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## CRISIS AND CAPABILITY BUILDING IN THE PRODUCTION OF COFFEE AND REFORESTATION: FROM STATIC COMPARATIVE ADVANTAGES INTO THE KNOWLEDGE ECONOMY

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### Abstract:

This paper analyses aspects of the structural change that occurred to socio-economic formation of the State of Espírito Santo. Located in the most dynamic industrial region in Brazil - Espírito Santo differed from its neighboring states (São Paulo, Minas Gerais and Rio de Janeiro) by its strong dependence on the coffee monoculture.

It examines two experiments that goes against a trend of defensive innovative strategies historically rooted . Those experiments took place in activities that are considered traditional. Coffee is the first and results from articulations between government entities and private companies (of various sizes and acting in the entire coffee production chain) in order to implement competitive strategies centered on technological researches for the production of a type of coffee that is environmentally and economically adequate to the state s characteristics. The second experiment refers to the production of wood from eucalyptus plantations an exotic species and emphasis is given to its sustained competitiveness based on growing rates of forest productivity and innovative capacity, both in the development of seedlings, as well as in forest handling.

The analysis is based on neo-Schumpeterian theoretical reference with emphasis in innovative processes based on inter-organization articulations geared towards innovation and generation/use of knowledge.

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## **1. INTRODUCTION**

This paper analyses aspects of the structural change that occurred to socio-economic formation of the State of Espírito Santo due to the crisis that fell upon the main item of support of its economy between the second half of the 19<sup>th</sup> Century and the 1960s. Located in the Southeast Region – the most dynamic industrial region in Brazil - Espírito Santo differed from its neighboring states (São Paulo, Minas Gerais and Rio de Janeiro) by its strong dependence on the coffee monoculture.

When this activity underwent a crisis in the 1960s, the local government sought a solution through a tardy industrialization within the context of the already lagging Brazilian industrialization. As related by Villaschi (2008a), this resulted in a strong productive diversification centered (i) on large producers of commodities (mainly metallurgic and cellulose industries, marble and granite extracting companies) concentrated in a small fraction of the state's territory; and (ii) on pulverized installation of micro, small and medium companies for the production of wage goods (mainly food, clothing and furniture).

In spite of this dynamic and well succeeded diversification (for various years Espírito Santo has been showing an industrial growth rate higher than the national average and of its neighbors in the Southeast Region), it has been marked by a weak innovative performance. The technological innovation researches conducted by IBGE<sup>1</sup> show that the greater part of the innovations that occur in Capixaba<sup>2</sup> companies have an incremental content and are directed mainly to process improvements<sup>3</sup>.

The purpose of this paper is to examine two experiments that are going against this trend of defensive innovative strategies and that have occurred in a growing fashion in two activities that are considered traditional. Coffee is the first and results from articulations between government entities and private companies (of various sizes and acting in the entire coffee production chain) in order to implement competitive strategies centered on technological researches for the production of a type of coffee that is environmentally and economically adequate to the state's characteristics.

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<sup>1</sup> - The Brazilian Institute of Geography and Statistics – IBGE is making a research named PINTEC that intends to indicate the innovative position of Brazilian companies classified by activity, size and region.

<sup>2</sup> - A Word of Tupi origin that refers to persons born in the State of Espírito Santo or to activities developed in that state.

<sup>3</sup> - Villaschi (2008b) analyses some of the public policies attempts to overcome this conservative sense of the innovation processes of companies of the marble and granite, clothing and metal-mechanical segments in activity in Espírito Santo.

The second experiment refers to the production of wood from eucalyptus plantations. The extensive planting of this exotic species is aimed at the production of bleached cellulose that has shown competitiveness on the international market, is sustained by growing rates of forest productivity and innovative capacity, both in the development of seedlings, as well as in forest handling. These growing rates and the innovative capacity are the result of internal articulations (production/in-house R&D) and external (its own group of researchers/partnerships with universities, research institutes and suppliers, in Brazil and abroad).

Furthermore, the main feature of these activities is that they have not been centered only on innovation, but by different means and instruments they also comprise actions and policies aimed at the diffusion of these innovations. Thus, besides analyzing Innovation Systems (IS) in a lagging socio-economic formation, the purpose of this paper is distinguished by the fact that it results from experiments that, in spite of having received support and incentive from governmental organizations, they were never the object of an action explicitly aimed at the generation/diffusion/use of knowledge, be it by the federal or state governments. And further: this happens in segments that were initially favored by static comparative advantages (mainly low cost land and labor and adequate climatic conditions).

The analysis is based on neo-Schumpeterian theoretical reference with emphasis in innovative processes based on inter-organization articulations. Those articulations can take place in the production sphere, as well as in activities geared towards innovation and generation/use of knowledge.

The empiric evidences used herein were taken from papers prepared due to initiatives of the Capixaba Innovation and Development Research Group (GPIDECA) and/or papers (Monographs and Dissertations) guided by its associated researchers. Among the mentioned papers emphasis is given to Cosme (1994), Rodrigues (2005) and Freitas (2009). Among the initiatives, mainly Celin (2009), Medeiros (2009) and Rodrigues (2009).

In the item that follows this introduction, the theoretical elements that guide the article shall be presented, while the third item will feature the genesis of the coffee monoculture crisis that occurred in the 1960/70s and its main consequences on the Capixaba peripheral socio-economic formation. Item four analyses the aspects of the trajectories of the establishment of technological capabilities and the growing international productivity and competitiveness, both for coffee production, as well as for eucalyptus planted forests.

The last item points out the singularities of these trajectories with the purpose of subsidizing public policies aimed at the insertion of socio-economic formations of tardy inclusions in the so-called knowledge economy. Emphasis is given to the windows of opportunity that are opened in economic sectors that until recently were considered as public policy formulators in less developed formations and with little susceptibility to accelerated incorporation of technological progress.

## 2. THEORETICAL LANDMARK

The purpose of this item is to recover elements of the neo-Schumpeterian contribution (mainly those connected to centrality of establishment of innovative capabilities and knowledge generation) that shall be used in both cases (coffee and eucalyptus planted forests) that are the objects of this paper.

### 2.1 – INTERACTION AND INSTITUTIONALITY FOR INNOVATION AND KNOWLEDGE GENERATION: THE NEOSCHUMPETERIAN FOCUS

The emergence of a new technical and economical paradigm (TEP), may be described, among others, by the speed and intensity in which changes occur, significantly increasing the requirement for learning in all economic activities (LUNDVALL, 2002). In the so-called 'learning economy' (LUNDVALL and JOHNSON, 1994), agents (public and/or private) need to reshape their productive and institutional systems, increasing their dynamic contents in order to create the necessary conditions and capabilities to face the new contexts and challenges.

In the neo-Schumpeterian literature, Innovation Systems (IS) are a tool to analyze the appearance and/or stimulation of these development conditions, beginning with the adaptability and adjustability of the productive, institutional and promotion/incentive systems to innovation and, consequently, of the possibilities of growth and economic development. This perspective also considers that any economic development strategy should integrate the matters referring to social capabilities, an element that if not considered diminishes the feasibility of those strategies or policies in having significant qualitative and quantitative effects (LUNDVALL, 2002 and FREEMAN, 1997).

Therefore, it is the configuration and evolution of the institutional landmarks, production systems, incentives to innovation and social capabilities that need to be analyzed so that, in a systemic and integrated manner, a specific region/sector be placed in routes that have greater sustainability and have development rates that are superior in quality. This results in a requirement of intense learning processes directed to the generation and use of knowledge.

According to Villaschi (2009), the creation of forces needed to face new challenges and to take advantage of new opportunities is rooted in promoting the convergence between and intra-elements of four axis: the one concerning innovation; knowledge; the productive system; and the building of new capacities<sup>4</sup>.

Regarding innovation – incremental, radical or paradigmatic – Lundvall (2005) places it as a cumulative and continuous process that derives from a new combination of knowledge. This combination results in new products or differentiated processes and can be adapted to the market's offer and demand structure

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<sup>4</sup> - In the terms of Lundvall (2007, p. 13) "*This implies that the system needs to be characterized simultaneously with reference to its elements and to the relationships between those elements*".

(incremental innovation) or rupture these structures (radical or paradigmatic innovation). In any way, learning is a precondition to innovative processes (LUNDVALL, 2007). That is, innovations are unleashed by the accumulation of learning interactive processes, for example, between firms, research institutes, individuals and other organizations.

According to Lundvall and Johnson (1994), due to the change in the current paradigm<sup>5</sup>, these processes are occurring in ever higher speed and intensity. This means that the element of success of countries, regions or companies lies in the intensive logic of learning, which culminates in the speed of knowledge creation that may not be easily taken over by others, since they possess a strongly tacit dimension. Therefore, it should be said that the generation of tacit knowledge is a phenomenon that typically lies on local codes that are strengthened by the generation of new competences.

Regarding the productive system, Villaschi (2009) states that actions, strategies and policies must be focused on making the production process have a more dynamic content, by means of a more intense penetration/generation of knowledge and new learning as fundamental elements to generate economic and social value. It is necessary to establish strategic projects to foster innovative capabilities and its diffusion throughout the entire productive system.

Lastly, the competence system must be considered. As proposed by Lundvall (2007), the creation of new competences that are adequate to the TEP cannot depend solely on economic/organizational strategies used within firms. On the contrary, they should result from the convergence between economic and social capabilities that are sufficiently rooted to make the whole economic system work in a more dynamic manner, with knowledge as the main element of value and wealth generation.

Under this perspective, importance must be given to institutional setting that motivates and stimulates generation and diffusion of new knowledge. This means that the qualitative dimension of these interactions depends on the institutional environment and configuration in which they occur.

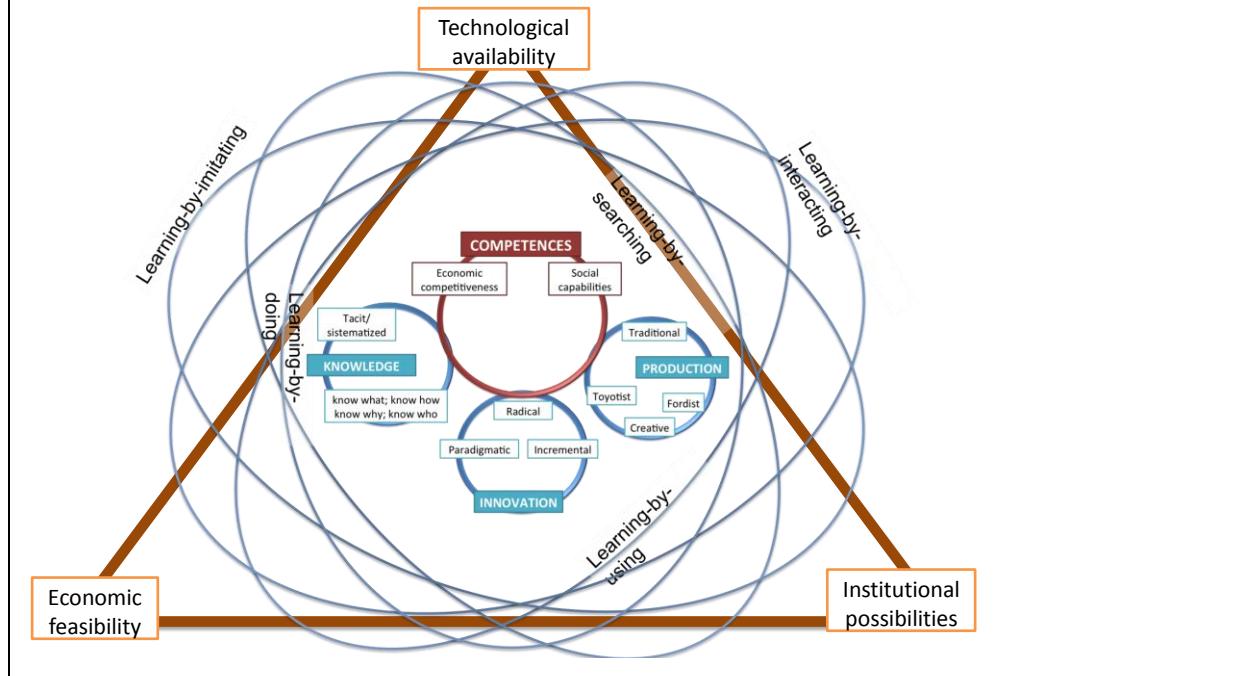
Besides, institution configures the backdrop where these interactions occur. It should be said that when qualitatively influencing such interactions, institutions motivate or not the search of new knowledge, new learning or formation of new competences. More than this, since institutions change very slowly, in moments of crisis they may potentialize mismatches between economic, technological and institutional structures, leading the system to a situation of crisis for a long period of time (PEREZ, 2004).

## **FIGURE 1 –**

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<sup>5</sup> - In the terms originally established by Freeman and Perez (1988).

## System of innovation, learning and capabilities - SILC



Source: Villaschi (2009)

Thus, only the integrated existence of these elements may create the conditions for quality leaps, since neither a new institutional configuration nor productive capital are capable of separately producing long term effects.

### 2.2 – CRISIS AND DECISIONS FOR DEVELOPMENT

Schumpeter (1942) gave crisis a decisive role in the replacement or redirecting of economic development conditions. The crisis result from the exhaustion of the effects of an innovation (or of a technological system), generating an extremely negative reaction in the economic system. In this vision, stagnation will only be interrupted when a new technological system is established to reorient the decision taking and investments made by companies.

This perception opens the possibility of a destructing and/or regenerating function of crisis that might be considered a deeper vision of the ‘creative destruction’ process. On one hand, crisis clearly express the contradictory character of interconnections that are essential for the continuation of the economic system’s accumulation, marked by disarticulation among the technological, productive and institutional systems in an economy (PEREZ, 2004). On the other hand, this means new possibilities to implementing corrective actions that turn the configuration’s system more adequate to the new techno-economic paradigm

### 3 – THE GENESIS OF STRUCTURAL CRISIS IN A LAGGING SOCIO-ECONOMIC FORMATION

The decade of 1960 was marked by the reorganization of the Capixaba economy. Up to the 1950s, this economy was mainly sustained by the culture, processing and export of its main agricultural product: coffee. However, there was no "coffee complex", which means that since the production was based on small farms, capital was pulverized, not generating any kind of externalities, neither from productive agglomeration nor from dynamic overflow to other sectors of the economy.

Buffon (1992, p. 262) indicates that the signs of the collapse of this economy became evident when the state migratory balance became negative. It was the "expression of a stagnated agrarian economy, destitute of greater perspectives". The tendency of decadence of this economy – due to the precarious production conditions and the collapse in the product's prices – was reinforced by the Federal Government's policy of eradication of the coffee plantations.

The crisis and productive disorganization to which the local economy was subjected may be illustrated by the fact that 53.8% of the Capixaba coffee plantations were eradicated and about 60 thousand jobs eliminated. As a result, an intense rural exodus was observed. The demographic indicators show that between the decades of 1960 and 1970 there was a 95% increase in the growth of urban population and only 10% in the growth of rural population (CELIN, 2009).

The crisis, on the other hand, created the conditions and motivations to favor the tardy industrialization that would be marked by the installation of heavy industries producing basic commodities.

The purpose of this item is to describe the main elements of the crisis that fell upon the peripheral formation in the tardy Brazilian industrialization; and the strategies adopted in order to endow it with new dynamics through the use of abundant factors (low cost land and labor), combined with new knowledge generated for the production of coffee and eucalyptus.

### 3.1 – GENERAL FEATURES, GENESIS OF THE CRISIS AND ON COFFEE GROWING IN ESPÍRITO SANTO

#### A – The initial formation of Capixaba coffee growing

Coffee production began in Espírito Santo on large plantations, with the use of slave labor and as a result of the expansion of cultivation in the Vale do Paraíba (São Paulo and Rio de Janeiro). Its initial impulsion, however, was not strong enough to economically invigorate the region.

The end of slavery and the coffee crisis that took place between 1897 and 1905 provoked the establishment of a new productive and agrarian structure. As a consequence, large properties were subdivided with the transition to a structure mainly marked by a partnership production system, besides the appearance and increase of importance of small independent producers (BUFFON, 1992).

According to Buffon (1992), this system based on small family properties began to characterize coffee dynamics in Espírito Santo. Added to this, European immigration, mainly of Germans and Italians, consolidated this agrarian type of structure (COSME, 1998). Thus, in a general manner, it may be said that the Capixaba coffee growing in the first half of the 20<sup>th</sup> Century was characterized by a low agrarian concentration and family production and, above all, by the near total absence of wage earners.

These features of the Capixaba coffee economy did not create any economic dynamics that were sufficiently strong to influence other sectors of the internal market, mainly a consumer market, as happened in other regions in the country (mainly São Paulo and Minas Gerais) based on the same monoculture. In this way, the planting of coffee in Espírito Santo did not provoke any change in the local productive structure and neither did it significantly affect the product's prices in times of crisis.

In moments of crisis of overproduction and the collapse in prices of coffee, the Capixaba economy, contrary to what was happening in the coffee growing region of São Paulo, did not present structural changes and neither did it make any significant movements to replace its cultivation. The producing units, despite the brutal reduction in the level of income caused by the collapse of the prices of coffee, maintained the coffee plantations and reinforced the production of subsistence in order to compensate the reduction in the purchase of certain products on the market. Therefore, the productive units became more self-sufficient, the trade flow was reduced and the accumulation process stagnated.. (ROCHA; MORANDI, 1991, p. 22)

In spite of this, it should be noted that coffee growing, in a state which is not economically dynamic, gained considerable relative importance, becoming the main economic activity. The data from the Coffee Census in 1920, reveal that this product already represented 17.5% of the cultivated area in each Capixaba rural establishment, besides having, in relation to the total surface, 5% of its territory used for growing the product, a proportion only inferior to São Paulo (7.0%) and Rio de Janeiro (6.8%), the main national producers at the time (CELIN, 2009).

## B – The Genesis of the crisis, the economic disorganization and the strategic solutions

Due to its productive structure, the expansion of which happened by means of the forest-coffee-pasture<sup>6</sup> cycle and that was predominant up to the middle of the 20<sup>th</sup> Century, the Capixaba coffee growing presented a low generation of surplus and since its expansion was mainly in the field, generated little urbanization dynamics. For Rocha and Morandi (1991), these singularities caused the Capixaba economy, as a whole, to have little dynamism.

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<sup>6</sup> This was based on the productive logic in which forests were cut down to create new coffee plantations and/or pastures. According to Cosme (1998), since the production technique was maintained, it was evident that there was little incentive for innovation in the production techniques.

Even with these characteristics, the socio-economic importance of the coffee production is registered in the data from the Coffee Census of 1960. It was verified that at the time, 68.1% of the state's economically active population (EAP) was employed in the agricultural sector, and 80% of which were dedicated to coffee planting. Besides this, the Capixaba production already represented 10% of the national production (CELIN, 2009).

The twenty years that followed after 1955 showed a longtime crisis in the prices of coffee and marked a new model of state intervention in the sector. Instead of an intervention to increase the regulating stocks, as in the previous crises, the Federal Government decided to eradicate anti-economic coffee plantations to balance the productive capacity with the demands of the consumer market, mainly the international market (COSME, 2009).

Considering the structural features of the Capixaba coffee growing economy, it may be said that the impact was relatively larger in Espírito Santo than in other states where eradication also took place. According to Rocha and Morandi (1991), the climatic conditions and terrain, the archaic production techniques used, besides showing an extremely low productivity, caused the coffee produced in the state to obtain lower prices. Besides the economic matters, the eradication of coffee plantations in Espírito Santo caused a serious social crisis. In Brazil 13% of coffee plantations were eradicated. However, Espírito Santo contributed with 22% of this and with 20% of all its entire cultivated area. This generated the loss of 60 thousand jobs (CELIN, 2009).

The eradication meant the demise of farming in a situation where the dependence of coffee was extremely meaningful. The question that was posed was: what activity would successfully replace the coffee culture?

From an economic development standpoint the solution to the crisis pointed to two distinctive areas of action. The first one was based on leveraging traditional economic activities developed in the State (coffee, cocoa, sugar and wood). The second, the fostering of activities that allowed the integration of the local economy to the national (through the road network) and international market (via the use of the geographical location, mainly through the port that would drain the export production).

The deployment of what became known as "Big Projects" was, in addition to the activities related to iron ore (expansion of Companhia Vale do Rio Doce and Samarco), also cellulose (Aracruz), steel (Companhia Siderúrgica de Tubarão), port (terminal of Transport Corridor for Export), shipbuilding (disassembling and shipbuilding shipyards) and tourism (investments in the south coast of the state). In such cases, these investments in a backward state can only be explained from the existing local factors (land with adequate climatic conditions and low prices, plenty of manpower and a given infrastructure to transport heavy materials).

It is noteworthy that in both cases the strategies to address a way out of the crisis did not mean any break with the logic to use the static comparative advantages. On the contrary, besides exploring them in full, it meant for the future, an increasing dependence on external factors (mainly prices) as determinants of the local economic dynamics. Furthermore, the installation of steel and cellulose plants showed a lower local integration of production and therefore a lower potential of opportunities for the low significance local capital.

#### **4. NEW MOMENTUM IN THE AGRICULTURAL SECTOR FROM THE ROOTING OF THE INNOVATIVE TRAINING: COFFEE AND CELLULOSE IN ESPÍRITO SANTO**

Despite the diversity of the adopted strategies to overcome the crisis that erupted in the social-economic development of Espírito Santo in the 1950/1960s, this item will focus on two of these strategies that were not explicit in them. In other words, the dynamics of boosting coffee production and promoting the production of bleached cellulose from the planted forests of eucalyptus, as originally conceived, were heavily dependent on static comparative advantages (mainly low-cost land and labor and fiscal and credit incentives). The entrepreneurship that was identified in individuals and organizations, however, overturned this logic and started a virtuous cycle of competitiveness, focused on (i) innovation that enables the learning process produced between and within the spheres of production of goods and services; (ii) knowledge; and (iii) economic and social capacity building. The two experiments to be analyzed have nuances that differentiate them (mainly their respective institutionalities) but also some that are common to them both (mainly the processes of internal and external cooperation to the organizations and the dissemination of innovations that generate positive externalities for a growing share of social-economic development of Espírito Santo).

##### **4.1 – THE FEASIBILITY OF A CULTURE WITH LOW AGGREGATE VALUE VIA KNOWLEDGE - THE CASE OF CONILON COFFEE**

According to Buffon (1992), conilon coffee<sup>7</sup> has become an alternative for farmers after eradication of the coffee plantations of the Arabic species. However, because it is a species with different characteristics from those grown until then, the support of the new product was neither automatic nor natural. The insertion of new species, even more appropriate to the climate and soil of the region, initially did not receive any support from the local institutional or financial community. The fiscal

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<sup>7</sup> - Arabic coffee (*Coffea arabica*) and conilon coffee (*Coffea canephora*) are of greater economic interest and are, respectively, 70% and 30% of world production. Arabic coffee has distinct characteristic from the conilon species, since it is a fine coffee, with a more distinct aroma and flavor. Because of this characteristic, the global demand and market prices for Arabic coffee is higher than that of the conilon coffee. This produces a coffee of inferior quality. However, their solids are much more soluble in water than the solids of *Coffea arabica*. Although the conilon coffee has a market value lower than the Arabic coffee, the liquidity of this commodity is ensured by the growing demand from the instant coffee industry and its use in blends (FERRÃO et. Alli., 2007).

incentives mechanisms created by the State were designed to diversify the agriculture of Espírito Santo, and not to support the monoculture of coffee (COSME, 1998).

It was not until 1973 that the Secretary of Agriculture of the State officially made the deployment of conilon coffee in the state. Early on, the expansion of the 'new coffee' came in both small farms with family labor and/or systems of partnership, as well as in the capitalist rural enterprises, with the employment and large-scale production.

The conilon coffee project conditioned that the farmers who received the free seedlings should necessarily adopt the planting level technology, due to the topography of the municipality and as recommended by the Brazilian Coffee Institute - IBC (Silva et.al 2007, p.550).

In any event, the use of new inputs and new production techniques was initiated. This resulted in higher productivity and higher quality of coffee, on which the level of knowledge was still very low. In addition, the installation of a instant coffee plant in the state to stimulated the creation of crops of the new product, accounting for a significant flow of demand.

The 'new coffee' growing in Espírito Santo has been built from the overcoming of great challenges. The knowledge that was accumulated by the 1980s was the result of such overcoming and it was primarily concentrated in the pioneering coffee growers. It is from this knowledge, that the work of the Capixaba Institute of Research, Technical Assistance and Rural Extension - INCAPER<sup>8</sup> that introduced in the grower's production systems more appropriate technologies for the rational exploitation of the species.

In 1983, during the visit of the technicians now extinguished Brazilian Coffee Institute - IBC to the seed-plot clonal multiplication of eucalyptus at Aracruz Celulose S.A., that the possibility was seen to adapt that process used by the company for the production of clonal seedlings of eucalyptus (*Eucalyptus*), in a large scale, for the clonal seedlings of Conilon coffee (PAULINO et al, 1994, p. 3).

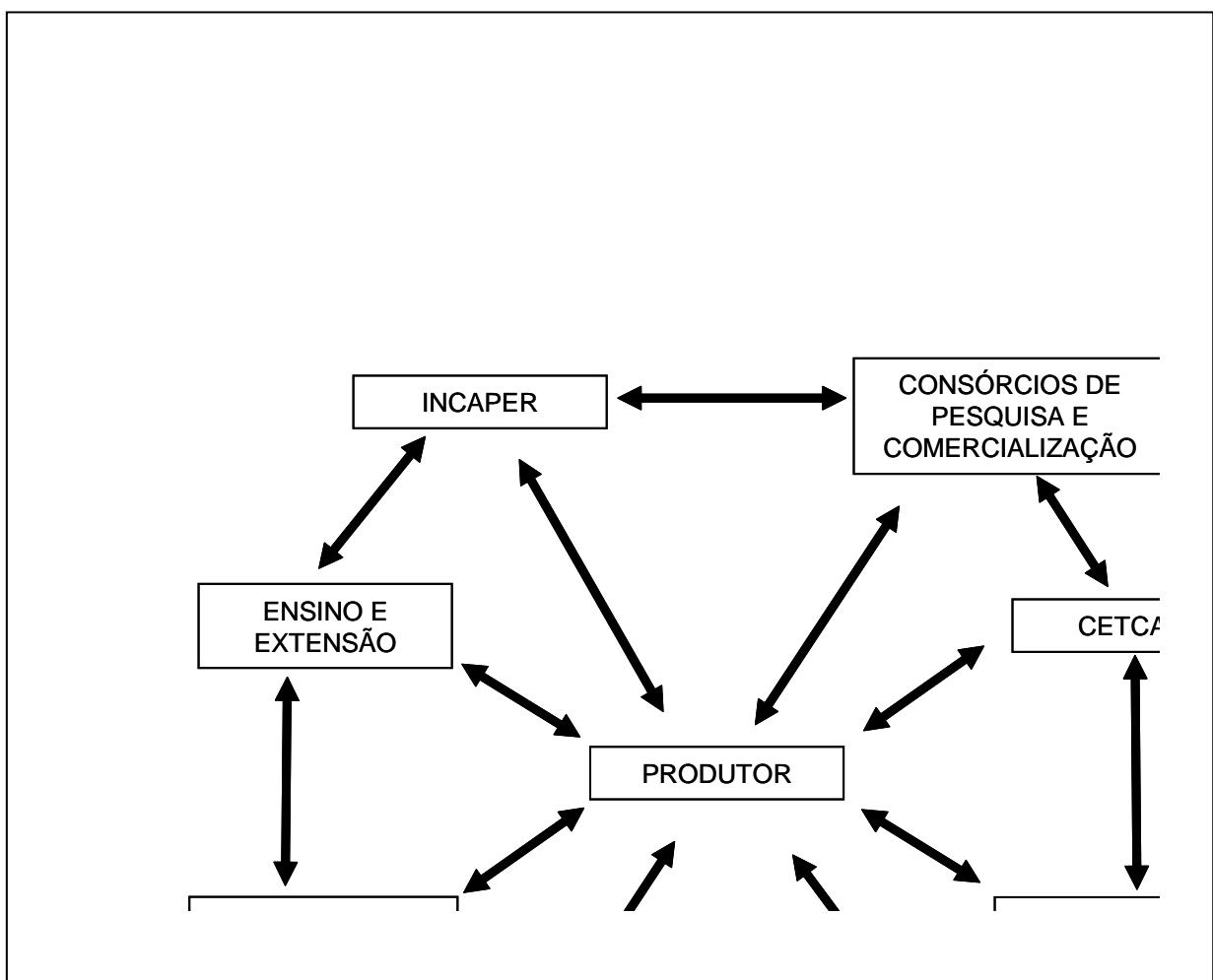
The first results of what at first seemed just a possibility, would emerge in 1993 with the introduction of the first clonal varieties. There was an increase in average productivity of conilon coffee from 9.5 to 26.6 bags per hectare (more than 150% growth) between 1993 and 2008, reaching 120 bags/ha on high tech and well managed farms. During this period, production had an increase of around 190%, from 2.4 to 7.4 million bags (COSME, 2009).

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<sup>8</sup> The INCAPER is the main institution related to research and technical assistance and rural extension in the state. Responsible for the generation, dissemination and transfer of technology and knowledge, and jointly with other public and private institutions (research, development, technical assistance, rural extension, associations, and others), have provided the institutional environment for the innovative process in the agriculture in ESPÍRITO SANTO (Freitas 2009).

Over time, the institutional arrangement eventually became a large network of organizations committed to the development of genetic innovations in production technologies and, above all, dedicated to provide access for producers (big or small) to new production techniques and technologies. The figure below is a simplified version and presents the main actors of such arrangement focused on coffee in Espírito Santo.

**FIGURE 2 - INSTITUTIONAL NETWORK FOCUSED ON THE CAPIXABA COFFEE - MAIN ACTORS**



The crucial point is that each of the agents participating in the institutional operation are geared towards cooperation and interaction, with the common objective of continuous improvement of the production processes, mainly focusing on building new productive and technological capacities. The table below summarizes each of their functions.

**TABLE 1 - INSTITUTIONALITY FOR COFFEE IN ESPÍRITO SANTO - MAIN CONSTITUENTS**

**ASSOCIATIONS:** The associations provide for the development of studies, researches and activities which give technological and economic support to the coffee production chain, through integration of R&D institutions and other components of the coffee sector. They include lines of research in agro climatology and physiology of coffee growers, genetics and improvement, biotechnology applied to the industrial chain of coffee, soil and nutrition, pests, diseases and nematodes, crop management, irrigation, social and economic sustainability. Also noteworthy is the Consortium of Brazilian Coffee Research and Development (CBP&D/ Café), which currently has more than 40 institutions, covering 12 Brazilian coffee producing states, and INCAPER and the Coffee Technology Development Center (CETCAF) participate in ESPÍRITO SANTO.

**CETCAF:** The Coffee Technology Development Center (CETCAF) is a non-governmental organization created in 1993, with the purpose of being the liaison between the various sectors of agribusiness in ESPÍRITO SANTO. Since its inception, it promotes an approach to the sectors of industry and export, besides articulating the union process of the coffee production chain.

**COOPERATIVES:** Besides the technical, managerial and cooperative support to its members, it contributes in the network of the production of coffee and among other things, it aggregates laboratory services, storage and marketing, production and sale of seedlings besides providing technical advice.

**INNOVATIVE COMPANIES / DISSEMINATORS:** Among the private undertakings two are noteworthy: Verdebras, a biotechnology company with a more traditional production of conilon coffee seedlings for the State, and Real Café, an undertaking that since the 70s buys conilon grown in Espírito Santo to use in the production of instant coffee, thus encouraging the planting and fostering the improvement of the product quality.

**FINANCING:** With regard to credit for such investments, the main institutions are the Development Bank of Espírito Santo (*BANDES*), the Banco do Nordeste do Brasil (*BNB*), the Banco do Brasil (*BB*) and Banco do Espírito Santo (*BANESTES*). In general, all these financial institutions encourage programs to improve the quality and productivity of coffee, mainly of family production.

**EDUCATION AND EXTENSION:** In the education scope, there are the institutions that are more agriculture work-oriented. /1} *The Federal Agro Technical Schools (EAF)* incorporated into the IFES - Federal Office for Education of Espírito Santo train professionals in the high school level, particularly agricultural technicians, many of whom are children of farmers, who contribute to the spreading of information and knowledge. On the other hand, the state has the National Service of Rural Learning (*SENAR*), a private and parastatal institution maintained by the rural employer class and linked to the Federation of Agriculture and Livestock of Espírito Santo (*FAES*), which aims at organizing, managing and implementing professional training and social promotion of youths and adults engaged in activities in rural areas.

**LOCAL GOVERNMENTS:** Municipal City Halls also constitute an important element of the institutional organization. They participate as a major partner in the dissemination of technologies, since they hold about 20% of clonal gardens and most of the seedling-crops. They have increasingly acted in the technical assistance and rural extension, through agreements with INCAPER, which has provided a higher qualification of their professionals, in terms of technological, methodological and drafting of credit projects.

Source: Adapted from Freitas (2009)

The suitability of the Capixaba conditions for conilon can be analyzed by its technical feasibility, economic viability and institutional capability.

#### *a - technical availability*

The process of development of seedlings for the planting from seed, in *C. canephora*, showed a number of disadvantages such as non-uniformity among plants, differences in size, fruit ripening, productivity and lack of resistance to certain diseases (PAULINO et al, 1995). The deployment of the variety and its initial

expansion would have to be provided through other techniques of vegetative reproduction. According to Silva (2007, p. 55),

The generation of information, knowledge and technology for the conilon coffee in the State has as its main reference point the technique of vegetative spreading which started in 1972, when experts of the Brazilian Coffee Institute (IBC) were able to root parts of the plant as poles of entire node and half node, resulting in seedlings with normal characteristics.

The success of this initial experiment allowed the emergence of research fronts, mainly carried out by the IBC and the private sector.

Due to the social and economic importance and the main problems encountered in the production of conilon, INCAPER initiated a program to improve the species, aimed mainly at providing the Capixaba growers with genetic material best suited to their needs, since up to that time, varieties used by producers were spreaded by seeds, with great diversity of plants, production and other characteristics, with limited management, low overall production potential and quality (FERRÃO *et. al.*, 2007, p. 205).

Because of these improvements, the productivity of coffee rose from 0.7 tons of coffee beans per hectare in the three years 1972/74 to more than 1.2 tons/ha in the subsequent three years, 1984/1986, representing an increase of 71% (ROCHA and MORANDI, 1991).

Genetic improvement, the main area of research and innovation applied to conilon, has contributed significantly to increasing productivity, improving quality and reducing production costs. This was because most genetic improvement programs aimed at the development of superior cultivars, which guaranteed larger profitability and economic stability to the producer. In this sense, new spaces for new techniques have been opened in order to make the expansion of the new culture technologically possible.

#### *b - economic viability*

In economic terms, factors that contributed to the viability of the new crop unlocked the problems of supply and demand. Regarding production, it was significant that municipal city halls have worked both in the construction of plant nurseries for the spreading and distribution of free seedlings to farmers.

In relation to demand, it has initially contributed to the installation of Real Café, as an important player buying conilon for the formation of a *Blend* with Arabic to produce instant coffee.

#### *c - institutional possibility*

Institutional barriers that needed to be overcome for the implementation of the conilon variety in Espírito Santo were significant. That is, initially all the institutional setting was turned to planting and cultivating Arabic coffee. Even IBC itself - the Brazilian Coffee Institute was initially opposed to the introduction of this

kind in the state. Thus, the introduction was made by default from the IBC and with secret technical assistance of the former ACARES.

Despite all the initial difficulties, the introduction of Conilon coffee in Espírito Santo unleashed a virtuous circle process due to the building of a shared common vision among agents involved in the production and commercialization of coffee. Such a vision recognized that an upgrade in the production system need to break with a pattern that relied mainly on static advantages and needed to be geared towards a more dynamic system based on knowledge creation, diffusion and use.

Moreover, as far as knowledge was concerned, it was need to continuously pursue a better understanding of internal and external physical, chemical and biological mechanisms that influence coffee tree and its grain. Besides that, it was also acknowledge that novelties should generate innovation that should result on higher productivity levels and should be accepted in the market.

Given the type of knowledge that is present in Lundvall and Johnson (1994), it is worthwhile to see how some of these would be included in the case being discussed.

<b>KNOWLEDGE</b>	<b>APPLICATION TO THE CAPIXABA COFFEE GROWING</b>
<i>Know-who</i>	Central element in the research process. Since innovations in the coffee matches a range of technologies based on knowledge of different areas, it is essential to identify their experts (in genetics, nutrition, soil, etc..).

That kind of knowledge is central to the activities of INCAPER and it connects the knowledge of various areas through their researchers with different backgrounds, besides being crucial to the development of new technologies generated from partnerships with other entities within or outside the state.

It should be said that when using this type of knowledge, by identifying the experts in each area, the researchers contribute to the process of *learning-by-interacting*, which is critical to the development of cultivars. This interaction and cooperation is important not only among researchers, but also with the producers, who have their process of accumulation of knowledge focused heavily on the *learning-by-doing*, but that are enhanced by its interaction with other entities of the formed institutionality.

<b>KNOWLEDGE</b>	<b>APPLICATION TO THE CAPIXABA COFFEE GROWING</b>
<i>Know-how (skills)</i>	The search for the solution of a problem goes through procedures based on skills related to standards of recognition, which are rooted in the experiences gained in the learning of the researchers.

In the case of genetic improvement that is a central axis of development of the Capixaba coffee growing, the selection of plants with superior characteristics requires that the researcher establishes criteria for both the phenotypic identification and the evaluation of the size and plant architecture, its uniformity and variance in

grain maturity. These practical skills are accumulated through experimental learning, and are manifested mainly in the form of tacit knowledge.

The *learning-by-interacting* as well, which in this case is directed to the development of innovative activities and helps reduce and overcome the uncertainties that are inherent in the process of experimentation. Building skills of both researchers and producers is crucial for the identification and selection of cultivars that have desirable characteristics.

All these efforts focused on knowledge have caused a continuous increase in the productive sphere of this crop's productivity in the state. It is noteworthy that this evolution in the productivity of conilon coffee in Espírito Santo is also due to major extension projects developed through the above-described institutional arrangement. According to Ferrão et al (2007), such projects involve 130 thousand families and 60 thousand properties. Furthermore, the cloned plants, which are the result of technological development and INCAPER researches, still according to the author, are present in 40% of the rural properties in the State.

#### 4.2 - COMPARATIVE ADVANTAGES OF THE CORE FOCUS OF KNOWLEDGE: ON THE EUCALYPTUS FORESTS OF ARACRUZ CELULOSE S.A.<sup>9</sup>

##### A) - The installation of Aracruz Celulose in Espírito Santo and the logic of comparative advantages

The rising cost of raw material for cellulose production - especially of long-term maturation of the wood traditionally used for this purpose - was, in the 1950s, the result of a series of studies aimed at developing technologies for the production of short fiber cellulose from eucalyptus. The results of researches and of new technologies generated led the sector, globally, to a revolution due to the fact that the significant cost reduction for undertakings located or which should be located in areas conducive to the cultivation of eucalyptus. From then on, and with the tightening of environmental legislation in countries, which are traditionally pulp producers (U.S., Canada and the Nordic countries mainly), the climatic conditions have been given weight in the designs of new enterprises.

The worldwide restructuring of the sector was strongly characterized by the geographical redistribution of production of cellulose, and the core countries strengthening the position of producers of paper, thus expanding the import of cellulose. These events contributed to the reconfiguration of the industry in Brazil with the entry of foreign investors in *joint ventures* which increased the production scale for export (Villaschi, 2009)<sup>10</sup>

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<sup>9</sup> - Aracruz Celulose merged with Votorantim Celulose e Papel in 2009 through the form FIBRIA. For purposes of this analysis we will only be made considerations for the period in which the Company operates as an independent and autonomous company.

<sup>10</sup> This reconfiguration was boosted by the Second National Development Plan (1974/79). Through this the Brazilian government sought to make efforts to cover the border area between underdevelopment and development. This goal encompassed some fronts: (i) consolidation of a modern economy, by setting up new industries and technology adaptation, (ii) adjustment to the new realities of the world economy, (iii) new stage towards national integration and (iv) a social

This flow of investments derived from an urgent need caused by the dramatic deterioration of the Brazilian economy that was mainly due to the oil shock and the critical situation of its external accounts, with structural deficits, that were continuous and increasing in the Balance of Payments. By these terms, the investments of the II PND (National Development Plan) were mainly intended to replace imports and diversify exports. The Government also put forward the concern for national integration, the economic incorporation of backward areas with the potential for exploitation of natural resources and that had some sort of geographical advantage in the regions.

In the wake of these facts, studies commissioned by the then state-owned Companhia Vale do Rio Doce<sup>11</sup> pointed to significant economic advantages in the exploration of commercial reforestation of eucalyptus. The recommendation of the location in Espírito Santo presented the following arguments:

The municipality of Aracruz, State of Espírito Santo has the soil and climate conditions conducive to the development of eucalyptus forests, since it (was) a region of economically meaningless activities, with land that is available at low prices, flat topography convenient for mechanization, a privileged location on the road system, near the main pole of development of the state and close to the sea, which would facilitate the construction of a port for the export of the product (PEREIRA, 1998, 188).

The company was made possible by a capital structure characterized as a *joint venture* among the international, private domestic and public capital (mainly through the then expressive BNDE - National Bank for Economic Development). Furthermore, it was designed to operate in an integrated manner - forest-plant-port - and self-sufficient with regard to natural inputs (PEREIRA, 1998). The plant went into operation in 1979.

Until merging in 2009 with Votorantim Celulose e Papel and being constituted as Fibria, Aracruz was the world's leading producer of bleached cellulose from eucalyptus<sup>12</sup> with a nominal production capacity of about 3.3 million tons per year of short fiber bleached cellulose from eucalyptus and in 2008 exported 98% of all its production<sup>13</sup>. The company has about 313 thousand hectares of plantations, interspersed with about 198 thousand hectares of native reserves. In addition to its own plantations, Aracruz foments the reforestation of eucalyptus-based third party plantations through the Forestry Program, which covers about 96 thousand hectares contracted with more than 3 thousand farmers in Espírito Santo, Bahia, Minas Gerais, Rio de Janeiro and Rio Grande do Sul (Aracruz, 2009).

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development strategy aimed at eliminating, as soon as possible, outbreaks of absolute poverty (CASTRO and SOUZA, 1985).

<sup>11</sup> - That intended to diversify its activity concentrated in the extraction, transport and marketing of iron ore.

<sup>12</sup> In this segment, in terms of countries, even taking into account the expansion of production in neighboring Chile and Uruguay, Brazil in 2010 should account for 55% of global production of this segment (Villaschi, 2009).

<sup>13</sup> In 2008, the distribution of sales of Aracruz Celulose was as follows: Europe (39%), North America (33.7%), Asia (25.1%), Latin America (0.3%) and Brazil (1.8%).

## **B) The core of knowledge in the implementation of eucalyptus forests**

The increase in forest productivity is the result of technological developments based on cloning and accurate technique for handling that enabled Brazilian companies to position themselves in competitive global frontiers of bleached cellulose from eucalyptus (Villaschi, 2009). This was the result of a combination of results of researches in universities, research institutes and businesses internally, most of them directed to genetic improvement, biotechnology, plant propagation, soils and plant nutrition, plant ecophysiology, forest protection and biodiversity, which had the common goal of obtaining plantations with high added value (Aracruz, 2009b).

According to Villaschi (1998), Aracruz Celulose S.A. has adopted strategies to ensure its position as a world leader in forestry development based on these technologies. Because of this, the company's actions are directed to the technological frontier and occur both in the products (species most appropriate environmentally and economically) and in the processes (technical forest management), through intensive programs of R, D&I.

R, D&I Programs are in three directions. Some are carried out through internal research effort, others by agreements with other research institutions. There are also those that are based on cooperation with competitors in the pre-competitive phases. These directions, however, are not exclusive and most programs work with the combination of them, making them complementary.

Aracruz Celulose started planting eucalyptus in late 1960s. The choice of eucalyptus was made in terms of its potential for producing wood for cellulose and also for its compatibility to the environmental conditions typical of Espírito Santo. The species initially considered suitable for areas of Aracruz were *Eucalyptus grandis*, *E. saligna*, *E. urophylla* and *E. alba*, so that the first plantations were established with these materials, from seeds produced in the Horto Florestal de Rio Claro - SP.

From 1973, a forestry research program was initiated aimed at the development of genetic materials. After evaluation of 55 species, a genetic improvement program was initiated of *Eucalyptus grandis*, *Eucalyptus urophylla* and the hybrids among them (Aracruz, 2009b).

With the advent of cloning on a commercial scale, great emphasis was given to the selection and spreading of superior trees resulting from the improvement program. The clonal forests obtained thereafter showed significant gains in productivity, uniformity and quality of wood, which allowed the cellulose produced by Aracruz to make a positive difference in the world market.

Thus, we can say that the introduction of more adapted species, the establishment of continued improvement programs of pure species and their hybrids, and the application of rigorous selection to identify superior individuals for forming

advanced generations of the population of *E. grandis*, *E. urophylla* and their hybrids, were primarily responsible for the success of the company.

### C - The institutional framework and forms of learning

The success in the technological development of Aracruz is based on various forms of learning. These involve large collaborative efforts and external interaction maintained by the CPT - Technology Research Center - by making the learning-by-interacting an aggressive business strategy of technological leadership for Aracruz Celulose.

By way of illustrating the construction and operation of this interaction focused on the generation and use of knowledge, the following are three projects in which Aracruz has played an important role.

#### C.1 – MIPIS PROJECT (Biodegradable Micro Bait-Holder)

The MIPIS project (Biodegradable Micro Bait-Holder) is part of the program to combat pests and forest damage kept by the Aracruz. The project is aimed at controlling ants (cutting ants), through two main components: the product "Bait-Holder," the process "Monitoring System" - the system that allowed the efficient use of bait-holders in the field without the need to apply techniques that are environmentally degrading (RODRIGUES, 2004).

<b>Company</b>	<b>Research Institutes / Universities</b>
Aracruz Celulose SA	ESALQ - Escola Superior de Agricultura Luiz de Queiroz of the São Paulo University
Equilíbrio Proteção Florestal S / C Ltda	
Atta Kill Ind. And Trade Pesticides Ltd.	

#### C.2 – THE BRAZIL EUCALYPTUS POTENTIAL PRODUCTIVITY PROJECT

The Brazil *Eucalyptus* Potential Productivity (BEPP) project studies 8 experimental sites in Brazil, located in Aracruz-ES, Eunápolis, Teixeira de Freitas-BA, Mogi Guaçu-SP, Luis Antônio-SP, Guanhães-MG, Bocaiúva-MG and Inhambupe-BA (IPEF, 2010). In each site, experimental tests manipulating water, nutrients or dominance with one or more clones have been carried out, to measure forest productivity (aerial and leaf biomass growth) and carbon balance (gross primary productivity estimated through measuring C flows to the radicular and breathing systems).

The purpose of the BEPP project is to understand the eco-physiological relations existing between the lumber production and use and the efficiency in the use of natural resources: water, light and nutrients, the so-called production ecology.

<b>Companies</b>	<b>Research Institutes / Universities</b>	<b>Development / Financing</b>
Aracruz Celulose S.A.	North Carolina State University	CNPQ

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Celulose Nipo-Brasileira – CENIBRA	ESALQ
Copener Florestal	University of São Paulo
International Paper do Brasil Ltda	Colorado State University
Suzano Papel e Celulose S.A.	USDA Forest Service
Veracel Celulose S.A.	
Votorantim Celulose e Papel S.A.	
V&M Florestal	

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### C.3 - THE GENOLYPTUS PROJECT (BRAZILIAN NETWORK OF EUCALYPTUS GENOME RESEARCH)

The project established a pre-competitive research network uniting the public and private sectors in the generation of genomic information regarding eucalyptus. It mainly works to discover, sequence, map and determine the function of genes of economic importance and species of "Eucalyptus" for further incorporation of such technologies in genetic improvement programs and forest production, with emphasis on the process of wood formation.

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<i>Companies</i>	<i>Research Institutes / Universities</i>
Aracruz Celulose S.A.	Embrapa - Recursos Genéticos e Biotecnologia
Suzano - Bahia Sul Celulose S. A.	Embrapa – Florestas
Ferro Gusa Carajás - CVRD	Catholic University of Brasília
Celulose Nipo Brasileira S.A.	State University of Campinas
International Paper do Brasil Ltda	State University of Santa Cruz
Jarí Celulose S. A.	Federal University of Goiás
Kablin S.A.	Federal University of Viçosa
Lwarcel Celulose e Papel Ltda.	Federal University of Rio Grande do Sul
Rigesa Celulose, Papel E Embalagens Ltda	
Instituto RAIZ de Investigação Florestal	
Vallourec & Mannesmann Florestal	
Veracel Celulose S. A.	
Votorantim Celulose e Papel S. A.	
Zanini Florestal Ltda.	

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### C.4 – RURAL EXTENSION – FORESTRY PRODUCERS PROJECT

The Forestry Producers Program created by Aracruz Celulose S.A. is carried out in a convergent manner and in partnership with the Forestry Extension Program of the State of Espírito Santo, aiming at enabling the offer of forestry raw material by means of the participation of small and medium sized rural producers in the State's reforestation programs, decentralizing the forest formation area and allowing the reduction of the pressure on natural forests (SIQUEIRA et al, 2004).

The Forest Producer Project was initiated in 1990 and it covers four states (Espírito Santo, Minas Gerais, Bahia and Rio de Janeiro), totaling 132 municipalities and 2,513 assisted producers (ANDRADE, 2009).

## 5. FINAL REMARKS

This paper shows evidence that the opportunities that might emerge in moments of crisis vary in time, space and, in many cases, according to specific economic segments. Therefore, while the Brazilian economy passed through unique structural changes caused by the conception and operation of the 'Plano de Metas' of the Juscelino Kubitschek Government (1956-1961), the state of Espírito Santo lived through its most severe socio-economic crisis.

During that period, while the remaining states (São Paulo, Minas Gerais and Rio de Janeiro) that comprise the highest industrialized region in Brazil (the Southeast Region), had their economies boosted by the building of basic infrastructure (power, roads, among others), as well as by incentives for the installation of industrial complexes to replace imports (cars, naval, among others), the state of Espírito Santo kept its territorial isolation and suffered a structural crisis in its main economic activity – coffee growing. This, with low productivity and low quality products, was more vulnerable to fluctuations of international prices than those practiced in other Brazilian states (mainly São Paulo, Minas Gerais and Paraná).

The specificities of the crisis that affected the small Capixaba state in a period of strong economic vitality of the Brazilian formation, however, opened windows of opportunity sought due to on a necessity consensus (MEDEIROS 2009).

The first of these opportunities was the attraction of intensive investments with located advantages (mainly low priced land, port infrastructure); the second was the erection of an institutional framework (including financing mechanisms and fiscal incentives) that would allow the installation in the state of wage goods producers (mainly food, clothing and furniture) that aggregate value to the local production; and the third, a 'clandestine' (in a first moment) articulation between municipal administrators and agricultural technicians with the purpose of recuperating the coffee growing activity with species that are more adequate to the local climatic conditions and topography.

This paper discusses the trajectories followed by two experiments within these sought windows of opportunity. The first one, regarding the appearance and consolidation of a 'new coffee growing' structure, is described in the analysis made herein as the building of social and economic capacities deriving from an increasingly complex institutional arrangement involving research, extension, primary production, processing and trading of conilon coffee.

The second discussed experiment is the establishment in Espírito Santo of eucalyptus planted forests for the production of bleached cellulose for export. This establishment, in a first moment, had as its main attraction the availability of vast low cost areas of land and adequate for intensive mechanization. But the competitive dynamics of an industrial unit built for the production of short fiber cellulose was carried out over the last forty years, more centered on innovative capabilities for the

production of clonal seedlings, as well as for forest handling of its main raw material – eucalyptus wood.

In both cases the significant technological progress obtained from the well articulated cooperation networks was built over time. These networks were structured by local R&D teams (in the case of coffee by a public institute; in the case of eucalyptus by an in-house team), and were mounted through articulations with other research groups on national and international levels. For this reason, in this field of knowledge generation, it may be said that regarding the continuous improvements in the production of cloned eucalyptus and coffee seedlings, as well as in the advances in agronomic handling of both cultures, the local production has access to the borderlines of the world.

The institutional arrangements that allowed these respective technological availabilities to be incorporated in a growing way to the production processes of coffee and eucalyptus planted forests in properties of various sizes are also noteworthy. This diffusion process supported by these institutional arrangements has enabled capabilities in the economic (with growing levels of competitiveness for coffee and cellulose produced in Espírito Santo) and social (with improvements in the standards of living and in the way that the Capixaba agricultural production incorporates environmental sustainability values) fields.

From the point of view of building public policies (not necessarily nor exclusively governmental), it may be said that in both cases these were well succeeded even though they were based on different logics. In the case of coffee, the participation of government agencies was fundamental, both for the offer of seedlings, as well as for the diffusion of new agronomical handling techniques. In the case of eucalyptus, both the advances in the production of seedlings, as well as the diffusion of handling techniques were carried out by an anchor-company, the final activity of which is the production of bleached cellulose.

Thus, in the case of eucalyptus, the rapid diffusion had as a fundamental inductor the purchasing power of the anchor-company. In the case of coffee, the diffusion process was of greater institutional complexity since it involved various agents (cooperatives, financing system, conilon coffee processors and product exporters).

From the point of view of preparing and operating policies, in both cases it may be said that the main pillar was the building of capacities through processes of learning-by-searching. This is due to the fact that a considerable portion of acquired knowledge was still under the tacit form and incorporated into few researchers and/or research teams. It should also be noted that in the search for know-how for the production of seedlings, as well as for the handling of plantations in different scales of farms, the search for varied processes of learning-by-interacting were fundamental among the agents operating in the spheres of production in itself, knowledge and generation/diffusion of innovation.

Moreover, this interactive process has allowed positive externalities in other activities on properties with coffee production and/or eucalyptus planted forests, as well as in other productive units. This occurs both with reference to the search of economic sustainability, as well as with that of environmental nature. This is not a small result when it is known that the ‘new coffee’ and eucalyptus plantations took place in a socio-economical formation with strong roots in predatory agriculture.

The transformation of this vicious cycle in a virtuosity of knowledge-innovation-production which is economically, socially and environmentally sustainable deriving from growing learning-by-doing/using/interacting processes may be seen as a positive inspiration for public policies in other business segments and other socio-economic formations.

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