local producers. However, overcoming challenges related to infrastructure, logistics, and access to external markets is necessary to fully exploit the potential of the industry.

Lastly, in addressing future challenges and prospects, it is crucial to promote more sustainable agricultural practices, invest in research and innovation, and strengthen the training and

organization of producers. Collaboration among different actors in the production chain, including governments, research institutions, the private sector, and civil society, is essential to address challenges and seize opportunities for sustainable development.

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