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Coffee Production Chain: A case study of the logistic flow of field grain for export

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Abstract

The agribusiness sector is one of the most important Brazilian economy 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 which 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 the 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 a 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.

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 on the basis of Brazilian economy and represents 21.1% of gross domestic product - GDP (CEPEA - Esalq/USP, 2019; Estatística, 2016). 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 (Machado Filho et al., 2017; Santos et al., 2019). 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 (CECAFÉ, 2019; ICO, 2019; MAPA, 2019). Coffee is a commodity exported and commercialized as dehydrated green grain (Barjolle et al., 2017; CECAFÉ, 2019) to maintain their 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(CBI, 2019a, 2019b).

Internally, the state of Minas Gerais is the main Brazilian producer area, accounting for about 82% of the volume exported (da Cruz Correia et al., 2019). There exist mountainous areas available the southern region of the state, which are very suitable to the 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 which meets these issues and put Brazil in a prominent position is of paramount importance (Dias, 2003; Menezes & Souza, 2013; Viana et al., 2018).

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(Carminati, 2013; Silveira et al., 2016). However, this is not the only villain into 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 which make it possible to adapt the means of production of coffee grain to the needs of the market.

With the purpose of understanding and presenting the logistics aspects, 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 the following steps:

1. 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 (Marconi & Lakatos, 2009). We used the keywords: coffee, world agribusiness, agribusiness in brazil, coffee export, production engineering. The databases consulted were: Science Direct, Emerald and Scopus.
2. To complement the database, we consulted some institutions websites: International Coffee Organization (ICO) (ICO, 2019), Council of Coffee Exporters of Brazil (CECAFE) (CECAFÉ, 2019), Ministry of Agriculture, Livestock and Supply (MAPA) (MAPA, 2019), Brazilian Institute of Geography and Statistics (IBGE) (IBGE, 2016). 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.
3. 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 (Marconi & Lakatos, 2009), 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 Results and Discussion

3.1 Case Study

3.1.1 Characterization

The case study is about a cooperative in the Southern Region of the State of Minas Gerais (Figura 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 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 a coffee produced 100% by female labor.

Figura 1: Map of the region

3.1.2 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 proprieties 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 bean. However, in most of the farms, all of the work is manual. Figure 2 depicts a scheme of cooperative coffee exportation.

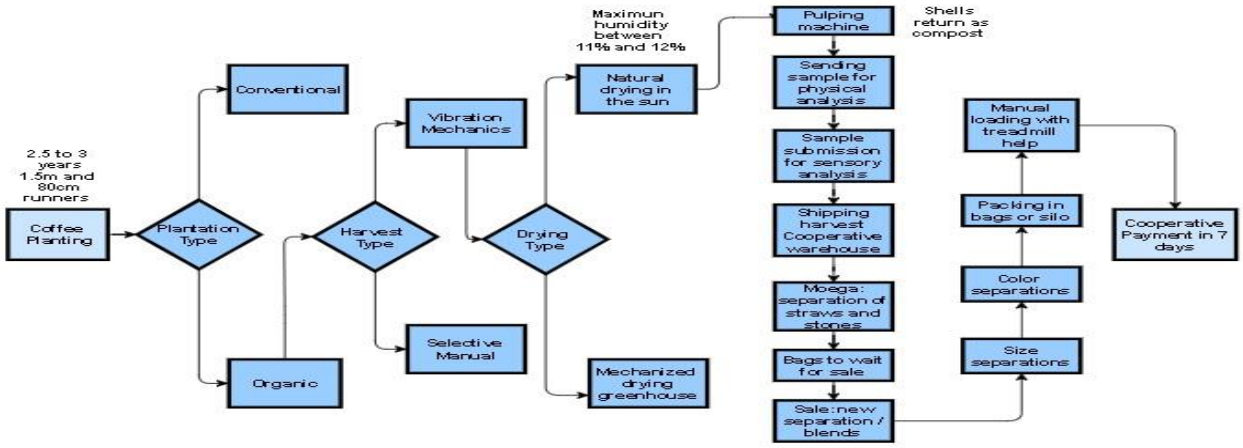

Figure 2. Flowchart of the cooperative coffee exportation. This figure was depicted from the observation of the processes verified in the cooperative (Source: Autors).

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, Figure 3.

Figure 3. Coffee feet layout

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, Figure 4.

Figure 4. Fruit formation

After the picking, the grains proceed to the dry process. It is perdormed by spreading the grains and moving every 8 (eight) hours during a timespan between 20 and 30 days, Figure 5. At night, the grains a recovered to avoid night moisture. In the case of the mechanized process, the drying process is 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.

Figure 5. Coffee drying on patio

3.1.3 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, Figure 6.

Figure 6. Sampling

The next step is a sensory tasting, in which the grain is roasted and tested in 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, Figure 7.

Figure 7. Tasting

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

Figure 8. Receipt of coffee in the Cooperative warehouse

Figure 9. Receipt of coffee in the Cooperative warehouse

Figure 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, Figure 11.

Figure 11. Separation of coffee bean types

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

Figure 12. Container for exportation

3.2 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 which includes production management, quality, logistics, supply chains, and so on (Jesus & Costa, 2014; Neto et al., 2019).

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 (Farías & Angélica, 2019).

The production processes of the coffee sector goes 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 (Neto et al., 2019).

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 (Farías & Angélica, 2019).

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 prices.

3.2.1 Analysis of process logistics

According to the Council of Supply Chain Management Professionals - CSCMP (CSCMP, 2020) 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 (CSCMP, 2020). 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 (Farías & Angélica, 2019), 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 make it difficult to use machinery intended for this purpose. The small producers feel the need for the use of machinery and make adaptations which can meet their demands and optimize their processes. Takeshima et al. (2020) carry out a study of the impact of agricultural mechanization for producers which refer 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 (Takeshima et al., 2020).

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 make this investment. However, even with this difficulties, Brazilian producers can adapt to achieve their goals.

Another interesting point which deserves attention is the issue of roasting. Brazil is the largest producer and exporter of green coffee grain (CECAFÉ, 2019; MAPA, 2019) 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 value of up to 70% (Barjolle et al., 2017; CBI, 2019a, 2019b; CECAFÉ, 2019).

There are barriers to roasting the coffee bean 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 gives 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 bean. Moreover, it is not yet available a large-scale technology which 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 bean 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.

For future work, it is suggested to conduct simulation studies on the best use of industrial facilities, aiming at reducing time and optimizing processes, with the use of suitable machinery for each process in order to compare different scenarios and verify the best way to perform the processes from planting to exporting the coffee grain.

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