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QUANTITATIVE ANALYSIS SUPPORTED IN SNA OF THE PRODUCTION MILK CHAIN IN BRAZIL

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ABSTRACT This article proposes a study to identify quantitatively the milk production organization in Brazil. The milk production chain in Brazil is of great relevance to society and to the economy as a job generator, accounting for a significant part of the Brazilian food and foreign exchange export earnings. The micro-economics of the production segments supply chain from small producers was analysed by identifying and modeling the relationships betweens contributors, located directly in production cooperatives, rural associations or unions. The attributes of the supply chain environmental considerations, allow the establishing of trust between the participants and formal contracts. The proposed methodology for the study provides a graph theory as a descriptive method based on the networks vision as a set of contributors connected by links. In this sense, the research is geared towards the development of a set of indicators obtained from the application of computational tools for gathering information, that add a final model with the main characteristics of the studied chain. Guided actions for improvement are inferred using these indicators. The main results achieved was a better understanding of the production chain from its structural features, launching indicators to generate bases for the proposed changes to the chain to promote general improvement of relationships and processes.

Keywords: network analysis, graph theory, supply chain.

INTRODUCTION This research aimed to develop a survey of dairy farms and their infra structure, and their interactions identifying the network players and their infra structures. It was used the construction of the adjacency matrix and part of the analysis of data from the dairy chain to understand the farmers, associations, distributors, certification, planning bodies and control, and small dairy producers and suppliers. Milk production in Brazil has had a consistent increase, considering the volume of product under federal inspection (MILKPOINT, 2009). In this research the analysis considered the view axes, poles and clusters that includes areas of local development at different stages with different potential and eventually united in common supply chains. The modern dairy production has been organized in supply chains to obtain products with quality and technology, with a low cost, high safety and effectiveness in the quantities

and delivery times. Nowadays, companies rely upon resources and knowledge as integrated management, information technology, and business logistics. For the adequate integrated management it has become imperative to reduce costs, waste and to meet the costumers' requirements. A number of initiatives have been developed in order to the product reaches the consumer with a recognized quality standard. This paper proposes further study to identify quantitatively the dairy production organization, in both micro-local and/or regional economy, in segments of the supply chains from small farmers by identifying and modeling the relationships of its agents at cooperatives, rural associations or unions. The attributes of the supply chain and the environment considered require a learning phase of the advantages, the establishment of trust between the participants, and finally formal contracts. The diagnosis forecasts the possibilities of improvement within the dairy chain. In this sense, the research is focused on developing a set of indicators obtained from the computational tools application, and furthermore to use these indicators to guide the actions for the chain processes' improvement.

METHODOLOGY This is an exploratory and descriptive study, and data collection was carried out by means of literature review. Documents analysis and reports generated by research groups related to dairy production chain in the country was also taken into account. The study covers up the use of data analysis software technique based on social network analysis (Borgatti, 2002). The methodology relies on a graphic theory using a descriptive method based on the network visualization as a set of nodes connected by links, and the relational data corresponding from the identification of the adjacency matrix to the analysis.

RESULTS AND DISCUSSION

Productive chains and networks constructions To study the milk production chain in order to have the understanding of agro-industrial system (AIS), which is related to the macroscopic system and measures of market regulation, involves the knowledge of the organizational and institutional environments. Zylbersztajn (2000) points that the dependency relationships between suppliers of agricultural equipment, agricultural production, food industry and distribution system began to be observed more frequently in studies on agro-industrial relations, based on the theoretical foundations of Davis & Goldberg (1957), and also the overall concept of the production chain. Referring to the traditional definition of agribusiness made by Davis & Goldberg (1957), Santana (2002) points out that when the analysis is restricted to a particular product, it has a cut-out in agribusiness, resulting in the concept of chain production, which fits to the relations of input-output and chaining retrospective and prospective economic activities. To make the analysis of a supply chain, should also consider the existence of institutional environments, organizational and business. The institutional environment consists of federal, state and municipal development support activity, in addition to customs, culture, ethnicity and traditions. These factors distinguish the company is able to influence the organizational environment. We must understand, too, the involvement of macroeconomic sector policies that reflect the modernization of the sector, technological innovations and performance of organizations. Kotler and Armstrong (1998) say that the market consists of all the potential customers who share a particular need or desire, willing and able to change a meeting that need or desire. Therefore, a supply chain market is represented by the consumer, since each segment is responsible for a chain link and that the factors of competitive performance of a chain are equal for all, what changes

is the process, the chain value (Porter, 1989). Currently, according to Pereira (2005), both in practical and theoretical, the issue of inter-organizational relationships is applied to a wide variety of relationships between organizations, for example, joint ventures, strategic alliances, clusters, franchising, supply chains, export groups, interorganizational networks, among others. In this context, it is important to highlight the three reasons for the increased interest in the theme "interorganizational networks": a) The emergence of "new competition"; b) The emergence of information technologies and communication technologies (ICTs); c) The consolidation of network analysis as an academic discipline (Nohria and Eccles, 1992).

The networks of cooperation and business alliances occur in many different sectors and between companies of various sizes and may involve varying degrees of cooperation and change in relation to the purposes and goals. The inter-institutional cooperatives seeking to facilitate the process of achieving the common goal, ensuring the autonomy and independence of each participant, are called "organizational networks" (Nohria and Eccles, 1992).

Production chain - components of the network The vision of the production chain help indicating the responsible for decision making in order to address the issue of access to inputs and markets in addressing productive activities. Since the 90s production chain is defined as "a network of different agents that generate power relations conference that directly influence the marketing strategies and business, and decision making of individual actors" (Jank, 2008). To better understand the chain it is important to know the main structures that make up the network: System-agent - is one component of a subjective character that represents a substructure of an organized base segment of activity. Technical function - This is a step in the process of production / processing / marketing. Production chain - is a system composed by all the technical tasks involved, from production of products to the consumer, in the case of dairy products. These three basic concepts allow break the chain and decipher its complexity, while preserving its essence systemic. The concept of system facilitates the analysis of the strategies of the actors, the influence of the overall scheme of each component, the processes of structuring, operating and production limit points.

The milk production chain Fresh milk goes through several stages of processing before reaching the final consumer. According to Canziani (2003), the milk production chain is divided into four segments: (1) The sector suppliers of inputs, machinery and equipment, ranging from pasture for livestock veterinary technical assistance, among others; (2) The manufacturing sector, which consists of specialized producers that use in the dairy herd and by non-specialist producers who can use cattle with double fitness; (3) Dairy Industry, made up of processing plants (Dairy cooperatives and mini-mills). At this stage, the concept of industry is explained by the fact that the raw milk, fresh, get some kind of processing. Milk is sterile only when used in the production of UHT (long life milk - Ultra High Temperature) or, is pasteurized when used to produce products such as cheese and milk beverages; (4) The last sector of the chain refers to the distribution to the final consumer, retail, bakeries, supermarkets, institutions, or even can be sold in the informal market (CANZIAN, 2003). Still, by the same author, you can represent the chain of activities of milk production, as shown in Figure 1:

Figure1. Milk Production Chain (Canziani, 2003).

A dairy production activity involves the herd and the farmer. Among the most important mechanisms to increase efficiency in the production process there are health, nutrition and genetics; which consist on the share of the industry input responsibility of the milk quality. Within this sector recent innovations have led to successive increases in productivity, which started from manual milking in buckets, to the use of cooling tanks, milking and advances in genetics. However, producers may not follow the layout of the chain as presented, but they might give their product directly to the market without delivering to the industry. This is the informal market and it is used mainly by small producers to get a higher market price. According to Canziani (2003) the informal market accounts for almost 40% of milk sold. However, the processing plants and dairy industries earn an important role in the chain, as they are responsible for adding value to the final product. This sector can contribute significantly to the systemic performance of the production of milk, it can achieve economies of scale and scope from partnerships and vertical integration. According to Jank (2008) since 2000 milk supply has been incorporating more professionalism to their production structure. With significant growth in primary production, the country also has been advancing in per capita consumption and exports of milk. Already recognized as an important global player in the coming years, the dairy segment of Brazil responded to the stimulus of the price with great performance. The first half of 2008 indicates average growth rates above 10% to 25% in some months over the same period last year.

Use of social network analysis to study the milk production chain A social network analysis (SNA) was developed to understand the relationships between agents in a network structure in social settings, in order to understand how the position of a certain agent is influencing the network and its access to resources, goods, capital and information. This allows us to infer that economic activity is related (connected) to the social structure of the network, which leads to the concept of social capital. The software package UCINET is flexible enough to analyze data from social networks (Borgatti et al., 2002). This tool supports several file formats, can view networks with an average of 32 thousand nodes. The methods of social network analysis package UCINET existing include measures of centrality, identification of subgroups, analysis of roles and elementary theory of graphs. In addition, the tool has several routines for the analysis of arrays. It has an integrated module to draw graphics social network called NetDraw. The NetDraw software enables the creation, reading and social network data analysis. When the SNA methodology is applied as a diagnostic tool, this can help access to some of the challenges associated with planning and implementing projects, the presentation of the institutional challenges and identifying initiatives that will duplicate efforts and facilitate the building of social capital between different agents. The analysis of organizational levels and community networks, help the understanding of the local people by highlighting the interactions between different groups, and identifying the actors for greater involvement or influence. This material also allows a good starting point to encourage key agents of the network to discuss their relationships and benefits of working together to build a network based on collaborative relationships between institutions.

RESULTS AND DISCUSSION

Data collection on dairy production Directly from field research conducted by the Brazilian project GESis Leite 2010, which is the project of the Strategic Management System Agro industrial Milk in Sao Paulo, it was possible to extract data from relationships among the main actors of the network components that form the production chain milk in Brazil. From these data, we can develop into a structural analysis of this network, making appropriate adjustments excluding statements that are not represented the values and running in the UCINET software and Netdraw software having which results are shown in Figure 2:

From the data collection of the graph corresponding to the network of relationships and the production milk chain, were exported from the environment NETDRAW to the UCINET environment in which it was possible to obtain answers to the following data:

Measures of degree centrality (Freeman): The degree centrality is measured by the number of ties an actor has with other actors in a network (Wasserman and Faust, 1994). The result achieved through the use of software Ucinet was 54.46%.

Measures of centrality of proximity: The centrality of closeness is based on proximity or distance of an actor in relation to other actors in a network. The measure of centrality of proximity (closeness) of an actor is obtained by sum of geodesic distances between all other actors (Hanneman, 2001; Hanneman and Riddle, 2005, Scott 2000, Wasserman and Faust, 1994). According to Scott (2000), the measure of closeness centrality is given to know the centrality of global actors. The result achieved through the use of software Ucinet was 57.40%.

Measures of centrality of mediation: The centrality of mediation, the interaction of nonadjacent actors might depend on other actors, which may potentially have some control over the interactions of the two nonadjacent actors. According to Freeman (1979) and Wasserman and Faust (1994), an actor is an agent that binds to several other actors that do not connect directly. The result achieved through the use of software Ucinet was 54.90%.

Properties of density and distance of the geodesic network: Mathematically, the geodesic distance $d_{A(a,b)}$ between points *a* and *b* within the set *A* is the minimum path between all the paths from a to *b*. If *B* is a subset of *A* (Eq. 1) and may thus be defined as the shortest distance between two network nodes.

$$d_{A(a,B)} = MIN_{\,b \in B}\left(d_A(a,b)\right) \qquad eq.1$$

The tool calculations, then determines the average of all the geodesic distances between the actors of the network and the network density. The average distance reached is 1,883, and the density is equal to 0,265.

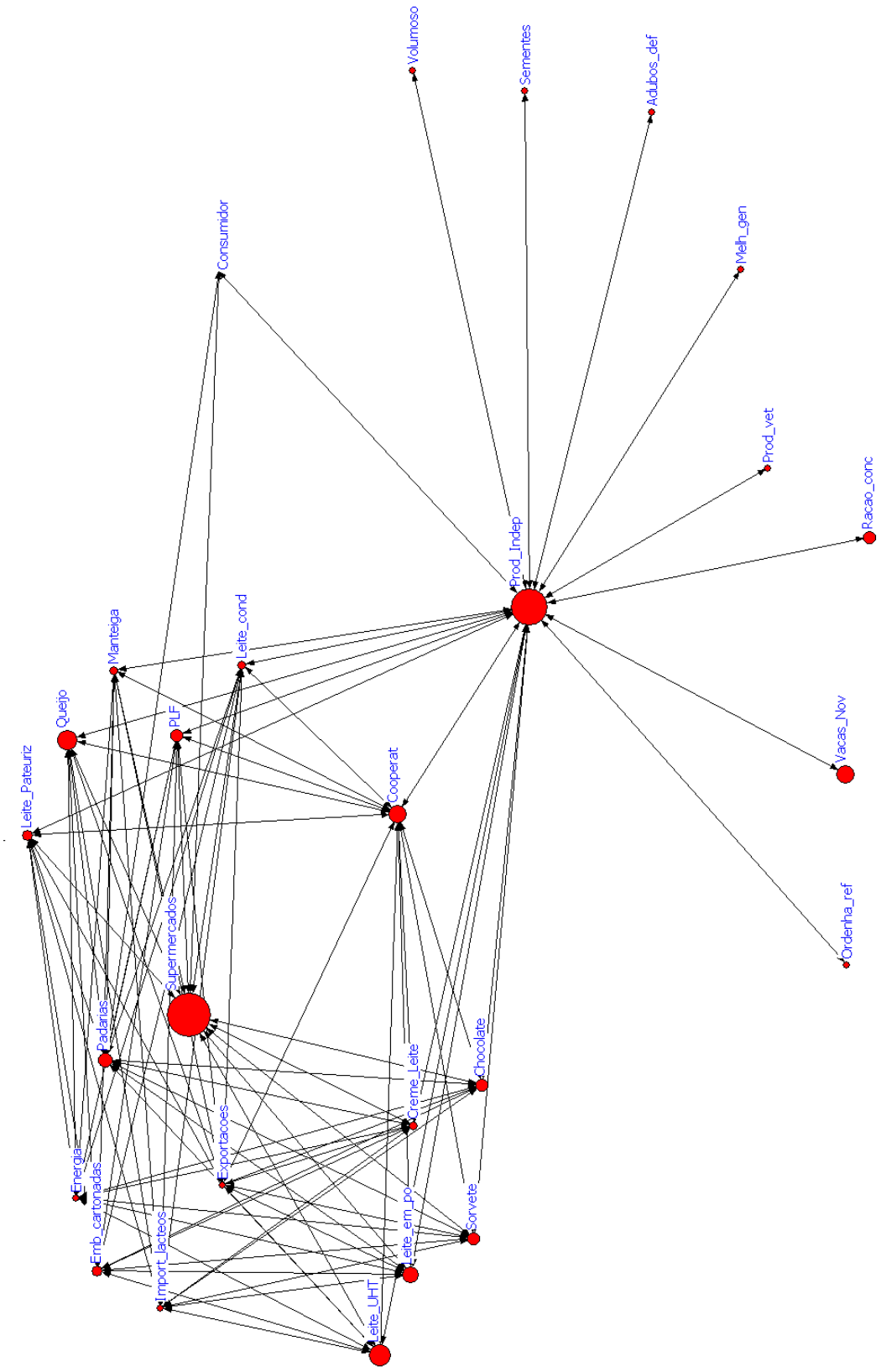

Figure 2. Representation of the production chain in the form of collaborative network. Build using the software UCINET.

Cohesion properties of social network: One of the biggest corporate interests in network analysis is to identify cohesive subgroups of actors in a network. In structural terms, cohesive subgroups are subsets of actors that have relatively strong ties, direct, uncompromising, intense and frequent (Wasserman and Faust, 1994). It is argued that cohesive groups have their own norms, values, orientations and subcultures (Scott, 2000), being the basis for solidarity, identity and collective behaviour in a higher level between the actors within the group than with outsiders. This phenomenon is known as homophily (De Nooy, Mrvar and Batagelj, 2005). Measures of subgroups based on mutuality are attached to verify to what extent all the choices of people in a subgroup are mutual, forming cliques among the players. Click fundamental concept is to study the cohesion of subgroups, in which the graph theory offers a formal concept and precise. Click or subnet is a complete subgraph of three or more nodes in which all points are directly connected (De Nooy, Mrvar and Batagelj, 2005, Scott 2000, Wasserman and Faust, 1994). The software tool discovered a total of 20 clicks to be considered.

Properties reachability between the actors of the network: The reachability is an idea of alternative subgroup that takes into account the intermediaries in the social process. Therefore, cohesive subgroups, based on reachability, require that the geodesic distance between points is small, formalized the concept of *n*-click. An *n*-click is a subgroup in which the largest geodesic distance between two nodes is less than or equal to *n* (Wasserman and Faust, 1994), where n is the maximum path in which members of a click can be connected (Scott, 2000). Again using the UCINET software tool, we obtain the 3 *n*- clicks of the network under study, which were detected among the 20 initial clicks.

Clustering coefficient of the network: The coefficient group to be evaluated, is in a universe between zero and one, and shows the proximity between the actors of the network, the software tool UCINET responds with the value of 0,066.

DISCUSSION The network under study, based on the results obtained by processing the tool UCINET, lead to the following key parameters:

Density: 0.265;

Middle Distance = 1.883;

Deviation = 0.025;

Clustering coefficient = 0.066;

Number of groups (clicks) = 20;

Mean distance between groups (n-clicks) = 2.

These values indicate that the density of the network, which is calculated as the proportion of an existing trend, with the number of lines allowed, and thus may be between 0 (zero) and 1 (one), having only reached the value of 0.265 is therefore low. Since the average distance obtained (1.883) is thus taking only two intermediaries to contact that occurs between one organization and another. Analyzing the standard deviation shown by calculations (0.025) suggests that there is a trend of centralization of us around the groups and subgroups, much lower than the value of the average density

presented by the network. Regarding the grouping of the network, it is observed that the coefficient of 0.066, suggests a considerable distance between the actors, which also indicates a group of decentralized organizations. In order to reveal the number of ties an actor has with other actors in a network, considering their relationships (links) adjacent, we have measures of centrality of the actors. The values determined by the tool were:

Centrality degree: 54.46%; Centralization proximity = 57.40% and; Centralization intermediation = 54.90%.

The values obtained by the network in this question shows that the network is sparse, but may be considered to be well established, with significant relevance in the area of the network focused on the actor independent producer and actor in "cooperative", but there is much space for the maturation process. Addressing the groups in the network, the exploitation of clicks, the tool we have revealed the existence of a total of 20 groups that occur naturally overlap between the actors (organizations), in which we deploy the agents involved in more than one group, as the case of the actor "cooperative". The average distance found between the groups is equal to 2, which indicates the need, on average, to locate two actors of the network, so you can locate any of the twenty groups identified.

CONCLUSION. It was observed that companies in the agribusiness producers in general and exporters of milk in particular, have network organizations that are more likely to gain sustainable competitive advantage. The network studied involves the participation of various organizations from different contexts, aimed at different goals in a wide variety of formal and informal interactions in parallel. We identified some agents representing a superior relevance and centrality in the interaction and intermediation among the agents of the network. The network has a total of 20 groups, with the overlap of some agents. However, looking at the composition of the groups it shows that they are formed by different organizations with different goals and structures. This research contributed to quantify the structural analysis of the network, with a better understanding and recognition of the network structure of milk production in Brazil.

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