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RESPONSIVENESS AND VALUE CHAIN IN SUGAR-ETHANOL PRODUCTION

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ABSTRACT

Brazil is the world's major sugarcane producer. In 2018/19, the country will have produced about 47.34 million tons of sugar and 58.8 billion liters of ethanol. Sugar and ethanol are produced in the same production process and the definition of both quantities is pre-established to sugarcane agro-industry. The purpose of this paper is to identify how managers define the production mix of sugar-ethanol in an agro-industry and how this decision adds value to its operations. The results showed that the searched mill adds value to its production through responsiveness and flexibility while orienting the production to sugar and/or ethanol according to the most profitable market during the moment of the decision making.

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Keywords: ethanol and sugar production; responsiveness; flexibility; competitiveness; value

1. INTRODUCTION

Brazil has cultivated sugarcane since the 16th century (NOGUEIRA; CAPAZ, 2013). Currently, the country is the biggest producer of sugarcane and sub products like sugar and ethanol (MINISTRY OF AGRICULTURE, LIVESTOCK AND SUPPLY - MAPA, 2016). The use of ethanol as fuel has been mandatory since 1931, but a blending with gasoline and pure ethanol has been commercialized since 1975 (NOGUEIRA; CAPAZ, 2013). Currently, due to flex-fuel cars - vehicles that can use either gasoline or ethanol - the sugarcane agro-industry has been considered as strategic.

Despite the concerns about the impacts of sugarcane agro-industry in food reduction and soil contamination, this sector is growing in Brazil. During the 2018/19 crops, the country will have produced 47.34 million tons of sugar and 58.8 billion liters of ethanol (MAPA, 2016).

As it happens to all commodities, sugar and ethanol depends on the international markets conditions and internal demand; for this reason, their prices are directly affected. To reduce this influence, the sugarcane agro-industry is searching for value addition to the production of ethanol and sugar, by adopting responsiveness and flexibility. In this perspective, researchers like Goldemberg et al. (2008), Sousa and Macedo (2010), Nyko et al. (2011), Milanez et al. (2008) and Milanez et al. (2014) have investigated the causes and effects of the recent transformation of this supply chain, which involves technological changes and consolidation of international groups.

These international groups have invested on clean energy sources and on the search of active at advantageous prices, in view of the economic difficulties faced by the sector (SHIKIDA et al., 2011; MILANEZ et al., 2012).

The modern supply chains bonded to agribusiness are inserted into a scenario of global competition, in a market controlled by a few big corporations and food producers either with added value or as commodities, whose value addition comes from a closer relationship among the members of the supply chain (ROH et al., 2014).

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The sugarcane cultivation is exposed to high levels of risks such as pests, plant diseases and climate unpredictability. In sugarcane mills, the manipulation and post-harvest processing are vulnerable to the deterioration of the product until its final phase. Consequently, a set of activities performed inside the productive system must be effective and agile (BEZUIDENHOUT, 2010).

Furthermore, from the risks inherent to sugarcane production since the 2008's crisis, the world has watched a significant increase of speculative capitals in all future markets from agriculture commodities (FEDERATION OF INDUSTRIES OF THE STATE OF SÃO PAULO - FIESP, 2015). Moreover, such speculative movements contribute to an increasing variation of the commodities' price, as it happens with sugar and ethanol, requiring from the agents the correct decision-makings related to commercialization and profit.

Considering this scenario, the objectives of this paper is to comprehend how the decision-makers of a sugarcane agro-industry define the production mix between sugar and/or ethanol and how this decision adds value to its operations.

The paper is divided in some parts that include this introduction, the background in section 2, methodology procedures in section 3, the case study in section 4, the discussion about case study in section 5, and finally the final remarks in section 6.

2. LITERATURE REVIEW

2.1. Value Chain

The addition of values to the final products and the increase of the margins have been the main strategies of the companies. According to Porter (1998), the strategy guides the way that a firm performs the individual activities and organizes its entire value chain, as shown in Figure 1. The value chain is part of a larger system that includes upstream suppliers and downstream clients (AMARA et al., 2016).

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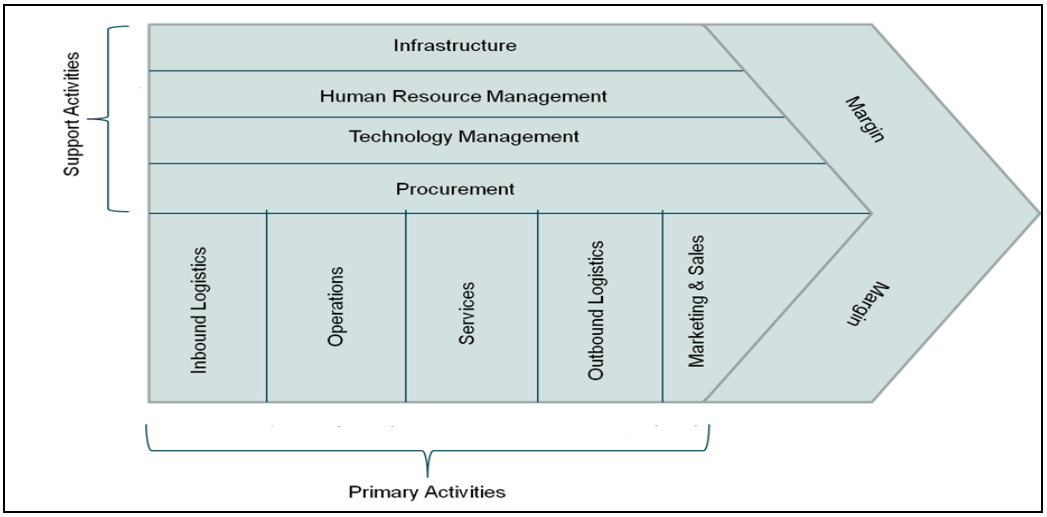

Figure 1: The value chain.
Source: Adapted from Porter (1998) and Saha (2011)

The value chain involves a full range of activities which are required by a company to bring a product or service from conception, through the different phases of production, until the delivery to final consumers, and their disposal after use (KAPLINSKY; MORRIS, 2001).

The added value is generally distributed along the production process in which the highest value is established during both far upstream (basic and applied R&D) and far downstream stages (marketing, distribution, and brand management) and the lowest value-added activities occur during the value chain (manufacturing and assembly) step (SHIN et al., 2012; AMARA et al., 2016).

In agriculture, the study of the value chain can provide the knowledge for increasing the competitiveness. Moreover, it improves the efficiency of the processes through the integration of the network players in order to increase the response capacity.

In sugarcane agro-industry, for example, the companies and researchers have studied the addition of value based on the low prices of sugar on the international market and by the high costs of production (HIGGINS et al., 2007). Bezuidenhout and Baier (2009) identified five dimensions in which the sugarcane agro-industry may be characterized: (i) value chain; (ii) material handling chain; (iii) collaboration chain; (iv) information chain; and (v) innovation chain.

Higgins et al. (2007) outstands seven points of this value addition to the sugarcane agro-industry: (i) logistics opportunities, business integration, free

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information and products co-generation; (ii) the adoption of technical value which tends to be more evolutionary than revolutionary; (iii) the opportunity of value that requires both the collective participation of all members and the evolutionary changes of the management; (iv) elaboration of metrics aiming social and economic developments; (v) principles of lean and agile supply chains with significant potential for systems turned to mills; (vi) use of methods of multi-agents for modeling; and (vii) climate, bio-physical and social complexities which has limited the adoption of value techniques.

2.2. Responsiviness

In competitive markets, the companies seek for responding to the consumers' demands, including the responsiveness, through their actions. According to Jimenez et al. (2015), many industries are pursuing responsiveness as one of their main performances.

Holweg (2005) points out that responsiveness is easily aligned to a wide range of manufacturing strategies; also, the supply chain strategies would be in accordance with that when capturing the consumers' demands in order to provide the right product. Kristianto et al. (2016) consider that responsiveness is the ability of dampening the effects of demand changes through a purposeful reaction within a specified moment for response.

Indeed, the responsiveness evokes the different reactions of production systems according to the customer demand. A responsive system or supply chain reacts by using three dimensions: volume (nature of demand and customer expectations); product (external variety, internal variety, customization points); and process (production lead times and decoupling points) (HOLWEG, 2005). Thus, the responsiveness is directly bonded to both competition and firm performance (PEHRSSON, 2011).

The main way to include responsiveness into the commercial activities is by adopting flexibility for the production practices (JIMENEZ et al., 2015). The flexibility is the capability of a company to react to external changes in a short period of time (UPTON, 1994). According Yu et al. (2015), flexibility is the capability of a company in responding to uncertainty either proactively or reactively.

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The main types of flexibility involve: machine flexibility, labor flexibility, material handling flexibility, routing flexibility, operation flexibility, expansion flexibility, volume flexibility, mix flexibility, product flexibility, and modification flexibility (YU et al., 2015). Jimenez et al. (2015) also corroborated to this idea, by inferring that responsiveness needs to meet the costumers' demands by using flexible types in both internal and external environmental uncertainty.

In volatile markets, there is an important condition for competition, when the adoption of flexible operations becomes essential for reaching the responsiveness. A volatile market can be defined as a constant change of supplies, demand and prices. Christopher (2000) points out that the volatile markets are becoming the core of global economy.

Noteworthy, sugar and ethanol is a volatile market that has its production process and volume directly affected. The production dimension is affected by the customization of sugar products and ethanol; the process itself is adapted to respond to the better market prices and lead times; and volume of production varies according to the marketing prices and government policies. So, we can infer that responsiveness is essential for the companies that run in sugarcane production.

We often observe the sugarcane agro-industries changing the production mix in order to respond to a more profitable market. This decision basically affects the supplying of one of these products, mainly the ethanol. According to Reis et al. (2011), one tone of sugarcane can produce 2.7 bags of sugar or 85 liters of ethanol. If we compare productivity to the current prices provided by Center of Advance of Studies in applied Economics (CEPEA, 2014 a, b), the 2.7 bags of sugar correspond to US$ 31.02 and 85 liters correspond to US$ 27.82. In Figure 2, it is possible to verify that when sugar shows more profitability in relation to the hydrous ethanol (used as pure fuel) the volume of ethanol production decreases.

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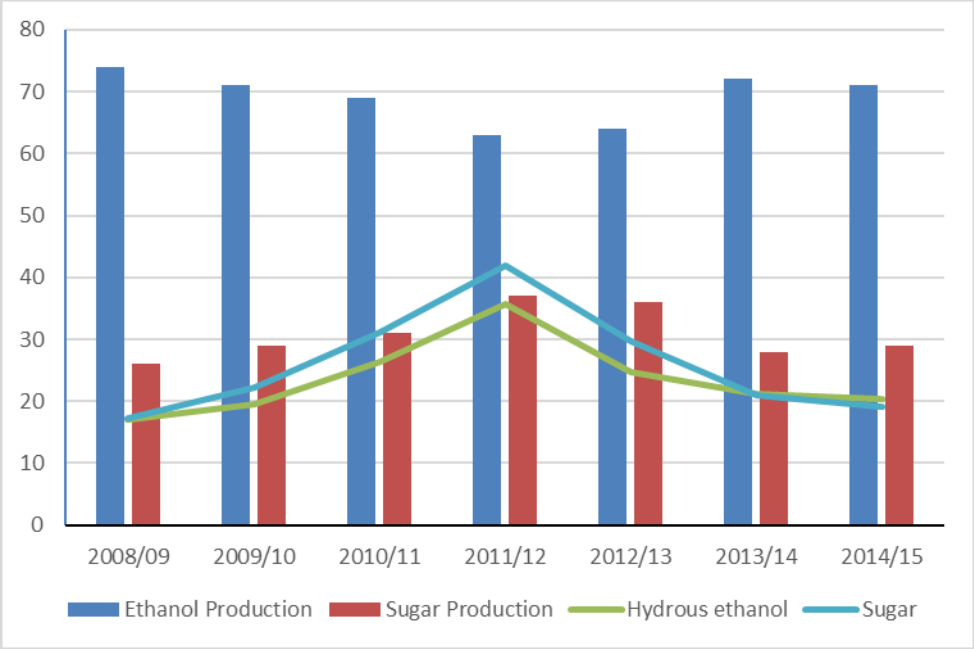

Figure 2: Sugar and Ethanol Production in MS State.
Source: Created by the authors using data from CEPEA (2015a, b); Association of Bioenergy Producers of Mato Grosso do Sul (BIOSUL, 2015)

Figure 2 considers productivity, the values present by Reis (2011) and the average prices presented by CEPEA (2015a, b) and BIOSUL (2014).

2.3. Sugarcane Agro-Industry

The sugarcane agro-industry is directly bonded to the development of Brazil. The cultivation of this specie dated the year of 1.530 and it became one of the most important economic activities due to its social and historical context.

According to BRAZILIAN SUGARCANE INDUSTRY ASSOCIATION - UNICA (2015), in 2012, the sugar-ethanol sector had an income around US$ 36.0 billion, with exportation receipts around US$ 16 billion of derivative products from sugarcane, occupying the second place of national agribusiness exportation. The sector remains behind soy complex that has significantly contributed to the equilibrium of the Brazilian public finances with the creation of 1.15 million new jobs.

According to the MAPA (2015), until 2014 there were 390 agro-industries properly registered on the Brazilian Agro-energy and Cane Department. From this total, 61.53% (204) are mixed unities, we mean, they produce both sugar and ethanol; 31.28% (122 unities) are distilleries (exclusive ethanol production) and only 3.8% (15 unities) with sugar production. Forty-nine unities did not fit into the classification, what corresponds to 12.56% of the total data.

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Milanez et al. (2012) point out that over the recent years, big international groups have bought Brazilian industries. Great part of such industries was managed by familiar groups. On the other hand, the acquisitions by such international groups did not imply on the installation of new mills or facilities, but in fact on the expansion of the existent ones. Besides, there is a concentration of mills under the control of big foreign groups.

The current situation of fusions and acquisitions created a context of lack of financial investments. This overview crucially corroborates to a limited offer of products, due to the lack of new Greenfield projects for expansion. It is noteworthy that the investments concentrated on the installation of new facilities would enable the increase of sugarcane production (FIESP, 2015).

Despite this scenario, several unities of production went to bankrupt as result of the crisis that Brazil went through in 2008. Consequently, such situation brought another aggravator, once the sugarcane processing migrated to other neighboring unities, which is a limiting factor for the sector's expansion (COMPANHIA NACIONAL DE ABASTECIMENTO - CONAB, 2013).

According to Shikida et al. (2011), the Brazilian sugarcane agro-industry is technically qualified and presents the world's lowest cost of production. However, the technological paradigm that both mills and distilleries are forced to keep working - or to overcome - the market forces the articulation of this segment in partnership with the public sectors aiming the maximization of the research and development (R&D) sector and the overcome of sectorial constraint.

The theoretical model of agro-industrial system, in Figure 3, is understood as a set of enterprises with different levels of vertical coordination. It involves several agents able to turn them to a complex network of interactions through the information and materials' flow and formal transactions. The huge world financial crisis from 2009 reached the Brazilian sector and enabled the entry of big international and economic groups (especially oil and trade companies) that either bought or merged to the already established enterprises aiming to find undervalued actives, instead of looking for new productive capacities (VALENTE et al., 2012).

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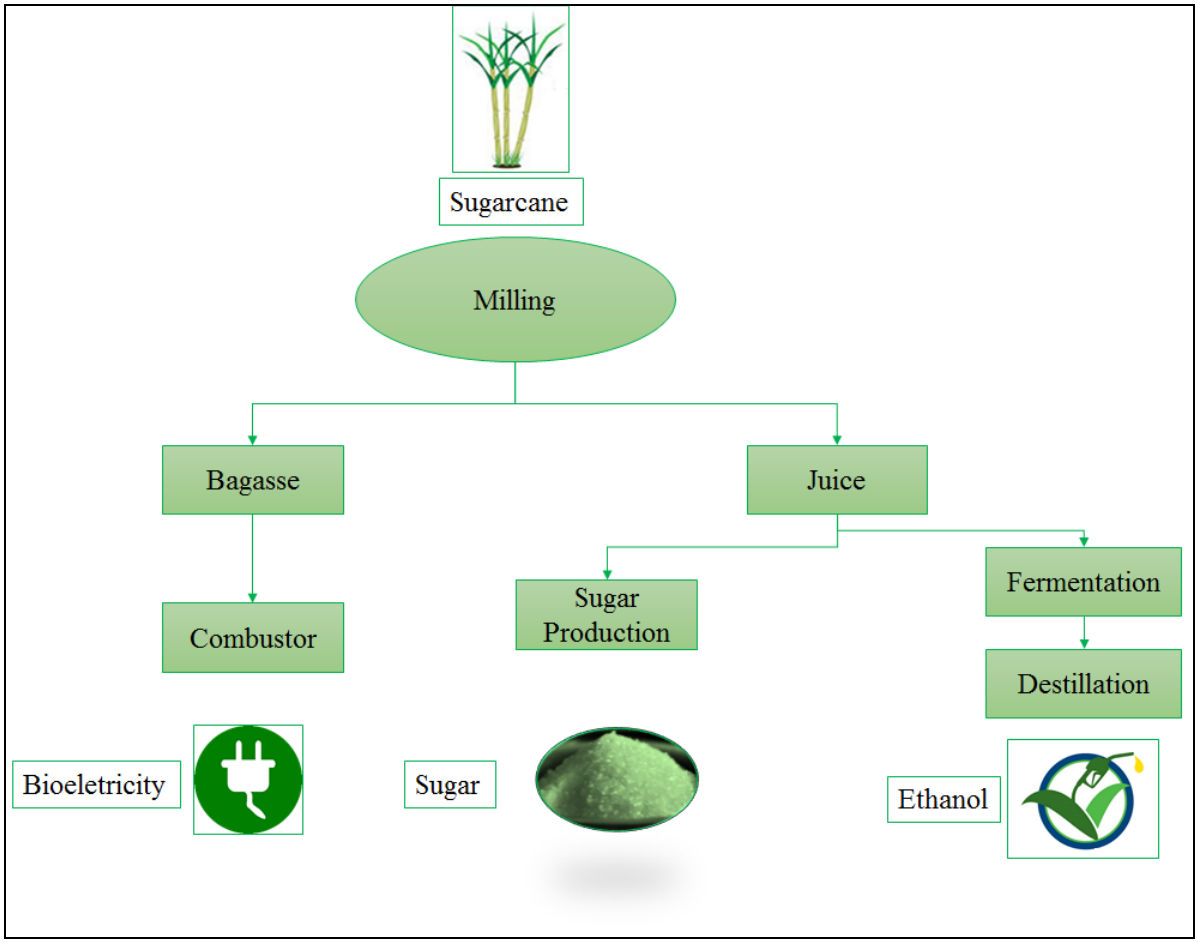

Figure 3: Sugarcane Agro-industrial System.
Source: Authors

3. METHODOLOGY

We adopted a qualitative approach in order to analyze a specific sugarcane mill's responsiveness for market demands. According to Pratt (2009), a qualitative research is good at addressing the best questions to understand the world from the perspective of the studied object.

Our study was guided in order to better understand how the production mix of sugar and ethanol is empirically defined by the decision makers and, in this regard, we carried out a case study that is a qualitative technique that allows a better comprehension of currently process and its gaps. According to Gillham (2000), a case study enables the investigation of some situations in which only a little is known about, while exploring complexities that are beyond the scope of other approaches and, finally, it permits the researcher to see the case from the perspective of those involved.

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Furthermore, Yin (2010) points out that this approach enables the researchers to retain the holistic and significant characteristics of the real life events, like the organizational and management processes of a company. In addition, Godoi et al. (2010) explain that the case study is recommended when the research problem comes from a daily situation and the researcher seeks for the explanation of a situation based on the practice.

This case study was performed in two steps: first, we visited the facility which was a result of a Greenfield project, in order to get more information about the production process. Then, we applied a questionnaire for data collection through a semi-structured interview with the representative agents from commercial department and production managers - containing both open and closed questions.

Marconi and Lakatos (2010) argued that this technique of interview and questionnaire is a procedure used in social investigations for data collection or when the aim is the diagnosis or treatment of a social problem. Cervo et al. (2006) point that the survey enables the interviewer to measure more precisely what he/she wishes through a set of questions logically turned and related to a given core problem.

The study was conducted in October and November of 2014 and followed the process proposed by Neale et al. (2006): the introduction should contain information intended for all readers of the journal, not just for specialists. It should describe the problem statement, its relevance, significant results and conclusions from prior works and also the objectives of the work described in the manuscript submitted.

- Plan: we identified the stakeholders and potential sources of information. We listed the sugarcane mills plants that could participate and ensured that the research would follow ethical standards.
- Development of instruments: we established a guiding interview and the procedures for the research explanation;
- Collect data: all the relevant documents were gathered. Data collected in this study were provided by the questionnaire, by the visit to the facility, by database obtained with the interviewed and documents from the literature review.

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- Data analysis: we reviewed the collected data and opted by the analysis and discussion about the findings through qualitative techniques in which we compares the results to the literature data.
- Disseminating Findings: our findings are discussed in the next session.

The limitation of this study was the use of a single case, once only one representative agreed to participate in this research. However, Siggelkow (2007) explains that a single case can be a very powerful example. Based on the relevance of the responsiveness as a theme, the case study was used as an illustration by following the guidelines of Siggelkow (2007).

4. CASE STUDY

In order to identify the responsiveness over the production of sugar and ethanol, a research based on a case study has been designed. The case was performed in a sugarcane mill that belongs to an important Brazilian agribusiness corporation, whose activities encompass reforestation, infrastructure and energy, among other sectors.

The sugarcane mill is located in the municipality of Dourados, in southeast region of Mato Grosso do Sul State. The territorial area comprises 4.086 km² with a Municipal Human Development Index of 0.747. In Mato Grosso do Sul State, where this research took place, the sugarcane activity went through a large expansion period after the financial investments in 2006, resulting in the installation of 22 facilities (BIOSUL, 2014).

The sugarcane activity favored the increase of the local economic capacity and brought the expansion of the agro-forestry activities, especially the ones turned to paper production on the east region of the State. With the fortification of such activities from 2009 on, and due to the fact they are perennial (agro-forest) and semi-perennial (sugarcane) activities, the risks of bankrupt were minimized. Figure 4 shows the location of the 22 productive facilities of Mato Grosso do Sul state.

The agro-forest and sugarcane production brought great investments to the regional agribusiness sector and diversification of the agricultural activities previously restricted to soybean, corn and livestock.

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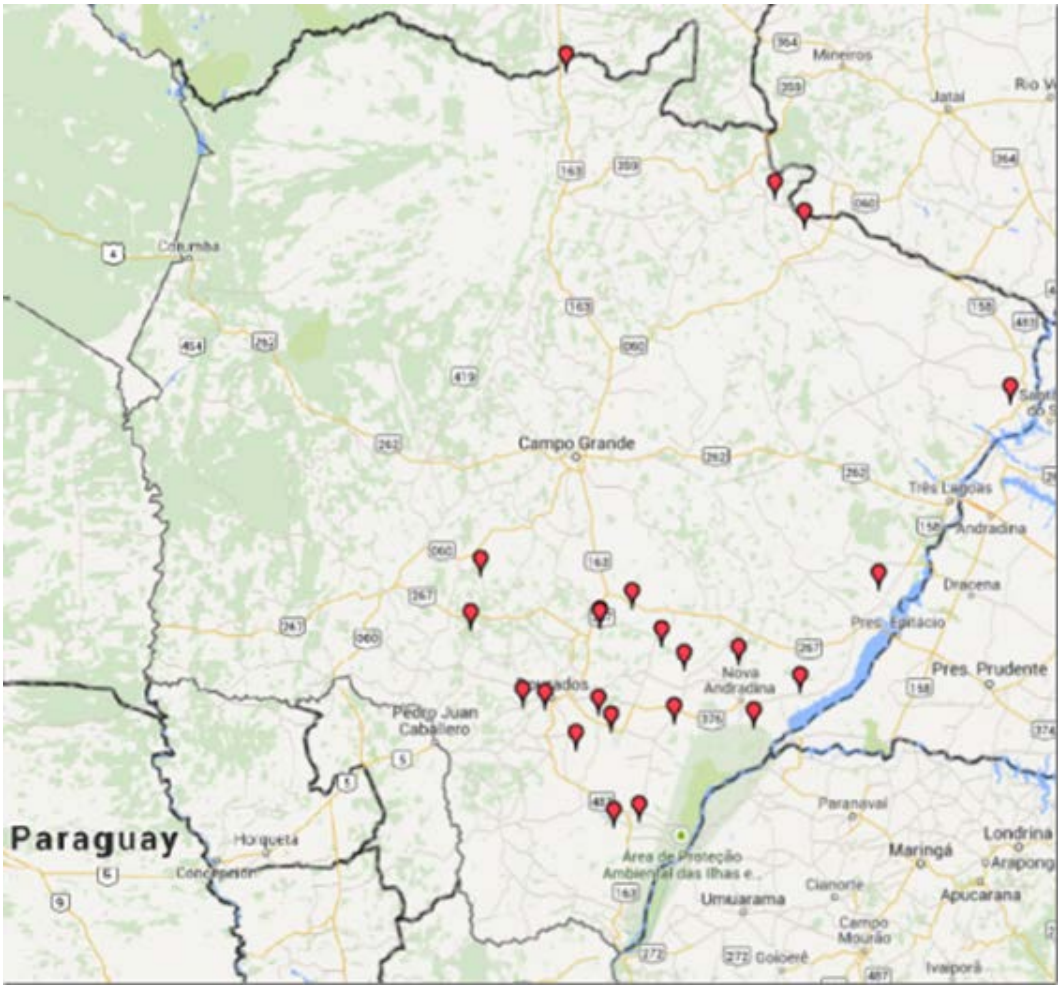

Figure 4. Map of location of the sugarcane agro-industries from Mato Grosso do Sul State.
Source: Union of Bioenergy Producers [UDOP] (2015)

The sugarcane agro-industry of this study sprang in 2009, a period of great investments on the sugar-ethanol sector that began in 2004, due to the emergence and increase of the fuel flex vehicle fleets in the country. Herein, we named this industry simply as Mill or Sugarcane Agro-Industry in order to keep the confidentiality of its data, in order to respect the ethical standards. In that same period, five other mills sprang in the neighboring cities: Bataiporã, Ponta Porã, Caarapó, Chapadão do Sul and Nova Alvorada do Sul. In addition, such mills were results of Greenfield investments and new expansion projects after a boom of investments before the beginning of the crisis on the sector. Table 1 describes the Mill's capacity of production.

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Table 1: Capacity of Production

Description	Quantity	Product
Capacity of grinding	4.5 t (*)	Cane
Growing area	60,000 ha	Cane
Cogeneration of energy	244.4 MW	Energy
Capacity of sugar production	330 t (**)	Sugar
Capacity of ethanol production	150 m^3 (**)	Anhydrous and / or hydrous Ethanol
Clean Development Mechanism	indefinite	Carbon Credit

Source: Interview Managers
(*) millions (**) thousands

The initial investments of this Sugarcane Mill were around US$ 184 million and it will reach its maximum grinding capacity in 2017. The unit currently comprises an area around 60.00 ha for cane growing in leased lands. The harvest goal for the cycle 2013/14 was 3.924 million tons of sugarcane. For energy generation, it has two generators with individual capacity of 122.2 MW. This data put this Mill as one of the greatest national energy generator from cane biomass.

All the harvest procedures are mechanized. Producers use modern agricultural techniques for cane planting and growing and carbon commercialization. Despite the modern mechanization of such procedures, this Mill is one of the main employers of human capital in the municipality. The numbers of employees reached 3.000 in 2014 and it became the most important income source of this rural region. As a result, the agricultural activities are carried out in partnership with rural producers through land leases contracts.

On the social aspect, the Mill develops projects in municipal schools related to environment care and activities that stimulate the cooperation. The Mill's directors also built an Educational Center for Kids and implemented the Center of Professional Qualification for teens, both in partnership with the municipal public power.

5. DISCUSSION

The Sugarcane Agro-Industry's main production is a mix of sugar and ethanol (anhydrous and hydrous). To establish the production mix, the managers consider the previous contract sales. Thus, they define the percentage of sugar and ethanol production by considering the contracts and sugarcane Total Recoverable Sugars (TRS). The TRS refer to the sugar-solids content of sugarcane, however in countries where only sugar is processed from sugarcane, the usual reference is sucrose content (HALEY, 2015). Both help managers to decide the mix of production of sugar and ethanol. As we previously mentioned, a responsive system reacts by using

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volume, product, and process to respond the customer' demands (HOLWEG, 2005). In this case, we concluded that the TRS contracts are the main object that influences the responsiveness of this Mill, once it defines the kind of production that will be chosen - ethanol or sugar, or both - also the respective volumes and the changes during the process.

The Mill only produces VHP (Very High Polarization) sugar, a genuine Brazilian product that is sold to the foreign markets. The VHP was introduced in the 1990s as a result of a research project about new types of sugarcane hybrid materials, mainly for the foreign market. The composition of VHP sugar allows it to be converted into different types of sugar for consumption (XAVIER et al., 2011). The international demand affects the prices of sugar and, consequently, the responsiveness of the Mill. Thus, the first factor aiming an effective responsiveness is the previous contract and, secondly, the prices that will influence the new contracts.

This scenario was pictured based on the managers' answers. According to the data, 65% of the cane corresponds to the production mix during the grinding period of the crop planning (contracts). The other 33% corresponds to the safety margin, which is inherent to the production risks (fine payment in case of non-deliverance of the final product) and may capture the opportunities for the sales on the spot market (prices). We observed the existence of sugar supply contracts for more than one crop as a common practice of several sugarcane mills.

Another important aspect is that the company directs great part of the ethanol commercialization to the spot market; however, the ethanol transactions' costs in spot market can distort pricing process in future markets, resulting in financial losses to a potential contractor (TONIN and GODOY, 2013). For this Mill, the strategy enables it to capture the best market opportunities, besides the income generation with the ethanol sale, which, until the moment, is the core product. Moreover, the billing of the sugar sale happens only in medium-term period.

We also observed that the Mill should have a best financial and operational planning for the biofuel production, as it happens with the biodiesel and electric energy auctions, with the creation a long-term contracts practice among the distributors. This kind of strategy aims the value addition to the company's products.

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In spite of the operational flexibility that enables the Mill to drive the proportions of juice for ethanol and sugar production, alongside the decision process related to the percentage of the products, the prices of commodities and previous contracts are not the only items taken into consideration.

The commitments of sale and leasing must also be observed, once they cause direct impacts to the production (CZINAR, 2013), for example: (i) if there is a change on the production from sugar to ethanol there are some costs, like the washouts - cost for deliverance cancellation, often from sugar for exportation - that varies according to the involved parts plus the situation of the sugar market at the period. Moreover, some banks require the exportation contracts in contrast to loans based on foreign money; (ii) in the case of a change from ethanol to sugar, there must be an analysis about the possible commitments of both storage and deliverance of ethanol based on Brazilian Resolution 67/2001 of ANP - or even the need of extra financial sources, once the sugar market tends to have a liquidity lower than ethanol; (iii) the difficulties and technical limitations must be considered, since it is expected that during the milling period of the high-quality cane, there is a greater production of sugar in comparison to the initial and final phases, when it is easier to produce ethanol.

The contracts are important guides for responsiveness once they influence the creation of the crop plan in which the product mix is established. In the beginning of the grinding period, the production is commonly divided into 55% for ethanol and 45% for sugar. When we compare this result with the average in the State showed in Figure 2, we observe that the Mill is oriented to a more profitable market that, in this case, is sugar production. The strategy seemed to be precise, once the profitability of sugar is equal or surplus to the ethanol in the last crops, what lead us to conclude that the Mill seeks to add value to products using responsiveness and flexibility by orienting the production to the most valuable market.

The mix is adjusted along the crop cycle, according to the market conditions and to the opportunity of ethanol sale to the spot market. Although this is not a practice of this sugarcane Mill, there can be an unpredictable breach of contract resulting in a change from sugar to ethanol, which is a mechanism to be considered.

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Another important aspect observed in this Mill is that, due to the modern equipment and due to the fact the mill is a result of Greenfield project recently created, the unity has a system of molecular sieves that enables the total change of production from hydrated ethanol to anhydrous ethanol and vice-versa, thus, capturing the best moment with the best marker conditions. Indeed, the company gets a second flexibility which involves the choice of what kind of ethanol will be produced.

6. CONCLUSIONS

Our study concluded that the responsiveness of the sugarcane agro-industries is influenced by previous contracts and prices of the spot markets. Moreover, the contracts are the guarantee of the Mill to obtain the profitability that permits the continuity of the operations.

The Mill uses the responsiveness and flexibility of production process to add value to the final products, by considering the more profitable scenario. Furthermore, the market prices have influenced the new agreements that directly affect the production mix.

Finally, this study identified that in agribusiness sector some companies use concepts applied in common manufacture industry such as responsiveness and flexibility. Thus, we may infer that the importance of the knowledge on production management in agro-industrial process is essential to make profitable results of the operations possible, which is a practice of the studied mill.

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