

## Productive Coffee Chain: A Case Study of the Logistic Flow of Field Grain for Export

### Cadena productiva del café: un estudio de caso del flujo logístico de granos del campo para exportación

**Paula Ferreira da Cruz Correia<sup>1</sup>, João Gilberto Mendes dos Reis<sup>1,2,\*</sup>, Fernanda Alves de Araújo<sup>1</sup>, Luiz Rodrigo Bonette<sup>1</sup>, Aguinaldo Eduardo de Souza<sup>1</sup>**

<sup>1</sup>RESUP-Research Gruoup in Supply Chain Management-Postgraduate Program in Production Engineering, Universidade Paulista. Rua Doutor Bacelar, 1212, CEP 04026-002. São Paulo/SP, Brazil.

<sup>2</sup>Federal University of Grande Dourados-UFGD, PPGA. Rodovia Dourados a Itahum km 12. Dourados/MS, Brazil.

\*Autor de correspondencia: [joao.reis@docente.unip.br](mailto:joao.reis@docente.unip.br)

Este documento posee una [licencia Creative Commons Reconocimiento/No Comercial 4.0 Internacional](#)



Recibido: 24 junio 2021 Aceptado: 28 junio 2021 Publicado: 2 de julio 2021

#### Abstract

The agribusiness sector is one of the most important Brazilian economic bases and has an expressive impact on its GDP. Brazil is one of the largest global exporters of grains, fruits, cereals and is an essential player in agriculture worldwide. However, despite this importance, the sector lacks studies that could boost agribusiness growth. One of the most relevant products in Brazilian agriculture is coffee grain. The country is the world's largest producer and exporter of it. Our objective is to carry out a case study identifying processes by which coffee grains go through from planting to exportation. The study was conducted in a cooperative in the State of Minas Gerais and is part of research on the coffee production chain which seeks to present solutions for the development and increase of the Brazilian coffee chain's competitiveness. The methodology is based on a literature review associated with a case study. As the main result, the understanding of the coffee production made it possible to correlate the stages of the coffee process with production engineering, evidencing logistics as the main actor. Moreover, it highlights some points which need attention and investments.

**Keywords:** Coffee, Logistics Issues, Production Engineering Impact, Agricultural Export Flows

#### Resumen

El sector agroindustrial es una de las bases de la economía brasileña más importante y tiene un impacto expresivo en su GDP. Brasil es uno de los mayores exportadores mundiales de granos, frutas y cereales, siendo un actor esencial en la agricultura en todo el mundo. Sin embargo, a pesar de esta importancia, el sector carece de estudios que puedan impulsar el crecimiento de la agroindustria. Uno de los productos más relevantes en la agricultura brasileña es el grano de café. Brasil es el mayor productor y exportador mundial del mismo. El objetivo del presente trabajo fue llevar a cabo un estudio de caso que identifique los procesos por los que pasan los granos de café desde la plantación hasta la exportación. El estudio se realizó en una cooperativa del estado de Minas Gerais y forma parte de una investigación sobre la cadena de producción de café que busca presentar soluciones para el desarrollo y aumento de la competitividad de la cadena cafetera brasileña. La metodología se basa

en una revisión bibliográfica asociada a un estudio de caso. Como resultado principal, la comprensión del proceso de producción de café hizo posible correlacionar las etapas del proceso con la ingeniería de producción, evidenciando la logística como el actor principal. Además, destaca algunos puntos que necesitan atención e inversiones.

**Palabras clave:** Cuestiones logísticas, Impacto en la ingeniería de producción, Flujos agrícolas de exportación

## 1. Introduction

World demand for food has been rising agribusiness role in the economy and affecting important players such as Brazil, which has a high influence on food supply chains. Agribusiness is based on the Brazilian economy and represents 21.1% of gross domestic product-GDP [1,2]. This fact is the result of a stabilization policy to the economy in the 1990s which boosted internal demand, plus an increase of the country's exports [3,4]. Among the exported products, it is possible to highlight grains, meat, fruits, and cereals. However, there is a necessity to conduct studies and to propose policies to sustain this agriculture growth for many productive chains.

One of these chains is the one of coffee production. Brazil is the world's largest producer and exporter of coffee, responsible for 37% of the market [5-7]. Coffee is a commodity exported and commercialized as dehydrated green grain [5,8] to maintain its flavor when toasted in the buyer market. The main buyer of Brazilian coffee is Germany, which using chemical components and an efficient logistics network creates and distributes blends all over Europe, being responsible for 20% of the market [9,10].

Internally, the state of Minas Gerais is the main Brazilian producer area, accounting for about 82% of the volume exported [11]. There are mountainous areas available in the southern region of the state, which is very suitable for coffee production. The area was occupied because the state of São Paulo, the previous main pole, started to convert coffee plantation land into sugarcane production areas.

With the importance of the area for coffee production, studies are dealing with the logistics process, but the perspective of production engineering is a quite neglected aspect. Most of these works include transportation-related costs.

Logistics is the subject of studies because it is one of the key factors of competition and it is decisive to add value to the product, both in the domestic and international markets. Factors such as the development of competition and the sustainability of logistics processes are pointed out in such a way that a market share is conquered and maintained. That said, and coffee being one of the products which make up the base on Brazilian agribusiness, logistics that meet these issues and put Brazil in a prominent position is of paramount importance [12-14].

Studies highlight economic factors related mainly to freight costs for the flow of coffee production, as one of the main factors influencing the high logistics costs of the process [15,16]. However, this is not the only villain in the process. Issues related to the logistic processes of planting and commercialization have a significant impact. The perspective of production engineering can present a holistic view of the processes and propose alternatives that make it possible to adapt the means of production of coffee grain to the needs of the market.

This article investigates the coffee flow and processing from Minas Gerais farms (Poço Fundo district) to ports. To this end, a case study was conducted in a cooperative of producers.

This article is divided into sections, and after this introduction, we present the literature review, the session concerning materials and methods, the case study, the session about results and discussions, and the final considerations.

## 2. Methodology

This article was carried out according to three steps. Initially, we conducted a literature review, in Brazil, consisting of documents related to the subject in order to produce a qualitative analysis of the case study data [17]. We used the keywords: coffee, world agribusiness, agribusiness in Brazil, coffee export, production engineering. The databases consulted were: Science Direct, Emerald and Scopus.

Afterwards, To complement the database, we consulted some institutions websites: International Coffee Organization (ICO) [6], Council of Coffee Exporters of Brazil (CECAFE) [5], Ministry of Agriculture, Livestock and Supply (MAPA) [7], Brazilian Institute of Geography and Statistics (IBGE) [2]. Note that we opted to write the article in sections Introduction, Methodology, and Results and Discussion using the literature throughout the paper. It makes the paper dynamic, allowing the reader to obtain knowledge from the case study and literature review.

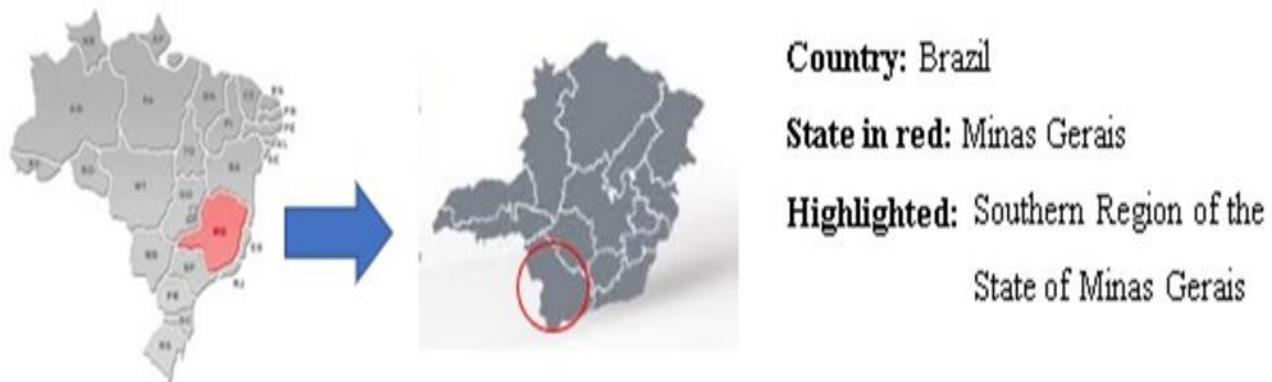
For the field research, a case study was carried out in a Cooperative in July 2019. The president and the manager of the cooperative presented us with the process and indicated the procedures. Moreover, we conducted a thorough interview with the manager, detailing all of the processes observed, and the reasons for carrying out them were questioned. The data collected during the interview allowed us to obtain real and objective information [17], which is in line with the purpose of this exploratory research. The analysis was conducted based on the information collected, information was transcribed in the form of a flowchart of the productive processes through which the coffee grains pass after it is harvested.

## 3. Case Study

### *Characterization*

The case study is about a cooperative in the Southern Region of the State of Minas Gerais (Figure 1). It was chosen considering its importance in the region, accessibility, and deal with exportation. The cooperative was established in 2003, starting with a movement of the Pastoral da Terra (Catholic Church) in 1980. The association of small producers started the cooperative as it currently exists.

The cooperative is sustained by the donation of all associates, a tax usually paid in coffee grains. They commercialize standard (95%) and organic coffee (5%). Moreover, they are connected to the social causes of its associates, selling special brands as coffee produced 100% by female labor.

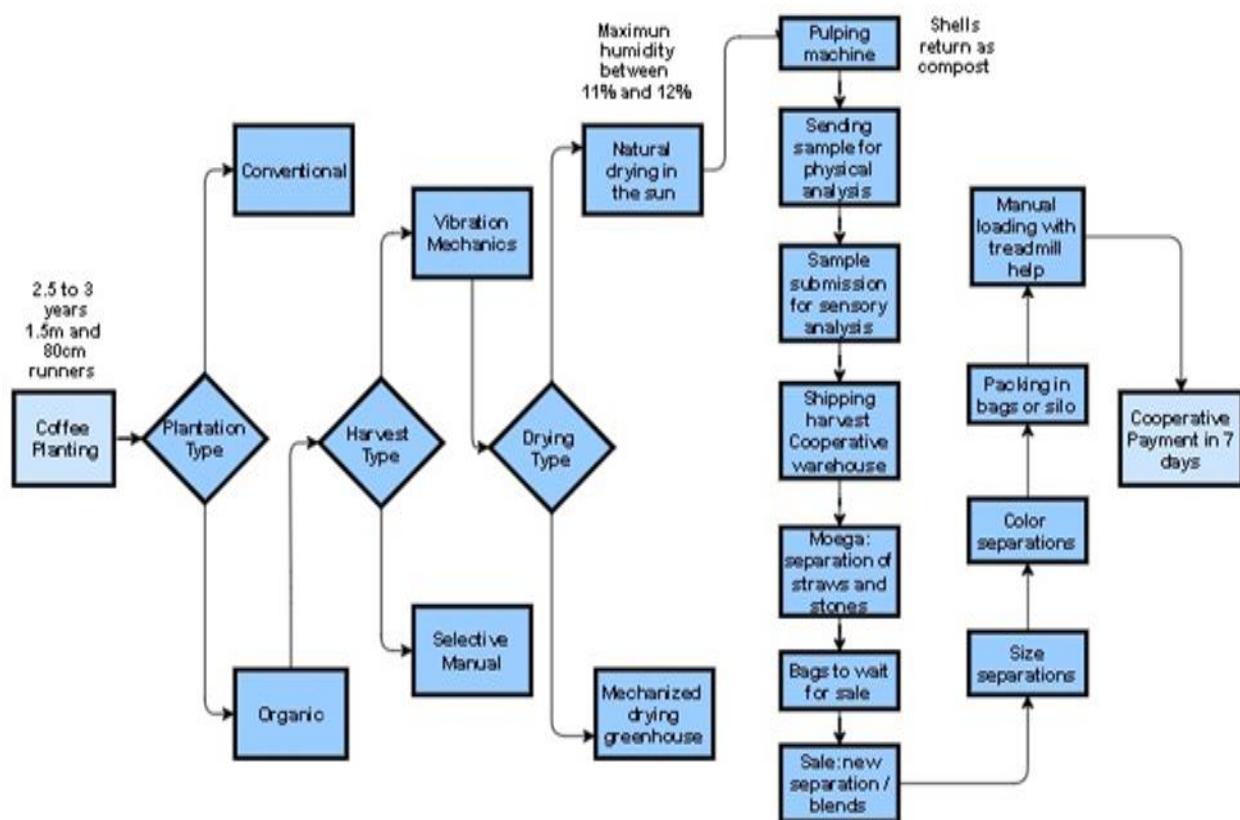


**Fig.1** Map of the region

## Farming

During the observation in the field, all the processes in the farm and the agro-industrial plant were checked, such as crop, dry area, storage, processing, and so on.

All the farm's properties are managed by the family workforce with different technological levels. We visited a farm with a good level of mechanization where they use a two-wheeled self-propelled vehicle adapted to sow coffee planting and a cherry coffee pulping machine to facilitate and streamline the drying process of the grain. However, in most of the farms, all the work is manual. Figure 2 depicts a scheme of cooperative coffee exportation.



**Fig.2** Flowchart of the cooperative coffee exportation

The coffee production process begins with the planting of the seed. It is necessary between 2.5 to 3 years for them to start to produce. To ensure that they receive nutrients properly and can grow healthy, it is used a corridor 1.5 meters wide with 80 centimeters between plants, as is observed in Figure 3.

The coffee plant receives organic fertilization through composting organic matter from the planting swidden and external nutrients which balance the soil. The harvest is performed mechanically through vibration or manually, as is shown in Figure 4.



**Fig.3** Coffee feet layout



**Fig.4** Fruit formation

After the picking, the grains proceed to the dry process. It is performed by spreading the grains and moving every 8 (eight) hours during a timespan between 20 and 30 days, Figure 5. At night, the grains are recovered to avoid night moisture. In the case of the mechanized process, the drying process lasts from 15 to 20 days. The drying ensures the grains humidity between 11% and 12%, which is the standard for commercialization. This percentage is measured using appropriate equipment. Finally, a pulping machine mechanically peels the grain to prepare the product to be delivered to the cooperative.

#### *Processing*

The next stage is performed in a pulping machine which mechanically peels the grain to prepare the product to be delivered to the cooperative. Moreover, a sample of 100 grams is sent to analysis, where the raw material is separated, and the amount of stones, straws, and defects is checked, as is shown in Figure 6.



**Fig.5** Coffee drying on patio



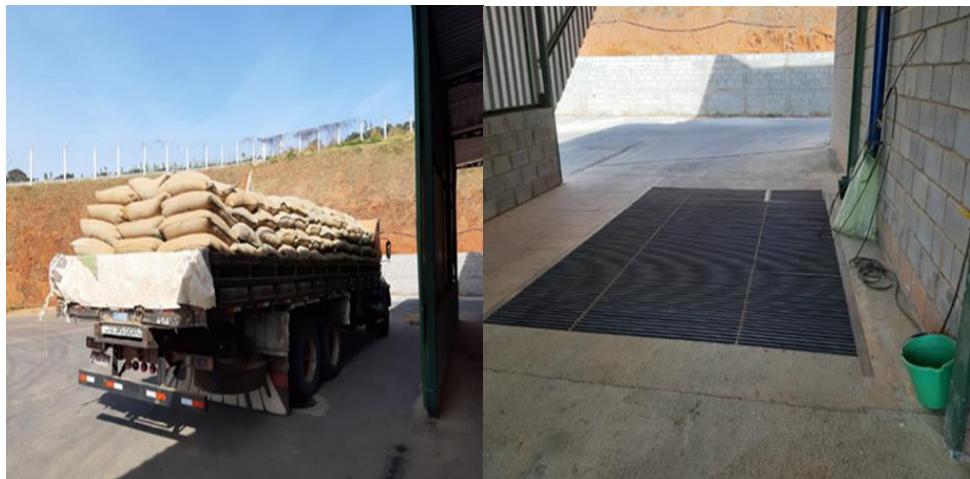
**Fig.6** Sampling

The next step is a sensory tasting, in which the grain is roasted and tested threefold: hot, warm, and cold. The characteristics of the beverage are measured, and the evaluator adds or subtracts points from the quality of the product. These tests are necessary to prepare blends and establish the coffee value, as is shown in Figure 7.



**Fig.7** Tasting

After the sample test, the coffee is classified, packed, and stored. Cooperative warehouse admits bags or bulk cargo, as is observed in Figures 8 and 9. The exported grain is stored in large bags of 600 or 1,300 kg, as is shown in Figure 10.



**Fig.8** Receipt of coffee in the Cooperative warehouse



**Fig.9** Receipt of coffee in the Cooperative warehouse



**Fig.10** Receipt of coffee in the Cooperative warehouse

Before being stored, grains are separated by size. This process is important because it ensures that the grains have the same size, which facilitates the roasting stage. Also, grains are selected by color, spoil, and malformation, as is shown in Figure 11.



**Fig.11** Separation of coffee grain types

When the coffee is sold, the containers are fulfilled with the storage bags based on the classification and contract requirements, as is observed in Figure 12.



**Fig.12** Container for exportation

#### *Analysis of case study*

The study of the production processes of the coffee chain has an interesting academic aspect, since studies are developed in areas related to the grain but focused on its commercialization and development.

As the detailing of the production stages becomes clear, it is possible to understand its direct relationship with Production Engineering, an area that includes production management, quality, logistics, supply chains, and so on [18,19].

Another aspect to consider is the huge organization of the coffee production sector. A true industry, in the way known nowadays, is formed from these processes. There is a systematization of the steps so that there is an adequate production line [20].

The production processes of the coffee sector go from the organization of rural workers who need to be divided between the stages of planting and harvesting, the drying processes, and despolpe of the grain for sending - in this case, to the Cooperative. The Cooperative is responsible for the next steps which are cleaning, separating, and mixing the grains to provide a quality product, within the specifications required by the buyers.

The entire organization was inferred by Production Engineering, which within its areas of knowledge shapes the processes so that they are efficient, and production is used almost entirely, avoiding waste; so that the time spent to execute the processes is fair, avoiding rework; the processes of handling and transportation are carried out according to the needs of the client [19].

All the processes which coffee goes through are directly related to logistics. At the time of planting, in which the seeds must be arranged in an organized manner, the fertilization of the plantation, the harvest of the grains, all the movement for the drying of the fruit, the movement for storage, the separation of the types of grains, the packaging in bags, the sealing of containers for export, etc. [20].

Logistics, in addition to dealing with the stages of the processes, should consider aspects such as humidity, organic debris, and climatic conditions. The efficient management of logistics processes can result in industrial development, with grain traceability, reduction of handling and transportation costs, directing the coffee industry to a more competitive and better environment price.

#### *Analysis of logistics process*

According to the Council of Supply Chain Management Professionals-CSCMP [21] logistics management revolves around activities such as inbound and outbound transportation management, fleet management, warehousing, material handling, order fulfillment, logistics network design, inventory management, supply/demand planning, and management of third-party logistics service providers. It shows that logistics covers several other activities essential for the growth of any industry. In different categories, it also covers the supply and acquisition, planning and scheduling of production, packaging and assembly, and customer service. Logistics is involved at all levels of planning (operational, tactical, and strategic), integrating the various activities to optimize them. Moreover, it integrates logistics activities with other functions, including marketing, sales, manufacturing, finance, and information technology [21]. Based on one of the widest definitions of logistics management, it is possible to analyze the case study from another perspective.

In our case study, it is possible to emphasize that the integration of activities is not explored in its entirety. The organization-level does not meet all the needs of the industry. Even with examples of success in the coffee sector [20], in this case, the systematization of processes is not as available as it is for large properties. In this example, it is verified that some processes take place manually, others are a mixture of manual with mechanized, to achieve the integration and optimization of processes.

Planting and harvesting are done in a mechanized manner, with the help of a two-wheeled self-propelled vehicle adapted for this purpose. The planting of coffee, in many localities, is carried out in high-altitude areas, which makes it difficult to use machinery intended for this purpose. The small producers feel the need for the use of machinery and make adaptations that can meet their demands and optimize their processes. Takeshima et al. [22] carry out a study of the impact of agricultural mechanization for producers which refers to the cost advantages experienced by a company when it increases its level of production; this work is considered as one of the first that portrays this theme.

Much of the volume of green coffee exported comes from small producers. These producers do not get the benefits of machinery because the interest in producing machinery is aimed at large latifunds, for example for soybean. The machines available are sold at high prices, and often small producers

are not able to make this investment. However, even with these difficulties, Brazilian producers can adapt to achieve their goals.

Another interesting point that deserves attention is the issue of roasting. Brazil is the largest producer and exporter of green coffee grain [5,7] and does not show great interest in improving the roasting technique so that it can add value to its product, starting to sell, in addition to the green grain, the grain benefited which can be added in the value of up to 70% [5, 8-10].

There are barriers to roasting the coffee grain in Brazil. Some are related to the conditions of transportation of the product, such as the seal of the conveyor and the quality that can be impaired due to the travel time; others refer to legislation stemming from some countries buying the product already benefited. One suggestion would be the development of techniques to supply and overcome these barriers to raise Brazil to another level of production.

#### 4. Final Remarks and Outlooks

This research explored a case study of the production processes carried out on coffee grain, from planting to export, based on its theoretical basis in a literature review. The understanding of the coffee chain made it possible to relate the stages of the coffee process with production engineering, and it is evident that logistics is the main actor. Logistics is an essential part of coffee's production processes because it depends on the success of this venture. The entire logistics organization and grain quality give Brazil the title of the world's greatest exporter. However, even with the quality recognized worldwide, Brazil lacks investments in technologies which could promote the seal for export of roasted coffee grain. Moreover, it is not yet available a large-scale technology that could make it possible to pack the coffee to preserve the roasting so that its quality is preserved until it gets to the destination country. The coffee grain is transported by sea and water remains a barrier. Investment in machinery which can serve all types of producers is still low and not always is affordable for small producers. Small producers, to optimize their plantations, adapt machinery which can meet their plantation needs.

#### References

1. CEPEA-Esalq/USP. Centro de Estudos Avançados em Economia Aplicada-CEPEA-Esalq/USP. Available at: <https://www.cepea.esalq.usp.br/br/indicador/cafe.aspx>.
2. IBGE, Instituto Brasileiro de Geografia e Estatística Estatística. *A geografia do café: dinâmica territorial da produção agropecuária*, 2016. Rio de Janeiro.
3. Machado, C.P., Caleman, S.M., Cunha, C.F., *Governance in agribusiness organizations: challenges in the management of rural family firms*. Revista de Administração, 2017. **52**: p. 81-92 DOI: <https://doi.org/10.1016/j.rausp.2016.09.004>.
4. Santos, L.P.D., Avelar, J.M.B., Shikida, P.F.A., Carvalho, M.A.D., *Agronegócio brasileiro no comércio internacional*. Revista de Ciências Agrárias, 2019. p. 54-69. DOI: <https://doi.org/10.19084/rca15065>.
5. Cecafe, C., *Fatia do Brasil nas exportações globais de café deve aumentar*, 2019. Available at: <https://www.cecafe.com.br/publicacoes/fatia-do-brasil-nas-exportacoes-globais-de-cafe-deve-aumentar-20190116>.
6. ICO, *Total production by all exporting countries*, 2019. Available at: <http://www.ico.org/prices/po-production.pdf>.
7. MAPA, *Café no Brasil*. Available at: <http://www.agricultura.gov.br/assuntos/politica-agricola/cafe/cafeicultura-brasileira>.

8. Barjolle, D., Quiñones-Ruiz, X.F., Bagal, M., Comoé, H., *The role of the state for geographical indications of coffee: case studies from Colombia and Kenya*. World Development, 2017. **98**: p. 105-119. DOI: <https://doi.org/10.1016/j.worlddev.2016.12.006>.
9. CBI, *Exporting coffee to Germany*, 2019.
10. CBI, What is the demand for coffee in Europe?, 2019.
11. da Cruz Correia, P.F., dos Reis, J.G.M., de Souza, A.E., Cardoso, A.P., *Brazilian coffee export network: an analysis using SNA*. In: Ameri, F., Stecke, K.E., von Cieminski, G., and Kiritsis, D. (Eds.) *Advances in Production Management Systems. Production Management for the Factory of the Future*, 2019. Springer International Publishing: Cham. DOI: [https://doi.org/10.1007/978-3-030-30000-5\\_19](https://doi.org/10.1007/978-3-030-30000-5_19).
12. Dias, C.A., *Logística e comercialização de cafés especiais no estado do espírito santo*, 2003. Available at: <http://repositório.ufla.br>.
13. Menezes, J.R.G.S., de Souza, E.O., *A logística na produção do café e dificuldades encontradas na exportação*. Encontro Nacional de Engenharia de Produção ENEGEP, 2013. Salvador.
14. Viana, G.D., Pakes, P.R., Rodrigues, F.P., Godoy, G.M., Turquetti, W.P., *Dificuldades logísticas de transporte e armazenagem de café no interior de são paulo: estudo de caso*. Simpósio em Engenharia de Produção-Universidade Federal de Goiás, 2018. Catalão.
15. Carminati, T.F., *Logística brasileira de escoamento da produção: cenário e investimentos atuais*. Available: [https://riuni.unisul.br/bitstream/handle/12345/1706/109180\\_Tiana.pdf?sequence=1&isAllowed=y](https://riuni.unisul.br/bitstream/handle/12345/1706/109180_Tiana.pdf?sequence=1&isAllowed=y).
16. Silveira, D.R.S., Souza, R.S., Silva, F.M.C.S., Silva, M.R.J.D., Pereira, G.M., *Os desafios logísticos para o escoamento do café produzido no Sul de Minas Gerais*. XIII SEGeT Simpósio de Excelência em Gestão e Tecnologia, 2016. Resende.
17. Marconi, M.A., Lakatos, E.M., *Fundamentos de metodología científica*, 2009. Atlas.
18. Jesus, I.R.D., Costa, H.G., *A nova gestão pública como indutora das atividades de engenharia de produção nos órgãos públicos*. Prod., 2014. **24**: p. 887-897. DOI: <https://doi.org/10.1590/S0103-65132013005000063>.
19. Neto, R.I.M., Silva, B.A.C., Souto, H.E.G.F.R., Nametala, M.T., *Processo produtivo de leite condensado em um laticínio em Araxá-MG e seus aspectos logísticos*. BJD, 2019. **5**: p. 6197-6212. DOI: <https://doi.org/10.34117/bjdv5n6-129>.
20. Farías, V., Angélica, B., *Propuesta de un modelo en el proceso de distribución y transporte del café orgánico, basado en la integración logística enfocada en asociaciones del departamento de Junín*, 2019. Available at: <http://hdl.handle.net/10757/625873>.
21. CSCMP, *SCM Definitions and Glossary of Terms*. Available at: [https://cscmp.org/CSCMP/Educate/SCM\\_Definitions\\_and\\_Glossary\\_of\\_Terms.aspx](https://cscmp.org/CSCMP/Educate/SCM_Definitions_and_Glossary_of_Terms.aspx).
22. Takeshima, H., Hatzenbuehler, P.L., Edeh, H.O., *Effects of agricultural mechanization on economies of scope in crop production in Nigeria*. Agricultural Systems, 2020. **177**: 102691. DOI: <https://doi.org/10.1016/j.agsy.2019.102691>.

## Acknowledgements

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior “Brasil (CAPES)” Finance Code 001.

## Conflict of Interests

There is no conflict of interest.

## Author's Contributions

**Paula Ferreira da Cruz Correia.** ORCID: <https://orcid.org/0000-0003-1648-0398>

Conceptualization, data set, acquisition of funds, research, methodology, project management, resources, validation, draft, draft and editing of the manuscript.

**João Gilberto Mendes dos Reis.** ORCID: <https://orcid.org/0000-0001-6409-2299>

Conceptualization, methodology, supervision, validation, draft, draft and editing and review of the manuscript.

**Fernanda Alves de Araújo.** ORCID: <https://orcid.org/0000-0001-8437-9414>

Conceptualization and revision of the manuscript.

**Luiz Rodrigo Bonette.** ORCID: <https://orcid.org/0000-0001-9146-764X>

Elaboration of the methodology and and revision of the manuscript.

**Aguinaldo Eduardo de Souza.** ORCID: <https://orcid.org/0000-0001-6100-752X>

Elaboration of the research and review of the manuscript.