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CORPORATE FORESIGHT: THE STRATEGY OF LOOKING TO THE FUTURE IN A RESEARCH ORGANIZATION

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[1]Danielli Rondon
[2]Adriana Bin

Abstract

Purpose – The purpose of this paper is to present the practice of foresight at a public research organization in Brazil.

Theoretical framework – It was used the concept of foresight to research institutes of a public nature, from the perspective of corporate foresight.

Design/methodology/approach – A case study was carried out at the Brazilian Agricultural Research Corporation (EMBRAPA). The type of case study adopted was the single case study, with an emphasis on in-depth understanding of the investigated case. The phenomenon studied was the accumulated experiences and foresight practices within a research organization.

Findings – EMBRAPA has a formal structure and processes related to foresight, indicating the importance that the company places in foresight exercises to support decision making. To this end, it has been employing several foresight exercises to assist strategic planning, research agenda definitions and identification of emerging and future technologies.

Research, Practical & Social implications – It should be noted that the conclusions presented are based on a single case study, and it is not possible to make further generalizations.

Originality/value – According to the literature, it was possible to understand that public research organizations can also use foresight to establish strategic research priorities to answer national and international trends in S&T (Science and Technology) well as to the development and societal needs.

Keywords – Foresight. Corporate foresight. Research Organization. EMBRAPA.

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[1] Universidade Estadual de Campinas - UNICAMP, São Paulo, (Brasil). E-mail: dani_rondon@yahoo.com.br Orcid id: https://orcid.org/0000-0001-9532-1023
[2] Universidade Estadual de Campinas - UNICAMP, São Paulo, (Brasil). E-mail: adribin@unicamp.br Orcid id: https://orcid.org/0000-0001-9774-2753

FORESIGHT CORPORATIVO: A ESTRATÉGIA DE OLHAR PARA O FUTURO EM UMA ORGANIZAÇÃO DE PESQUISA

Resumo

Objetivo: O objetivo deste artigo é apresentar a prática da prospecção tecnológica em uma organização pública de pesquisa no Brasil.

Método: Foi realizado um estudo de caso na Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA). O tipo de estudo de caso adotado foi o estudo de caso único, com ênfase na compreensão aprofundada do caso investigado. O fenômeno estudado refere-se às experiências acumuladas e as práticas de *foresight* no âmbito de uma organização de pesquisa.

Resultados: A EMBRAPA possui estrutura formal e processos relacionados à prospecção, indicando a importância que a empresa atribui aos exercícios prospectivos de apoio à tomada de decisão. Para tanto, vem empregando diversos exercícios prospectivos para auxiliar no planejamento estratégico, definição de agendas de pesquisa e identificação de tecnologias emergentes e futuras.

Originalidade/Relevância: De acordo com a literatura, foi possível compreender que as organizações públicas de pesquisa também podem usar a prospecção para estabelecer prioridades estratégicas de pesquisa para responder às tendências nacionais e internacionais em C&T (Ciência e Tecnologia), bem como às necessidades de desenvolvimento e da sociedade.

Palavras-chave: Prospecção tecnológica. *Foresight. Foresight* Corporativo. Organização de Pesquisa. EMBRAPA.

1. INTRODUCTION

The concept of foresight has long been introduced to characterize future studies and the readiness to deal with long-term issues (Miles, 2010). It has been increasingly used as an approach to think, debate, and shape the future, especially in science, technology, and innovation. In this sense, foresight activities have a fundamental supporting role in planning and decision-making processes in national and corporate levels since they allow the expansion of knowledge about long term possible challenges and opportunities from the perspective of different actors (Georghiou, 1996, Becker, 2002).

In the past two decades, several large companies in diverse sectors such as energy, automotive, telecommunications, and information technology have established foresight and strategic planning processes to analyze the long-term perspectives of new technologies and their impact on markets and corporate strategies (UNIDO, 2005; Cuhls and Johnston, 2008). These efforts have been known since the 2000s, mainly through the perspective of corporate foresight, even though some foresight methods have already been used before at the corporate level.

According to Rohrbeck, Battistella and Huizingh (2015) corporate foresight is the ability to create and maintain a high-quality, coherent, and functional vision of the future. Although the foresight literature has been more dedicated to countries and companies' cases, tracing relationships between the adoption of foresight techniques and implications for development and competitiveness, the practice associated with the concept is applicable in different organizational contexts (Gordon *et al.*, 2020).

In the case of research institutes (whether public or private), foresight can be, for instance, used to help establish research priorities in alignment with national and international trends in scientific and technological development and also with societal needs.

The goal of the present work is to analyze the foresight practice in a research organization, a theme slightly explored in the literature, from the perspective of corporate foresight. It is observed that research organizations are often partners in national, regional, or sectoral foresight projects but rarely implement a corporate foresight process to anticipate their development (Sacio-Szymańska, Mazurkiewicz and Poteralska, 2015). In the Brazilian context, there are some historical national foresight initiatives. Nevertheless, there are a few about foresight on companies and even less on research organizations.

This study contributes to filling this gap using EMBRAPA as a case study. It is oriented by the following questions: a) How does a research organization implement corporate foresight?

b) What are the methods used in the practice of corporate foresight? and c) What are the results and experiences obtained through corporate foresight exercises?

2. THEORETICAL FRAMEWORK

An increasing number of corporations have considered corporate foresight as a tool that helps the organization prepare for the future, whether in terms of producing a long-term strategic vision or fostering ideas for product and/or process innovations (Daheim and Uerz, 2008). Overall, corporate foresight involves organizations' systematic effort to study emerging markets and trends, identify weak signals, and formulate corporate strategies and innovation policies, seeking to prepare for an uncertain future (Horton, 1999; Becker, 2002; Müller, 2008 *apud* Daheim and Uerz, 2008).

Although organizations have different understandings about foresight and get involved in it with varying degrees of intensity, it can be said that through corporate foresight, private and public enterprise understand the complex forces that drive changes in the economy, the decision-making process, and the development of strategies and incentives for innovation research (Reger, 2001; von der Gracht, Vennemann and Darkow, 2010; Battistella, 2014; Gershman, Bredikhin and Vishnevskiy, 2016).

Corporate foresight activities, according to Becker (2002), usually focus on one of the following intermediary functions: a) competitive intelligence; b) definition of general guidelines for corporate strategy; c) priority setting; d) formulation and implementation of the strategy (Becker, 2002).

Cuhls and Johnston (2008) highlight that foresight can be used in organizations for four purposes: strategic planning, marketing (consumer behaviour, new consumption patterns, or people's needs/demands in general), reorganize the organization to prepare for possible future events, and innovation management.

There are two different situations in which foresight can contribute to the innovation process: before an idea is born and when the idea is already established. In the first situation, foresight is applied to inspire and create new ideas that can become innovations in the future. In the second situation, the foresight process can help assess commercial and technological feasibility to adjust or abandon ideas/projects in the innovation process (von der Gracht, Vennemann and Darkow, 2010).

Nevertheless, how foresight processes occur in organizations? Reger (2001) presents a conceptual model of technological foresight. According to the author, the technological

foresight process can be divided into six phases: 1) formulation of information needs and selection of the research area – as a way to determine objectives, central issues or areas of research; 2) selection of information sources, methods, and instruments; 3) data collection; 4) filter, analysis, and interpretation of information; 5) presentation of decisions - as seen, technological foresight must be an integral part of the strategic management of R&D and technology in order to influence and support decisions on the allocation of resources in R&D and technology; 6) evaluation of proposals and results of technological foresight activities, to support a new decision on whether to proceed with the initiative and the allocation of resources.

Horton (1999) provides in his paper a short and straightforward guide to the foresight process with the specific objective of deriving real value for organizations. The process described by the author follows three phases: 1) the collection, compilation, and summarization of available information (generally, such as trends, expected developments, debates about possible or unusual events, among others) and results in the production of prior knowledge of the vision; 2) the translation and interpretation of this knowledge to understand its implications for the future from a specific point of view of a given organization; 3) the assimilation and evaluation of this understanding to produce a specific organization's commitment to action.

More broadly, Miles (2002) describes foresight as a process with five complementary phases. The pre-foresight phase comprises the definition of logic, justification, and foresight exercise objectives. The recruitment phase is almost permanent throughout the process and is essentially linked to the recruitment of specialists, consultants, among other actors who must participate in the exercise. In the generation phase, the existing knowledge is analyzed and synthesized; tacit knowledge is codified; new knowledge is generated, and new visions of the future are created. The action phase is when the actions will be implemented, involving prioritization, decision-making, innovation, and changes. Finally, there is the renewal phase, which involves constant monitoring and evaluation to verify whether the foresight process has helped achieve the original objectives and the extent to which the results have been implemented.

Voros (2003) also presents a more comprehensive foresight process, which is described with questions to be answered in each one of its five phases. In the Analysis phase, the question to be asked is, "What seems to be happening in the environment? In the Interpretation phase, the question to be asked is, "What is going on? What changes are significant?". In the Foresight phase, the question is "What can happen?". In the Output phase, the question asked is "What needs to be done?". Finally, in the Strategy phase, the question is "What will we do" and "How will we do it". With that, action planning is elaborated.

As there are different views about the foresight process in organizations, there are also different perceptions about the organizational and managerial structures that support these processes.

According to Reger (2001), technological foresight is performed in organizations at three different organizational levels and by different actors. First, technological foresight can be conducted at the corporate level, mainly through an R&D, technology, or corporate innovation organizational unit. In this case, technological foresight activities are usually part of the researchers' daily work in the central research laboratory or similar structure. Researchers are the core personal conducting technological foresight at this level and supply information directly into new project ideas. Here, long-term strategic thinking predominates (Reger, 2001).

Second, technological foresight is carried out much less extensively by divisions and business units. This level of technological foresight has a short-term orientation and is mostly determined by the day-to-day business. Its primary concern is to identify new customers and markets, as well as benchmarking competitors. At this level, the concern is not so much with technological foresight, but with foresight techniques (in the sense of converting the results obtained from research and technology into concrete products or processes) (Reger, 2001).

The formal structural levels of corporations and business units are overlapped by the third level of prospective technology structures. These are the lateral or virtual structures that can be characterized by bringing together people from various levels and hierarchical departments and acting as temporarily limited tasks. The purpose of these structures is to create direct communication, hierarchies, and transversal functions between technological foresight actors. These forms of organization's advantages are their flexibility, their temporary nature, and their high degree of autonomy (Reger, 2001).

In turn, Becker (2002) uses another classification to identify the support structures for the foresight processes. There are three approaches presented by the author: The Collector, The Observatory, and The Think Tank.

The first approach is called The Collector. In organizations with a comparatively low degree of foresight activities, future research is mainly done in conjunction with - and heavily incorporated into other strategic R&D activities. It is mainly concerned with providing necessary information, i.e., about competitors or patents, for decision-making. Dedication of people responsible for this information is done on a part-time basis, since foresight is just one of their many tasks, and most foresight activities end up focusing on the search and collection of future information that has already been prepared by others and that is easily accessible.

The second approach is called The Observatory. In contrast to the first type, the Observatory is truly an autonomous foresight unit, with full-time staff and its budget. Besides, it also has a clear mandate to focus on issues related to the future. Its particular feature is that it serves a highly specialized purpose for the company. To provide this strategic intelligence in the long term, the activities of these foresight units include not only the reuse of existing data but also regularly generate new knowledge.

The third approach is called The Think Tank. In this approach, there are a group of people working full time - experts and researchers who explore all kinds of issues related to the future not only in the commercial environment but also in the socio-economic, cultural, and regional sphere. They have a much more comprehensive range of tasks than the Observatory and, therefore, need to be more generalist than specialists. However, this does not mean that they do not have considerable knowledge in certain areas, but their aim is not to analyze only developments in their fields of expertise but to connect them to a broader picture of the future. To fulfill their tasks, think tanks create a global network of experts from both the company and abroad. Some of them even establish a job rotation or long-term cooperation with external research centers or institutes. In any case, however, these think tanks are called upon for many tasks and are widely respected both within the company and outside - and as such, they even carry out foresight activities for selected external customers such as large suppliers or customers.

Daheim and Uerz (2008) considered it appropriate to add a fourth type of organizational form to Becker's original typology, naming it as Outsourcer. This type of corporate foresight unit identifies and defines the subject area and objectives of a foresight process according to its technical perspective within the company, but generally allows the process itself or a large part of the research involved to be conducted by an external organization /consultancy before reintegrating and using the results in strategic planning or other business fields within the company. The company's process is often led by a project team selected concerning the specific tasks and issues to be addressed by the foresight process, and even though the unit is small, it has high visibility inside and outside the company. The unit will have a high level of expertise in foresight, but most of the day-to-day work, such as trend checking, is outsourced.

3.METHODOLOGY

The study involved a case study carried out at the Brazilian Agricultural Research Corporation (EMBRAPA).

EMBRAPA is a research, development, and innovation company linked to the Ministry of Agriculture, Livestock, and Supply (EMBRAPA, 2017). This research organization was chosen because it is one of the most prominent and representative research organizations in Brazil and because it has a background of leading foresight studies since the 90s.

The type of case study adopted was the single case study, emphasizing an in-depth understanding of the case investigated. The phenomenon studied was foresight within the scope of this research organization.

The case study's data collection was based on oral verbal acts through semi-structured interviews and document analysis using information obtained through the EMBRAPA website.

The choice for interviews was based on seeking the respondent's free expression, thus opting for not having the intention of statistical generalization. Furthermore, more specifically, the choice for semi-structured interviews was based on following a certain number of leading and specific questions, in a particular order, with the freedom to include other questions.

An interview script with several items were elaborated to understand: why, how, by whom, when, where, organization structure, and people involved in the foresight process, in addition to the real and potential benefits of such practice. The interviewees' inclusion criteria were people with experience in foresight processes within EMBRAPA, regardless of educational level. The sampling method used to select the interviews was the snowball and based on that, references chains at EMBRAPA were used.

In total, 11 people were selected for interviews (8 from Headquarters and three from Decentralized Units). An email was sent to the selected people with a brief personal presentation explaining the research project (attaching it to the email) and the interview's purpose. Not all people returned the email and, in total, eight people were interviewed, according to table 1, which are: a person from Secretariat of Intelligence and Strategic Affairs (SIRE), a person from Secretariat General (SGE), a person from Secretariat for Innovation and Business (SIN), a person from EMBRAPA Genetic Resources and Biotechnology, three people from EMBRAPA Environment (in this case one person was contacted to conduct the interview and during the interview, other people were invited to participate) and one person from EMBRAPA Agroenergy.

Table 1. List of interviewed at EMBRAPA

Interviewed	Position	Unit	Area	Year hired
#1	Coordinator	Coordination of Process Management (CGPR) Secretariat General (SGE)	Personnel Management	1987
# 2	Interim Manager and Supervisor	Secretariat of Intelligence and Strategic Affairs (SIRE)	Strategic Management	2010
# 3	Deputy Head of Research	EMBRAPA Genetic Resources and Biotechnology	Technology Transfer	2002
# 4	Supervisor	Marketing - Secretariat for Innovation and Business (SIN)	Research and Development	2010
#5	Deputy Head of Technology Transfer	EMBRAPA Environment	Research and Development	2010
# 6	Supervisor	EMBRAPA Environment	Business	2004
#7	Supervisor	EMBRAPA Environment	Strategic Management	1995
# 8	Supervisor	EMBRAPA Agroenergy	Business	2011

Source: EMBRAPA, 2019, https://www.EMBRAPA.br/equipe

The people interviewed have worked on average for 14 years at EMBRAPA, thus having representative knowledge about the company. They have leadership, supervision, management, and coordination positions and work in strategic management, business, people and process management, technology transfer, and research and development units.

In addition to the interviews, documentary analyzes were performed using information obtained through the EMBRAPA website. Documents related to corporate governance and institutional information were analyzed, such as Master Plan (document in which EMBRAPA's strategic planning materializes), EMBRAPA in numbers, Central and Decentralized Units Regulations, and the documents Vision 2014-2034 and Vision 2030: the future of Brazilian agriculture (documents in which the results of EMBRAPA's foresight process are presented).

Information was also sought about other prospective exercises carried out at EMBRAPA. Also, in order to identify more specific works related to technological prospecting at EMBRAPA, a non-exhaustive search was conducted to identify internal publications related to prospective studies at the company. The database consulted was the EMBRAPA Alice Repository (https://www.alice.cnptia.EMBRAPA.br/). This repository was chosen because it

comprises scientific information produced by EMBRAPA researchers and edited in book chapters, articles in indexed journals, articles in conference proceedings, theses and dissertations, and technical notes, among other types of publications. A search conducted in 2019 found 739 documents, and some of these experiences are reported to illustrate exercises that were done for and by individual Decentralized EMBRAPA Units on specific topics. The choice of such documents was not made by the level of importance, but in an exploratory way, trying to illustrate initiatives over time in the context of EMBRAPA. Content analysis was used to interpret interviews and institutional documents.

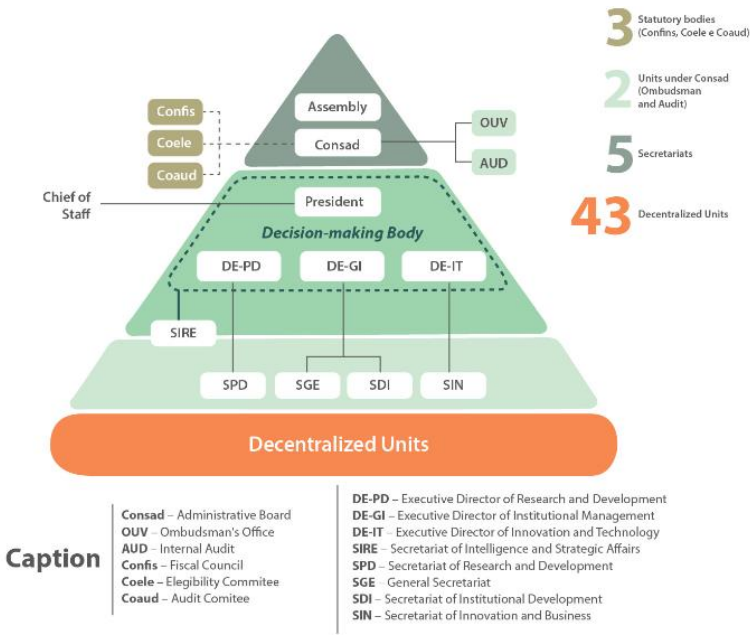
4. FINDINGS

EMBRAPA is present in almost all Brazilian states. The organization has 9,545 employees, of whom 2,430 are researchers, 12% with master's degrees, 75% with doctorates and 13% with post-doctorates (EMBRAPA, 2017). Its budget in 2018 was approximately R$ 3.4 billion (SECRETARIA DE ORÇAMENTO FEDERAL, 2017).

EMBRAPA's mission is “to provide research, development, and innovation solutions for the sustainability of agriculture and for the benefit of Brazilian society” (EMBRAPA, 2020, https://www.EMBRAPA.br/en/missao-visao-e-valores). It has as vision **“**be a world reference in the generation and supply of information, knowledge, and technologies, and thus contribute to innovation and sustainability in agriculture and to food security” (EMBRAPA, 2020, https://www.EMBRAPA.br/en/missao-visao-e-valores).

EMBRAPA's internal organization is formed by Assembly and Administrative Council (Consad), linked to Consad: Fiscal Council (Confis), Eligibility Committee (Coele), Audit Committee (Coaud), Ombudsman (OUV) and Audit (AUD); the Presidency, 3 Directorates, namely the Executive Directorate for Research and Development (DE-PD), Executive Directorate for Institutional Management (DE-GI), Executive Directorate for Innovation and Technology (DE-IT), 5 Secretaries, which are the Secretariat of Intelligence and Strategic Affairs (SIRE), Secretariat for Research and Development (SPD), Secretariat General (SGE), Secretariat for Institutional Development (SDI), Secretariat for Innovation and Business (SIN) and 43 Decentralized Units, as presented in figure 1 (EMBRAPA, 2020, https://www.EMBRAPA.br/en/corporate-governance).

Figure 1. EMBRAPA Organizational Chart



Source: EMBRAPA, 2020, https://www.EMBRAPA.br/en/organograma

4.1 EMBRAPA's HISTORY IN FORESIGHT STUDIES

EMBRAPA was created in April 1973, under law 5851, of December 7, 1972 (Franco, 2009). The organization was created with a public company's legal nature under private law (Mendes, 2015).

In 1988, EMBRAPA prepared its first strategic plan, which resulted in its 1st Master Plan. In its first Master Plan, EMBRAPA took into account future trends of society, economy, and, particularly, agriculture and livestock, thus establishing the course of its action for the 1988/1992 period.

In 1990 EMBRAPA published a study on the future of Brazilian agriculture, entitled Scenarios for agricultural research: theoretical aspects and application at EMBRAPA. This foresight study aimed to analyze trends in technological evolution for the next 20 years and, in addition, to support the formulation of research objectives and guidelines for that time and the development of a set of strategic planning actions (Nogueira and Fuscaldi, 2018).

EMBRAPA's II Master Plan: 1994-1998 used the prospective exercise mentioned above. The EMBRAPA's III Master Plan: strategic realignment 1999-2003 included an item on Brazilian agribusiness trends and the vision of the future of Brazilian agribusiness, directing, in this sense, a strategic realignment of the organization, incorporating the set of premises,

components and necessary mechanisms for articulating EMBRAPA's actions with the external environment (EMBRAPA, 1998; Franco, 2009).

In 2002, another prospective study was carried out, as an initiative of EMBRAPA in partnership with the Center for Management and Strategic Studies (CGEE), called Scenarios of the Operating Environment of Public Research and Development Organizations for Brazilian Agribusiness in the Horizon of the Next 10 Years (Nogueira and Fuscaldi, 2018).

In parallel to the aforementioned study, which started at the end of 2002, the Quo Vadis Project - The future of Brazilian agricultural research was developed under the leadership of EMBRAPA and in partnership with ten countries in Latin America (Nogueira and Fuscaldi, 2018).

Based on the future studies mentioned above, EMBRAPA's IV Master Plan: 2004-2007 starts from the vision of possible future scenarios and of external determinants and conditions to EMBRAPA (EMBRAPA, 2004)

Another relevant prospective study in the context of EMBRAPA was conducted in 2007. Entitled Scenarios of the Operating Environment of Public and Private Research, Development & Innovation (RD&I) Institutions for Agribusiness and Brazilian Sustainable Rural Development in Horizon 2023 (Nogueira and Fuscaldi, 2018).

Thus, EMBRAPA's V Master Plan: 2008-2011-2023 was based on a foresight analysis supported by the Scenarios study mentioned above (EMBRAPA, 2008).

In 2014, the Secretariat of Intelligence and Macro-Strategy (SIM) was created at EMBRAPA as a Central Unit, responsible for promoting and coordinating systematic processes that can generate new visions, scenarios, and strategies. EMBRAPA's Strategic Intelligence System (Agropensa) was structured under the coordination of this Secretariat, dedicated to producing and disseminating knowledge and information in support of the formulation of Research, Development, and Innovation (RD&I) strategies for the Company itself and partner institutions (Nogueira and Fuscaldi, 2018). In 2018, SIM turned to be called SIRE Secretariat of Intelligence and Strategic Affairs (EMBRAPA, 2018).

In the same year of 2014, Agropensa conducted a large prospective study that generated the document Vision 2014–2034: The Future of Technological Development in Brazilian Agriculture. The document is a set of information, reflections, and hypotheses, which provided elements for the elaboration of EMBRAPA's VI Master Plan, which comprises the Company's strategic planning for a period ranging from 2014 to 2034 (EMBRAPA, 2014; EMBRAPA, 2015; Nogueira and Fuscaldi, 2018).

In 2016, based on the Vision Document 2014–2034, Agropensa presented the study Exploratory Scenarios for the Technological Development of Brazilian Agriculture, in partnership with the Secretariat for Strategic Affairs of the Presidency of the Republic (SAE-PR) (Nogueira and Fuscaldi, 2018).

The most recent document, launched in 2018, was the foresight study called Vision 2030: the future of Brazilian agriculture, elaborated from an in-depth study of signs and trends related to the future of agriculture, involving various actors in the Agricultural Sector and presenting from in addition, seven megatrends for the future and challenges for agricultural research (EMBRAPA, 2018b). To generate the Vision 2030 document, five stages were planned and executed, focusing on the identification and analysis of aspects of the global context that directly and indirectly impact the agricultural sector, namely: 1) identification of signs and trends / drivers in generated content by different actors from different links in the agricultural production chains; 2) analysis of these signals and trends / drivers of the environment prepared by EMBRAPA's Observatories of Studies and Trends, Project Portfolios and specialists (ad hocs); 3) definition of megatrends and derived challenges; 4) consultations on megatrends and challenges to segments of the private sector, the third sector, public organizations and EMBRAPA units and specialists; and 5) consolidating the vision of Brazilian agriculture (EMBRAPA, 2018b).

In addition to the more comprehensive foresight studies previously presented, more specific foresight studies were also conducted in the organization (see Table 2), referring to a production chain, an ecosystem or research theme (thematic), thus aiming to support planning in the particular contexts of EMBRAPA's Decentralized Units.

It is important to note that the aforementioned works do not correspond to the entire universe of initiatives that EMBRAPA has carried out in foresight matters, but illustrate how the subject has been treated at the company along its trajectory.

Table 2. Foresight studies at EMBRAPA

Study title	Description/ Purpose	Unit
Agriculture and Environment: trends	The study was a contribution to reflection on the situation and trends in the relationship between man and nature, as well as the impact of agriculture on the environment in Brazil. This reflection became a fundamental input to inform the direction and priority decisions of agricultural research and agriculture in general (QUIRINO, 1998).	EMBRAPA Environment
Study of the Brazilian Agribusiness Software Market	It presents an overview of software supply for agribusiness, the relationship between supply and demand for software for agribusiness, a study of the Brazilian software market for agribusiness, containing scenarios, prospecting and opportunities and finally presents trends and perspectives of the information technology applied to agriculture (Cassia Isabel Costa Mendes, Oliveira, & Santos, 2011).	EMBRAPA Agricultural Informatics, in partnership with several institutions
The use of foresight studies in EMBRAPA's strategic planning	Study presents the logic of EMBRAPA's strategic planning cycle and from that plan it shows how EMBRAPA's Swine & Poultry Unit prepared its strategic planning taking into account the information generated from the prospective study with representatives of the swine chains and poultry from all over the country, considering the medium (2008-2011) and long term (until 2023) horizon (Bassi, Silva, Ieis, & Poit, 2013).	EMBRAPA Swine & Poultry
Foresight exercises for research demands for the Brazilian artisanal fisheries production chain: PROSPESQUE	Its main objective was to raise and prioritize research and development (R&D) demands in a participatory manner for the fishing sector at the national level, through scientific and technological foresight. Based on the Delphi and Expert Panel methods, experts from the Brazilian fishing sector, continental artisanal fisheries and marine artisanal fisheries, discussed the demands of technological research and development (P&D) (PRYSTHON, 2014).	EMBRAPA Fisheries and Aquaculture, with the support of the Ministry of Fisheries and Agriculture
Technology Roadmapping, a method to support technological management	This research aimed to apply *Technology Roadmapping* (TRM) method for the technological planning of research on tomato, with a focus on plant health (diseases and pests), at EMBRAPA Vegetables. As a result, the application of the TRM allowed a clear proposition of actions aimed at meeting the main demands related to plant health for tomatoes. (Mori, Cruz, Nagata, & Freitas, 2017).	EMBRAPA Vegetables

Source: EMBRAPA Alice Repository

This means that there is a very large parallel effort of formal/centralized foresight that supports organizational strategic planning and those efforts made by the Decentralized Units to assist themselves in their R&D and innovation projects and/or in their own strategic planning. It can be inferred that there is a relationship between the scope of the foresight exercises and the sphere of support for decision-making at EMBRAPA. Figure 2 below represents this relationship.

Figure 2. Relationship between scope and decision-making support at EMBRAPA

Coverage		Sphere to support decision making	
	Macro	Foresight studies on the Future of Agriculture/ Agricultural Research	Strategic Planning
	Meso	Foresight studies on a given production chain, an ecosystem or comprehensive research topics	R&D Planning
	Micro	Foresight studies on a specific technology or specific research topic	Research Areas / Projects Planning

Source: Prepared by the author.

4.2 FORESIGHT AT EMBRAPA

Firstly, it was found that the corporate foresight concept is not used at EMBRAPA. Nevertheless foresight concept appears in the article "Strategic Intelligence: EMBRAPA's new paradigm", by Maurício Antônio Lopes, then President of EMBRAPA, published in 2014, as the main approach used by this organization regarding future studies.

> There are several concepts for dealing with strategic intelligence. We work with the anticipation of possible futures, a study model called Foresight, which allows us to evaluate scenarios and trends and to anticipate what future can be expected in a given area in five, ten, fifteen years (Lopes, 2014, p. 20).

Although the foresight concept appears in the EMBRAPA's document, mentioned above, it was observed that there is no single term that is more widely used to define technological foresight in the company, such as prospective, prospective scenarios, strategic intelligence, and future prospection.

4.2.1 FORESIGHT PURPOSE AND OBJECTIVE

Based on what was identified during the interviews and through documental analysis, it was found that the purpose of foresight at EMBRAPA is to support organizational decision making with a view of generating research, development and innovation solutions in agriculture, which are useful for the society. This means to identify, through constant monitoring of the external environment, which are the main trends and opportunities, and

through these signals, guide the institutional development and the research agenda of EMBRAPA.

> [...] the main objective is to have this "radar" with the external environment [...] to have the flexibility to adjust and incorporate new things in its R&D programming and to make a decision of continuity and even some action (Interviewed 1, 2018).

However, one of the interviewees reinforced the purpose of foresight for decision making in EMBRAPA in a more comprehensive way:

> The purpose, in fact, is to support decision-making - to support strategic decision-making at EMBRAPA (considering EMBRAPA's strategic planning) [...], but it is also to support decision-making by the Minister, Congress, the productions chains, in others words, not only to support internal decision-making but also to support external decision-making (Interviewee 2, 2018).

The importance given to identification of weak signals through foresight exercises was identified by one of the interviewees when saying that: “Not everything is data, not everything is a trend. It is important to be aware of weak signals”(Interviewee 2, 2018).

In addition to the importance cited for identifying weak signals, respondents addressed the importance of foresight to their daily practices:

> Prospecting is important because it helps us to stay in line with what the Unit needs to return to society, helps us focus more on developing practical processes, technologies and even services that are more consistent with what they expect from the Unit, it helps us do this self-analysis (Interviewed 7, 2019).

> The foresight work involves a very interesting thinking together activity [...] is a time to reflect about activities in progress (Interviewed 8, 2019).

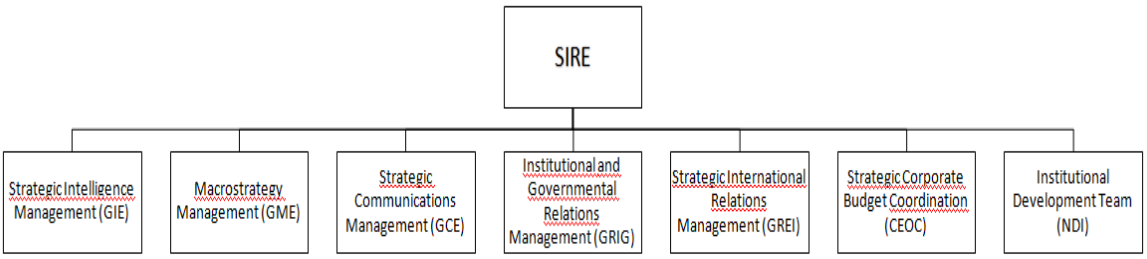
4.2.2 ORGANIZATIONAL STRUCTURE AND SUPPORT TEAM FOR THE FORESIGHT PROCESS

The current Secretariat of Intelligence and Strategic Affairs has a fundamental role in supporting the foresight process at EMBRAPA. This organizational unit at strategic level under the Corporation's Executive Board was created in 2018 and it was responsible for the management of the macroprocess of intelligence and strategic governance and for the processes of strategic intelligence, macro strategy, communications, and institutional and governmental,

national and international relations. It is also known as SIRE from the acronym in Portuguese (EMBRAPA, 2020, https://www.EMBRAPA.br/en/secretaria-de-inteligencia-e-relacoes-estrategicas-sire).

SIRE is composed of five organizational units: Strategic Intelligence Management (GIE), Macrostrategy Management (GME), Strategic Communications Management (GCE), Institutional and Governmental Relations Management (GRIG), Strategic International Relations Management (GREI) and one Coordination, Strategic Corporate Budget Coordination (CEOC) and by the Institutional Development Team (NDI), thus comprising the structure shown in figure 3 (EMBRAPA, 2020).

Figure 3. SIRE Organogram



Source: Prepared by the author based on EMBRAPA, 2020, https://www.EMBRAPA.br/secretaria-de-inteligencia-e-relacoes-estrategicas-sire.

SIRE has a regulatory mandate to conduct the company's Strategic Intelligence process. Exactly because of its importance, the Secretariat is directly linked to EMBRAPA's Board of Directors, being the only secretariat that reports directly to the Board of Directors (the president and the 3 directors). Therefore, SIRE is a secretariat with a more general and transversal administration.

This Secretariat is responsible for coordinating foresight studies, collecting information, interacting with the external environment and working with the other Secretariats to interpret this information to the internal environment. Therefore, prospecting for the future is coordinated by SIRE, and more specifically by the Strategic Intelligence Management (GIE). According to the Regulations of EMBRAPA's Secretariats, item 10.4.2.1 - Purpose and Attributions of SIRE, it is up to the Strategic Intelligence Management:

> a) coordinate the network of observatories focusing on monitoring the external environment, prospecting and capturing technological, socioeconomic, institutional, organizational and market trends and signals for agriculture;
> b) coordinate and carry out strategic studies and analyzes, elaborate scenarios (technological, socioeconomic, institutional, organizational and market) and the vision of the future of Brazilian agriculture (EMBRAPA, 2018a).

SIRE, through the Agropensa System, promotes the creation of a knowledge network through Observatories. They are called Observatories of Studies and Trends. The concept for the operation of the Observatories is to produce and disseminate knowledge, with the support of internal and external partners, to EMBRAPA in the entire process of foresight (EMBRAPA, 2019, https://www.EMBRAPA.br/agropensa/rede-de-conhecimento).

However, for the structure and functions of the Observatories of Studies and Trends there is no regulatory mandate and there is no pattern of operation.

About the Observatory's structure, one of the interviewees commented: "[...] in the structure, we have the Observatories network. In the ideal world, we would have an observatory in each unit of the company, but today we have 29 Observatories"(Interviewed 2, 2018).

Governance issues and perspectives for improving the process were also highlighted:

> So in the sense of governance with the Observatories, what has to be, do and deliver must be much better structured. [...] In the case of the observatory, a more complex issue comes in because you need to have a good knowledge of a number of tools, have a certain process and do this with a certain routine to generate a certain content also with a certain frequency - this is difficult to coordinate, especially when you're not talking about a team of 10 people who are in the same place, you're talking about a team of hundreds of people who are across the country, it's not trivial [...].The complexity of this is huge. And people have different levels of knowledge in relation to foresight and its tools. This is a challenge and the area plans to bring everyone to the same base, providing training for all those involved in foresight process (Interviewed 2, 2018).

SIRE has is a team of specialists that works full time with foresight. There are also people who work with foresight part time, allocated in the Observatories of Studies and Trends.

However, according to one of the interviewees: "[...] in fact we understand that everyone is responsible for foresight and SIRE just coordinates this" (Interviewed 2, 2018).

According to the interviewees, EMBRAPA has historically had the participation of external consultants in organizing and conducting foresight exercises; however, more recently, foresight exercises are predominantly conducted by EMBRAPA, which is developing more skills for this.

4.2.3 FORESIGHT PROCESS

Agropensa is EMBRAPA's Strategic Intelligence System, which operates in the:

> (i) capturing and prospecting trends, to identify possible futures; and, (ii) in mapping and supporting the organization, integration and dissemination of the database and agricultural information. These two main focuses of activity have as their main objective the preparation of studies of the future, which contain and disseminate knowledge and information in support of the formulation of Research, Development and Innovation (RD&I) strategies for the Company itself and partner institutions (EMBRAPA, 2018, https://www.EMBRAPA.br/agropensa/sistema-agropensa).

Within the scope of EMBRAPA's strategic management process, this generation of knowledge and information to support the formulation of RD&I strategies provides inputs that can be used to expand, adjust and redirect EMBRAPA's portfolio of PD&I projects (EMBRAPA, 2018):

> Agropensa is the place where the greatest effort is concentrated, the greatest movement related to the construction of scenarios, identification of scenarios, identification of macro trends and elements of the external environment that can somehow influence R&D, innovation and Technology Transfer activities that EMBRAPA's carries out (Interviewed 4, 2018).

Agropensa is structured in three specific components, shown in the figure 4.

Figure 4. Components of Agropensa

Source: EMBRAPA, 2020. https://www.EMBRAPA.br/en/agropensa

The Observatory Component of Studies and Trends, represents phase I of the prospecting process, which is the capture and processing of databases and information. Through this component, Agropensa monitors and looks for trends on the agricultural sector in Brazil and abroad. In this phase, the intention is to qualify the information and provide knowledge that contributes to decision making on technological development, sustainability, related issues of economics / agricultural policy; and still focused on rural development and possible solutions that involve the generation and adoption of technology. The capture and processing of data and information generates relevant signals for the Agropensa System and inputs for more elaborate analyzes and studies that demand more time for its completion.

The Analysis and Studies Component represents Phase II and III of the process. Phase II is the stage of carrying out analyzes and studies, in which the priority themes, defined by the Strategy Management Committee (CGE) and the Executive Board (DE), from the systematization of the trends prospected by the Studies and Trends Observatory, are studied in more detail. The Agropensa Steering Committee identifies the teams necessary to provide the analysis of the topics. This committee also monitors the analysis and studies. Phase III analyzes and studies submitted to the Executive Board for validation and use, is the stage in which the results are presented to the Executive Board, which can validate them with the CGE and the National Advisory Committee (CAN). The main products generated by this component are strategic information with an indication of bottlenecks, opportunities and possible courses of action.

Phase III analyzes and studies submitted to the Executive Board for validation and use, is the stage in which the results are presented to the Executive Board, which can validate them with the CGE and the National Advisory Committee (CAN). The main products generated by this component are strategic information indicating bottlenecks, opportunities and possible courses of action.

The Strategies Component for EMBRAPA represents phase IV, which is the transformation of strategic information into plans and actions. In this phase, analyzes and studies approved by the DE are forwarded to the Institutional Management Secretariat (SGI) in order to transform strategic information into effective decision-making in the Company. The results produced in the studies are used to guide actions of RD&I, Communication and Technology Transfer relevant to Brazilian agriculture. Thus, results of analyzes and studies are transformed into plans, actions and agendas that can be implemented in the Company.

When observing the foresight process, we sought to identify how foresight activities are initiated in the organization and according to one of the interviewees:

> Today, as the process is already systematized and it already has a logic, I cannot imagine that it has a “start now” trigger, it is not like this, in fact this is already a continuous systematic process, because the idea is an update all time and there are Observatories, and there is a group at the company’s headquarters that is seeing these things, if “shine a different line” in some environment, this has to come to the area of Intelligence and Macro-Strategy to see what impact this may have on the directions and in EMBRAPA's planning. [...] so it has to be a fluid process, I wouldn't say that there is a specific thing that triggers, once it was like that every 4 years, you do it, and you do all those prospective scenario studies for the

> company, then everybody was only focusing on that [...]. I think nowadays is more dynamic and at every moment there are things that interfere or may has an influence on a planning process (Interviewed 1, 2018).

There is a defined logic in the foresight process, but its dynamics indicates the need for some adjustments to be made:

> The ideal world, as we wanted it to be happening today is that this was routine /everyday, the teams at the observatories could do it every day. This is not the case today. How is it happening - SIRE triggers a request – e.g. "observatories we are currently needing to generate content because we are starting Vision 2030" – that was what happened with Vision 2030 (Interviewed 2, 2018).

4.2.4 FORESIGHT METHODS AND SOURCES OF INFORMATION

It was observed and cited by the interviewees that the foresight methods used at EMBRAPA are survey and review of existing studies, workshops, seminars, consultations, survey, scenario study, expert panel, SWOT analysis, patent analysis, article analysis, roadmap (this being more specific for Decentralized Units to design technological trajectories) and, with less emphasis, Delphi. There is no standard line to be followed for the choice of methods; there is a set of options that are used depending on the result you want to obtain, the resource and the means that each team of researchers has:

> [...] each team of researchers, for example, can do some foresight study directed to the theme of the (R&D) portfolio, which will choose the instruments and methods are they. There is no standard to be followed for the choice of methods, there is a set of options that are used depending on the result that wants to obtain, the money that the department has and the means that each one has (Interviewee 3, 2018).

According to one of the interviewees, "foresight methods are known at EMBRAPA, this is not a language that people do not know".

The sources of information used for the foresight exercises are studies and information produced by: Ministry of Agriculture, Livestock and Supply (MAPA), Sectoral and Thematic Chambers (CSTs), linked to MAPA, Universities, Management and Strategic Studies Center (CGEE)), Institute of Applied Economic Research (IPEA), national and international foresight studies. There are also informal sources of information gathering, such as fairs, congresses and contacts with producers.

4.2.5 TEMPORAL HORIZON

Based on the last two foresight studies carried out by EMBRAPA, being the document Vision 2014-2034 and document Vision 2030, the usual time horizon of foresight studies was around 20 years. However, it was stated by one of the interviewees that there is no consensus regarding the definition of the time horizon, but the tendency is to think about 20 years. The Vision 2030 document had its timeline somewhat guided by the Sustainable Development Goals (SDGs), launched by the United Nations (UN) in 2015, which has targets for 2030. According to this interviewee, this was a point discussed for the preparation of Vision 2030 and his position was that these documents should not have a definite date, being called "Vision: the future of Brazilian agriculture". However, for the capture of content in the exercise of the Observatories there is no standard definition for the time horizon. This definition depends on the objective and the theme to be explored. For example, in the area of Biotechnology, a horizon of 10 or 15 years can be considered a long time, due to the speed of changes in this area.

5. DISCUSSION

Firstly, it was found that corporate foresight concept is not used at EMBRAPA and there is no common concept to all that represents the practice of technological foresight at the company.

However, regardless of this lack of conceptual convergence, there is a strong tradition of EMBRAPA in contracting and/or conducting foresight exercises. Over time, the company has been employing foresight exercises for strategic planning, research agenda definitions and technology/themes identification. The constant look to the future has been present practically since the company's origin, coupled with strategic planning.

According to what was seen in the literature, the objectives and purposes of foresight at EMBRAPA corroborate with what was identified by Reger (2001) - mapping new trends or "weak signals"; anticipating technological discontinuities, global changes or "weak signals", and by Becker (2002) - establishing general guidelines for corporate strategy and with Cuhls and Johnston (2008) - supporting strategic planning.

As seen, it was found that the foresight objectives identified at EMBRAPA are comprehensive and are well aligned with the propositions of foresight literature. Although there are efforts in the meso and micro plan, this is not so explicit in the analysis of the historical trajectory of EMBRAPA, as occurs in the macro plan.

Despite the long tradition of using the results from foresight exercises in its planning efforts, the institutionalization of prospective efforts into organizational and managerial structures is a more recent enterprise. The organizational structure and the support team for EMBRAPA's foresight process can be recognized through its holistic focus, with responsibilities described in the bylaws internal company.

In this sense, SIRE is characterized, according to Becker (2002), as a corporate level structure, being a support structure for the foresight processes. This structure is characterized as an autonomous unit, with full-time staff, its own budget and a clear mandate to focus on issues related to the future. In order to provide long-term strategic intelligence, the activities of these foresight units include not only the reuse of existing data, but also regularly generate new knowledge.

EMBRAPA's Observatories of Studies and Trends, according to Becker (2002), are lateral or virtual structures, being a support structure for the foresight processes, characterized by bringing together people from various levels and departments and functioning as temporarily limited tasks, creating direct communication between the actors of technological prospecting. Since it counts with part-time staff, prospecting is just one of the many tasks of the people involved, and most foresight activities end up focusing on the search and collection of future information that has already been prepared by others and that are easy to access.

The structure, although developed, does not keep up with the diversity of foresight demands at EMBRAPA and its need for updating.

As described, EMBRAPA's foresight process has similarities to the foresight process proposed by Horton (1999) and presented in this article. The author describes the foresight process in three phases: Phase I of collecting, compiling and summarizing available information (generally, such as trends, expected developments, debates about possible or unusual events, among others) and results in the production of prior knowledge of vision; Phase II of translating and interpreting information from this knowledge to produce an understanding of its implications for the future from the specific point of view of a particular organization; and Phase III of assimilation and evaluation of this understanding to produce a commitment to action in an organization. Although the EMBRAPA process has 4 phases, phases II and III together resemble phase II of the process proposed by Horton. It should be noted that, according to the author, in a successful foresight process, these three phases will result in decision making and actions that will be different from those that would have been performed in the absence of the process (Horton, 1999).

However, it was observed that the structuring of the foresight process is very recent and, in fact, there are few results that can be seen so far from it. Although well-defined phases were identified in EMBRAPA's foresight process, being in line with the corporate foresight literature, a divergence was identified between this being a cyclical process or started from a demand, as seen in the interviews and in the elaboration from the Vision 2030 document. It was also not possible to identify whether there is a relationship between the foresight studies carried out by the Decentralized Units and Agropensa and a clear role of the Observatories of Studies and Trends in this process.

It was observed that EMBRAPA makes use of foresight methods that are commonly used for this practice, as seen in the literature. The company has extensive experience in the use and development of scenarios, a practice identified over time and strongly associated as a tool to assist the company's strategic planning since its beginnings.

Table 3 which presents the elements described in foresight, namely: objectives, process, levels and organizational and managerial forms at EMBRAPA.

Table 3. Elements of Foresight at EMBRAPA

Elements	Attributes				
	Literature				EMBRAPA
Purpose and objective	Reger (2001) -identify new technologies or areas of knowledge; - map new trends or "weak signals"; - generate new business or new technological knowledge; - anticipating technological discontinuities, global changes or "weak signals"	Becker (2002) - provide information and notice of recent developments; -establish general guidelines for corporate strategy; -identify the most desirable lines of R&D; - stimulate and support innovation processes	Cuhls & Johnston (2008) - support strategic planning; -support marketing; -bring about organizational changes; - contribute to the innovation process		- support strategic decision making; - identify key trends and opportunities; - analyze how EMBRAPA can anticipate something that is emerging; - capture signals to guide the research agenda; - identify which are the megatrends, in terms of themes, technologies, partnerships; - identify what are the future challenges for the company

Process	Reger (2001) 1) formulation of information needs and selection of the research area; 2) selection of information sources, methods and instruments; 3) data collect; 4) filter, analysis and interpretation; 5) presentation of decisions; 6) proposal evaluation and decision making	Horton (1999) 1) collecting, compiling and summarizing information; 2) translation and interpretation; 3) assimilation and evaluation	Miles (2002) 1) pre-foresight; 2) recruitment; 3) generation; 4) action; 5) renewal	Voros (2003) 1) inputs; *2*) analysis; 3) interpretation; 4) prospection; 5) outputs	1) Capture and processing of information; 2) Analysis and study; 3) Submission of analyzes and studies for validation and use; 4) Transforming strategic information into plans and actions
Organizational and managerial structure of the foresight process	Corporate level; Divisions and business units; "Lateral" or "virtual" structures (Reger, 2001)				Corporate level: SIRE; "Lateral" or "virtual" structures: Observatories of Studies and Trends
	Becker (2002) Collector Observatory Think Tank	Daheim e Uerz (2008) Collector Observatory Think Tank Outsourcer			Collector: Observatories of Studies and Trends; Observatory: SIRE
Temporal horizon	Short term; Mid-term; Long term				Long term: 20 years - Vision 2014-2034 and Vision 2030
Foresight time	Internal; External				Internal
Methods	Scenarios; Workshops; Expert panel; Scanning; SWOT analysis; Weak signals/wild cards; Bibliometry; Modelling; Patent analysis; Extrapolation of trends/Impact analysis; Delphi; Critical technologies/key technologies; Multi-criteria analysis; Stakeholder analysis; Roadmapping (Popper, 2008)				Workshops, seminars, consultations, survey, Delphi, scenarios, expert panel, SWOT, patent and bibliometric analysis and Roadmapping.
Sources of information	Internal; External and Formal; Informal (Reger, 2001; Becker, 2002)				MAPA, Sectorial Chambers, Universities, CGEE Studies, IPEA national and international foresight studies, NTs, Fairs, in a

		Congress and contact with the producer.

Source: Prepared by the author based on the cited references

According to table 3, the main objectives of corporate foresight at EMBRAPA are: to support strategic decision-making; identify the main trends, opportunities; analyze how EMBRAPA can anticipate something that is emerging; capture signals to guide the research agenda; identify which are the megatrends, in terms of themes, technologies, partnerships; identify what are the future challenges for the company. These objectives serve as a basis for EMBRAPA's process. However, as previously mentioned, both the process and the organizational and managerial structure are relatively new and role of the Studies and Trends Observatory needs to be revisited and better structured as to its functions. As the maturity level increases, the Studies and Trends Observatories can probably change from Collector to Observatory, according to Becker (2002).

Regarding the SIRE structure, it has the characteristics of an Observatory, as presented by Becker (2002), but as it increases its maturity, this structure may become a Think Tank, according to Becker (2002) and be a reference both inside and outside EMBRAPA.

6. FINAL REMARKS

In view of what was presented about corporate foresight throughout this article, it was possible to notice that this concept appears strongly related to companies and its application in the scope of research institutes is still little addressed in the scientific literature.

In spite of the growing importance of the theme, it is not a trivial task to find reports on corporate foresight that present how such a process occurs, since the most common is to find only the results obtained by specific foresight studies.

Through the case study, it was possible to identify, how, by whom and for what purpose a public research institute, in this case EMBRAPA, does foresight.

It was possible to conclude that EMBRAPA has practices that signal the importance that the company places in the prospective exercises to support decision making. This importance can be seen both in the institutionalization of foresight, with the identification of purposes and objectives, process, organizational and managerial structure, methods and team for corporate foresight. However, it was observed that the structuring of the foresight process is recent and,

in fact, there are few results that can be evidenced from it. Although well-defined phases were identified in EMBRAPA's foresight process, it was not possible to accurately identify the relationship between the prospective studies carried out by the Decentralized Units and the Intelligence System - Agropensa, as well as the role of the Observatories of Studies and Trends in that process. In this way, although there is a clear link between the prospecting and the different spheres of planning at EMBRAPA, in practice this relationship does not always occur in the planned way.

One of the conclusions derived from this work is that the task of exploring the future for better planning is complex. Although there are several ways to do this, dealing with the arsenal of methods, collecting data and information, gathering experts and structuring consistent foresight exercises that bring good results is something that requires some experience and above all it requires the organization to identify this as something essential and relevant for decision making. In this context, the institutionalization of foresight was perceived as a component to demonstrate the importance of building organizational strategies based on the practice of foresight, combined with the vision of building a desired future in order to support decision making.

Therefore, through this work, it was possible to observe that foresight can offer a strategic reflection in the face of alternative futures, better preparing the subsidies for the managers' decision-making process.

However, it is worth mentioning that the conclusions are based on a single case study, making it impossible to make generalizations. A larger set of cases could provide additional information and allow comparisons on the maturity level of the practice of foresight in organizations.

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