

Full Length Research Paper

Relationship in the production chain of apple in the perspective of complexity theory

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This work was built from the necessity of understanding how relationships occur between members of the apple production chain to propose mechanisms that can assist in improving the inter-relationships. Thus, the ring tetralogical approach was used in the identification of actions arising from the implementation of IPM (integrated pest management) in the apple production chain in the states of Rio Grande do Sul and Santa Catarina. This is a qualitative research, operationalized through a case study which was conducted from interviews with expert members of the Brazilian apple production chain. Data analysis provided evidence of the results as: identification of the ring tetralogical concepts in the implementation of the integrated production of apple, verification of the supply chain strategies used by apple as a guiding system and the presence of relationships in the actions and attitudes they bring to the system. As such, they need to work towards the behavior of cooperation and teamwork, besides the necessity of a reorganization aimed at achieving the certification process by the link wholesalers and retailers, as well as consumer awareness to end the requirement quality control at the time of purchase.

Key words: Production chain, complexity theory, ring tetralogical.

INTRODUCTION

A supply chain is understood by all the activities it is composed of from pre-production to consumption of the product or service. The study of complexity presented by this arrangement in relation to productive interactions among all members, as performed by the following actions taken to implement the production process, is a challenge to be faced. Studies in the production chain seek to define actions enabling the identification of opportunities and a better use of them. From the identification of opportunities, the propositions should be in making the supply chain more efficient in meeting the market demands and supply shortfalls of the needed links it contains and also of their end customers. Complexity theory may provide through their approaches a better understanding of the behavior of the components of economic and market trends in a chain. It may also assist

in developing actions that will bring more competitiveness to the system. It is not intended to replace the concepts of clarity, consistency and determination by ambiguity, uncertainty and contradiction, based on the need for coexistence, interaction and mutual work between principles (Morin, 2000).

This study addressed aspects related to the problem of complexity, based on the proposal of Edgar (1977), taking as a prism the theoretical vectors analysis listed, especially the circuit tetralogical. The research was performed with respect to different consistencies, working and accepting antagonism, complexity and contraditoria-lidade before disintegrating, interacting and reorganizing the system (Morin, 2001). The ring tetralogical makes a recursive relationship (mutual feeding) of the supplemen-tation (company, association and mutualism), competitor (competition and rivalry) and antagonist (free riding and vandalism), and it shows a view of the universe and a dialogue between terms, where every person calls the other, each needs the other to constitute an inseparable

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party, complement each other and are being antagonistic to each other (Morin, 2000).

The central question revolved around the study of how the assumptions of the complexity theory can guide the productive chain of the apple in the states of Rio Grande do Sul and Santa Catarina in reducing the relationship conflict between its members. The main objective was to present mechanisms that can guide the productive chain of the apple, from the theory of complexity, in the states of Rio Grande do Sul and Santa Catarina in improving relationships between its members.

THEORETICAL SUPPORT

Integrated production of apple

The productive chain of apple in the state of Rio Grande do Sul was the first to be certified by the seal of the 'integrated production of fruit'. This certification was because this state has a large volume of fruit production in the country which can be grown in orchards that follow the rules of the PIF. For the development and deployment of the seal work between the Ministry of Agriculture, Livestock and Supply (MAPA), a partnership was contracted with the Brazilian Association of Apple Producers (ABPM), Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), Inmetro, National Council of Scientific and Technological Development (CNPq), Brazilian Support Service for Micro and Small Enterprises (SEBRAE) and universities and state research institutes (AGAPOMI, 2009). With the certification of the 'integrated production of fruit', the chain was traced from the growing areas to the end consumer. The PIF is an agricultural model that is based on sustainable resources and is characterized by being environmentally friendly, socially just and economically viable. Specifically, in the apple, there was a significant reduction in the use of pesticide in orchards. As such, employment fell by 67, 67, 25 and 15% of herbicides, acaricides, insecticides and fungicides, respectively (AGAPOMI, 2009).

According to the socio economic atlas of Rio Grande do Sul (SCP RS, 2009) this state is the second largest producer of apple, with 327,068 ton representing 36.42% of the total production in the country, along with Santa Catarina, which accounts for 95.26% of the Brazilian production. The region of Campos de Cima da Serra is the largest producer with 67.7% of the total production (221,347 ton). Highlighting the municipalities, Vacaria had 43.45% of the total production (142,113 ton), along with Caxias do Sul (66,773 ton) and Muitos Capões (29,000 ton) (SCP RS, 2009).

In Brazil, the first fruit system was certified on the apple that received the 'integrated production of apple' (PIM). Currently, there are seven certified fruits (apple, mango,

grapes, papaya, cashew, melon and peach). The PIF is a modern system for fruit and other agricultural products which, according to permanent controls, leads to the production of plants with safety features for the consumer, the producer and rural workers, and also ensures the preservation of the environment (EMBRAPA, 2009). The term 'integrated production' was formed in Europe in the 1970s and is a strategy being used, from the concern about integrated pest management, to rationalize and reduce chemical use and sustainability of growing fruits. The consequence of this proposal is the creation of working groups with experts from different countries, aimed at getting the definition, scope and organization of the 'systems integrated fruit production', which is the first target of these studies. In 1989, a regulation that has been accepted and acknowledged by the International Organization for Biological Control of Pests (IOBC) was established (EMBRAPA, 2009).

According to EMBRAPA, Uva and Vinho Bento Gonçalves 'integrated production system' has some basic features such as: (a) Definition of a document on the standards for the integrated production, and consequently, on the practices to be followed in each culture.

(b) The set among the registered pesticides, which are allowed, are restricted and prohibited. Also, when recommended, it establishes the dose and position in which it allows its usage. (c) The Ministry of Agriculture and regulatory institutions of quality define the conditions under which one obtains the integrated production of fruit. As such, they must accredit private or public entities, not bound by the producers, to qualify as certifiers. These companies work directly in the orchard, checking compliance with the standards of culture. (d) The charge on the farm, which is voluntarily decided by the use of this system, where one could sign a contract with a certifying company, pledging to adopt and receive periodic training, complete records of all routine activities in the production area, accept control certification of compliance with the standards and provide samples for analysis of pesticide residues, whenever required. (e) At the end of the season, the process of each producer is analyzed and any deviation from the standards means the system is shutdown.

The producers with full compliance of the standards, documented by field notebooks, inspection visits and results of satisfactory testing, receive approval of the market products checked-in with the harvest seal. The aforementioned advantages of the integrated production of fruit and their feasibility for adoption in Brazil, demonstrated by working with the apple, made research institutions and education in the country to accept and adopt this system of production as an alternative to other cultures. Thus, we study now the standards for integrated production of grape and mango in the Valley of San Francisco, citrus, papaya, coconut and wine grapes

(EMBRAPA, 2009).

The gain in competitiveness that the fruit has an integrated production, as well as the advantages to preserving the environment for human health, has made the Ministry of Agriculture to prioritize activities related to research and development of an integrated production and all necessary support for the actions of regulation and organization of the integrated fruit production in Brazil (EMBRAPA, 2009).

Complexity theory

The understanding of complexity can be seen as a kind of thinking that articulates the necessary and inter-dependent relationships involving all aspects of human life, and make an integration of all modes of thinking, as opposed to simplistic and reductive mechanisms. According to Rebelo (2004), the detailed studies on the complexity theory started in the 1960s and 1970s, but its roots date back to 1956 when, Heinz von Foerster, along with Ross Ashby, Warren Mc Culloch, Humberto Maturana Gordon Pask and others from the United States, explored themes such as circular causality, the self-referential considerations and the organizing role of chance. However, its distribution was based on studies developed by mathematicians and computer scientists, physicists and chemists, such as Murray Gell-Mann and Ilya Prigogine (Nobel Prize winners) for great expression. Also, its distribution was also based on the studies of other scientists such as Stuart Kauffman, Christopher Langton and John Holland (Santa Fe Institute in New Mexico), researchers at the Center for Complexity Studies, University of Illinois, and Brian Goodwin (the Open University in the United Kingdom) (Rebelo, 2004).

The science of administration gave rise to a rapid progress in the twentieth century, focusing on the deterministic systems of ideas towards a major product, such as social and human development based on economic rationality and advanced technologies to the detriment of human beings, subjected to their own lives (Erdmann, 1995). The complex line of thinking proposed by Morin (2000) is understood through the concepts of order and disorder. The concept of order goes beyond the bases of stability, rigidity, repetition and regularity, which is a union with the concepts of interaction and recursive disorder, governed by two poles: one objective and one subjective. Moreover, the concept of a self-organized complex refers to "the chain of relationships between components or individuals that produces a complex unit or system, endowed with qualities unknown to the components or as individuals (Morin, 2002)." Concerning self-organizing system complexity is the association of ideas of unity and multiplicity, which normally repel each other, and is mutually exclusive. According to Morin (2002), one cannot

reduce all the parties or the parties as a whole (not one to multiple, or multiple to one). Complex adaptive systems strand of the complexity theory approach have a kind of dynamism that enables them to actively respond to what happens around them, making them qualitatively different from static objects. According to the theory of complexity systems, constant oscillation between the tetragrammaton is presented by Morin (1977) as order / disorder / interaction / organization.

The term complexity refers to the idea of something "messy, complicated and intricate" (Ferreira, 1998), and according to Morin (2001), "the word complexity does not have a noble heritage of philosophy, science or epistemology, but supports instead a heavy semantic load, because it carries within it confusion, uncertainty and disorder." The origin of the word 'complexity' comes from the Greek word *complexus*, which means "weaving together". From a structural standpoint, the idea of complexity is associated with "a set of heterogeneous constituents inextricably linked" and the point of view of the process that can be understood as a "tissue of events, actions, interactions, feedbacks and chances determinations that constitute our world" (Morin, 2001: 20). The complexity issue has important aspects to be considered, for example, the relationship to systems theory, and the discussion of the organization as a complex system originated general systems theory, circulated in the 1960s (Anderson, 1999). Thus, studies of the development of a complex body of knowledge applied to management should position themselves in relation to general systems theory, setting forth the key commonalities, differences and complementarities (NETO, 2008).

Morin (1990) presents complexity in the company, by the example of a simple tapestry industry, which reports that a company in one piece is more than the sum of the parts that constitute it. Thus, the complexity when applied to management in organizations can not fail to consider both the fundamentals of the perspective (s) of science (s) of complexity as the contributions for a more complex thought. Thus, the whole company is not the simple sum of its parts. This complex form of thinking about 'part-whole' influences the study of science in general and is been applied to organizations. Such thinking makes organizations have actions for the future, and delivers bold choices for developing their strategies in building long-term planning and carrying out quantitative measurements of their actions with detailed control of them. Complexity theory offers another perspective to answer the many questions which arise for contemporary organizations. The new form of scientific thought brings a new alternative for the understanding of society seeking to join events that were treated in a piecemeal fashion. Thus, this perspective studies the world as a process of flux and change with the same components, making

endless combinations.

Studies conducted by Erdmann (1995: 3) show that the complexity and plurality of social life is not a single reality. Apprehending the social heterogeneity and complexity far exceeds the use of cutting mechanisms and the identity of life and their fertility. Complexity is seen as logical thinking, but that does not separate the fact that it unites the necessary relationships and interdependency with all aspects of human life, which is an idea of integrating all modes of thinking. "It is opposed, therefore, to the mechanisms of reductionist and simplicity, and it considers the influences received from the internal and external environment, thereby coping with uncertainty and contradiction, and living with the solidarity between the existing phenomena" (Morin, 2000). For Morin, complexity has always existed and is continually expanding, showing where the simplifying thinking fails.

The process of interaction in the relationship

The interaction process through customer and supplier relationships are made up of episodes that influence the organizations and are influenced by the organizations (Turnbull et al., 1996). These relations do not form a collection of independent, isolated transactions, but are the result of actions and reactions during the complex negotiation process (Ford et al., 1998). The forms of relationships have a history and a future where every event of interaction must be analyzed within the context that happens to be well understood (Håkansson and Johanson, 1992; Easton and Araújo, 1994). The relationships between firms have characteristics that must be analyzed because all are influenced by their own acts and the attitudes of other members and companies (Ford, 1990; Ritter and Ford, 2004). The characteristics of the relationships are identified over time, away from the idea of a transactional model, based on discrete exchanges that are independent with no time projection (Easton and Araújo, 1994). Håkansson and Snehota (1995) relationships have high complexity and intensity in relation to the purpose and contact patterns, number and diversity of people involved, and in continuity, duration of relationships, symmetry and informality.

Håkansson and Snehota (1995) underscore the importance of the interaction partners, which are fundamental to conflict resolution and management of the actions taken by companies, being that this interaction also facilitates the cooperation that the second (Easton, 1992) action is an important tool to be used by actors to achieve common goals both as different goals. Thus, the relationship can not be imposed, because it is necessary that they engage each stakeholder in order to make it strong and to help with the ultimate goal, and also, the views of each participant can determine the development,

stagnation or approximation of the actors according to their commitment, expectations and relational attitudes (FORD et al., 1998).

To Blois (1998), Ford et al., (2003) and Snehota and Håkansson (1995), firms have relationships, but there are no homogeneous relations, requiring therefore that there is a union of these goals which can happen in ways of relating to a higher level of commitment, trust, loyalty and reciprocity. In this sense, Turnbull et al. (1996) assume that there must be an understanding of the nature of relationships and as such, their quality should not be judged, because each relationship has its own peculiarities and characteristics that result in the development process of interaction and also in the goals which each company has engaged in a relationship.

Håkansson (1995) presented a model that formulates the integration between the participants of a relationship, and thus reports that actors (individuals, groups or organizations) are playing their activities and controlling their own resources. Each actor needs to maintain its identity, which is a result of their activities and resources. The performance of each actor depends on the activities he performs within the network of relationships and the connections that he establishes with its partners. As such, these links do not depend only on the will of each one, but on the will of every one of them. He may know what actions needed to be taken and also the actions of other actors. However, he must be found with the right partners that there is harmony between the activities performed by each participant in the relationship (Ford et al., 1998).

Relationships between members of the production chain

Production chain can be considered as a network of labor and production processes whose end result is a commodity (Gereffi and Korzeniewics, 1994). In view of Gereffi (1995), to understand a supply chain is necessary to investigate not only their performance and economic characteristics of each link, but the pattern and nature of relations within and between each of these links. If the supply chain is understood as a set of cooperative relationships that goes beyond the simple relationship of sale and that of the analysis of the relationship between demands, the examination of these companies is between employers and employees. So, it is relevant for studies to highlight the work relationships within a production chain (Gereffi, 1995).

According to Peppers and Rogers (1997), a strong relationship will be considered when the exchange takes place between the company and the client who offer opportunities to grow and endure, in order to resist forces that might damage that relationship. Strong relationships

characterized by trust, commitment, reciprocity, alignment and dialogue should be with two hands and it must meet the company's expectations with regard to the client (Grunig, 1992). The development of customer relationship undoubtedly increases the retention of the customer (Dwyer et al., 1998). The practice of keeping close contact with the client establishes an idea of having positive results for both sides (a logic of the win-win relationship). Retailers also can collect data from their customers and take advantage of these data over the applicability of the message content to the current needs of the client. The use of specific information to customize the content of communications has a significant impact on the strength of the relationship. The effect can be seen in various types of communications, including offers on services, pricing information and proposals for partnerships (Peppers and Rogers, 1997).

On the other hand, the data collected from customers are used improperly to decrease the strength of the relationship. The frequency of customer communication has fundamental importance for the strengthening of the relationship, but the contact is done excessively and may annoy the customer. Then, there must be a balance. There is a great opportunity to improve the level of the individual's relationship and collective manner with the client, regardless of the situation that the company is simply creating a competitive edge, which will bring strengthening to the relationship.

Strategies in the supply chain

The survival and success of the company depends on a number of choices and strategies that it designs. These strategies are responsible for the evolution and expansion of the competitive landscape and the quality of its service (Albrecht and Bradford, 1992). Therefore, it is necessary to develop a strategy to define and explore the company's strategic position, which is distinct from its competitors, while continually seeking new positions allowing the company to take advantage of emerging market opportunities. Moreover, the company needs to protect itself from threats that could weaken its market power (Thompson and Strickland, 2003). To Prahalad and Hamel (1998), the ability to adapt quickly to opportunities is the source of competitive organizations. The faster, the company understands the new landscape and its stand on it, the greater the chances of success.

In the production chain, greater emphasis should be given to the final consumer, and it is from these emphases, that the strategies are constructed in order to satisfy their needs and desires. Going this way, the production chain follows a logic that starts in its last element and they decide what changes need to occur in the system, but any change in the existing chain will only be

sustainable if it is recognized by consumers as a differential to ensure that the balance will be maintained (Battle, 1997). The relationships between the production chains are seen as strategic elements and then how the physical and financial resources are managed and the information that flows throughout the chain become decisive factors for the success of all. The action of a benefit for all leads to competitiveness once it is seen that there is synergy between the members (Carvalho and Laurindo, 2003).

Porter (1992) establishes the essence of a competitive strategy of building the company in relation to its environment, not allowing outside influences affect the company, but knowing how to skillfully use the forces presented by the external environment.

Regarding the competitive strategy, it is noteworthy that the relative position of a company in the chain is what determines whether the return will be high or low compared to the presented average, where a good position is able to bring good return even if the entire structure is unfavorable (Hitt et al., 2003).

Conflict in relationships

Social conflict arises when one party or both parties have divergent interests or notice, wherever these may be real, as it can often be only one interpretation of a part. The conflict is between people, states, organizations or groups. It is characterized by the divergence of interests, the belief of one or both parties that the events are not meeting the interests of the individual or the collective individuals (Mnookin, 1997).

For Mnookin (1997), conflicts have their origins in the beliefs and values of a negotiation feature. Factors such as scarcity of resources and competence can also generate conflicts as well as the definition that a party makes of the situation that presents itself and the value that is given to the bond or relationship.

Kennedy (1991) defines conflict as a reason to negotiate differing viewpoints, attitudes, interests, actions, needs, aspirations, intentions, hopes, rules, expectations, interests, and behavior solutions. Competition may arise for a scarce resource, which can be tangible (land, money, goods and services) or even intangible (power). Conflicts may be classified as irreconcilable conflicts, resolved through the "live and let live" or through the triumph of violence, decided between peace and war. It also has to reconcile the conflicts which are resolved through settlement, with a mediation, arbitration or negotiation. The decision is "to discuss or do business" (Kennedy, 1991).

The causes for the emergence of conflicts, according to Kennedy (1991) are in miscommunication, misunderstanding and through the use of an unfamiliar language, as can

be derived from structural factors, such as power struggles, conflicting or competitive rewards for scarce resources, or may have personal touch, by incompatible personality, values or goals.

METHODOLOGY

Objective and sample characterization

The study aimed to provide mechanisms from the theory of complexity that could guide the productive chain of the apple in the states of Rio Grande do Sul and Santa Catarina in improving relationships between its members. For the purpose sought to be reached was the understanding of the sequence of events that resulted in the implementation of the integrated production of apple (PIM), and has been made to identify the process that results to disorder and order, and the interactions that occurred between agents in the process and analysis of the organization resulting in the implementation of the order.

The research in their approach is qualitative and the approach describes the complexity of a particular problem, which is necessary to understand and classify the dynamic processes experienced in groups that contribute to the process of change, allowing for better understanding of the particularities of various individuals (DIEHL, 2004).

The study is exploratory and descriptive. The exploratory research is undertaken with the aim of providing an overview of the facts. Since the descriptive research is premised, it seeks resolution of problems by improving the practice through observation, analysis and objective descriptions (Gil, 1996).

Sample

The research consists of a set of elements (companies, products, people and units) that have the characteristics of the object of study (Vergara, 1997). The sample is a part of the universe that can be divided into two types: probabilistic and non-probabilistic. The first is based on random selection of respondents, while the second does not use any form of random selection (Lakatos and Marconi, 1982).

This study is a universal research of all elements that are part of the Brazilian apple production chain. The sampling procedure used in the study is an intentional non-probabilistic sampling, which, according to Lakatos and Marconi (1982), is one that arises from the need to investigate a part of the population chosen intentionally. Thus, the sample consisted of members or expert researchers in the production chain of the apple. The criteria used are intentional instruction and knowledge of the productive chain of the apple.

The instrument for collecting data and conducting interviews and data analysis

The conduct of the fieldwork was with the interviews and document analysis to collect data, such as to compose a case study. The inspiration for using the method came from the work of Yin (2001). He said the field research is the most realistic and uncontrollable analysis, and applying this methodology in this study is more appropriate. The questions were prepared, following the links in the tetralogical ring of Morin (1977), in the process of reorganizing the system in the face of nonlinearities, returning the order and identifying the other links in the ring. We sought to identify the characteristics of each stage:

a) Disorder: It is a time of instability that can be thought of as a starting point for an evolution towards a new order. Therefore, the disorder must be recognized and harnessed with their potential, because it is active, and their presence fuels the complex deviation with standard deviation, awakens dormant powers for regulating reproductive organs and resurface the eddies. However, new forms can only arise from the imbalance and disruption.

b) Interaction: This process can be regarded as the result of moving from the launch of reciprocal actions, associations, oppositions, communications, aimed at constructing areas of connection between subjects and between society and nature, where the elements that are isolated can be integrated from a complex view of oikos-polis-domus-ethos.

c) Organization: The organization corresponds to the implementation of integrated management of the disorder and outcome of the interaction, from dialogue and settings that assume the regulatory role of the dynamic process of a complex unit. With the organization, it should be implemented to have a new model in the object, both in relation to ways of being acting and being capable of generating combinations of heterogeneous elements into a whole. This will unite and transform the elements that are produced and fed back into the system. The attitudes and actions must come from principles to ensure that the organizations ordered the stay of all, keeping shape, existence, identity and the movement of transformation. In order to produce, transform and virtualize the disorder (entropy and latent antagonisms) that leads to active potentiality, these situations are used as the basis for re-organization.

c) Order: The order form is the standard and management system that is stabilized temporarily, by the action of the cohesive force of the rules and limits arising from interactions. This new form also points to the resulting need for constant interactions that will be able to signal changes in the various moments, keeps the reflective moments and re-evaluate the need for mentors to sustain the ring.

Besides the interviews, other sources were used for data collection. This step was important because it shows yet another form of data in the object of study, during interviews and direct observations in the member companies of the productive chain of the apple. As such, the following sources of evidence can be highlighted: (i) Interviews: chairman, director, executive manager, production manager, agronomist and consultants. (ii) Direct observation: orchards, packing houses and office. (iii) Documents: provided by institutions such as strategic planning, field notebooks, folders, magazines, newsletters and website companies, like AGAPOMI, ABPM, IBRAF and EMBRAPA.

The data analysis was done using the technique of data triangulation. The concept of triangulation comes from symbolic interactionism, developed by Denzin (1979), which means the combination and interweaving of multiple points of view, the task for researchers from different fields, the sight of several informants and the use of various collection techniques data during the investigation. Using this technique in practice allows for interaction, intersubjectivity and comparison (Denzin, 1979; Minayo and Sanchez, 1993; Minayo and Cruz-neto, 1999).

RESULTS AND FINAL CONSIDERATIONS

With these data, we were able to obtain the results that were presented in sequence. Respondents noted that the events that led the apple supply chain to implement the PIM were due to health and food safety for consumers, the environment and safety to the handler and removing

harmful elements and molecules present in the health pesticides; while from standardization, the use of field notebook and the control of chemicals in pesticides and grace period, modified the idea that the apple is a fruit that uses much poison, and so, not many people ate the fruit believing they could become contaminated. The strategies described by experts about apple, in relation to government incentives, are to overcome the country's high tax burden, improve the population's purchasing power and promote the union of companies to effect strong partnerships and competitiveness in importing raw materials from countries with lower tax burden than the union of producers to control supply of the product to stabilize prices during the year. The main differences highlighted by the experts in labor laws are in relation to the "welfare" of the government and in relation to manpower, turnover of skilled labor and low educational level and knowledge level of employees with secondary school results. Delay in making decisions, regarding government agencies, involved lack of interference from the government for exports. Another impediment is the adversity presented by climate, with heavy rain, or drought and hail.

In marketing, it appears that a lack of quality control for wholesalers and retailers do not comply with the standards of food hygiene. Also, it was highlighted that the lack of professionalism and poor financial situation of some producers, are facts that lead farmers to use such a large fluctuation in the price of fruit at the time of sale. Aiming to introduce mechanisms that can support the relationship between the various links that make up the production chain is that 'apple' had used a relatively new theory for studies in the area of administration that is the approach of 'complexity theory'. It is therefore important to replace or supplement the linearity of the mechanistic paradigm, underscored by the subdivision of shares which constitute the system and which seek to have the understanding and solutions to obstacles that are taken, using an approach that seek to involve all of the events and situations that comprise it. This quest for global may cause the results achieved to bring greater satisfaction and opportunities to operate the system. Morin notes that complexity is not the key to the world, but the challenge and complex thinking is not what prevents or suppresses the challenge, but it helps to reveal it, and sometimes even surpass it.

For Morin, 'complexity' occurs between order and disorder, and they establish mediation. The idea of interaction is the union of components and transformation, which may organize or disperse the elements; then, the organization arises from the interactions and transformations, while order and disorder are complementary, and competitors are uncertain, which according to Morin, is the logic of complexity. Regarding the identification of emerging non-linearities in the production chain of the

apple and presentation of the solutions to them, it was found that there is much to be worked on for the Brazilian apple production chain to become more competitive and get better results, taking into account the purposes of several members, especially small, medium and large producers. To achieve a sustainable production chain competitiveness in apple, one needs to know the best scenario, involving its members in decision making and in behavior toward cooperation, as well as resolving their embarrassment related government decisions.

The scenario analysis is an essential factor to explore different assumptions about the future, in that they provide a way of conducting complex environments, where many relevant trends and events interact and affect each other. The scenarios help in dealing with uncertainty, and can be an important tool for the supply chain management. Regarding the specific relationship between all links in the complex chain of the apple production, it is necessary to use dialogue at all stages. The interactions take place permanently and leave aside the behavior based on self-interest which can bring this system's supply chain, sustained competitiveness. The apple production chain must attack the problems in advance rather than just respond to them after its birth, presupposing the adoption of a proactive stance eminently and planning for the future by analyzing market trends to avoid simple reaction and especially, to avoid repeating what has always been done. However, this disregards the dynamic environments, markets and people. As the apple production chain is considered to be a more organized chain of the Brazilian agricultural sector, including serving as a model for other cultures, there is need to have members that are fully aware of their work based on a win-win, or a vision oriented mutual interest, without the use of devices that put some of the links in disadvantageous situations by actions, attitudes and procedures.

In this sense, it is necessary, as was reported by the specialists of greater professionalization of some components of the view that group work can be much more beneficial than isolated efforts and behaviors.

The apple production chain and complex system, through this study, made possible the use of complexity theory, specifically the identification of the ring tetralogical proposed by Edgar (1977). However, it is noteworthy that this theory is much broader than it was reported here, leaving the explanation to achieve the proposed objective of the theory, but it is important to say that it should only be used to identify an event, or a disorder, and it is necessary to use it as propositions of what is occurring in a single event. The implementation of an integrated production of apple, visibly brought to the productive chain of the Brazilian apple industry organization, a systematization of the production process and it contributes immensely to the control of agrochemicals and assist in

food security and safety of workers in the orchards. Using this range of technology in Brazil has advantages in the orchards with balanced production and productivity and reduces outbreaks of serious pests and diseases. However, the way was made during the conduct of the implementation of PIM that experts provided a valuable learning teamwork which serve as both a continuation of this system that has provided many advantages to the production chain and as new experiences that are necessarily keeping the system updated and serving as support for production.

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