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Operations in the Cotton Chain: A Study at Agro-industrial Cooperative Holambra II and the Paulista Association of Cotton Producers (PACP)

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***Keywords*— Operations Management, Agro-industrial Cooperative, Cotton Chain, Cotton, Plume.**

***Abstract*—** *The study aims to study the operations of the cotton chain at Agro-industrial Cooperative Holambra II, especially the operations of planting, harvesting, processing and storage and destination of by-products. Of a basic nature, with a qualitative focus and exploratory descriptive objectives, the Case Study approach was used, supported by bibliographic research. Semi-structured interviews, documentary research and structured observation were the tools used in data collection. The Cooperative implemented changes in its organizational and compliance structure, seeking to increase its efficiency in decision-making, in addition to expanding its competitive advantages with better market positioning. The 2020/21 crop showed a sharp reduction in planted area, in view of the uncertainties caused by the Covid-19 pandemic, in addition to competition from other products, with a consequent drop in production, and productivity above the average of the last five harvests. The Cooperative's strategy for anticipating the harvest period provides conditions for making the product available on the market in advance, with the possibility of obtaining higher prices. In the 2019/20 harvest, the production of plume at the Cooperative was equivalent to more than 70% of the state production. The study contributes to the expansion of the study of agricultural cooperatives in the field of management, focusing on the production of cotton, which produces the most important of textile fibers.*

I. INTRODUCTION

Agribusiness has been for several years one of the main players in the Brazilian economy, with unequivocal and evident capacity for growth, as well as remarkable proof of resilience, demonstrated, above all in the most recent periods of economic instability.

In terms of world merchandise volume, there was a small decline of 0.1% in 2019 after an increase of 2.9% in the year 2018. In terms of value, world trade was down by 3.0% compared to the 10.2% increase in the year 2018 (WTO, 2020). Fact is that all global regions recorded a decline in merchandise trade in terms of volume and value in the year 2019.

Probably, the COVID-19 pandemic will cause a significant contraction in world trade in 2020. Preliminary indicators already point to sharp falls in the first and part of the second half of 2020. For the first time since the 2008-2009 crisis, the volume of world trade in goods has plummeted in the first half of 2020, under pressure from rising trade tensions, especially between the United States and China, and weakening economic growth, particularly due to COVID-19.

The International Monetary Fund (IMF) forecast for 2020 predicted that after China, the countries that would show the highest growth rate would be those of Latin America and the Caribbean, surpassing even the United States and the average of the European countries. The worsening of the economic scenario led to the opposite situation. The countries that suffered most from the implementation of policies of isolation and social distancing were the countries of Latin America and the Caribbean.

Brazil is the fifth-largest producer and fourth-largest exporter of cotton in the world, behind the United States, Australia and India (Abrapa, 2017). New agricultural management techniques, investment in research and development (R&D) and improved processing have contributed to increasing the quality and quantity of Brazilian cotton, adapting it to the needs of the industries.

In Brazil, cotton (Gossypium hirsutum L.), considered one of the most important industrial crops in the world (Farias et al., 2016), has been growing steadily over the years, becoming the second-largest exporter of lint worldwide. With the crisis caused by the Covid-19 pandemic, demand, both internal and external, has suffered a negative impact. In this scenario, the projections are for reduction in the area and production for the 2020/21 cotton crop. However, the specificities of the production system (highly technical production structure, including machinery and workforce), the investments already made, as well as the high percentage of future marketing, discourage producers from reducing the area.

The Brazilian cotton lint crop of 2020/21 is estimated at 2.59 million tons, down 11.7% compared with the 2.93 million tons indicated in the 2019/20 crop. The productivity of crops is estimated at 1,746 kilograms of cotton lint per hectare, compared with 1,753 kg/ha in the 2019/20 crop. According to the econometric model of forecast scenarios, the area planted with cotton in the 2020/21 season is estimated at 1,495 million hectares, down 10.5% compared with 1.67 million hectares of the previous crop (Conab, 2020).

Cotton is delimited in the concept of natural fiber (Akil et al., 2011; Pujer et al., 2014), being the main raw material (plant fiber) employed in the textile sector. According to its origin, natural fibers can be divided into animal and mineral, in addition to plant fibers, with their own characteristics and properties (Sanjay et al., 2018). The uses and applications of seed cotton and its derivatives were described and analyzed in a study conducted by Desrochers & Szurmak (2017).

For what is intended in this study, the processes that involve planting, harvesting, as well as all the handling of cotton until the processing plant are essential in the commercial quality achieved by the final product intended for the textile industry.

The research aims to study the operations of the cotton chain at Agro-industrial Cooperative Holambra II, especially planting, harvesting, processing and storage of the lint and destination of by-products.

From the amount of studies found in the literature, there is a belief that cooperatives have attracted little interest in the field of management science, being largely neglected within economics and management theory (Mazzarol et al., 2011; Jussila et al., 2012; Puusa et al., 2013; Puusa et al., 2016). Thus, a primary contribution of this article can be seen as the insertion of the study of cooperatives in the field of management research, especially agricultural producer cooperatives (Hernández-Espallardo, Arcas-Lario, & Marcos-Matás, 2013; Verhees, Sergaki, & Van Dijk, 2015), focusing on the production of cotton, which, according to Embrapa (2005) produces the most important textile fibers, natural or artificial, since it is able to offer a wide range of products with great relevance in the national and world economy, which is why it is considered one of the most fully exploited plants.

The structure of the article is established from this section, where the introduction and the objective of the study are located. Section 2 was reserved for the literature review, followed by the methodology (section 3). Section 4 was designated for data presentation and discussion, followed by the conclusion (section 5).

II. LITERATURE REVIEW

2.1 Cotoniculture Production

The shift of the cotton production hub to the Mid-West enabled the expansion of the cultivated area and the transition from an obsolete production model, characterized by low productivity, to a corporate production model with better performance. Consequently, the commodity's production grew, which, concomitant with the reduction in domestic consumption, led to an increase in exports, made possible by the quality of the Brazilian product (Alves et al., 2021).

Data from the National Supply Company (CONAB) show a 14.5% reduction in the planted area when comparing the 2019/20 and 2020/21 harvests, registering a rupture in the expansion that had been occurring since the 2014/15 harvest. The reduction was the result of the market downturn that occurred during the Covid-19 pandemic, which caused the paralysis of sales, renegotiation and cancellation of signed contracts, and an increase in global transit stocks, causing lower sales of the

crop to be planted, when compared to the previous crop (Conab, 2021). Production and productivity also fell by 16% and 2.3%, respectively, compared with the previous cycle (2019/20).

The state of São Paulo showed a significant reduction of 57% in the planted area compared with the previous crop, going from 11,000 hectares cultivated in the 2019/20 crop and plume production of 17,200 tons, to 4,700 hectares in the 2020/21 crop and production of 7,400 tons. Many of the traditional producers in the Avaré region have opted to plant soybean instead of cotton, taking advantage of the moment of attractive prices that soybean has presented.

The cultivation of cotton - harvested as seed cotton, it needs to go through a processing process in order to separate the seed from the fiber (Coleman & Thigpen, 1991; Bajpai, Mary, & Chand, 2015) - results in products with diversified industrial application, with a high rate of utilization of the plant (Abrapa, 2013; Desrochers & Szurmak, 2017).

The application of cotton occurs in two main segments: the textile that absorbs the lint, which in economic terms is the main primary cotton product (Amaral et al., 2018), which can represent up to 40% of the fruit, and the non-textile that uses the seed in the production of oil and derivatives, feed production (Li & Robinson, 2011; Świątkiewicz, Arczewska-Włosek, & Józefiak, 2016), the fibril, used in the automotive industry (Kamath, Bhat, Parikh, & Mueller, 2005; Dunne, Desai, Sadiku, & Jayaramudu, 2016) and other waste (Ouslimani & Boureghda, 2018).

The cotton chain is characterized by, among other things, the intensive use of technology (Conab, 2018) and the high capacity to add value (Abrapa, 2017). Technologies such as the No-till System (SPD) have been adopted since the 1970s in Brazil, where more than 32 million hectares of land are under this system (Peixoto et al., 2019). SPD is characterized by non-involvement, permanent soil cover and crop rotation, increasing the sustainability of ecosystems (Salton, Hernani & Fontes, 1998). Phillips et al. (1980) define SPD as one in which the crop is planted entirely without soil preparation or only with sufficient preparation to allow seed placement and coverage with soil to allow it to germinate and emerge.

The technology of reducing the spacing between the rows of cotton - adensed method (Narrow Row cotton - NRC), is a technique of North American origin that allows reducing the crop cycle (Rosolem et al., 2012; Kazama et al., 2016), allowing the minimization of phytosanitary applications, with consequent reduction of production cost, being, in many cases more advantageous in relation to the conventional cropping system (Conventional Row) - spacing between 0.76 to 102 cm (Constable, 1977; Clawson et al., 2008). Empirical studies have demonstrated the reduction in costs resulting from the adoption of the adensed planting system in comparison with the conventional system (Jost & Cothren, 2001), above all because of the lower use of phytosanitary products.

Cotton has a high production cost, about three times that of soybeans (Brandão, Zonta & Ferreira, 2014). The need for high application of external inputs (fertilizers and synthetic pesticides), in addition to the need to maintain the levels of sufficiency in the soil (Rosolem & Mellis, 2010) increase production costs and directly affect the profitability of the crop; these inputs can reach 65% of the total cost of production (Cepea, 2020).

Currently, cotton harvesting is mostly mechanical, performed with self-propelled harvesters. The fiber, which has its quality (Boykin & Reddy, 2010) determined by its color (Barker, Baker, & Laird, 1990), is the main raw material of the textile industry. The economic value of cotton is directly related to the harvest process, taking into account factors such as the contamination of cotton with other fragments of the plant and other impurities, excess moisture that can cause fermentation, early fibers, strength, length and color of the fiber. According to Embrapa (2005), care in harvesting, packaging and transportation are responsible for the quality of cotton, since excess impurities imply additional expenses with transportation and problems in processing and obtaining low-quality fiber.

The cotton mechanical harvesting process can be carried out by the cotton picker that operates based on manual harvesting, and the machine is equipped with rotating spindles; and the cotton stripper, equipped with a pulley system that harvests open or semi-open stalks and fruits. In this type of machine, the harvested cotton contains a higher quantity of impurities, increasing transportation costs per bale, besides the higher costs of cotton processing. Even using an HL extractor, the levels of matter will still be higher than those found in picker-type harvesters (Faulkner, Wanjura, Shaw & Hequet, 2007).

The stripper-type harvesters have lower acquisition prices, fewer moving parts in the row units, lower fuel consumption and maintenance. The picker-type harvesters, although with higher acquisition prices, harvest cotton with less impurity, increasing the capacity to preserve the characteristics of fiber quality, besides being able to harvest cotton at higher speeds in places with high productivity (Faulkner et al., 2007).

Fiber quality is assessed by visual classification and laboratory analysis using the High-Volume Instrument (HVI) and other complementary instruments (Sayeed, Schumann, & Wanjura, 2021). Through the HVI, fiber characteristics such as Strength (STR), Length (UHML), Micronaire (Fiber fineness), SFI (Short Fiber Index), Elongation (ELG), Maturity (MR), RD (Reflectance/Brightness/Grayness), +B (Yellowing degree), Thash Sheet (Impurity degree) are analyzed. A set of procedures will be indispensable for determining the economic value and the appropriate types of use of the fiber, especially by the textile industry.

2.2 Agro-industrial Cooperatives as Forms of Collective Action

Firms are creating organizational models based on complementarity, collectivity and through relationships and interdependence ties between the most diverse actors, which is considered fundamental for agri-food economies (Hardin, 1997; Ménard & Klein, 2004).

Cooperatives in general and agro-industrial cooperatives in particular are configured as forms of collective action (Ménard & Klein, 2004; Zylbersztajn, 2005). The governance structures of this type of collective action (cooperatives) are able to enable advantages such as increased revenues, cost reduction through economies of scale, reduced transaction costs, greater bargaining power, risk minimization, increased bargaining power, in addition to collective learning and positive externalities (Lazzarini et al., 2001). These agricultural associations are capable of appropriating the coordination of complex agri-food systems. This know-how, as a rule, follows the verticalization trend of cooperative structures. Corroborating with Sexton (1986), understanding cooperatives means understanding the incentives for vertical integration as a value appropriation strategy.

It was believed that the industrialization of agriculture would bring about the end of farmers' cooperatives (Helmberger, 1964). In response to this prediction, Abrahamsen (1966) contested by advocating that as the industrialization of agriculture evolved, cooperatives would increasingly become the "integrating agency of the farmer".

Cooperative can be defined as an association with its own autonomy, consisting of people who seek to satisfy their common economic, social and cultural needs and aspirations through a jointly owned and democratically controlled enterprise (ICA, 2017). Agricultural cooperatives are able to provide economic benefits to farmers through sharing and pooling of resources, better access to markets, higher yields for their products and strengthening in bargaining position, improving members' livelihoods and local reinvestment, and supporting rural development (Sergaki et al., 2020). Through production contracts, granting of delivery rights and delivery obligations, all business functions can be streamlined. Nevertheless, cooperatives are important competitors in many industries (Hendrikse, 1998), agribusiness being one of them.

2.3 The Agro-industrial Cooperative Holambra II

The Cooperative Agro-industrial Holambra II is headquartered at Rodovia Raposo Tavares, km 256, in the municipality of Paranapanema – SP, founded on 23 December 1960, operating for over 60 years, with an area of operation in the national territory, operating in agricultural and extractive production with approximately 62,000 hectares of production area. In 2018, the Cooperative was ranked by Exame magazine among the 400 largest in the agribusiness segment and among the 1,000 largest companies in net sales.

The Cooperative developed within the traditional patterns until the year 1988. However, the indispensability of improving its efficiency in a competitive environment directed its board of directors to conduct a process of operational structure reduction (the structure of operations had 5 departments that reported to a general manager who, in turn, answered to the Council) and, consequently, more agility and flexibility (Zylbersztajn, 1994).

The changes that took place in the Brazilian political-economic environment, especially in the 1980s and 1990s, pressured the cooperatives to adjust with a view to expanding or at least maintaining their market share. In this sense, although the Cooperative does not configure a vertical integration in all its amplitude, it is consistent with the postulated by Sexton (1986) for whom the reduction of costs through better bargaining power in the acquisition of inputs; the economies of scale, the improvement of the bargaining position in the market, the efficiency gains from the coordinating capacity and the reduction of risks in joint actions are common factors to this type of enterprise, even though this is not the predominant pattern, since most cooperatives do not have appropriate structures to correspond to the qualification, diversification and flexibility requirements that the current conjuncture demands. Figure 1 presents the institution's organization chart according to the information on its website.

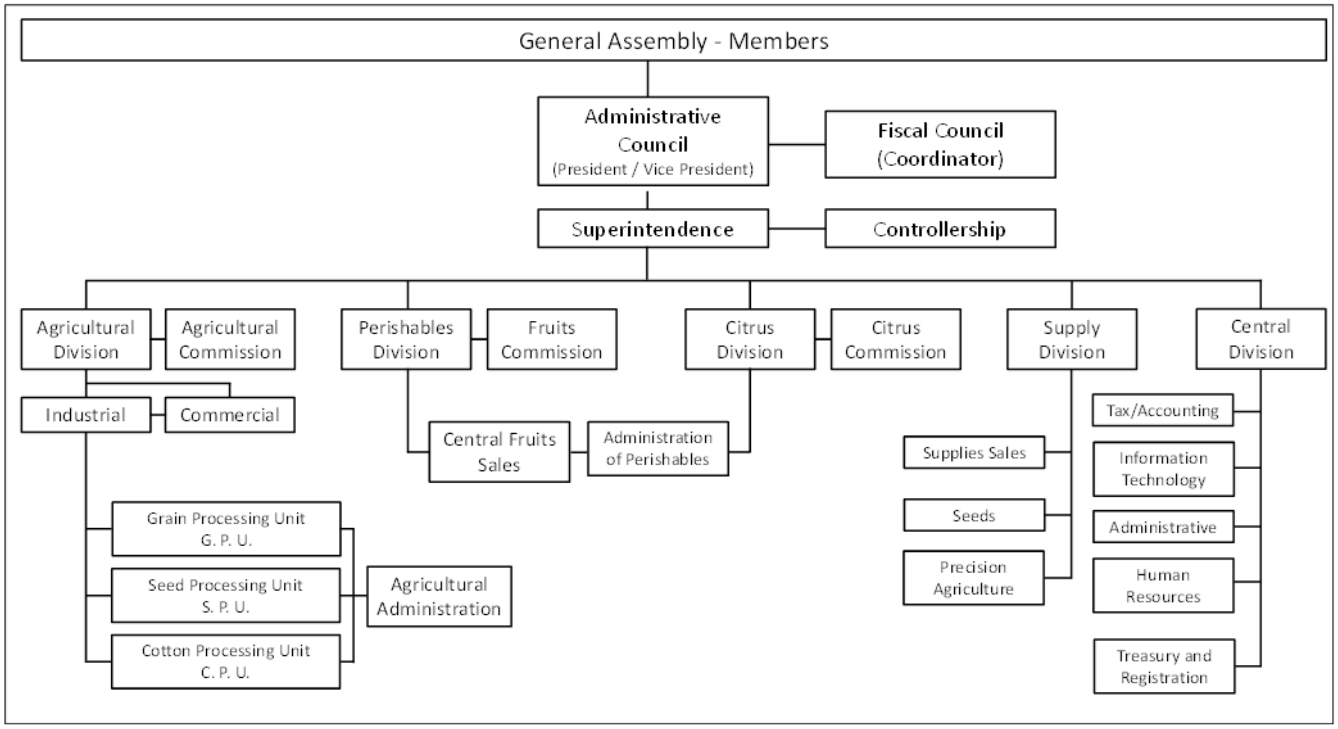

Fig.1: Holambra II Cooperative's organizational chart as shown on the institutional website
Source: Adapted from Holambra II Cooperative's Institutional Website. Available at: https://www.holambra.com.br/cont.php?p=organograma. Accessed on April 14, 2020.

It is understood that this configuration represented an increase in managerial flexibility and improvement in the capacity to control the results in each Cooperative business, with a focus on increasing efficiency in the decision-making process (Alves, Ferreira, & Araújo, 2019; Fedorova & Valiev, 2021). Zylbersztajn (1994) adds that the producer-cooperative was stimulated to increase his participation in the strategic decision-making process and his interest in controlling the managers of the units in which he has investments. His income became associated with the results of the business unit that centralized his investments.

This is what we know up to the moment we collected information from the documents available on the Cooperative's institutional page.

III. MATERIALS AND METHODS

Of a basic nature, the method adopted in this study proceeds a qualitative approach with exploratory descriptive objectives. Given the need for a holistic view of the process, in addition to the need to accommodate a variety of data sources (Eisenhardt & Graebner, 2007), we opted for the Case Study approach (Benbasat et al., 1987; Meredith, 1998; Orum, Feagin, & Sjoberg, 1991), as understood by Hartley (1994), Gummersson (1988), Eisenhardt (1989), Yin (1993) and Stake (2000).

The bibliographic research was adopted as a research strategy, considering it as a research subsidy (Boote & Beile, 2005). The empirical field of analysis was the field operations (planting and harvesting) and the internal operations (processing and storage of the lint and other byproducts) in the Agro-industrial Cooperative Holambra II, referring to the 2020/21 crop. The interviews were carried out in April 2021 (start of the harvest), by means of a semi-structured script, with the Executive Director of the Paulista Association of Cotton Producers (APPA), the Commercial Manager of Agricultural Commodities, besides the Supervisor of the Cotton Beneficiation Unit (plant), both from Holambra II Cooperative, corroborated by the implementation of structured and non-participant observation, whose methodological artifacts were circumscribed in the case study protocol, previously prepared. To complement the information, a second interview was scheduled with the Commercial Manager and Commercial Coordinator (Trade) through the Microsoft Teams platform in May 2021 with a 60-minute duration. The documentary research was used as a way to gather financial data, production data, organizational charts, among other physical components that contributed to the research. To better understand the phenomenon, we adopted the perceptual triangulation as proposed by Bonoma (1985) in order to ensure the accuracy of the evidence.

IV. RESULTS AND DISCUSSION

Cooperative Holambra II, a direct consequence of a collective action (Ménard & Klein, 2004; Zylbersztajn, 2005), has 159 cooperative members, 523 employees, and presented in 2020 a turnover of 1.3 billion reais. In the words of the president of the Board of Directors "*in a short time the market not only recovered, but began to react positively, with excellent prices for soybeans, corn, cotton, wheat and even fruit, in a year with excellent productivity! This, coupled with other factors, contributed a lot to build the expressive result of the Cooperative in 2020*".

In mid-2020, the Cooperative implemented changes in its organizational structure and governance, aiming at long-term sustainable growth, efficiency gains in the decision-making process (Alves, Ferreira, & Araújo, 2019; Fedorova & Valiev, 2021), and enhancement of the corporation's competitive advantages (Lazzarini et al., 2001). Figure 2 presents the current corporate structure of Cooperative Holambra II.

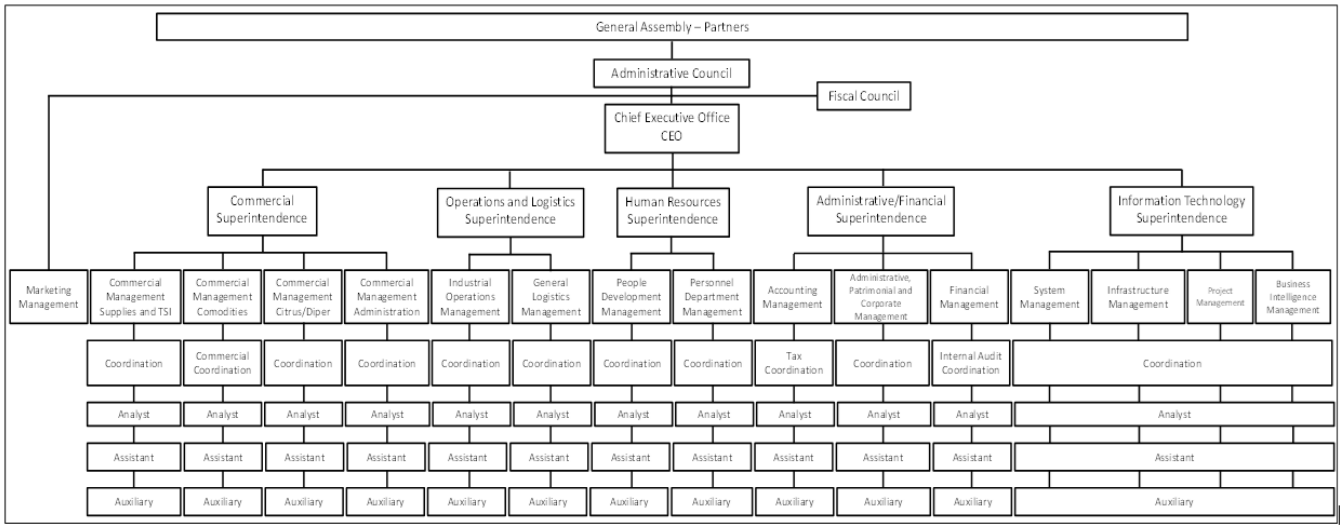

Fig.2: Holambra II Cooperative's current organizational structure

Approximately half of the cooperative members plant cotton, with this number varying from harvest to harvest. In the 2020/21 crop year, 1,100 ha of cotton were planted, an 80% reduction when compared to the previous crop year, and even more expressive in relation to the national and state scenarios (Conab, 2021). According to the Cooperative's commercial manager, "*in March 2020, at the beginning of the pandemic here in Brazil, there was a lot of uncertainty, and the producer decided not to plant cotton... besides, soy was very favorable with high gains*". Table 1 presents the number of farms, planted area production and productivity for the cooperative producers for the last five harvests.

Table 1: No. of farms, planted area, production and productivity for crop years 2016/17 to 2020/21

Crop-Years	Nº of Farms	Planted Area (ha)	Plume Production (ton.)	Productivity (kg/ha)
2016/17	15	1.155	2.287	1.980
2017/18	39	4.446	8.803	1.980
2018/19	64	7.995	16.789	2.100
2019/20	44	5.380	12.266	2.280
2020/21	11	1.100	2.442	2.220

Agricultural planning and the execution of crop treatments are the exclusive responsibility of the cooperative producer (Hardin, 1997; Ménard & Klein, 2004). The Cooperative purchases all the inputs that will be used by the producers, achieving a differentiated price in relation to the quantity purchased, allowing producers to purchase the inputs directly from the Cooperative with a more competitive price (Abrahamsen, 1966; Sergaki et al., 2020). Therefore, all the cooperative members' production is purchased by the Cooperative, which will market it in the domestic and foreign markets. In the case of cotton, in particular, the byproducts arising from the processing process (seed, fiber, waste, in addition to the polyethylene film already used) are also marketed to third parties, according to uses and applications proposed by Desrochers and Szurmak (2017). Nevertheless, the Cooperative's customary performance finds support in Hendrikse's (1998) proposal. Figure 3 illustrates the dynamics of the

relationship between the Cooperative, the members, the processing unit, and the buyer market.

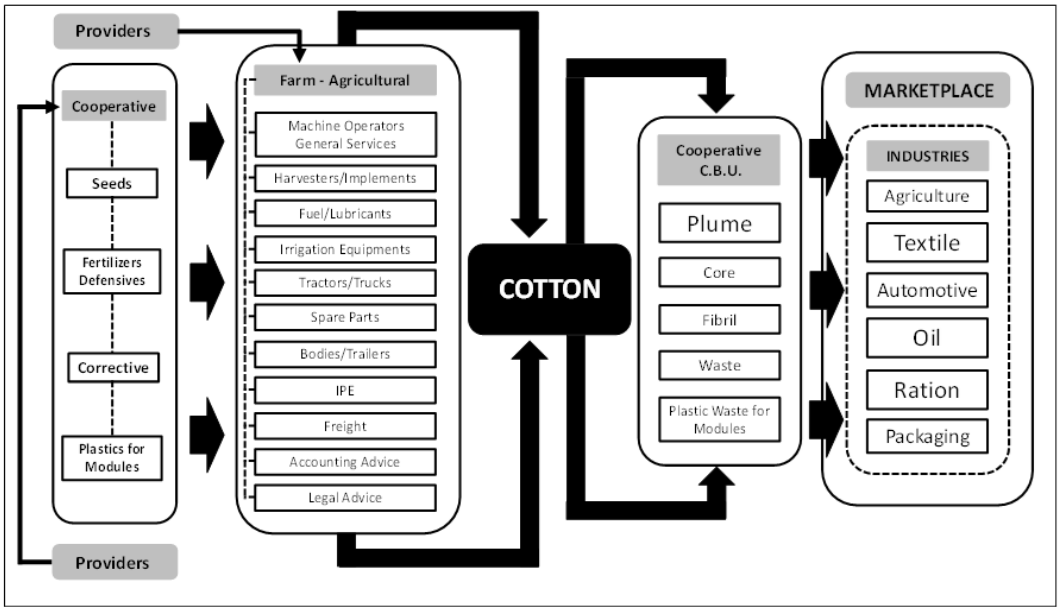

Fig.3: Outline of the relationship between the Cooperative, producers, processing unit, and buyer market

APPA, whose headquarters are in the Campos de Holambra district, acts as a strategic partner of the Cooperative, besides participating in the "agricultural" and "UBA" stages of cotton.

According to APPA's Executive Director, "*we are partners, we exchange several information (planting area, quotations, quantities of seeds bought, etc.). Indirectly, we encourage the increase of the cotton area to be planted in the region and help the cooperative economically...*". Figure 4 illustrates APPA's performance in the agricultural and cotton processing stages.

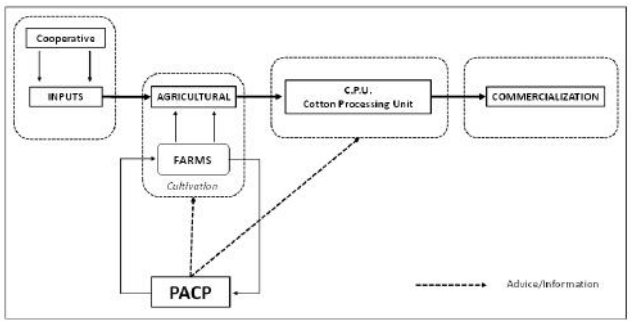

Fig.4: APPA's activities in the various stages of cotton production

Especially in the Agricultural area, the Association offers monitoring of cotton growers by means of traps. Armed with this information, producers can make better decisions in combating the pest, obtaining better productivity, quality and, consequently, profitability. APPA traditionally promotes Field Days, Meetings, crop tours, actively participates in GTA meetings, and frequently hires consultants from other regions to advise on the implementation of improvements in the management conducts, improving the productivity, quality and profitability of the plume.

APPA has 80 members distributed in 13 municipalities with cotton planting areas. In the last 5 harvests (2016/17 - 2020/21), in descending order in hectares planted are the municipalities of Itaí, Itapeva, Riolândia, Rancharia, Martinópolis, Cardoso, Paranapanema, Taquarituba, Angatuba, Paulo de Faria, Pirassununga, Mogi Guaçu and Guará.

The planting system adopted in the farms is SPD, possibly inserted in the area volume cited by Peixoto et al. (2019), whose understanding is anchored in the molds proposed by Phillips et al. (1980), presenting the gains gauged by Salton, Hernani and Fontes (1998). Cotton planting in the research region is done in the conventional system (Clawson et al., 2008) to the detriment of the adensed system as discussed in Rosolem et al. (2012) and Kazama et al. (2016). According to the APPA executive, "*our region is very humid, so if it is adensed, it is much more prone to diseases. And, if it is adensed, it gives us less productivity*". Given the climatic conditions of the region, the conventional method is the most appropriate, otherwise (Jost & Cothren, 2001), there will be increased cost, decreased productivity and loss of profitability, especially due to the need for greater use of inputs (Rosolem & Mellis, 2010).

In the last harvest (2019/20), cooperative members produced 12,150 tons of plume - equivalent to more than 70% of the state production. Inputs accounted for 64.29% of production costs, within the parameters identified in the literature (Cepea, 2020), followed by farming, with 19.28% and processing with 16.43%. The standard period of the cotton harvest in Brazil varies by region, in general the planting is between the months of December/January and the harvest May/June/July. In Holambra "*the harvest is between October and April, therefore, two months in advance*", says the Executive Director. The anticipation strategy provides the Cooperative the advantage of making the product available in advance in the market, with the possibility of reaching higher prices.

Data from the field stage show the mechanized harvest (Embrapa, 2005), using a John Deere 7760 harvester with 537 hp and gross weight of 30,700 kg (Fig. 5a), capable of harvesting, storing, pressing, baling, and wrapping the fibers in a polyethylene film that protects the seed cotton (Fig. 5b), and can weigh up to 2,500 kg. The cylindrical roller baling technology allows the harvester to perform a continuous harvest without interruptions for unloading the harvested cotton.

Fig.5: Self-propelled picker and the cotton drum wrapped in polyethylene film

The quantitative losses in the harvest are around 8 and 10% of cotton, as recorded by the structured observation and corroborated by the interview with the executive director who states that it is "*standard [...] these eight or ten percent stay right in the crop*". He complements that "*if the producer chooses to pass the bale harvester after having passed the roller harvester, the bale harvester will get there another eight or seven percent and ends up getting there two or three percent still in the field, but it is standard, yes ...*". In this case, the producer uses a John Deere harvester mod. 3350, without a baling system, to harvest this cotton. When its reservoir is complete, the harvester unloads this cotton into a press (Bass Boy - Buza - mod. EB-11T) that stays in the field and, after compacted, the bales weighing 11,000 kg are transported to the processing plant. Notably, this is only feasible because the producer in which the field research was conducted, already has the machine and the operator full time on the farm. Figure 6 shows the harvester model used for the residual harvesting (a), as well as the unloading into the Bass Boy press (b).

Fig.6: John Deere 9935 e Bass Boy press - Buza mod. EB-11T

Considering the load capacity and harvesting speed of the John Deere 9935 machine, it is estimated that the press can take up to a full day's work to be filled and in the pressing stage, when the bale will have a weight of 11 tons.

The rolls and bales are collected the same day, being brought from the field to the yard of the processing plant (Coleman & Thigpen, 1991). According to the words of the supervisor of the UBA, "*the first step in the processing of cotton in the mill, is the placement of the roll in the 'piranha', belt or bale cutter*," where the plastic is removed and separated (Figure 7-a). The cotton goes on the conveyor belt for decompacting (b), at which time the first measurement of the cotton's humidity is taken, which "must be between 6.5 and 7.0" (c); the next step is the pre-drying process and concomitant pre-cleaning of the seed cotton, separating the larger impurities (husks, leaves, and small wood chips).

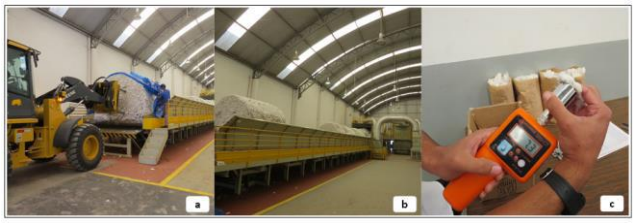

Fig.7: Roll inlet on conveyor, conveyor and moisture measurement

Through suction ducts, the cotton proceeds to the gin, which mechanically separates the fiber from the seed, turning it into ginned cotton (Figure 8-a), according to Bajpai, Mary and Chand (2015). The seed is sold as a by-product (Li & Robinson, 2011; Świątkiewicz, Arczewska-Włosek, & Józefiak, 2016); the plume (b), follows by pipelines to another cleaning stage. The impurities of the plume, the fibril, is separated and transported by suction to the press (c), where it is pressed and subsequently sold as a by-product, especially to the automotive industry (Kamath, Bhat, & Mueller, 2005; Ouslimani & Boureghda, 2018).

Fig.8: Ginning, lint cleaning and fibril pressing

The fiber (plume) in its final stage goes to the pressing operation (Figure 9-a), where it is compacted into bales with an average weight of 200 kg (b) in a time of 1min20sec to 1min30sec, and stored in sheds (c). Before packing the pressed bale, two fiber samples are taken, one being taken for visual classification (C.V. - right label, Figure 9-b), where a quality code will be assigned (Boykin & Reddy, 2010), as a first step in the product value scaling (Barker, Baker, & Laird, 1990), and the other will follow for laboratory analysis in a laboratory outsourced by the Cooperative.

Fig.9: Smart Box 45 press, bale labeling and transport to storage

The coded result of the laboratory analysis is later reported on the bale label with the acronym HVI (High Volume Instrument - equipment used to measure the intrinsic characteristics of cotton fiber), according to Sayeed, Schumann and Wanjura (2021). This result will be fundamental in the lint valuation process, as well as in the correct use by the textile industry, being destined for both domestic and foreign markets.

V. CONCLUSION

The study aimed to study the operations of the cotton chain at Agro-industrial Cooperative Holambra II, especially the planting, harvest, processing and storage of the lint and other byproducts.

The Cooperative has implemented changes in its organizational structure and compliance, seeking to increase its efficiency in decision-making, besides expanding its competitive advantages with better market positioning. The 2020/21 crop showed a strong reduction in the planted area, due to the uncertainties caused by the Covid-19 pandemic, with a consequent drop in production. Although productivity was a little lower than last year's, it remained above the average of the last five harvests.

The organization has a strong position in the commodities market, serving the internal and external markets. APPA acts in partnership with the Cooperative and the producers in the search for the best market positioning.

Primarily, the article contributes to the expansion of the study of agricultural cooperatives in the field of management, focusing on the production of cotton, which produces the most important textile fiber. Although the field operations were circumscribed to a single producer, the information collected can be safely generalized to the cooperative producers, since they are standardized operations, except for the specificities mentioned.

The conclusion of the study allows the proposition of a future research agenda that undertakes efforts to better understand the implications of structural changes in the organizational context.

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