
PRODUCTION CHAIN OF BLACK PEPPER IN BRAZIL

MOREIRA, Wendel K. O.¹
BENEDUZZI, Humberto Martins²
ALVES, Fernando de Lima³
MACHADO, Silvia Renata Coelho⁴
MENDONÇA, Adriane Silva de⁵
SILVA, Raimundo Thiago Lima da⁶

Recebido em: 2020.08.12

Aprovado em: 2021.08.19

ISSUE DOI: 10.3738/1982.2278.3826

SUMMARY: The Brazilian trade balance shows positive surpluses every year, due to the strong performance of the Brazilian agribusiness, which has played a fundamental role in the country's economy. In view of the economic scenario the peppercorn culture has shown great importance in the Brazilian export market. Considered a commodity this has its transaction carried out through the stock exchange and oscillate through the world market. The present research aims to characterize the chain of black pepper production in the Brazilian scenario. The dynamics of pepper production chain in Brazil is established by its high added value in the product, basically its production is developed by family agriculture, where it shows its strong impact on the maintenance of labor in the field. The Brazilian productivity of black pepper is higher than the world average. However, the initial exploitation of black pepper requires high capital, besides presenting great variability in prices, even though it is a commodity. Being a demanding crop in nutrients and highly susceptible to fusariosis, it is essential to develop alternative exploitation, which can be consortium exploitation, in SAF, besides the technical assistance and organization of producers, to realize sales with volumes and quality in the processing (drying and cleaning) and production of differentiated products, such as white pepper, which has the highest final product value.

Keywords: Marketplace, spice, *Piper nigrum* Linnaeus, king of spices

CADEIA PRODUTIVA DA PIMENTA-DO-REINO

RESUMO: A balança comercial brasileira mostra superávits positivos a cada ano, devido ao forte desempenho do agronegócio brasileiro, que vem desempenhando papel fundamental na economia do país. Diante do cenário econômico a cultura da pimenta-do-reino vem mostrando grande importância no mercado de exportação brasileira. Considerada uma *commodity* esta tem sua transação realizada por meio de bolsa de valores, e oscilar por meio de mercado mundial. A presente pesquisa tem como objetivo configurar a cadeia produtiva da pimenta-do-reino no cenário brasileiro. A dinâmica da cadeia produtiva da pimenta – do – reino no Brasil, é estabelecida pelo seu alto valor agregado no produto, tendo basicamente a sua produção desenvolvida por agricultura familiar, onde mostra o seu forte impacto na manutenção de mão-de-obra no campo. A produtividade brasileira de pimenta-do-reino é maior do que a média mundial. Contudo, a exploração inicial da pimenta-do-reino exige um alto capital, além de grande variabilidade nos preços, mesmo porque se trata de uma *commodity*. Sendo uma cultura exigente em nutrientes, e de alta suscetibilidade à fusariose, é imprescindível desenvolver alternativas de exploração, que podem ser exploração consorciada, em SAF, além da assistência técnica e organização de produtores, para realizarem vendas com volumes e qualidade no beneficiamento (secagem e limpeza) e produção de produtos diferenciados, como a pimenta-branca, que possui maior valor final do produto.

Palavras-chave: Mercado. Especiaria, *Piper nigrum* Linnaeus. Rainha das Especiarias.

¹ ORCID – ID-<https://orcid.org/0000-0002-7778-0151>. Programa de Pós-graduação em Engenharia agrícola, Universidade Estadual do Oeste do Paraná, Campus Cascavel, Paraná

² Instituto Federal do Paraná (IFPR), Foz do Iguaçu – PR, Brasil.

³ Instituto Federal do Paraná (IFPR), Cascavel – PR, Brasil.

⁴ Programa de Pós-graduação em Engenharia agrícola, Universidade Estadual do Oeste do Paraná, Campus Cascavel, Paraná

⁵ Tecnologia de Alimentos, Universidade Estadual do Pará (UEPA), Redenção, Pará, Brasil.

⁶ Universidade Federal Rural da Amazônia, Instituto de Ciências Agrárias, Capitão Poço, Pará, Brasil.

INTRODUCTION

Brazil has maintained a positive trade balance for several years, supported by its strong agribusiness sector. In September 2017, agricultural exports netted a surplus of US\$ 7.4 billion, 32% higher compared with September 2016 (FIESP, 2017). These figures are evidence of the importance of Brazilian agricultural production to the global food supply and indicate that the sector is able to respond effectively to constant market changes resulting from globalization, external crises, and supply–demand mismatches (PAVESI; GOMES, 2011).

A high-value agricultural product that has shown great export potential in Brazil is black pepper (*Piper nigrum* Linnaeus, Piperaceae). Black pepper is a flowering vine native to tropical Indian forests and widely cultivated in several countries (REHMAN *et al.*, 2015; GRINEVICIUS *et al.*, 2017). It is known as the king of spices, considered the oldest and most valuable medicinal spice in India (TRAN; KRUIJT; RAAIJMAKER, 2008; SHANMUGAPRIYA *et al.*, 2012; GU *et al.*, 2013), treated as a commodity, and used as an exchange currency in the International Pepper Exchange.

The global black pepper market is divided into two main regions. Pepper-producing countries in Asia (Vietnam, Malaysia, and India) trade mainly with other Asian countries (China and Thailand), European countries, and the United States. Latin American producers (Brazil and Ecuador) export mainly to North America (United States and Mexico), the European Union (Germany, Spain, the Netherlands, and France) and Mercosur countries (Argentina) (DESER, 2008).

Brazil is currently among the largest producers of black pepper. The states of Pará and Espírito Santo are the largest producers in the country, accounting respectively for 75.3% and 14.3% of the national yearly production of 52 thousand tonnes (SERRANO *et al.*, 2012).

Black pepper began to be cultivated in Brazil as a garden plant in the 17th century. The first plants were grown in Bahia and from there were taken to Paraíba, Maranhão, and Pará. (ALBUQUERQUE; CONDURU, 1971). In the 1930s, Japanese immigrants established the first commercial plantation of black pepper in Pará. In 1982, Brazil ranked as the largest producer and exporter of the spice (FILGUEIRA *et al.*, 2002).

Black pepper is an important source of income for rural farmers and their family in northern and northeastern states. In Pará, black pepper represents a prominent export, and pepper plantations employ a significant part of the rural labor force. However, the structure of the black pepper market and the relationship between family farmers, processors, and exporters has yet to be elucidated (DESER, 2008). Thus, this study aimed to describe the black pepper production

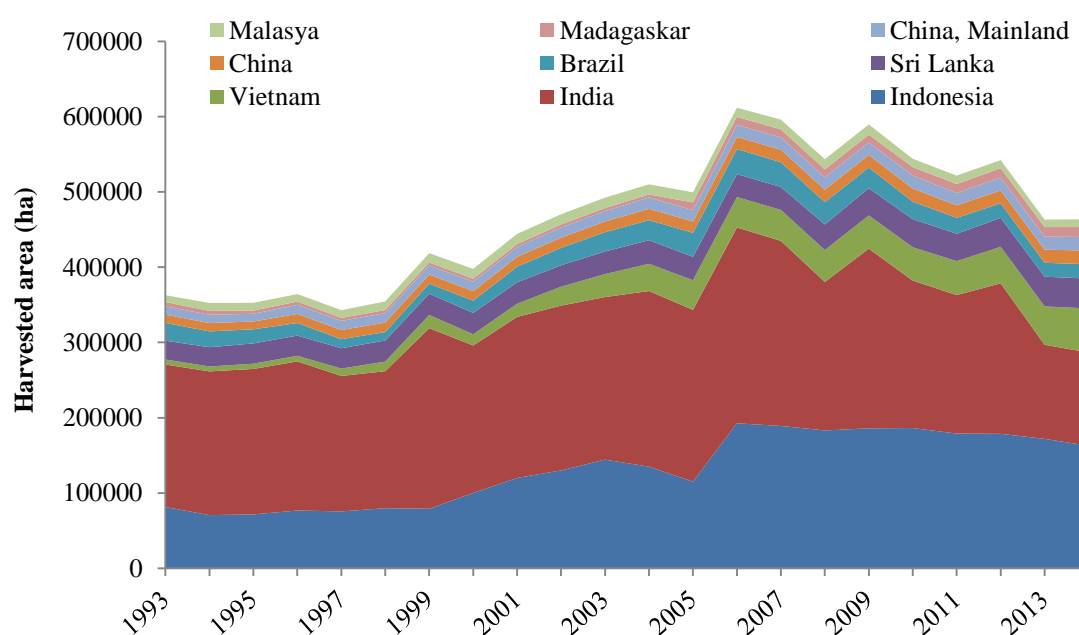
chain in Brazil and analyze the importance of this agricultural product to the economy of the country.

Black pepper production in Brazil and worldwide

Global black pepper production

According to data from the Food and Agriculture Organization (2017), the harvested area of black pepper increased in major producing countries between 1993 and 2009. However, there has been a decrease in harvested area since 2010, possibly as a result of plant diseases (Figure 1).

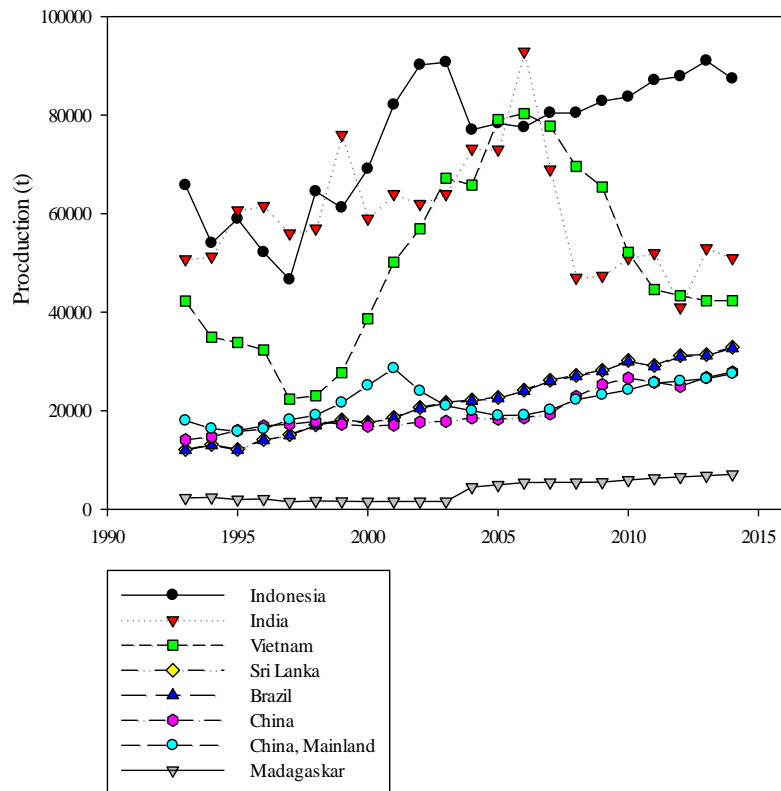
Figure 1. Black pepper harvested area (ha) in major producing countries from 1993 to 2015.



Source: created by the authors from Food and Agriculture Organization data (FAO, 2017).

Indonesia is the world's largest producer of black pepper, followed by India and Vietnam. In 2014, the three countries were responsible for 73.50% of the world production of black pepper, whereas Brazil accounted for 4.06% (Figure 2). India and Vietnam showed a marked decrease in production from 2007 to 2013 (Figure 2).

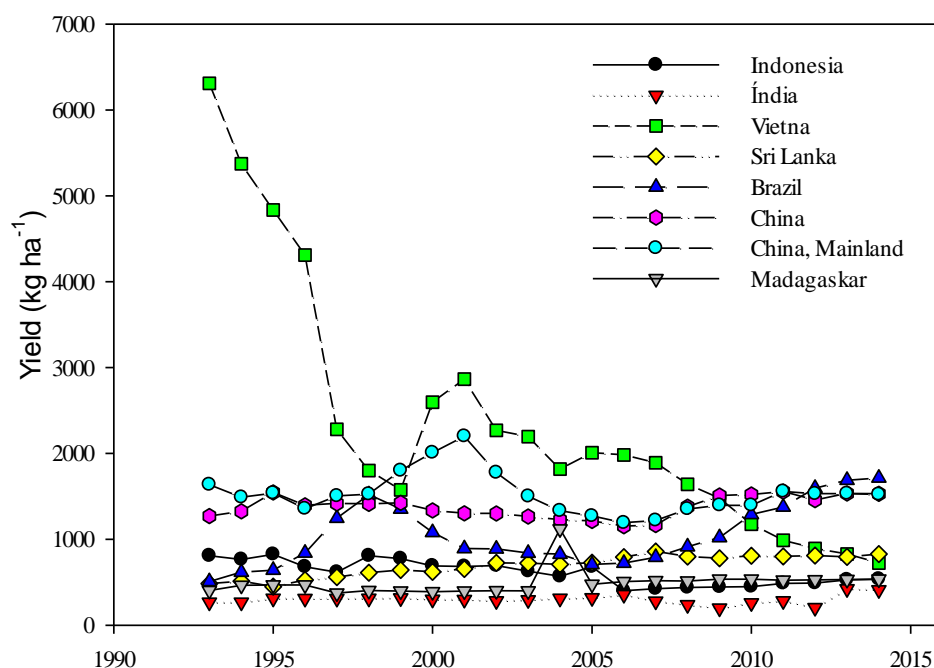
Figure 2. Black pepper production (t) in major producing countries from 1993 to 2015.



Source: created by the authors from Food and Agriculture Organization data (FAO, 2017).

Yield, measured as production per harvested area, is notably low in most countries. Vietnam had a dominant position in terms of black pepper yield from 1993 to 2008. In Brazil, production yield has gradually increased and is now comparable to that of China (Figure 3).

Figure 3. Black pepper yield (kg ha^{-1}) in major producing countries from 1993 to 2015.



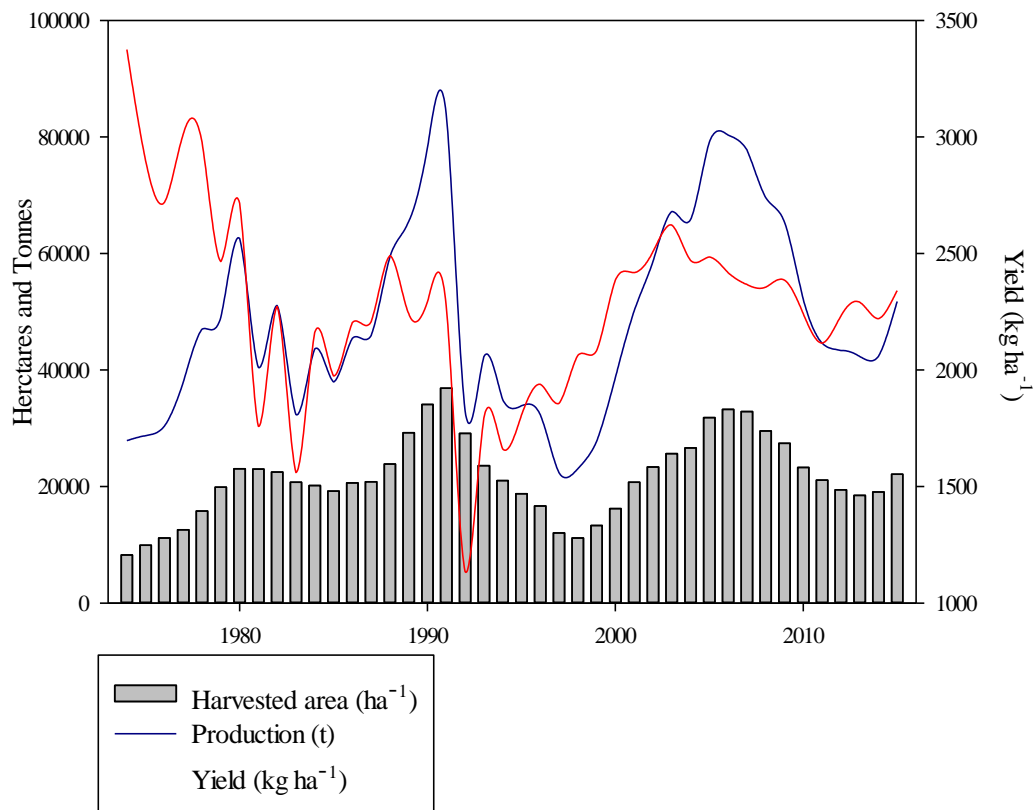
Source: created by the authors from Food and Agriculture Organization data (FAO, 2017).

The economic importance and high market value of black pepper have motivated research efforts to develop high-yield, high-resistance varieties, but little success has been achieved. Black pepper cultivation is challenged by diseases, such as the destructive foot rot caused by the oomycete *Phytophthora capsici* (SIMOJ *et al.*, 2014; ANANDARAJ; SARMA, 1995; TRAN; KRUIJT; RAAIJMAKER, 2008). infect all plant parts during all growth stages. In black pepper cultivation, yield losses caused by *Phy. capsici* can amount up to 40–50% (DRENTH; GUEST. 2004). When transmitted through the soil, the fungus infects all parts of the plant. Infection at the collar region results in sudden wilting, defoliation, and death (GEORGE; KUMAR; PRABHAKARA, 2015). PRABHAKARAN (2011) reported that plant diseases devastated a considerable number of black pepper crops in rural India.

Black pepper production in Brazil

Black pepper production in Brazil has been characterized by growth peaks followed by periods of decline. This same pattern is seen in harvested area. Yield has decreased since 1976; there was a large drop in 1992 followed by a slight increase in the following year (Figure 4).

Figure 4. Black pepper harvested area (ha), production (t), and yield (kg ha^{-1}) in Brazil from 1974 to 2015.



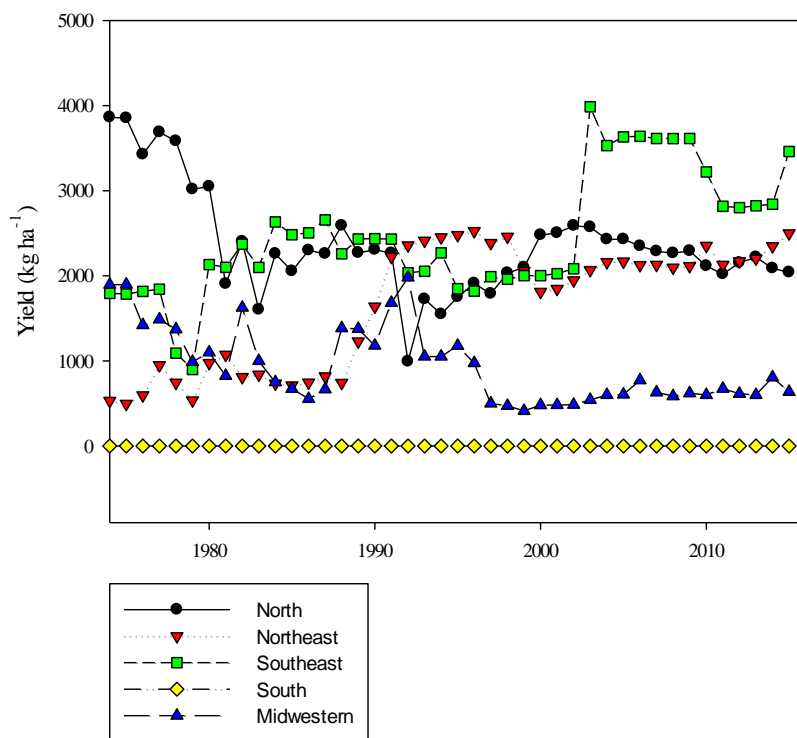
Source: created by the authors from Brazilian Institute of Geography and Statistics data (IBGE, 2017).

As shown in Figure 4, area harvested, and production have continuously decreased since 2006. This may be due to sales problems, as black pepper producers in Brazil are not organized in cooperatives and the market has an oligopsonistic structure (FILGUEIRAS *et al.* 2001). Economic losses resulting from infection with *Fusarium solani* f. sp. *piperis* (*Nectria haematococca* Berck & Br.F. sp. *piperis* Albuquerque) have aggravated this situation (GAIA *et al.*, 2007). *Fusarium* wilt has plagued black pepper plantations around the world, discouraging farmers from remaining in the activity. The fungal infection reduces the economic life of a plantation from 20 to 6–8 years and the yield per plant from 3.0 to 1.5 kg (ANANDARAJ, 2000).

Maximizing yield necessitates further technological and scientific development (ALVES *et al.*, 2014), agricultural investment funds for farmers, and specialist professionals who can provide technical, commercial, and economic advice to farmers.

The evolution of black pepper production in each of the regions of Brazil in the last decades is shown in Figure 5.

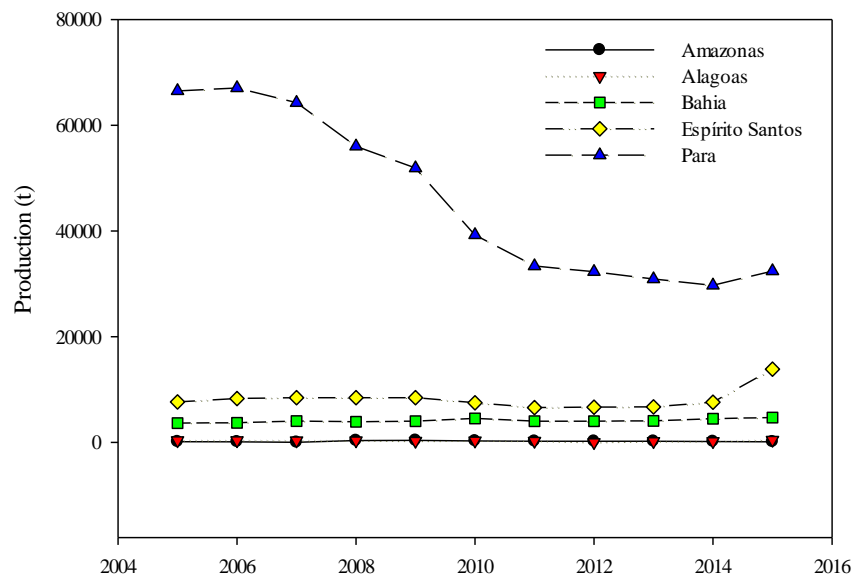
Figure 5. Black pepper yield (kg ha^{-1}) by Brazilian region from 1975 to 2014.



Source: created by the authors from Brazilian Institute of Geography and Statistics data (IBGE, 2017).

Pará and Espírito Santo accounted respectively for 62.19% and 26.90% of the national black pepper production in 2015 (Figure 6), which shows their importance to the country's positive trade balance. In these states, black pepper is considered a commodity whose main target market is the international market.

Figure 6. Total production (t) of black pepper in the five largest producing states in Brazil from 2005 to 2014.

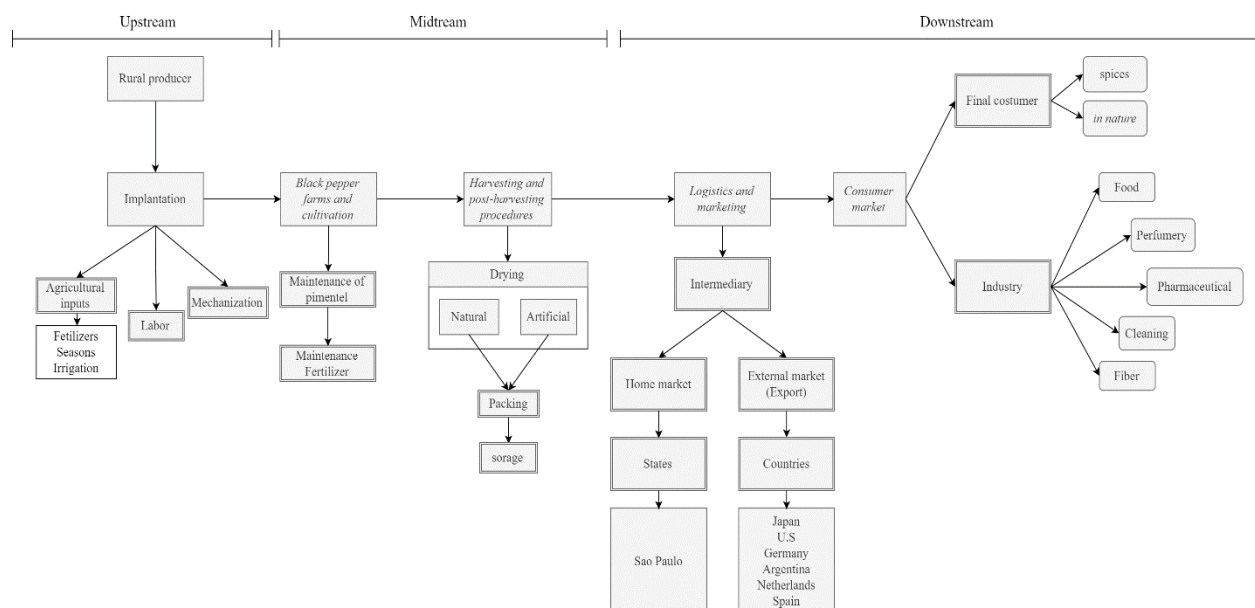


Source: created by the authors from Brazilian Institute of Geography and Statistics data (IBGE, 2017).

Pará has seen a steady drop in production, which can affect future exports. In contrast, black pepper production in Espírito Santo showed a slight growth in the biennium 2014–2015. These data are probably associated with crop management practices and phytosanitary problems (Alves *et al.*, 2014).

The black pepper production chain in Brazil

The dynamics of the black pepper production chain in Brazil are determined by the high added value of the product. Black pepper is mainly grown in family farms, which indicates its important role in maintaining rural labor force. The production chain does not establish the farm as the main source of capital; rather, it shows that black pepper trade mobilizes the national agricultural sector. Figure 7 depicts the structure of the black pepper production chain in Brazil.

Figure 7. Flowchart of the characterization of the production chain of black pepper.

Source: author, based on literature review used.

Black pepper farms and cultivation

Small production chains are essential for pepper farming. They stimulate the trade of pepper seedlings by small producers. Other agents are also mobilized, such as those that offer rural consultancy, agricultural inputs, agricultural products, and research aimed at optimizing production and generating new varieties. Black pepper cultivation helps maintain workers in the rural sector, thereby promoting rural development. According to Filgueira *et al.* (2002), for every tonne of black pepper produced, one worker is retained in the sector.

One of the major bottlenecks in establishing a black pepper plantation is its initial high cost. Other challenges are phytosanitary problems, which can negatively affect crop productivity (ALVES *et al.*, 2015; SILVA; BENTES; PENA, 2016). To avoid these problems, farmers should grow pathogen-free varieties that are adapted to the local climate and soil.

The optimal temperature range for black pepper growth is 23–28 °C. The plant requires a warm and humid climate for development, a total annual rainfall of at least 1,500 mm, and water availability during flowering and fruiting (ANDRADE *et al.*, 2017). Black pepper has a life cycle of 8 to 10 years. Good management practices are crucial for its growth. Staking is a well-established strategy in pepper cultivation for plant support. Stakes made of local hardwood (maçaranduba (*Manilkara bidentate*), acapu (*Vouacapoua americana* Aubl., *Leguminosae.*), jarana (*Holopyxidium jarana* (Huber) Ducke, *Lecythidaceae.*), among others) have been commonly used in Brazil. However, new alternatives are being sought to avoid negative environmental impacts from the use of hardwood stakes, such as forest logging (MENEZES *et al.*, 2013). *Gliricidia* [*Gliricidia sepium* (Jacq.) Kunth ex Walp.] is being investigated as a

substitute for forest species. According to Menezes *et al.* (2013), the use of gliricidia as a live stake can help reduce environmental problems, stimulate the use of stakes, and increase the longevity of pepper plants. Pruning, maintenance fertilization, weed control, and pest and disease control practices still need to be standardized in black pepper cultivation.

Harvesting and post-harvesting procedures

Manual harvesting methods are predominant, as black pepper is mostly grown in small family farms (Sabourin, 2007). White, green, and black pepper are the most produced types of pepper, but the largest volume of production is that of black pepper. Each type has different harvesting and post-harvesting characteristics (Table 1 and Figure 8).

Table 1. Harvesting and post-harvesting characteristics of black, white and green pepper.

Black pepper	White pepper	Green pepper
Time of harvest		
Semi-ripe fruits with peels beginning to turn yellow	Fully ripened fruits with red-colored peels	Fruits at two-thirds of the ripening process
Drying	Maceration	Processing
Under the sun for 3 days or mechanically until seeds achieve the recommended moisture content	Soaked in water tanks for 15 to 30 days (maximum) for softening and shell release. To improve color and aroma, the water is changed and pH is adjusted three times during the soaking period.	Spikes are thrashed, and fruits are placed in brine for preservation
	Drying	
	Under the sun for three days to preserve the characteristic aroma and color	
	Processing	
	Air drying and sieving	
Classification and standardization		

Source: adapted in EMBRAPA (2004).

Figure 8. (A) Black pepper (*Piper nigrum*) cultivation using live stakes; (B) ripe green fruits; (C) Black, white, and green peppers; (D) processed pepper.



Source: Ahmad *et al.* (2012).

Drying is carried out under the sun or using mechanical dryers. Substantial losses are incurred in both cases (Silva *et al.*, 2015). Because of the low technological level of pepper farms, black pepper is usually placed on the ground on top of tarps and dried under the sun. This favors contamination by *Salmonella* sp. and fecal coliforms, rendering peppers unfit for the industry. The main sources of contamination are the urine and feces of domestic and wild animals (ALVES, 2015). According to Keller *et al.*, (2013) the main manner of contamination of pathogens among dry spices is linked to the production and management system. American Spice Trade Association, (2015) cites as primary sources of contamination the outdoor drying, where additional dust, insects, animal waste and water may come in contact with the spice. After drying, spices often undergo several storages, processing, packaging and repackaging, events that can last for years.

Pepper produced in Brazil for exportation must comply with the quality standards of Resolution no. 176 (Brazil, 1989), which states that black and white pepper cannot be crushed or milled to powder. The quality parameters for black and white pepper are shown in Table 2.

Table 2. Classification of black pepper for export.

Classe	Black			White		
	Brazil	Brazil	Brazil	Brazil	Brazil	Brazil
	Asta	1	2	Asta	1	2
Humidity (% max.)	14	15	16	14,5	15,5	16
Ethereal extract (% min.)	6,75	6,75	6,75	6,5	6,5	6,5
Impurities and / or foreign matter (% max.)	1	2	5	0,5	1	3
Pecan grains (% max.)	2	5	25	1	2	4
Moldy grains (% max.)	1	2	2	1	2	2
Darkened grains (% max.)	-	-	-	5	15	60

Source: EMBRAPA, 2004.

Logistics and marketing

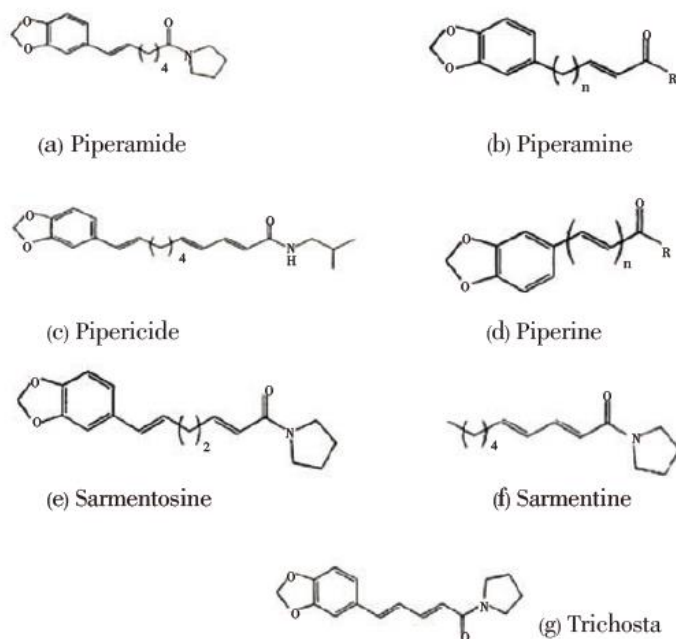
After black pepper processing, logistics companies direct the products to export companies. In Brazil, the main destination is São Paulo. According to DESER (2008), black pepper is mainly exported to the United States (41%), followed by Germany, Spain, and the Netherlands.

It is estimated that, by 2020, exports from Brazil, Malaysia, and Thailand will decrease because of increased labor costs, whereas, in India and Indonesia, exportation will continue to grow. Sri Lanka production is estimated to stabilize because of its limited production area. Black pepper exportation is expected to grow rapidly in Vietnam and China, reaching more than 60,000 tonnes per year (Prabhakaran, 2011).

Consumer market

As it is a versatile product, black pepper is used in various industries, especially in the food industry. Sarma, Babu and Aziz (2014) reported that black pepper is used for the production of processed foods, perfumes, medicines, and cosmetics. It has also found application as an insecticide. Another use is for the preservation of sausages (WANG *et al.*, 2018). According to Silva, Silva and Joele (2007), black pepper components (essential oils, resins, and oleoresins) are being widely used for the preparation of Vienna sausages.

In the pharmaceutical industry, black peppers are used for the production of drugs with anti-inflammatory, antioxidant, and analgesic activities. Piperine, capsaicin, and cosmoperine are responsible for the various health properties of black pepper, such as antimicrobial, antimutagenic, antitumoral, antidiarrheal, anticoagulant, antihypertensive, hepatoprotective, and thermogenic activities (Figure 9) (AHMAD *et al.* (2012); CARNEVALLI; ARAUJO, 2013; GASPARETTO *et al.*, 2017).

Figure 9. Important Black Pepper derivatives.

Source: AHMAD *et al.*, 2012.

FINAL CONSIDERATIONS

Black pepper production in Brazilian is higher than the world average. However, black pepper farming requires high initial investment. Because it is a commodity, the product is subject to high price variability. Black pepper has high nutrient requirements and is highly susceptible to *Fusarium* wilt. Thus, alternative forms of cultivation must be explored, such as polyculture in agroforestry systems. Technical assistance and farmer cooperatives can help producers benefit from large-volume sales, improve processing quality, and diversify production, for instance, by producing the higher-value white pepper.

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