



## EVIDENCES OF THE SUSTAINABLE INNOVATION IN THE CASHEW AGRIBUSINESS CONTEXT IN CEARÁ – BRAZIL

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## ABSTRACT

The state of Ceará is the major Brazilian cashew producer and highlights the social and economical feature of its agribusiness, capable of generating wealth and assisting in people's settlement in the countryside. Despite the support of several organizations which compose the local innovation system, seeking generation, adaptation and diffusion of innovations, the productive chain of cashew agribusiness lacks of innovations. In that context, it is assumed that the "sustainable innovation" would appear from the social-environmental management, stimulating, consequently, the local system. Based on this discussion, this paper contributes on the identification of innovation possibilities through the introduction of the Cleaner Production approach, contemplating on the mobilization of local system of Ceará's cashew agribusiness. The qualitative methodology is based on the documental compilation and in interviews/debates with a group constituted by specialists who work in the sector. The analysis was performed using the Thematic Analysis technique, which belongs to the Analysis of Content techniques group. It was verified that the local system mobilization includes the increasing of interactions among participant agents, facilitating the spread of sustainable innovations from the complete use of cashew, enlarging, consequently, the economical spaces with new business and market opportunities.

## KEYWORDS

Sustainable innovation; Innovation local system; Agribusiness; Cashew productive chain; Cleaner production.

## 1 INTRODUCTION

The cashew agribusiness in the Northeast of Brazil has great socioeconomic importance to the country due the explored area, the amount of employed people and the products destined to export. The numbers demonstrate that more than 90% of the production is concentrated in the states of Piauí, Rio Grande do Norte and Ceará (FIGUEIRÊDO JÚNIOR, 2008). The state of Ceará, being the major Brazilian cashew producer, is articulating a group of actions on behalf of the local system organization, by introducing innovations, seeking the development of the cashew agribusiness productive chain. This chain supplies an industrial park, constituted by the social technologies of mini-factories and small, medium and large companies (LEITE, 1994; FRANÇA et al., 2008).

Despite the support of the several organizations which compose the local innovation system, such as universities, centers and research and development laboratories (R&D), government funding agencies, governments and company associations, seeking the generation, adaptation and diffusion of innovations for products improvement and processes upgrade, the cashew agribusiness productive chain lacks of innovations (LUNDVALL, 1992; BELL; PAVITT, 1993). The low competitiveness of the companies is becoming a threat not only for the own companies, but also for the productive chains, which are dependent of traditional products. A challenge, therefore, is how to make the companies create and/or use the knowledge to innovate (FRANÇA et al., 2008).

Taking into account the evidences, according Oliveira and Ipiranga (2008), that the cashew agribusiness specialists of Ceará, who participate in Agropacto (Pacto de Cooperação da Agropecuária Cearense – Cooperation Pact of Ceará's Agriculture) (2008), just a few discussed the matters of sustainability, above all, with the integration of these to the innovation practices in the ambit of the productive chain.

Now the concern with sustainability is at prominence position in the innovation calendar, in which the concept of “creative destruction” developed by Schumpeter (1997), receives a new look when thought together with the sustainability. The innovative process vision is enlarged to adapt and to involve not only the economical performance, but also, the environmental and social ones (TIDD; BESSANT; PAVITT, 2008; ALMEIDA, 2007).

Berkhout and Green (2002) identify limitations in the literature about innovation when the theme is related with the sustainability. They propose the idea of the “management of sustainable innovation”, by pointing out that not much has been made in the literature on business and environment, environmental management and environment politics, to systematically explore the

concepts, theory and empiric evidences developed in the last three decades of study about innovation.

The social-environmental management, by adopting approaches and tools such as Produção Mais Limpa (Cleaner Production) or PML, which acts in wastes elimination, reduction and consequent reuse of generated residues in the productive process, can appear as innovation source for participant companies of productive chains (LEMOS, 1998; GASI; FERREIRA, 2006; NASCIMENTO; LEMOS; MELLO, 2008; CHRISTIE; ROLFE; LEGARD, 1995).

In this context, it is assumed that the “sustainable innovation”, when connecting the environmental dimensions with those economical and social ones, would appear from the implementation, in the ambit of the participant companies of the productive chain, of a social-environmental management approach, such as PML, consequently mobilizing the local system. Based on this discussion and focusing the participant companies of the cashew agribusiness productive chain, this paper objective is to identify the generation and diffusion possibilities for sustainable innovations by the perspective of the PML approach, contemplating on the mobilization of the local system of Ceará’s cashew agribusiness.

This work is composed by a theoretical reference, articulating the themes of productive chains and local innovation systems; the kinds and spaces of innovation and the management of sustainable innovation starting with the introduction of PML approach. Then the adopted methodological resources are presented. Later the analysis and discussion of the results are presented. Concluding, there are the considerations and references.

## **2 PRODUCTIVE CHAINS AND LOCAL INNOVATION SYSTEMS**

The concept of productive chain comes from the premise that the production of goods can be represented as a system, where the several agents are interconnected by flows of materials, capital and information, aiming at to supply a consuming market (CASTRO; LIMA; CRISTO, 2002).

The “agribusiness” concept was developed through the 1950’s, being this introduced in Brazil with the Portuguese denomination of “complexo agroindustrial” (agro-industrial complex), “negócio agrícola” and “agronegócio” (both expressions translated as agribusiness), defined not only related to what happens inside the limits of the rural properties, but also in what concerns all the interlinked processes that propitiate the agriculture products supply to their consumers (ZYLBERSZTAJN, 1994; BATALHA, 2008).

However, the agribusiness concept is very wide and not always appropriate to the formulation of sector strategies, mainly when it is promoting the technological management or the management of innovation and development. Therefore, the concept was developed additionally to create system models dedicated to the production, which incorporate everyone involved in the productive process. The concept of productive chain appeared this way, as a subsystem (or systems inside systems) of agribusiness (CASTRO et al., 1996).

The first works applying the focus of the productive chains appeared in the 1980's, having been thoroughly expanded in the 1990's. The development of consistent analytic tools also contributed to this expansion, basing the systemic focus of the productive chains in studies and development projects, increasing the understanding, the intervention and the management in the agribusiness performance (CASTRO; COBBE; GOEDERT, 1995; CASTRO et al., 1998; ZYLBERSZTAJN, 1994; BATALHA, 1995).

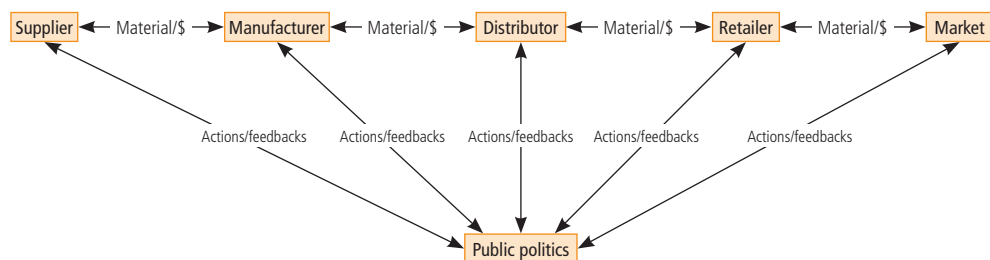
Among these contributions it is evidenced the one of Lambert, Cooper and Pagh (1998) who propose the concept of Supply Chain Management (SCM) as being the integration of the processes of a productive chain, from the origin point to the consumption, with the objective of supplying products, services and information with value aggregate to the customers and other interested parts (stakeholders) involved along the chain.

The analysis of the productive chains can be based on three different factors: the technology, the markets and the products. The static vision of a productive chain is defined by the overlap of those three factors. On the other hand, the dynamic vision is obtained by the simultaneous consideration of those three elements along time. Any modification in one of them can directly affect the others. To facilitate the global analysis of a chain, its scope should be divided in two levels, one of them linked to its main objective and other about indirect and auxiliary activities. Ultimately, the final consumer market is what will determine the characteristics of the products to be offered. Those preferences affect the other components of the productive chain, including the local productive systems and the correspondent natural systems (SOUZA; KLIEMANN NETO, 2002).

Adapting a model of Corrêa and Corrêa (2004), Figure 1 presents a generic productive chain. The main links of a productive chain are: Supplier; Manufacturer; Distributor; Retailer; and Market. Exchanges of materials by financial resources are accomplished among them. It is worth to point out that the link identified as "Public Politics" can act previously in any of the links mentioned. In this case, a two-way relationship is verified, containing actions and feedbacks.

FIGURE 1

## GENERIC PRODUCTIVE CHAIN



Source: Adapted from Corrêa and Corrêa (2004, p. 116).

## 2.1 THE LOCAL INNOVATION SYSTEMS

In Knowledge Economy, the collaboration networks are spaces through which the interorganizational interaction generates a favorable context for creation, sharing and use of knowledge, involving aspects such as articulation, cooperation, flexibility and interdependence among organizations, reinforcing the effectiveness for the participants to reach a larger level of competitiveness by relationships management (CASTELLS, 1999; BALESTRIN; VARGAS, 2004).

Lundvall (2002), considering the innovation as product of interaction among a group of agents, distributed in several institutions and different places, emphasizes the need to closely integrate this knowledge base, interactively developed and shared in networks, with learning and innovation processes. The participant organizations of networks innovate not only processing information “from outside to inside”, with the intention of solving the existent problems and to adapt to the changing environment, but also, creating new knowledge and information “from inside to outside”, in order to redefine not only the problems but the solutions and, in that process, recreate its environment (NONAKA; TAKEUCHI, 1995).

In this context, Lundvall (2002) points out that the learning process is socially linked and the initiative of organizations and institutions are decisive for the appearance of interactions and exchange. To learn and innovate depends on implied knowledge, located and cumulative, being the innovation and learning capacities strongly rooted in the social, institutional and productive structure of each area or country in which they can be found. For instance, in gatherings of small and medium interlinked companies along productive chains (LOIOLA; RIBEIRO, 2004).

According to Lundvall (2001) the public politics have a different and important role in this context, when they act on the formation of companies and institutions networks, gathering the several parts in smaller activities, in a cooperative way, so those can begin a “mutual support” work.

This perception on the systemic and complex nature of innovation opposes to the traditional notion, characteristic of the so-called “linear model”. This linear model establishes a well defined sequence which begins with the basic research activities and ends in the adoption of new products and processes in organizations. In the systemic approach, the innovation is not faced as an isolated phenomenon in the time and space anymore. It becomes considered as the result of cumulative and historically built paths, in agreement with the institutional specificities and economical specialization patterns inherent to a certain space or sector context (VARGAS, 2002).

## 2.2 KINDS AND SPACES OF INNOVATION

Bell and Pavitt (1993) affirm that the technological change involves two main activities: the first one refers to the generation, development and commercialization of significant innovations; the second one is based on the application of those innovations in the productive and economical processes, being this activity known as diffusion of innovations.

In the words of Vasconcelos (2001) the “innovations” – while transformations of a discovery in a new practice – can be seen as re-configurations of economical activity systems and change of roles between the economical actors, when they interact in value creation systems. The author distinguishes between the “micro-innovations” and the “macro-innovations”. The first ones are “increasing innovations” and they link to the efficiency of current operations, being important to reach operational gains and provide continuous improvements in production systems. The “macro-innovations” look for alternatives for the future, being fundamental for allowing qualitative jumps in productive systems, in competitive positions of companies and in configurations of relationships network among economical actors. This last one is considered as “radical innovations” which create a new configuration of economical actors. They are linked to the creation of qualitatively new values and they imply in the constitution of new actors networks, which collaborate on creation of value constellations.

This discussion on the different kinds of innovation is connected to the concept of “economical spaces”, in which applications of new ideas and methods in the economical sphere result in dilation of existent economical space. These are motivated by the perception of market opportunities, transformed in earnings by economical agents (BURLAMAQUI; PROENÇA, 2003).

It is emphasized that the innovative “economical spaces” do not just refer to the scientific development or demand for new technologies, being delineated the spaces also expressed by Schumpeter (1997) in five main situations: 1. the introduction of a new good albeit the consumers are not still familiarized or the introduction of a new kind of good already existent; 2. introduction of a new production method still not tested, without the need of being based on a scientifically new discovery; 3. the opening of a new market, whether that market has existed or not; 4. the conquest of a new source of raw materials supply and other inputs, independently of the existence of that new source; 5. establishment of a new organization of any industry.

## 2.3 THE MANAGEMENT OF SUSTAINABLE INNOVATION

Berkhout and Green (2002) identify limitations in the literature about innovation when the theme is related with the sustainability. There are studies approaching the use of environmental technologies and social technologies separately, without an integration perspective through concepts as sustainable development or sustainability. Jabour (2007) indicates, for instance, a terminological and conceptual diversity for terms that relate environmental aspects in the technological development.

The concept of “management of sustainable innovation” is proposed by Berkhout and Green (2002) when they point out that little has been made in the literature on business and environment, environmental management and environment politics to systematically explore the concepts, theory and empiric evidences developed in the last three decades of study about innovation. It deserves prominence the work developed by Daroit and Nascimento (2004), which presents a framework pointing out the integration of economical, social and environmental dimensions to the process of generation of innovations.

The concept of creative destruction, developed by Schumpeter (1997), receives a new look when thought together with the sustainability. The innovative process needs to have an enlarged vision to adapt and reach not only by its economical performance, but also, the environmental and social ones (ALMEIDA, 2007).

According to Tidd, Bessant and Pavitt (2008) the concern with sustainability is at prominence position in the innovation calendar. Berkhout and Green (2002) suggest that some proposals are presented as a way of associating sustainability research to research about politics, business management and innovation, besides overcoming the limitations found in the literature.

Thus, the proposal is that the analysis object reflects on the technological systems or regimes as well as in its evolution, instead of its management, based



on the assumption that innovation is consequence of combination of technological opportunity and the need of market, being still recommended the inclusion of social concerns. So, the business sustainability is involved by social attitudes which constantly change, generating an opportunity to the appearance of an innovation. This will just be able to adapt the business to patterns demanded by society or generate a new level of perception of social attitudes (TIDD; BES-SANT; PAVITT, 2008; BERKHOUT; GREEN, 2002).

Sustainability comes as a potential opportunity for the appearance of new markets, besides already challenging the existent ones. This way, it was chosen to use the concept of “management of the sustainable innovation”, proposed by Berkhout and Green (2002), seeking for an amplification of the perception of innovations generation related not only to the environmental and economical dimensions, but, also including those social ones.

### **3 THE SOCIAL-ENVIRONMENTAL MANAGEMENT AND PRODUÇÃO MAIS LIMPA (CLEANER PRODUCTION) – PML APPROACH**

Produção Mais Limpa (Cleaner Production) – or just PML approach – stands out among the several approaches of social-environmental management. It was developed in the beginning of the 90's by United Industrial Nations Development Organization (Unido) and United Nations Environment Programme (Unep). It presents as main objective to minimize or eliminate the wastes commonly found in the productive processes: the waste of raw materials and the waste of energy.

In 1994, national or regional centers were created for the diffusion of that proposal, which were denominated National Cleaner Production Centres (NCPCs). After 10 years of Unido-Unep's Cleaner Production Program operation, it was verified that it was operating at 31 countries and with 22 NCPCs, including Brazil (UNEP, 2006; GASI; FERREIRA, 2006; BARBIERI, 2007; NASCIMENTO; LEMOS; MELLO, 2008).

According to Unep/Unido, PML approach consists of a preventive and integrated environmental strategy, applied in a continuous way, in productive processes, products and services, looking for reducing the important risks to people and the environment. The practices of PML can be small or large, since the adjustments accomplishment in the productive process to the acquisition of complex technologies, generating innovations when unchaining changes in

the processes, products and management forms of the companies. These changes propitiate the adoption of preventive approaches of pollution, instead of “end-of-pipe” approaches (GASI; FERREIRA, 2006; NASCIMENTO; LEMOS; MELLO, 2008).

The adoption of PML by an organization suggests some stages to be followed seeking a better understanding and assimilation of the concepts and practices approached. The implementation stages of PML in Brazil follow the orientations of Brazilian NCPC, which acts as a facilitative instrument for spreading and implementation of PML in all the sectors and productive chains (NASCIMENTO; LEMOS; MELLO, 2008).

The program developed in Brazil consists of an adaptation of the Unido/Unep program and Stenum Consulting’s experience. Stenum Consulting is based in the city of Graz, Austria, and developed the Ecological Project for Integrated Environmental Technologies, so-called Ecoprofit. It presents, as a main goal, the economical invigoration of the company through pollution prevention (LEMOS, 1998; NASCIMENTO; LEMOS; MELLO, 2008).

It is also pointed out that the decision of implementing PML can be associated to the manager’s entrepreneurial characteristics that consider it as generating of new businesses and innovations opportunities, seeking to obtain competitive advantages and sustainability. Besides, the implementation can also be related to the connections between the commercial objectives and the politics referred to the environmental subjects and of social responsibility of the company. These politics impel the adoption and implementation of PML, propitiating, finally, the innovation generation in the participant companies along the productive chains (CHRISTIE; ROLFE; LEGARD, 1995).

In 1999, National Center of Clean Technology (Centro Nacional de Tecnologias Limpas – CNTL), Brazilian Service of Support for Micro and Small Enterprises (Serviço Brasileiro de Apoio às Micro e Pequenas Empresas – Sebrae) and Brazilian Business Council for the Sustainable Development (Conselho Empresarial Brasileiro para o Desenvolvimento Sustentável – Cebds) began to work together, promoting the sustainable development in micro and small companies, spreading the practices of PML and eco-efficiency with the increment of two subjects in the adopted PML model: the organizational management and the behavioral aspect. These actions would act as tools to increase competitiveness, innovation and environmental responsibility at the Brazilian productive sector. This way, the stages of PML were increased, involving: 1. planning and organization; 2. diagnosis; 3. measurements and definitions of indicators; 4. study of technical, economical and environmental viability; 5. implementation and continuity plan (NASCIMENTO; LEMOS; MELLO, 2008).

## 4 METHODOLOGICAL PROCEDURES

This is a descriptive-exploratory research, characterized by its qualitative nature. It used the bibliographical and documental research, seeking to know the primary and secondary sources that approach the theme and the problem explained at the theoretical reference (MARCONI; LAKATOS, 1999).

The field research was divided in two stages. In the first stage, the non-systematic and non-participant observation was used, visiting the reality of the productive chain of Ceará's cashew agribusiness, with the intention of picking information on the studied sector. In the second stage, a semi-structured interview guide was used for the information collection (MARCONI; LAKATOS, 1999). The interview guide was divided in six thematic blocks, based on this research's objectives. Still in this stage, it was formed a group of specialists, who act in cashew agribusiness sector, selected after the observation stage (LAVILLE; DIONNE, 1999). The 20 specialists who participated in that group were chosen for gathering to discuss on subjects related to the sector in specific forums, such as Caju Nordeste (Northeast Cashew) and Agropacto (2008). The interviewed specialists were selected by the use of the *snowball criterion*, in which the first participants indicate the next ones. The interviews were accomplished between April and May 2009, and were recorded in video, using a semi-professional camcorder – Sony Handycam HDR-FX7 –, generating nine hours of recorded interviews accumulated.

The Analysis Plan was constituted seeking the transcription, organization and qualitative analysis of data and information collected by the compiled documents, accomplished observations and application of the interview guide. The analysis was performed using the Thematic Analysis technique, which belongs to the Analysis of Content techniques group, whose objective is to evidence the significance items from the description of the built *corpus*, based on the code and categories units cut out of the interviews content and documents, being these guided by this study's problem and objectives (BARDIN, 1977).

As explained by Bardin (1977), this dialogue, understood under the light of categories and varied contextual information, makes the interpretation to emerge as intrinsic element to the research process. Based on these procedures, the different analysis stages were covered, among these: 1. transcription, constitution of corpus and pre-analysis; 2. flotation reading and exploration of material with the establishment of categories and significance items; 3. treatment of data through inference and interpretation; 4. confrontation and discussion of the results obtained from the articulate theory.

Thereby, starting with the theoretical categories, the process took, in a second moment, to the redefinition of empiric-analytic categories around the following thematic blocks: 1. socio-environmental management in the cashew productive chain and the mobilization of local system; 2. management of sustainable innovation and mobilization of local system.

## **5 CONTEXTUALIZATION OF CASHEW AGRIBUSINESS IN CEARÁ**

Ceará represents 50% of cultivated area of cashew in the country, being this subdivided in five poles: Pacajus, Aracati, Itapipoca, Camocim and Cariri, being still responsible for the generation of thirty thousand direct employments and a hundred thousand indirect ones. Besides, it awards a social importance due to its capacity of employments generation in the period between harvests of other agricultural activities (FIEC, 2007; FRANÇA et al., 2008; FIGUEIRÊDO JÚNIOR, 2008).

The cashew nut is the second product in the line of exports from Ceará, generating US\$ 140.515.788 in 2006, about three quarters of the exported total volume, while the internal market generates about of R\$ 72 million (FIEC, 2007).

The cashew nut almond market has a historical prominence that made possible the creation of an advanced research center directed to cashew's technological development. Thereby, National Center of Tropical Agribusiness Researches (Centro Nacional de Pesquisas da Agroindústria Tropical – Cnpat), also known as Embrapa Agroindústria Tropical (Empresa Brasileira de Pesquisa Agropecuária – Brazilian Agricultural Research Corporation – Tropical Agribusiness), appeared. It congregates a great number of specialists, directed to genetic improvement subjects, management, post-crop and food technology related to cashew fruit (ARAÚJO; PAULA PESSOA; LEITE, 1996).

## **6 ANALYSIS AND DISCUSSION OF THE RESULTS**

In search for resonances in the articulate literature in this article's first stage, the following is the final analysis, based on the empiric-analytic categories, defined during the interpretative process of the study.

## 6.1 SOCIO-ENVIRONMENTAL MANAGEMENT IN THE CASHEW PRODUCTIVE CHAIN AND THE MOBILIZATION OF LOCAL SYSTEM

In the documental analysis of the minutes compiled in Agropacto Forum's meetings (2007a, 2007b, 2007c, 2007d, 2007e, 2007f), was emphasized the existence of a wide collaboration network between the several organizations and agents involved in Ceará's cashew agribusiness. It assumes a favorable context for creation, sharing and use of knowledge aiming the sector's sustainability (CASTELLS, 1999; BALESTRIN; VARGAS, 2004). However, and according to the articulated theme of interviews, it is necessary to begin a work of "mutual support", seeking to integrate more closely this knowledge base, interactively developed in the network, with learning processes and innovation along the productive chain of the cashew agribusiness (LUNDVALL, 2001, 2002; CORRÊA; CORRÊA, 2004; LAMBERT; COOPER; PAGH, 1998). Thereby, the subjects pointed by the specialists make possible inferences about the existence of a local innovation system involving the productive chain of Ceará's cashew agribusiness. However, challenges are pointed in the sense of perfecting the management of relationships and network integration of the several participants and projects:

A local innovation system has some important characteristics. You need a research center. You need a center of people's training and here we can speak about universities, for instance. You need funding institutions, Banco do Nordeste (Bank of Brazil's Northeast), SEBRAE, other banks. You also need organizations that give support and generate politics that support innovation. Here, in Ceará, we have Funcap (Fundação Cearense de Apoio ao Desenvolvimento Científico e Tecnológico – Ceará's Science and Technology Development Support Foundation), Secitece (Secretaria de Ciência e Tecnologia – Secretary of Science and Technology). In the researches area, we have Embrapa, Nuteq (Fundação Núcleo de Tecnologia Industrial do Ceará – Ceará's Industrial Technology Center Foundation), etc. Then, if we consider the institutional framework that characterizes a local innovation system, Ceará has all the elements for the theme about cashew to become everyone's concern object. It can be inserted in a local innovation system, for which it can benefit the productive chain of cashew to correctly interact with those agents (passage from the 16<sup>th</sup> interview).

Perhaps, it is not completed as a system yet. I think the research is really advanced. On the integration between this research and the point and the rural producer's point of view, there is indeed a lack of interaction that needs to be solved (passage from the 1<sup>st</sup> interview).

In that context the consolidation of the analyzed themes allowed the description of the cashew agribusiness productive chain in the attempt of looking for a better articulation between the agents and the management of its obstacles seeking the mobilization of the local system in which it is inserted, according to one of the interviewees:

The cashew agribusiness productive chain is constituted by inputs suppliers for the production and for the complete spectrum of the chain as a whole: we have small, medium and big producers, including up to twenty or thirty thousand hectares of cashew tree production. We have processing industries as the next link, such as big, medium and small industries, and also mini-factories. The processing industries, the distribution system to the internal market and to the external market [...] with an additional component to this link, which are the “brokers”, those who make the intermediation of the cashew nut sale abroad. And we have, finally, the distributors, so much here in Brazil as abroad, and the final consumers. Then these would be the main links of the productive chain (passage from the 16<sup>th</sup> interview).

The interviewed specialists connected to class and government organizations, participants of local system, named the existence of a support group – Environmental Monitoring Center (Núcleo de Monitoramento Ambiental – Numa). In this ambit, are emphasized the themes placed by the coordinator of productive chains of Industries Federation of the State of Ceará (Federação das Indústrias do Estado do Ceará – Fiec) focalizing the work of that specialized group in socio-environmental management that supports all the industries which generate environmental impacts, including the ones of cashew nut improvement. Based on this verification, themes were extracted from the analytic corpus, which reveal the occurrence of social-environmental management through the use of residues, above all, in medium and large industries of cashew nut improvement, participants of the chain:

We work with three dimensions of the environmental management: the management of industrial effluents, gas and solid residues too. The selective collection enters inside this process now. The intention is to destine each one of the residues in a correct way, to pollute or don't pollute, or to pollute the atmosphere to the minimum. And we have, in a certain way, a financial return for the company. And our concern is also to verify, in the community, how people react to the environmental pollution, since the factory is inserted in an urban environment. We have been receiving community's good results (passage from the 14<sup>th</sup> interview).

Corroborating this thematic analysis, and in spite of not verifying the preventive management of a cleaner production, is evidenced that the implementation of a social-environmental strategy in search of a cleaner production, through the management of residues, which are generated and used in its own chain, or in chains of other products, is making possible the appearance of innovations in processes and products on behalf of the sector's sustainability (FERREIRA, 2006; NASCIMENTO; LEMOS; MELLO, 2008; BELL; PAVITT, 1993):

In cashew nut's processing, there is the peel residue and LCC (líquido da castanha de caju – cashew nut liquid), which is not extracted. That was a problem for the sector because we didn't have a place for that peel. Today the peel is completely sold to burn in kettles of large industries; the peel is used instead of wood. So, some factories that use the cashew nut peel generate energy in benefit of its own energy system. It is also a way of this cycle to become complete inside the chain. It is also completed outside the chain, when you use LCC for the production of several nobler products, such as additives and friction powders (passages of 1<sup>st</sup>, 3<sup>rd</sup>, 5<sup>th</sup> and 8<sup>th</sup> interviews).

When you do the substitution of cashew crowns, it generates residues that can be used as organic compound, by a biodegradation process which can be used later in the own chain as organic fertilizer in the own grove of cashew trees (passage from the 4<sup>th</sup> interview).

The introduction of the peel burn and the use of wood originating from the substitution of crowns were inspection and accompaniment objects of the environmental protection organs such as Brazilian Institute for Environment and Natural Renewable Resources (Instituto Brasileiro de Recursos Naturais Renováveis e Meio Ambiente – Ibama) and State Superintendency for Environment (Superintendência Estadual do Meio Ambiente – Semace). In those cases were regulated the use of filters in the chimneys of the chestnut improvement factories (LEITE, 1994) and the use liberation of the wood from the substitution of crowns in the burn, for not considering it as deforestation of native forest. Some specialists commented on the subject: "The bigger processors should use filters in the emission of smoke when the chestnut peel burns, after the extraction of LCC" (passage from the 5<sup>th</sup> interview).

You have, I would say, three organs which regulate, which treat of this environmental part in Ceará. One is IBAMA, which is national. In the specific case, I can give an example, when they were using the ranching cashew wood to burn, there was a heavy interference of IBAMA, but it was officially justified by the research

institution that the wood was the result of an activity of crop management, therefore it didn't bring any harm to the environment. In the state it is SEMACE that has been interfering, mainly, in what concerns the residues emission, or to the flow of those residues in water, etc. It has been made some demands, as well as the filter subject, the filtering of kettles that are being used with that raw material. [...] (passage from the 3<sup>rd</sup> interview).

Considering the evidences of a local innovation system's existence, the need for a larger mobilization of that system is emphasized, through the efficiency of the current operations, with continuous improvements in production systems, search for alternatives for the future which make possible the creation of values, improving the competitive positions of companies and re-configurations of relationships network among the involved economical actors (VASCONCELOS, 2001). In this ambit, the concern about the socio-environmental management of the participant companies along the productive chain in cashew agribusiness is a factor that is emphasized, above all, by the amount of stalk wasted.

One of the great problems of the cashew culture is exactly the non use of cashew stalk. We understood that there is a very wide field to work with the subject related to the use of stalk. About 80 to 85% of the stalk is wasted (passages of 4<sup>th</sup> and 15<sup>th</sup> interviews).

The cashew nut is one of the main items in the line of export from Ceará, today there is a very big pressure of the Asian countries, which cultivate cashew. In Africa, the cashew cultivation is also ballasted. In this sense, there is a need to be always innovating and looking for alternatives. Here the Brazilian differential consists on the attempt of looking for the use of stalk (passage from the 15<sup>th</sup> interview).

Several thematic blocks emphasized the great variety of products and sub-products that could be processed in an innovative way allowing new market opportunities. In this theme, the interviewees diversified the possibilities of innovations and markets related to new processes and products that could be generated from the use of stalk (PAIVA, 1997; LIMA, 2004; GALVÃO, 2006; BURLAMAQUI; PROENÇA, 2003):

We have, also, the cashew butter, which is used in a way similar to the peanut butter. They are developments of NUTEC's research, with EMBRAPA's participation. The cashew powder can be used in bread production, mixed with the



wheat. All these technologies were developed, tested and they are in the search of enterprising. Apart from those products, we emphasize the cashew gum, which is acquired from the stem; the sangria of cashew tree's peel, which can be used in the production of glues and/or capsules of medicines that are digestible, non-toxic. The glues already come with some active principles against moths, insects, etc. Recently we have entrepreneurs' cases which are manufacturing cashew liquor, and even cashew perfumes, using imported essences, with innovative products using the produced alcohol of the cashew for the composition of those perfumes. And, in the matter of alcohol, it is another by-product that we can develop and test its economical viability, because the cashew stalk also produces alcohol (passage from the 16<sup>th</sup> interview).

Beyond cashew juice, fibers and crystallized candies, cashew hamburger, and still for animal ration, to main opportunity for use of stalk is the production of clarified and deodorized cashew juice, a kind of "filler" to other juices, that can compete with the apple juice in the international market (passage from the 5<sup>th</sup> interview).

It is interesting that stalk has a lot of use that we are not still using, such as a pigment. ANVISA (Agência Nacional de Vigilância Sanitária – National Agency of Sanitary Surveillance) will prohibit, starting in 2010, the artificial colors. And cashew has a source of yellow color, being other possibility of value aggregation for the productive chain. It opens possibilities for the appearance of links with other productive chains that work, mainly, with biotechnology (passage from the 9<sup>th</sup> interview).

The themes extracted from the interviews with the specialists identified the following obstacles, strong and weak links along the cashew agribusiness productive chain, previously described: 1. high competition, depreciation of the cashew chestnut almond and exchange problems; 2. waste of stalk; discover use alternatives for the case of the production accomplished from the giant cashew tree; 3. high price of the basic inputs, such as the grafted seedlings; 4. low productivity of the producer and, consequently, a low profitability; 5. disarticulation of the productive chain with the presence of several middlemen who commit the prices and the quality of the product that comes to the final consumer (PAULA PESSOA; LEITE, 1998; AGROPACTO, 2007a; FRANÇA et al., 2008).

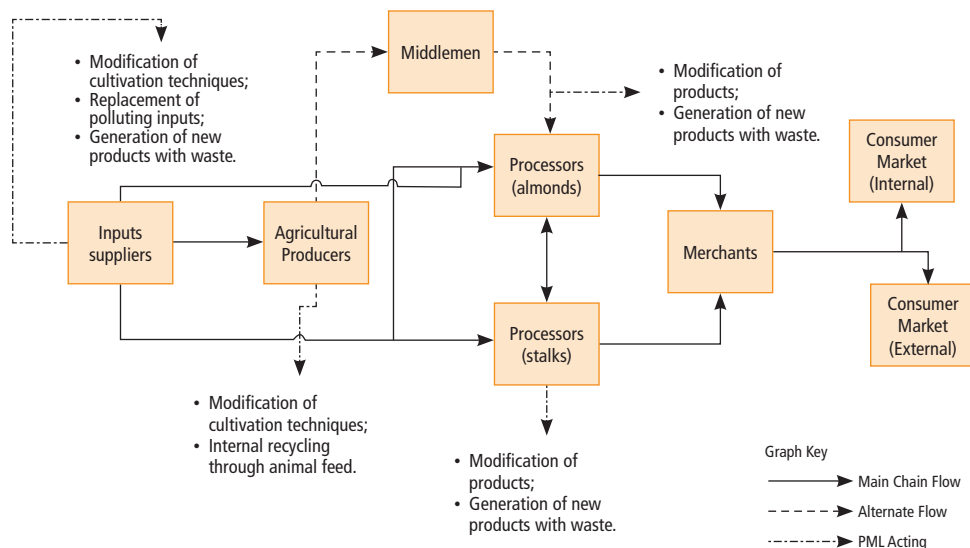
Options to a better management of residues, by the possible implementation of a preventive methodology such as Cleaner Production, were confirmed

by several specialists as a tool to increase the sustainability through the generation and adoption of innovations, as an alternative of income and work generation and amplification of new spaces of business and in the market, mainly when considered the following links of the productive chain: suppliers of inputs; small agricultural producers and processors, both of almond and stalk (BURLAMAQUI; PROENÇA, 2003; NASCIMENTO; LEMOS; MELLO, 2008; CORRÊA; CORRÊA, 2004; LAMBERT; COOPER; PAGH, 1998; BELL; PAVITT, 1993).

Considering the obstacles identified by the specialists and from the articulation of those discussion themes it was possible to analyze the effects of the socio-environmental management starting with the possible preventive implementation of Cleaner Production and its implications in the sustainability of the participant companies in the cashew productive chain. Figure 2 allows the identification of points to be improved in the ambit of the productive chain with the preventive introduction of Cleaner Production tools, generating and diffusing innovations when propitiating changes in the processes, products and management ways of the companies (LEMOS, 1998; GASI; FERREIRA, 2006; BERKHOUT; GREEN, 2002; BELL; PAVITT, 1993; CHRISTIE; ROLFE; LEGARD, 1995).

FIGURE 2

### SUGGESTIONS FOR THE PREVENTIVE ADOPTION OF PML IN THE PRODUCTIVE CHAIN



Source: Elaborated by the authors from the research data.

It is worth to point out, and according to analytic themes, some of the alternatives of innovative products and processes presented as a result of the socio-environmental management along the cashew productive chain are in final phase of researches in Embrapa's Research and Development (R&D) laboratories or they are also produced in a handmade way, therefore without a properly formalized industrial structure. The case of the natural color obtained from cashew pigments is a good example of this, because the concluded project will assist a strong demand that will appear starting from Anvisa's regulation.

## **6.2 MANAGEMENT OF SUSTAINABLE INNOVATION AND MOBILIZATION OF LOCAL SYSTEM**

The National Center of Tropical Agribusiness Researches (Centro Nacional de Pesquisas da Agroindústria Tropical – Cnpat) of Embrapa Agroindústria Tropical (Tropical Agribusiness) has been increasing with the development of sustainable innovations for the sector; some of those are already partially diffused and deserve prominence as the clone of precocious dwarf cashew tree and the substitution of crowns. The clones of precocious dwarf cashew tree are developed seeking to assist to climatic diversities of the cultivation areas and the cashew nut, stalk or cashew fruit processing (LEITE, 1994; PAULA PESSOA; LEITE, 1998; FIGUEIRÊDO JÚNIOR, 2008; FRANÇA et al., 2008). The thematic passages that follow emphasize the assertive of Loiola and Ribeiro (2004), who say that to innovate depends on implied knowledge, located and cumulative, being the innovation and learning capacities strongly rooted in the social, institutional and productive structure of each area which can be found. For instance, in gatherings of small and medium interlinked companies along productive chains. According to the consultant of Ceará's Science and Technology Bureau (Secretaria de Ciência e Tecnologia do Estado do Ceará – Secitece), the importance of those innovations for the sustainability of the cashew productive chain is evident:

The coming of the precocious dwarf cashew tree was the great step that happened from the point of view of innovative technology for the sector. That work was begun in 1965. Today we have several clones, some initially released in the 80's by the extinct EPACE (Empresa Agropecuária do Estado – Agricultural Company of the State) and later, when EMBRAPA assumed the experimental station of Pacajus. In fact, it brought a new encouragement in the matter of technological innovation, for many reasons: productivity, plant size and longer crop period have a series of advantages (passage from the 4<sup>th</sup> interview).

Several selected passages from the interviews and documental analysis emphasized the importance – clones technologies, processes of crowns substitution, storage with the adoption of good cultivation practices and a group of post-crop technologies and transport and, still, the cashew nut sale in the stock market, the entrance in the carbon credits market, the geographical denomination of some products elaborated from the cashew – that the private enterprise indicated and can test and develop with Embrapa's researchers and universities accompaniment, corroborating that the innovations, while transformations of a discovery in a new practice, can be seen as re-configurations of economical activity systems, resulting in dilation of existent economical space, motivated by perception of market opportunities (VASCONCELOS, 2001; BURLAMAQUI; PROENÇA, 2003):

We believed that radical changes happened and, in certain way, already begin to present positive impacts especially related to the productivity and sustainability. These changes are directly connected to the innovative coming of the precocious dwarf cashew tree clones. This technology and all its productive process, very advanced nowadays, opened markets including the cashew fruit, which is marketed in the period of the crop by the tourists who visit the state of Ceará and it already arrives at the national market (passages from 2<sup>nd</sup> and 7<sup>th</sup> interviews).

A very important innovation that had, and still has, impact is the substitution of crowns of unproductive cashew tree that EMBRAPA developed and proved in the agricultural properties through the partnership with private enterprise, and also all the irrigation, fertilization, pruning and management technologies, etc. (passages from 5<sup>th</sup>, 10<sup>th</sup> and 16<sup>th</sup> interviews).

Parallel to the generation of clone's innovation, technologies for storage of fresh stalk were also developed, making possible the introduction in the market of cashew fruit "in natura", which lasts around 24 up to 48 hours or even up to 3 weeks. This innovation made possible a market of cashew fruit for the South and Southeast of Brazil, through distances of up to 4.200 km, by refrigerated transportation (passages from 10<sup>th</sup> and 16<sup>th</sup> interviews).

A niche market is the matter of cashew fruit free of chemical products, project in development by EMBRAPA. In some communities, non-governmental organizations (NGOs) motivate people to have that care and wake up for those important niches, mainly, for small producing of mini-factories that could control it more easily (passage from the 4<sup>th</sup> interview).

Those thematic blocks point out the possibility of economical spaces amplification, defined by Schumpeter (1997) when involving the introduction of a new production method, with the conquest of alternative uses of raw materials source and inputs, establishment of a new industrial organization and consequent opening of a new market.

The performance of Embrapa Agroindústria Tropical's research center places the state of Ceará as the center of the cashew agribusiness innovation. However, and in spite of the unanimous opinions on the importance of the generation of those innovations for the sustainability of the sector, it becomes notable that the dissemination, diffusion and adoption of those technologies didn't reach a great part of the small rural producers (BELL; PAVITT, 1993):

Brazil is the most advanced country in the research related to cashew culture. What we need is that this research indeed arrives in a wide and opportune way in the countryside, with equipments and innovations effectively disseminated. Then, from the research's point of view, we can say that the country is quite advanced. From the point of view of the integration between that research and the point and the rural producer, the mini-factories, there is indeed a lack of interaction that needs to be solved (passage from the 1<sup>st</sup> interview).

The existent environment is not favorable to the dissemination of innovation, in spite of EMBRAPA's efforts, the new developed technologies are not adopted by producers because they don't have money, nor knowledge for such. So, they block the process due to techniques they don't have, because of their lack of access to information, basic knowledge and credit (passages from 5<sup>th</sup> and 17<sup>th</sup> interviews).

Nowadays, Ceará is where is located the largest reference center of technological development for cashew, a world reference. The transformation of that in a local innovation system, active, productive and sustainable, which could produce impact results in the productive chain, only depends on a coordination process through network (passage from the 16<sup>th</sup> interview).

However, it was pointed out of the analysis the performance of the cashew nut processing mini-factories while important Social Technology, with the objective of increasing the value aggregation for the small producers. In this sense, the mini-factories program is a good example of technological knowledge introduction directly to the small producers generating sustainable innovations by the connection of environmental, economical and social dimensions (BERKHOUT;

GREEN, 2002). The mini-factories received support of funding organs and prizes in “Social Technology” category:

For about 10 years, EMBRAPA is working on mini-factories technology. It is the organization of small producers, based on family nucleus, residents in the same place, for the production and processing of the products in personal micro-factories, made by them. EMBRAPA develops equipments and processes for that. About 5 or 6 years ago, we won the national prize of Fundação Banco do Brasil (Bank of Brazil Foundation) in Social Technology category, and that has been quite interesting because those people have been having opportunities to participate in exports, etc. Perhaps Ceará is the state with more mini-factories and the objective was to insert those people in the market, starting with a training designed to the products manipulation and processing. Not only for them to seek the chestnut in the ground and sell to other people, but for them to select the chestnut, break, remove the almond and make the export. [...] Perhaps that is one of the best examples of association of technology and social insert and inclusion of the needy people, than when they just had the cashew in their lands, picked and gave to a middleman (passage from the 10<sup>th</sup> interview).

The creation of the mini-factories program was widely diffused in the Northeast of Brazil, but today it presents some structural problems, mainly related to management. The following comment demonstrates the importance of those in the integration of new links of the cashew productive chain, introducing as much problems as solutions, specially by emphasizing that the possible preventive implementation of Cleaner Production tools can allow changes in the processes, products and management ways of the companies (LEMONS, 1998; GASI; FERREIRA, 2006; CHRISTIE; ROLFE; LEGARD, 1995).

The idea of the mini-factories is a consecrated idea. We need to do several fittings in the matters of the mini-factories, but in any way it is a consecrated matter. [...] The great step would be the matter of the interlacement: industrial sector and production sector. It would be the role of mini-factories in the middle. Mini-manufacture can exercise a fundamental role in the matter of the reorganization of those links, for obvious reasons. You would have mini-factories working not only on cashew stalk, but on cashew nut too. The big problem about mini-factories is the management. And also a paternalist and assistance vision, that has to be broken. Then comes the role of professionalizing the management of mini-factories (passage from the 4<sup>th</sup> interview).

These verifications evidence the need of mobilization of local system through the support organizations initiative and the implementation of new management practices and public politics along the cashew agribusiness productive chain, seeking for the interactions increase and coordination of exchange, allowing the generation and diffusion of sustainable innovations (LUNDVALL, 2002; LOIOLA; RIBEIRO, 2004; BERKHOUT; GREEN, 2002; BELL; PAVITT, 1993; CHRISTIE; ROLFE; LEGARD, 1995).

## 7 FINAL CONSIDERATIONS

The creation of agroindustrial sustainable systems has been a constant search close to Ceará's agricultural productive chains. The evidences articulated in the analysis of several thematic blocks reveal the existence of a group of support organizations and micro, small and medium companies, characterizing a local innovation system, which interacts on behalf of the sustainability of cashew agribusiness productive chain.

Several selected passages from the interviews and the documental analysis emphasized the importance of the following: clones technologies, products originated from crown substitution, storage processes with the adoption of good cultivation practices and a group of post-crop technologies and transport and, still, the possibilities of cashew nut sale in the stock market, its entrance in carbon credits market, the geographical denomination of products, the matter of produced cashew fruit in an organic way and, finally, Cnpat of Embrapa Agroindústria Tropical (Tropical Agribusiness), participant of the local system. They stand out on the development of sustainable innovations for the cashew agribusiness sector of Northeast region of Brazil.

However, the analysis revealed the need of coordination in network in the sense of a larger increase of relationships among the several agents, seeking a larger mobilization of local system, above all, in the sense of dissemination, diffusion and adoption of practices and innovative products generated by the participant research and development (R&D) centers.

In this ambit, it is important to highlight the concern with the social-environmental management through the creation of a support group Numa, seeking the development of technologies and practices that make possible the complete use of cashew. Particularly, it is possible to emphasize the actions directed to the development, in elapsing of the cashew productive chain, of differentiated products with good value aggregation, turning, for instance, the processing of cashew stalk in a new opportunity of business and markets.

It is pointed out of the analysis that many of the obstacles identified along the cashew productive chain can be improved by the preventive implementation of an approach like Cleaner Production, generating and spreading innovations by allowing changes in the processes, products and management ways of the companies.

In this sense, the mini-factories program, while an important Social Technology, participant of local system, shows the importance of those in the integration of new links of the cashew productive chain, presenting itself as a good example of technological knowledge introduction directly to the small producers generating sustainable innovations by the connection of environmental, economical and social dimensions.

Based on this discussion, is considered that the assumption elaborated for this research was confirmed partly when we notice that the “sustainable innovation” appears from the social-environmental management, connecting the environmental, economical and social dimensions mobilizing, consequently, the local system.

On the other hand and in spite of the great variety of products and sub-products already developed, with good possibility of aggregation of value for the productive chain and in association with other chains and which could be processed in an innovative way starting with the use of the stalk – such as the production of clarified and deodorized juice and the use as coloring of yellow pigment of cashew – those, find blocks in the spreading and use by most of small rural producers.

Those thematic blocks highlight the need of the management of sustainable innovation widely, which can be obtained by the implementation of an approach like PML along the participant companies in the productive chain, in the sense that the results obtained at the research and development (R&D) centers would be effectively spread, dilating the economical spaces defined by Schumpeter (1997), when involving the introduction of new production methods, with conquest of alternative uses of raw materials source and inputs, establishment of a new industrial organization and consequent perception of opportunities of new business.

It is suggested, finally, that the recently-formed Câmara Setorial do Caju (Cashew Sectorial Assembly) develops initial works for a better articulation of the productive chain and, soon after, acts close to the State and Federal Government in the formulation of public politics that motivate the adaptation of producers and processors towards the mobilization of the local system and the sustainable development of the area.



## EVIDÊNCIAS DA INOVAÇÃO SUSTENTÁVEL NO CONTEXTO DO AGRONEGÓCIO DO CAJU NO CEARÁ – BRASIL

### RESUMO

O Ceará, como maior produtor nacional, releva o caráter social e econômico do agronegócio do caju, capaz de gerar riquezas e auxiliar na fixação do homem no campo. Apesar do apoio das diversas organizações que compõem o sistema local de inovação, visando à geração, adaptação e difusão de inovações, a cadeia produtiva do agronegócio do caju carece de inovações. Nesse contexto, pressupõe-se que a “inovação sustentável” surgiria a partir da gestão socioambiental, dinamizando, em consequência, o sistema local. Com base nessa discussão, a contribuição do artigo está em identificar as possibilidades de inovações com a introdução da abordagem da Produção Mais Limpa, refletindo sobre a dinamização do sistema local do agronegócio do caju cearense. A metodologia de caráter qualitativa baseou-se na compilação documental e em entrevistas/debates com um painel constituído por especialistas que atuam no setor. Para a análise, foi utilizada a técnica da análise temática que se insere no conjunto das técnicas da análise de conteúdo. Verificou-se que a dinamização do sistema local passa pelo adensamento das interações entre os agentes participantes, o que facilita a disseminação das inovações sustentáveis a partir do aproveitamento integral do caju e amplia, consequentemente, os espaços econômicos com novas oportunidades de negócios e mercados.

### PALAVRAS-CHAVE

Inovação sustentável; Sistema local de inovação; Agronegócio; Cadeia produtiva do caju; Produção Mais Limpa.

## EVIDENCIAS DE LA INNOVACIÓN SOSTENIBLE EN EL CONTEXTO DEL AGRONEGOCIO DEL ANACARDO EN EL CEARÁ – BRASIL

### RESUMEN

El Ceará mientras mayor productor nacional releva el carácter social y económico del agronegocio del anacardo, con capacidad de generar riquezas y auxiliar en la

fijación del hombre en el campo. Pese el apoyo de las diversas organizaciones que componen el sistema local de innovación visando la generación, adaptación y difusión de innovaciones, la cadena productiva del agronegocio del anacardo necesita innovaciones. En ese contexto, presupone que la “innovación sostenible” surgiría desde la gestión socio ambiental, dinamizando, en consecuencia, el sistema local. Basado en esa discusión, la contribución del artículo está en identificar las posibilidades de innovaciones con la introducción del abordaje de la Producción Más Limpia, reflejando sobre la dinamización del sistema local del agronegocio del anacardo cearense. La metodología de carácter cualitativa se basó en la compilación documental y en entrevistas/debates con un panel constituido por especialistas que actúan en el sector. Para el análisis, fue utilizada la técnica del análisis temático que se insiere en el conjunto de las técnicas del análisis de contenido. Se verificó que la dinamización del sistema local pasa por el adensamiento de las interacciones entre los agentes participantes, facilitando la diseminación de las innovaciones sostenibles desde el aprovechamiento integral del anacardo, ampliando, en consecuencia, los espacios económicos con nuevas oportunidades de negocios y mercados.

## PALABRAS CLAVE

Innovación sostenible; Sistema local de innovación; Agronegocio; Cadena productiva del anacardo; Producción Más Limpia.

## REFERENCES

- AGROPACTO – PACTO DE COOPERAÇÃO DA AGROPECUÁRIA CEARENSE. *Situação e perspectiva da cadeia produtiva do caju, no mundo, no Brasil e no Ceará*. Fortaleza, 2007a. Disponível em: <<http://www.agropacto-ce.org.br/palestras/31%2007%2007.pdf>>. Acesso em: 17 jan. 2008.
- \_\_\_\_\_. *Potencialidades e limitações do segmento agrícola da cadeia do caju*. Fortaleza, 2007b. Disponível em: <<http://www.agropacto-ce.org.br/palestras/24%2007%2007.pdf>>. Acesso em: 17 jan. 2008.
- \_\_\_\_\_. *Oportunidades e limitações da cadeia produtiva do caju: segmento industrial da castanha*. Fortaleza, 2007c. Disponível em: <<http://www.agropacto-ce.org.br/palestras/31%2007%2007.pdf>>. Acesso em: 17 jan. 2008.
- \_\_\_\_\_. *Arranjo institucional para a competitividade da cajucultura no Ceará*. Fortaleza, 2007d. Disponível em: <<http://www.agropacto-ce.org.br/palestras/08%2008%2007.pdf>>. Acesso em: 17 jan. 2008.
- \_\_\_\_\_. *I – Oportunidades e limitações da cadeia produtiva do caju: segmento industrial e comercial; II – Uso do pedúnculo na ração animal*. Fortaleza, 2007e. Disponível em: <<http://www.agropacto-ce.org.br/palestras/20%2008%2007.pdf>>. Acesso em: 17 jan. 2008.

AGROPACTO – PACTO DE COOPERAÇÃO DA AGROPECUÁRIA CEARENSE. *Outros produtos da castanha e amêndoa do caju*. Fortaleza, 2007f. Disponível em: <<http://www.agropacto-ce.org.br/palestras/27%2008%2007.pdf>>. Acesso em: 17 jan. 2008.

\_\_\_\_\_. *Histórico*. 2008. Disponível em: <<http://www.agropacto-ce.org.br/Agropacto.htm>>. Acesso em: 6 jun. 2008.

ALMEIDA, F. *Os desafios da sustentabilidade*. Rio de Janeiro: Elsevier, 2007.

ARAÚJO, J. P. P.; PAULA PESSOA, P. F. A.; LEITE, L. A. S. Gestão estratégica de pesquisa e desenvolvimento em uma abordagem de agribusiness: o caso do Centro Nacional de Pesquisa de Caju da Embrapa. *Revista de Administração*, São Paulo, v. 31, n. 4, p. 97-101, out./dez. 1996.

BALESTRIN, A.; VARGAS, L. M. A dimensão estratégica das redes horizontais de PMEs: teorizações e evidências. *Revista de Administração Contemporânea–RAC*, Rio de Janeiro, v. 8, n. 1, p. 203-227, jan./abr. 2004.

BARBIERI, J. C. *Gestão ambiental empresarial: conceitos, modelos e instrumentos*. 2. ed. São Paulo: Saraiva, 2007.

BARDIN, L. *Análise do conteúdo*. Lisboa: Edições 70, 1977.

BATALHA, M. (Coord.). *Gestão agroindustrial*. 3. ed. São Paulo: Atlas, 2008. v. 1.

BATALHA, M. O. As cadeias de produção agro-industriais: uma perspectiva para o estudo das inovações tecnológicas. *Revista de Administração*, São Paulo, v. 30, n. 42, p. 43-50, out./nov. 1995.

BELL, M.; PAVITT, K. Technological accumulation and industrial growth: contrasts between developed and developing countries. *Industrial and Corporate Change*, v. 2, n. 2, p. 157-211, Apr. 1993.

BERKHOUT, F.; GREEN, K. Managing innovation for sustainability: the challenge of integration and scale. *International Journal of Innovation Management*, v. 6, n. 3, p. 227-232, Sept. 2002.

BURLAMAQUI, L.; PROENÇA, A. Inovação, recursos e comprometimento: em direção a uma Teoria Estratégica da Firma. *Revista Brasileira de Inovação*, v. 2, n. 1, p. 79-110, jun. 2003.

CASTELLS, M. *A sociedade em rede: a era da informação, economia, sociedade e cultura*. São Paulo: Paz e Terra, 1999. v. 1.

CASTRO, A. M. G.; COBBE, R. V.; GOEDERT, W. J. *Prospecção de demandas tecnológicas: manual metodológico para o SNPA*. Empresa Brasileira de Pesquisa Agropecuária. Departamento de Pesquisa e Difusão de Tecnologia. Brasília: Embrapa-DPD, 1995.

CASTRO, A. M. G. et al. Priorização de demandas da clientela de P&D em agropecuária. *Revista de Administração*, São Paulo, v. 31, n. 2, p. 94-105, abr./jun. 1996.

\_\_\_\_\_. Prospecção de demandas tecnológicas no Sistema Nacional de Pesquisa Agropecuária (SNPA). In: \_\_\_\_\_. *Cadeias produtivas e sistemas naturais: prospecção tecnológica*. Brasília: Embrapa-DPD, 1998. p. 21-59.

CASTRO, A. M. G.; LIMA, S. M. V.; CRISTO, C. M. P. N. Cadeia produtiva: marco conceitual para apoiar a prospecção tecnológica. In: SIMPÓSIO DE GESTÃO DA INOVAÇÃO TECNOLÓGICA, 22., 2002, Salvador. *Anais eletrônicos...* Salvador: ANPAD, 2002.

CHRISTIE, I.; ROLFE, H.; LEGARD, R. *Cleaner production in industry: integration business goals and environmental management*. London: Policy Studies Institute, 1995.

CORRÊA, H. L.; CORRÊA, C. A. *Administração de produções e operações: manufatura e serviços: uma abordagem estratégica*. São Paulo: Atlas, 2004.

DAROIT, D.; NASCIMENTO, L. F. Dimensões da inovação sob o paradigma do desenvolvimento sustentável. In: ENCONTRO NACIONAL DA ANPAD, 28., 2004, Curitiba. *Anais...* Curitiba: Anpad, 2004.

- FERREIRA, T. *Seminário vai apresentar importância do sistema agropecuário de produção integrada*. 2006. Disponível em: <<http://www.cnpat.embrapa.br/home/janela.php?Id=1144>>. Acesso em: 23 maio 2009.
- FIEC – FEDERAÇÃO DAS INDÚSTRIAS DO ESTADO DO CEARÁ. O desafio da cajucultura. *Revista da FIEC*, Fortaleza, v. 1, n. 6, p. 31-36, nov. 2007.
- FIGUEIRÊDO JÚNIOR, H. S. Desafios para a cajucultura no Brasil: análise de competitividade e recomendações para o setor. *Revista Econômica do Nordeste*, Fortaleza, v. 39, n. 3, p. 371-394, jul./set. 2008.
- FRANÇA, F. M. C. et al. *Agronegócio do caju no Ceará: cenário atual e propostas inovadoras*. Fortaleza: Federação das Indústrias do Estado do Ceará, Instituto de Desenvolvimento Industrial do Ceará, 2008.
- GALVÃO, A. M. P. *Aproveitamento da fibra do caju (Anacardium occidentale L.) na formulação de um produto tipo hambúrguer*. 2006. 64 p. Dissertação (Mestrado em Tecnologia de Alimentos)–Universidade Federal do Ceará, Fortaleza, 2006.
- GASI, T. M. T.; FERREIRA, E. Produção mais limpa. In: VILELA JÚNIOR, A.; DEMAJOROVIC, J. (Org.). *Modelos e ferramentas de gestão ambiental: desafios e perspectivas para as organizações*. São Paulo: Senac, 2006. p. 41-84.
- JABOUR, C. J. C. Resgatando o conceito de tecnologia ambiental. In: ENCONTRO NACIONAL DA ANPAD, 31., 2007, Rio de Janeiro. *Anais...* Rio de Janeiro: Anpad, 2007.
- LAMBERT, R.; COOPER, M.; PAGH, C. Supply chain management: implementation issues and research opportunities. *The International Journal of Logistics Management*, v. 9, n. 2, p. 1-20, 1998.
- LAVILLE, C.; DIONNE, J. *A construção do saber: manual de metodologia da pesquisa em ciências humanas*. Porto Alegre: Artmed; Belo Horizonte: Editora UFMG, 1999.
- LEITE, L. A. S. *A agroindústria do caju no Brasil: políticas públicas e transformações econômicas*. Fortaleza: Embrapa-Cnpat, 1994.
- LEMOES, A. D. C. *A produção mais limpa como geradora de inovação e competitividade: o caso da fazenda Cerro do Tigre*. 1998. 182 p. Dissertação (Mestrado em Administração)–Universidade Federal do Rio Grande do Sul, Porto Alegre, 1998.
- LIMA, A. C. *Estudo para agregação de valor aos produtos do caju: elaboração de formulações de fruta e castanha em barras*. 2004. 173 p. Tese (Doutorado em Tecnologia de Alimentos)–Universidade Estadual de Campinas, Campinas, 2004.
- LOIOLA, E.; RIBEIRO, M. T. F. Política de ciência, tecnologia e inovação como instrumento de governança para o desenvolvimento: uma proposta para o estado da Bahia. In: ENCONTRO NACIONAL DA ANPAD, 28., 2004, Curitiba. *Anais...* Curitiba: Anpad, 2004.
- LUNDVALL, B. A. *National systems of innovation: towards a theory of innovation and interactive learning*. London: Pinter, 1992.
- \_\_\_\_\_. Políticas de inovação na economia do aprendizado. *Parcerias Estratégicas*, n. 10, p. 200-218, mar. 2001.
- \_\_\_\_\_. *Innovation growth and social cohesion: the danish model*. Chetenham: Edward Elgar, 2002.
- MARCONI, M. A.; LAKATOS, E. M. *Técnicas de pesquisa*. 4. ed. São Paulo: Atlas, 1999.
- NASCIMENTO, L. F.; LEMOS, A. D. C.; MELLO, M. C. A. *Gestão socioambiental estratégica*. Porto Alegre: Bookman, 2008.
- NONAKA, D.; TAKEUCHI, H. *The knowledge creating company: how japanese companies create the dynamics of innovation*. New York: Oxford University Press, 1995.

- OLIVEIRA, L. G. L.; IPIRANGA, A. S. R. Sustentabilidade e inovação na cadeia produtiva da cajucultura cearense. In: SIMPÓSIO DE GESTÃO DA INOVAÇÃO TECNOLÓGICA, 25., 2008, Brasília. *Anais...* Brasília: Anpad, 2008.
- PAIVA, F. F. de A. Aproveitamento industrial do caju. In: CARVALHO, A. R.; TELES, J. A. (Org.). *Caju: negócio e prazer*. Fortaleza: Setur, Governo do Estado do Ceará, 1997. p. 47-68.
- PAULA PESSOA, P. F. A.; LEITE, L. A. S. Cadeia produtiva do caju: subsídios para a pesquisa e desenvolvimento. In: CASTRO, A. M. G. et al. (Org.). *Cadeias produtivas e sistemas naturais: prospecção tecnológica*. São Paulo: Embrapa, 1998.
- SCHUMPETER, J. A. *Teoria do desenvolvimento econômico*. São Paulo: Nova Cultural, 1997.
- SOUZA, S. O.; KLIEMANN NETO, F. J. Desenho e análise da cadeia produtiva de vinhos finos gaúchos. In: ENCONTRO NACIONAL DA ANPAD, 26., 2002, Salvador. *Anais...* Salvador: Anpad, 2002.
- TIDD, J.; BESSANT, J.; PAVITT, K. *Gestão da inovação*. 3 ed. Porto Alegre: Bookman, 2008.
- UNEP – UNITED NATIONS ENVIRONMENT PROGRAMME. *Applying cleaner production to MEAs: global status report*. Paris: Unep, 2006.
- VARGAS, M. A. *Proximidade territorial, aprendizado e inovação: um estudo sobre a dimensão local dos processos de capacitação inovativa em arranjos e sistemas produtivos no Brasil*. 2002. 255 f. Tese (Doutorado em Economia)–Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2002.
- VASCONCELOS, F. C. Da gestão do conhecimento à gestão da ignorância: uma visão co-evolucionária. *Revista de Administração de Empresas*, São Paulo, v. 1, n. 4, p. 98-102, out./dez. 2001.
- ZYLBERSZTAJN, D. Políticas agrícolas e comércio mundial – “Agribusiness”: conceito, dimensões e tendências. In: FAGUNDES, H. H. (Org.). *Instituto de Pesquisas Econômicas Aplicadas*. Brasília: Ipea, 1994. (Estudos de Política Agrícola, n. 28).