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**ORGANIZATIONAL R&D MODEL AND NETWORKED
INNOVATION AT A BRAZILIAN PUBLIC RESEARCH INSTITUTE IN
LIGHT OF RECENT PRACTICES**

MARTHA DELPHINO BAMBINI

Analyst at Embrapa Informática Agropecuária

Av. André Tosello, 209 - Barão Geraldo - Caixa Postal 6041

13083-886 – Campinas/S.P. - Brazil.

E-mail: martha.bambini@embrapa.br

ANDRE TOSI FURTADO

Professor at Scientific and Technological Policy Department – DPCT

State University of Campinas – Unicamp

R. João Pandiá Calógeras, 51 - Cidade Universitária Zeferino Vaz

13083-970 - Campinas/S.P. - Brazil.

E-mail: furtado@ige.unicamp.br

Abstract

This paper maps the evolution of the institutional and organizational structures employed by the Brazilian Agricultural Research Public Corporation (Embrapa in the acronym in Portuguese) in organizing and managing its Research and Development (R&D) projects portfolio. The recent key changes undertaken at Embrapa's R&D management model started in 2011 were described and analyzed through a qualitative research using the case

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study methodology. Several sources of evidence were employed both primary and secondary.

The Innovation System theoretical framework supports the analysis of Innovation in Agricultural Sector, considering the actors and institutions involved and the main challenges and transformations occurring of the XIX century.

The analysis of the academic literature about Embrapa and the study of internal documents offered a detailed overview of the company, since its foundation, considering the main challenges of each historic period and the strategies undertaken. This paper describes the main institutional and organizational changes undertaken by Embrapa from 2011 on, some of them being still under course.

The main recent reorganization efforts refer to: the revision of corporate policies; improvement and integration of information systems to build a business intelligence logic; and several transformations of R&D organizational model and practices by the establishment of corporate thematic project portfolios. Considering that these efforts are still very recent, there are still no information about the efficiency and efficacy of this new research model in attending the main challenges that are presented to the Brazilian agricultural innovation system. Further studies could analyze whether this new organizational model for research management would meet the proposed objectives of the recent reorganization of Embrapa's R&D Model.

Key words: *agricultural research; agricultural innovation system; innovation; organization model; Embrapa*

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Since the 1980s, the multidisciplinary literature related to Innovation studies have been emphasizing the interactive, adaptive and multifaceted character of innovative processes (KLINE AND ROSENBERG, 1986; FREEMAN and SOETE, 1997; CHESBOROUGH, 2003). According to this set of ideas, innovation is a result of negotiations, exchanges and decisions taken by heterogeneous arrangements composed of multiple parties such as research institutes, universities, private companies, among other actors.

The systemic approach of innovation was developed in the 1980's, and considers that a innovation is a result of the interaction of several actors that establish several relationships in order to produce, diffuse and appropriate new and economically useful knowledge in within a country (LUNDVALL, 1992; NELSON, 1993). The concept of National Innovation System, according to Lundvall (1992), involves the reunion of several elements and relationships which interact in the production, diffusion and use of new and economically useful knowledge. Its core activity is learning, a dynamic social activity characterized by interactions between individuals, combinations of existing knowledge and both by feedback and by reproduction.

The figure of a National Innovation System is an artificial construct developed to analyze the group of institutions that influence the technological capabilities of a nation, the processes by which they are developed through education and training, the business culture of the country, the financing agents and their mechanisms, the managerial decisions and working practices of the firms, and so on.

The systemic innovation approach is characterized by intensive formation of networks of organizations, permeated by institutions and policies that affect their behavior and innovative performance regarding the generation of new products and processes that are socially and economically appropriate (LUNDVALL, 1992; NELSON, 1993).

This broader approach regarding innovation assumes the influence of a larger number of type of actors in the innovation process, not just organizations that perform activities in the field of Science and Technology. Considering that the innovative activities and practices

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occurring in a given country are immersed in a broader economic system, several elements have to converge to complete the innovation cycle, with the effective use of new knowledge of technologies. Some of these elements are: adapted productive systems and infrastructure, institutional setting (regarding regulations, public policies, laws, norms and practices), capital availability and adapted organization models of the involved actors.

Edquist (2006) states the rapid diffusion of the Innovation System approach in the academic field as long as their variants: national, sectoral or regional. The sectoral approach is based on the differences in characteristics, sources of technological opportunities, knowledge domain, actors, institutions, relationships and policies that influence innovation processes in the various industrial sectors (MALERBA, 2006).

Agriculture and livestock have been considered for a long time as traditional and conservative sectors, when compared to industrial sector such as automotive, pharmaceuticals, telecommunications and software, as stated by Castro (2010). This view is no longer dominant, considering the transformation process of agriculture, initiated in the 1990's, with the increase in the knowledge base and in capacity building, and characterized by the growing incorporation of technologies in productive processes, increasing productivity and adding value to agricultural products.

Several authors have applied the systemic innovation perspective to agricultural sector (HALL ET AL, 2005; WORLD BANK, 2007; SALLES-FILHO ET AL, 2007; MENDES, 2009). Salles-Filho et al (2007) point out that the concept of an Agricultural Innovation System express the strong integration and economic importance of this sector, considering the context of a dynamic agribusiness sector, involving suppliers, producers, processors, distributors and other actors that together provide agricultural products to end consumers.

An Innovation System is characterized by intensive networking of organizations, permeated by institutions and policies that affect their behavior and performance to generate new products and processes. In the 1990's several authors studied the figure of Innovative Networks (FREEMAN, 1991; POWELL ET AL, 1996).

Immersed in a given institutional setting, networks have been described as an important locus of innovation (Powell et al, 1996), enabling sharing of assets, information, skills and resources to generate innovations, transcending organizational boundaries and involving the development of relationships with external partners and leading to the formation of inter-organizational arrangements. Building and managing innovation networks are not an easy task; it can be costly and sometimes not that efficient or effective regarding the achieved outputs.

This research was motivated to understand the dynamics of networked innovation

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processes occurring in the Brazilian innovative institutional setting with participation of the research teams from the Brazilian Agricultural Research Public Corporation (Embrapa in the acronym in Portuguese).

Embrapa is a Federal Government owned research company that has the mission of providing feasible solutions for the sustainable development of Brazilian agriculture through knowledge and technology generation and transfer (EMBRAPA, 2013). The company, founded in 1973, is a highly networked organization, formed by 47 Research and Service Centers distributed throughout Brazil. Embrapa can be categorized as a Brazilian Public Research Institutes (PRI) related to agriculture sector, as other public research companies, universities and other Government funded research centers. It is well established that universities and public funded research centers have an important role in developing relevant knowledge in developed and developing countries, and that they effectively contribute to technological change and economic growth (ROESSNER ET AL, 2013).

Regarding developing countries, Gouvea and Kassiech (2012) consider that Innovation Systems institutions and policies have been implemented with some delay, and there are still some improvements to be made, Besides that they stress the existence of significant innovative cluster arrangements in manufacturing, information technology, aerospace technology and agriculture, naming Embrapa as one positive example of innovative public company, highlighting its important contribution to reshape agribusiness in the country.

Therefore, this paper aims to map some organizational and managerial aspects related to Embrapa's R&D organizational model, characterized by dynamic networked innovation processes. The analysis takes into consideration the literature about Agricultural Innovation Systems, considering national challenges and the intense incorporation of technology in the development of new products and to promote productivity increases. The research was conducted by the analysis of primary and secondary data, collected through presencial and phone interviews and by the analysis of secondary data from case-studies about Embrapa and about other private companies with intensive R&D structures.

The next section describes an overview of the literature regarding innovation in the agriculture sector. Follow the methods employed and the empirical findings, providing an outlook of the evolution of Embrapa's organizational research model. The main conclusions and suggestions for further studies are presented at the end of the paper.

2. Agriculture and Inovation: concepts, challenges, actors and interactions

The concept of National Innovation System, according to Lundvall (1992), involves the reunion of several elements and relationships which interact in the production, diffusion

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and use of new and economically useful knowledge. Its core activity is learning, a dynamic social activity characterized by interactions between individuals, combinations of existing knowledge and both by feedback and by reproduction.

Nelson (1993) points out that the systemic approach emphasize the performance of a set of actors that together exert an important role to influence the innovative performance of a nation. The success of any specific technical innovation depends on other related changes in productive systems, infrastructure and capital availability. This broader approach regarding innovation assumes the influence of a larger number of actors in the innovation process, not just organizations that perform activities in the field of Science and Technology.

Lundvall (1992) points out that innovation is a ubiquitous phenomenon in the modern economy, and can be found in virtually all sectors of the economy, albeit with differences in intensity. Malerba (2006) stresses that innovation greatly differs across economic sector, proposing a sectoral systems framework. The author emphasizes that there could be several levels of sectoral aggregation, depending on the goal of the analysis (p.400). Some of the differences described by the author relate to knowledge domain, sources of technological opportunities, sources of knowledge base and cumulateness, actors and relationships established and institutional environment. The author employs the sectoral approach to analyze innovation processes occurring in different industrial sectors.

Castro (2010) states that agriculture and livestock have been considered for a long time as traditional and conservative sectors, when compared to industries, such as automotive, pharmaceuticals, telecommunications and software. This view is no longer dominant, considering the transformation process of agriculture, initiated in the 1990's, with significant increases in the knowledge base and in capacity building, with growing incorporation of technologies in productive processes, leading to greater productivity and adding value to agricultural products.

Contemporary agriculture is characterized by an intense incorporation of emergent technologies in innovation and also in productive processes, such as biotechnology, nanotechnology, information technologies, precision agriculture, geographic positioning technologies as well as sustainable and ecological concepts. It represents a new technological context characterized by the generation and intense use of data and information.

Several important changes occurring in contemporary agriculture development setting, pointed out by World Bank (2007) are presented below:

- a) the increase importance of markets in driving agricultural development (instead of production) adding product value by diversification and niche economies, instead of only by productivity gains;

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- b) regarding niche economies, traditional food sectors are structured according to value chains with growing product differentiation;
- c) a new dynamic environment for agriculture and agricultural products related to production, trade and consumption is evolving in unpredictable ways, with innovation playing a central role to provide competitiveness both to farmers and private companies;
- d) a growing role of the private sector (regarding the development and supply of several products such as seed, fertilizer, pesticides, and machinery) with the increasing intensification of agriculture;
- e) knowledge developed in other sectors or for other purposes has been applied to promote agricultural innovation; the matter of taking advantage of existing knowledge is as urgent in this sector;
- e) increased educational levels and interaction among different types of actors to develop responses is changing the knowledge structure and knowledge base;
- f) the growing globalized setting related to agricultural development raises several important issues: demand is not define only by domestic markets; existence of environmental and health issues that cross the borders of any country, international sources of knowledge and information spread through internationally organized networks of practitioners;
- g) some challenges such as hygiene and public health management, such as nutritional aspects related to deficiencies and obesity, are new demands that have called press attention and triggered public interventions;
- h) concerns over food safety and availability may influence input use and post-harvest management more than costs;
- I) labor and water productivity may be an issue as important as (or more important than) land productivity.

New theoretical and analytic approaches and frameworks are required to respond adequately to the opportunities and threats that the transformation of agricultural context and processes, providing new opportunities for innovation. Hall et al (2005) describe the Agricultural Innovation System (AIS) framework that addresses the dynamic and multi-faceted role of contemporary agriculture science and technology as well as the institutional dimensions of its performance. World Bank (2007) states that the AIS approach has evolved from a concept into an entire sub-discipline, with principles of analysis and action.

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2.1 Agricultural Innovation System framework: actors, interactions and innovations

An Innovation System is formed by a network of organizations, such as research institutes, private companies, government organisms, and farmers cooperatives, that provide new products, new processes and new organizational forms into economic us, embedded in a set of habits, practices, routines, rules and laws provided by institutions in order to regulate t their behavior, relationships and performance (HALL ET AL, 2005; WORLD BANK, 2007).

Hall et al (2005) highlight the importance of institutions and practices that encourage the creation of relationships between individuals and organizations, based on trust and cooperation, in order to generate capital. Cooperation is essential for the generation of innovation in agribusiness, so the figure of the arrangement of institutions - the network - appears as complementary to the figure of the Innovation System (Salles-Filho et al, 2007).

Salles-Filho et al (2007) point out that a sectoral innovation system is linked with other sectoral systems and the national innovation system of a country. The authors note that many sources of agricultural innovation ultimately relate to other sectors such as automotive, chemicals and processing industry. Considering the definition of an agribusiness sector, involving suppliers, producers, processors, processors and distributors that together provide agricultural products to end consumers, the systemic approach to express the strong integration and economic importance of this sector.

The attraction of the innovation system framework applied to agriculture emerges, however, not only from the holistic and conceptually-convincing explanation of knowledge production and use, but also to identify and categorize the actors and processes that are important to the contemporary agriculture.

Edquist (2006) stresses the general conceptual diffuseness present in the Innovation System approach. The term “institutions” is employed in different senses by various lines of studies. The author defines institutions as the common habits, norms, routines, rules and laws that regulate the interactions and established at a given Innovation System.

On the other hand, the author considers that organizations are the actors embedded in this institutional setting as firms, public research institutes, venture capital organizations, governmental organisms, and so forth.

Interaction and cooperation among actors in the Agricultural Innovation System are strongly related to the institutional setting and its evolution. Salles-Filho et al (2007) point out that there is a self-organizing character of institutions, technologies and organizations to promote the generation of innovations and sectoral development.

Institutional innovations, according to the authors, seek to promote new ways of using

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and valuing knowledge assets, develop new innovative assets, respond to increases in inter-organizational competition related to the changes in the existing organizations, and to promote flexibility and incentives to identify and incorporate responses to environmental challenges and market demands. They can relate to changes in mission, legal format, infrastructure, administration, research management, competences, responsibilities, articulation and interaction formats, coordination mechanisms and contractual arrangements.

The authors consider that institutional innovation can be viewed according to an individualized approach or a systemic point of view. **Individualized institutional innovation** regards the processes in reorganization of organizations to modify its role and competitive insertion in a given innovation system. **Systemic institutional innovation** relates to improvement of innovation policies, intellectual property legislation and practices, financing sources and strategies, mechanisms of prospecting demands and disseminating technological information and products, standardization, cooperative programs, formation of research networks and establishment of new institutes or agencies.

The authors also emphasize that institutional innovation can influence Innovation Systems with varying intensities, considering macro, meso and micro levels, according to their degree of influence to the whole system. The **micro level** regards changes conducted internally to the organizations, in order to promote increases in efficiency of management and efficacy of results. The **meso institutional level** relates to the interfaces and interactions among the organizations in an Innovation System. The **macro level** refers to the external setting where organizations are embedded.

The next section describes the Brazilian Innovation System and its influence on the agricultural sector.

2.2 Institutional setting and technological innovation in Brazilian Agriculture

In developing countries, such as Brazil, Innovation Systems institutions and policies have been established with some delay when compared to developed economies. Gouvea and Kassiech (2012) describe an important delay in the implementation of a strong institutional framework to support innovation in Brazil, when compared to developing economies. Legislation regarding intellectual property was promulgated in 1.996, with some additions in 1998 (regarding author's rights and software). In 2005, the so-called "Technological Innovation Act³" was promulgated in Brazil. It is the main legal framework to promote technological innovation and contribute to the delineation of a favorable scenario to scientific development in the country.

Even with the implementation of legal mechanisms to promote technological

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innovation, there are still several aspects to be improved, specially to increase the presence of private companies in innovative arrangements. Brazilian innovation indicators are still lower than other BRICS (Brazil, Russia, India, China and South Africa) and OECD countries, although some progress was made regarding the qualification of STI human resources and the growth of the number of publications and patents generated in the country (OECD, 2012).

Besides that, the authors stress the existence of cluster arrangements in manufacturing, information technology, aerospace technology and agriculture, and name Embrapa as one positive example of innovative public company, highlighting its important contribution to reshape agribusiness in the country.

Regarding the Brazilian Agriculture institutional setting, Castro (2010) emphasizes the influence of a positive ambiance characterized by the existence of well established organizations and institutions to support these changes such as: competitive firms, agricultural research institutes, world trade rules, national regulation, government policies (innovation, industrial, technological, intellectual property), funding agents as well as networking efforts and interactions among them.

The National System of Agricultural Research (SNPA, the acronym in Portuguese) was enacted in 1992, as an institutional construct coordinated by Embrapa formed by Agriculture Research Institutions (in the Federation States), universities and other research institutes as well as other public and private organizations that directly and indirectly contribute to agricultural research and knowledge generation (MENDES, 2009; EMBRAPA, 2013). In the same period there has been several changes in the macro institutional setting related to industrial policy, technological programs (biotechnology), funding and other innovation incentives (CASTRO, 2010).

Although there has been some changes in the roles and relationships of Embrapa and the other actors in within the SNPA caused by strategic directive asymmetries, limitations of funding and coordination difficulties over the years, this broad arrangement contributed to build a strong knowledge-base related to tropical agriculture.

3. Methods

This study was initiated in 2010, during the master research project of Bambini (2011). A qualitative research was conducted employing the case study methodology (YIN, 2010) based on several sources of evidence both primary and secondary (analysis of internal documents, semi-structured interviews and review of recent literature about Embrapa's organizational model). The analysis of the academic literature about Embrapa and the study of internal documents offered a detailed overview of the company, since its foundation,

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considering the main challenges of each historic period and the strategies undertaken. This paper maps the evolution of the structures employed by the company to organize and manage its R&D projects portfolio, focusing the recent key changes undertaken at Embrapa's R&D management model from 2011 on.

4. Empirical findings

Embrapa is a Federal government owned research company that has the mission of providing feasible solutions for the sustainable development of Brazilian agriculture through knowledge and technology generation and transfer (EMBRAPA, 2013). The company, founded in 1973, is a highly networked organization, formed by 47 Research and Service Centers distributed throughout Brazil, and by an international branch formed by several laboratories and business offices located in North, Central and South American countries such as United States, Panama, Venezuela, and also in Africa, Asia and Europe. Embrapa possesses a complex organizational structure and an institutional strategy that encourages and support the creation of Research, Development & Innovation (R&D&I) networks.

Embrapa can be categorized as a “networked company” in itself, as described by Castells (1999): “a company that changed its organizational model in order to adapt to unpredictability and to fast economic and technological transformations of this new world. The network format is inherent to the company either internally or externally”.

4.1 Embrapa's organizational trajectory between 1973 and 2010

Several authors describe the evolution of the organization of federal agricultural research structure from the 1970s until the 2000s (MENDES AND ALBUQUERQUE, 2007; MENDES, 2009; BIN E SALLES-FILHO, 2012). Table 1 presents a compilation of these descriptions, describing the different models of agricultural research organization employed in Brazil since 1971, when the federal agricultural research was also coordinated by the National Agricultural Research and Experimentation (DNPEA in the acronym in Portuguese).

This overview highlights the organizational trajectory that has been developed to organize Brazilian agricultural research in different periods, in order to cope with the

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challenges of agriculture that arise along history. Since the 1970s, the company has established corporate actions of research planning and, since the 1990s, efforts to the elaboration of scenarios and strategic directive plans.

These practices have been supporting the implementation of organizational innovations regarding Embrapa's R&D model. According to Mendes (2009), considering that Embrapa's organizational and R&D models influence in the decision processes and interaction among organizations of the SNPA, and also their relationship with private actors, it is adequate to consider that they represent meso institutional innovations embedded in the Brazilian Agricultural Innovation System.

4.3 Embrapa Management System (SEG)

The strategy of stimulating Research, Development and Innovation (RD&I) networked projects has been followed by Embrapa since the end of the 1990s. This strategy focuses on selecting and articulating external partners and Embrapa's research centers with complementary competences, resources and objectives to optimize both the company efforts and the research results obtained.

In order to accomplish this strategy, the organizational structure, practices, norms and R&D model have been continuously improved over the years. The actual model is the Embrapa Management System (SEG in the acronym in Portuguese), implemented in 2002.

SEG implementation was motivated to enable the sharing of resources, skills and infrastructure between Embrapa centers and external partners; participatory prioritization of research objects and management of R&D initiatives at Embrapa. It is based on the principle of organizing and managing a portfolio of R&D projects) and the related collaborative arrangements formed to develop them) according to different objectives and levels of complexity. A number of 6 macro-programs were established based on the purpose of the project and the complexity of the arrangements to be formed.

Several colegiats were implemented, with deliberative or consultative status, responsible for project selection, program management and evaluation of R&D results. In 2009, the colegiats of SEG were::

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- the National Advisory Council, formed by 28 member, have a consultative role and support Embrapa in the coordination of the SNPA, identifying demands and expectations of various segments of society;

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Timeline	Organizational Model of Federal Agricultural Research in Brazil	Facts & Events
1971 to 1973	<p>DNPEA Diffuse Model with no integrated planning initiatives.</p> <p>Bottlenecks: disconnection and little interaction between researchers and farmer's reality, low dynamism in the management structure, lack of mechanisms for planning, prioritization and evaluation of research, human resource challenges (quantity and qualification) and inadequate funding mechanisms and resources.</p>	<p>Need for institutional and operational restructuring of the Brazilian agricultural research system.</p> <p>1972-1973: constitution of a working group and proposal of creation of a national company of agricultural research in Brazil.</p>
From 1973 to 1985	<p>Concentrated Model of Research: centralization of initiatives and consolidation of a technological trajectory based on the modernization of Brazilian agriculture.</p> <p>Definition of Planning System for Agricultural Research.</p> <p>Directing research by national issues and division problems "before the farm gate", "inside the farm gate" and "after the farm gate."</p>	<p>New institutional model, incorporating the federal agricultural research in indirect administration.</p> <p>Institution of the National Agricultural Research Plan, integrating national and regional research centers and universities</p> <p>1974: Creation of the Brazilian Technical Assistance and Rural Extension Enterprise (EMBRATER) and its system SIBRATER</p>
End of the 1980s	<p>Circular Programming R&D Model / Research Model by Demand</p> <p>Increased complexity of the organizational model to support a broader mission and multiply interaction with society</p> <p>Establishment of National Research Plans (PNP) by Resource and product.</p>	<p>1988: Brazilian Constitution is enacted, with new criteria for distributing Governmental resources, reducing Embrapa's annual budget.</p> <p>1991: First strategic planning action at Embrapa.</p> <p>Incorporation of demands prospecting to define research priorities.</p>
1992 to 2000	<p>Implementation of Embrapa Planning System (SEP) Consisting of about 20 National R&D Programmes, focused on products, strategic themes and Eco-regions.</p> <p>Systemic approach, based on multi and interdisciplinary research.</p> <p>Involved three main processes: 1) identifying and prioritizing demands; 2) proposal, analysis selection of</p>	<p>1991: Dissolution of EMBRATER</p> <p>1992: Enactment of the figure of a National System of Agricultural Research (SNPA) by the Ministry of Agriculture</p> <p>1999: Implementation of the Sectoral Funds for Science and Technology, specially CT-Agribusiness.</p>

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	projects; 3) execution, monitoring and evaluation.	
From 2002 to 2010	<p>Embrapa Management System (SEG)</p> <p>Creation of 6 macroprograms based on the purpose of the project and complexity of the arrangements to be formed; establishment of decision-making collegiates responsible for project selection, program management and evaluation of R&D results; definition of a set of standards, procedures and guidelines for conducting and activities of Research, Development and Innovation .</p>	<p>Motivation: enable the sharing of resources, skills and infrastructure between Embrapa centers and external partners; participatory prioritization of research objects and management of R&D initiatives at Embrapa.</p> <p>Basic principle: organizing and managing a portfolio of R&D projects and the related collaborative arrangements formed to develop them.</p>

Table 1: Evolution of the Organizational Model of Federal Agricultural Research in Brazil

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- Program Managerial Committee: it is responsible for strategically manage projects portfolios defining thematic lines and considering corporative guidelines;
- the Technical Commissions for the 6 macro-programs, with a tactic character, are responsible for selecting, monitoring and evaluating R&D&I project portfolios to guarantee scientific and technical quality, strategic merit and the results do be obtained.

SEG was implemented through a set of 12 norms that state functioning procedures, relationships and practices of SEG (MENDES, 2009), defining a set of standards, procedures and guidelines for conducting and activities of Research, Development and Innovation. SEG provides a managerial structure to plan and coordinate its research activities and projects considering also technology transfer, communication and institutional development (Embrapa, 2013).

It is important to highlight that these procedures have to be followed by the company's research centers and also by their external partners that belong to collaborative arrangements funded by Embrapa. We can say then that Embrapa's institutional procedures tend to be employed to manage several activities in the RD&I networks that the company participates. Because of that Embrapa's set of management practices prevail in the networks, as dominant procedures being followed by the other partners (BAMBINI, 2011).

Even with the existence of dominant managerial practice, networked innovation processes can be very costly in terms of personal time of the manager, communication and coordination efforts. And also, some administrative and business processes related to contracts, financial norms and project management structure can be very bureaucratic and consuming.

After almost a decade of existence, SEG organizational model have undergone some changes in structure, aimed at reducing its fragility and strengthen the key aspects of this system. An external evaluation project was conducted in 2010 and a task force group was nominated by the President Director of Embrapa, with representation of several central departments and research centers.

This reorganization movement was conducted to print a strategic view on Embrapa's business in order to promote convergence of initiatives and integrate scientific and

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technological competences and economical resources. Evaluation focused on the macro-programs from interactive analysis between the strategic, tactical and operational aspects through indicators and metrics to measure effectiveness, efficiency and effectiveness of the system. The results of this external evaluation are described by Bin & Salles-Filho (2012).

4.4 Reorganization of Embrapa Management System: SEG -Phase II

Several adaptations and changes in strategic directives and organizational structure of Embrapa were undertaken since 2011 as a direct consequence of the revision of SEG model. Some fragility was identified in: evaluating and monitoring of R&D&I projects and portfolios and regarding tactical and operative aspects

Some of the main organizational and institutional changes undergone at Embrapa are described below:

- reorganization of SEG that incorporates: new dimensions of R&D portfolio management, insertion of new colegiates to define and manage R&D programs and the figure of new collaborative arrangements as a condition for project submissions;
- new strategic planning procedures, the Institutional Agenda, complementing the strategic planning processes and the quadrennial directive plans and emphasis in strategic intelligence initiatives such as the Agropensa project and technological observatories in order to cope with major changes such as new technological paradigms, climatic changes, new forest legislation .market drivers and so forth;
- new organizations structures: at the level of Embrapa's Research Centers, emphasizing some functions such as: technology transfer, information technology and institutional development; in corporation managing staff, in the Headquarters, as a complement of the changes related to organizational structure undertaken in the Research Centers; in corporative Technology Transfer structure and directives, including technology transfer and intellectual property dimensions in the context of R&D projects aiming to promote innovation and regional development;
- internationalization movement of Embrapa, with the implementation of laboratories (1998: United States; 2002: France; 2007: The Netherlands; 2009: south Korea; 2010: United Kingdom) and technological transfer offices (2004: Gana; 2008: Venezuela; 2010: Mali, Moçambique, Senegal, Panama).

4.4.1 Collaborative Models for Innovation and a new R&D&I organizational model

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A new organizational structure to promote R&D&I efforts and improve its outcomes was designed to cope with new challenges of cooperative innovation models such as Open Innovation (CHESBOROUGH, 2003). Procedure and processes have been reviewed in order to promote synergistic research efforts and resource sharing internally and in partnering initiatives.

Regarding tactical level of SEG, the external evaluation indicated that it was based only on R&D&I projects portfolio management, with significant dispersion of the general programs, limited interactivity among the different macro-programs and few synergy in the management of each macro-program. The study also highlighted that the process was excessively centered in the headquarters and that there was a low level of automation and information management and intelligence.

Concerning R&D&I evaluation, there was too much emphasis on evaluating effort instead of concrete results and that it was difficult to build an integrated evaluation of the entire research program of the company, in order to check if it was effectively responding to emergent problems and demands. Some redundancies and duplication of efforts was also identified, as well as competition between the projects instead of optimization. The need for improvement in data, information and knowledge management related to R&D&I activities became very clear.

Considering that, it was created a new organizational figure related to R&D&I: the corporate portfolios. A Corporate Portfolio is an instrument of management to support the management of projects regarding its scopes: R&D&I, Technology Transfer, Communication and institutional Development. It aims to direct, promote and monitor the achievement of results regarding emergent demands and considering the company's strategic objectives.

The macro-program figures were maintained and a matrix structure was defined, according to thematic portfolios defined with participative contribution of several managers, researchers and analysts from several units of Embrapa. The Institutional Agenda was implemented to support the identification of emergent challenges to be faced through a new thematic portfolio. Each thematic portfolio is managed by a collegiate, that would be responsible for repositioning the company initiatives to cope with national challenges of agriculture in order to develop new innovative assets (such as technologies, productive processes and systems, patents).

The R&D&I program also defines “arrangements of projects” as a new tactical figure to organize the thematic portfolios. An arrangement refers to a set of projects converging, complementary and synergistic, properly organized to face challenges prioritized related to a particular topic, summing the initiatives of several research centers and its partners.

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These arrangements relate to projects of different levels of complexity and different objectives, such as Research, Technology transfer or institutional Development (according to the macro-programs existent) and are formed to contribute to the major thematic challenges selected for the corporate portfolio.

A Strategies Management Committee is an advisory collegiate, established to advise the Executive Board of the company and monitor Embrapa's strategic focus in the areas of Research, Development and Innovation, Technology Transfer and Institutional Management, identifying relevant information in its internal and external environments. It is composed of 12 members, six from the headquarters and six representatives from the Research Centers.

Several corporate portfolios were established involving several themes such as: Sugar and Alcohol in Energy Sector; Climate Change; Dynamics of Use and Land Coverage in the National Territory; Ecological Productive systems and Palm Oil.

Some new organizational models for structuring research initiatives were also implemented as the “Mixed Research Centers”, in which an external partner cooperates with Embrapa to implement a new research unit and Multiuser Labs, that supports the whole company with specific research services in order to optimize infrastructure and resources.

5. Conclusions & Further Studies

This paper describes the main institutional and organizational changes undertaken by Embrapa from 2011 on, some of them being still under course. The main reorganization efforts refer to: the revision of corporate policies; improvement and integration of information systems to build a Business Intelligence logic; and several transformations of R&D&I organizational model and its practices. These changes and new initiatives, were mapped and analyzed, considering recent literature studies and internal documents.

A great number of corporate portfolios has been already determined and these line of organizing R&D is influencing the technology transfer sector of the company, that is organizing technological portfolios according to the same logic and topics, in a coordinated effort.

Considering that these efforts are still very recent, individuals are still learning about the new practices, norms and institutional procedures regarding new research endeavors. Considering this time-line in implementation, presently there are still no information about the efficiency and efficacy of this new research model in attending the main challenges that are presented to the Brazilian agricultural innovation system.

Efficiency of project portfolio management, therefore, could be determined by

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estimating the degree to which the portfolio fulfills its objectives. Some of the dimensions of portfolio management “success” according to Jonas (2010) are: effectiveness of the management process (information quality, allocation quality, cooperative quality); portfolio success (average project success, use of synergies, strategic fit, portfolio balance); and project portfolio-related corporate success (business success, preparing for the future).

Project Portfolio Management (PPM) is becoming a key competence for companies that handle numerous projects simultaneously, specially if they are science-based and R&D intensive (JONAS, 2010; WU & HAACK, 2013) further study could analyze whether this new organizational model for research management would meet the proposed objectives of the reorganization of SEG model.

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