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Analysis of the Process of Technology Transfer in Public Research Institutions: The Embrapa Agrobiology Case

SHEILA SERAFIM DA SILVA
FACULDADE DE ECONOMIA, ADMINISTRAÇÃO E CONTABILIDADE DA UNIVERSIDADE DE SÃO PAULO - FEA
sheila_serafim@yahoo.com.br

PAULO ROBERTO FELDMANN
FACULDADE DE ECONOMIA, ADMINISTRAÇÃO E CONTABILIDADE DA UNIVERSIDADE DE SÃO PAULO - FEA
feldmann@usp.br

RENATA GIOVINAZZO SPERS
UNIVERSIDADE DE SÃO PAULO (USP)
renatag@fia.com.br

MARTHA DELPHINO BAMBINI
UNIVERSIDADE ESTADUAL DE CAMPINAS (UNICAMP)
mdbambini@gmail.com

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1 Introduction

The State plays an important role in the food industry that goes beyond being a regulator to ensure food safety. On the one hand, in some countries, like the United States, the State has protected the food industries from foreign competition through trade measures like direct financial support, called direct subsidies, and reduction of tariffs for domestic farmers (Dicken, 2011). On the other hand, the State has played an important role in the technological development and in encouraging innovation through Public Research Institutions (IPPs). The long-term, persistent, and public, investment has been crucial for innovation in modern society (Mazucatto, 2014). This can be said of as well as in the context of private companies as for public.

In the case of Brazil, in the 50s, the State promoted development policies based on industrialization from external capital funds. And, since the beginning of the 20 century, sought to structure the agricultural industry and biomedicine. In this occasion, the Brazilian Oil and Gas Company (Companhia Brasileira de Petróleo e Gás - Petrobrás), the Aerospace Technical Center (Centro Técnico Aeroespacial - CTA) and the National Institute for Space Research (Instituto Nacional de Pesquisas Espaciais - INPE) were created. In the year of 1973, in vision that the State should lead innovation policies in the country, Brazilian Agricultural Research Corporation (Empresa Brasileira de Pesquisa Agropecuária -Embrapa) was created, to strengthen Brazilian agriculture.

Embrapa is a public research institution on technological innovation focused on the generation of knowledge and technology for Brazilian farming and cattle raising. It is recognized worldwide for its agriculture model as well as for Brazilian tropical farming and cattle raising, being one of the most efficient and sustainable models in the planet (Embrapa, 2016). This contributed to Brazil achieving a position among the world's largest producers and exporters of food (OECD, 2015), along with the United States and China (Dicken, 2011).

Historically, agriculture in the country has importance in the bases of the economy. There are a variety of small and medium-sized producers and traditional communities in all regions of the country, being distinguished for its economic and social subsistence. The gross value of production because of family farming represents 40% of Brazilian agribusiness, because of its prominence on the production of a considerable part of Brazilian foods, such as cassava, beans, milk, corn, rice, wheat and cattle. There are more than five million rural establishments and, of these, 84% are from family producers (IBGE, 2006). The participation of the farming and cattle raising sector in the economy of the country represented, in 2015, 23% of the gross domestic product (GDP), according to the Confederation of Agriculture and Livestock of Brazil (Confederação da Agricultura e Pecuária do Brasil - CNA).

Through partnerships between the private sector and the State, represented by Embrapa and the National Agricultural Research System (Sistema Nacional de Pesquisa Agropecuária - SNPA), the agricultural sector has been strengthened and has contributed to the impact in the lives of producers and to social, financial, economic and environmental transformation in the country (Carli, 2005). In this case, the role of the private sector is to develop new products, such as seeds, fertilizers and machinery, while the role of the State is to raise essential knowledge for the improvement of production, as the proper way of application of supplies, the best spacing in

crops, the mapping of risks and of best practices to overcome them, among others (Embrapa, 2014).

Through resources, almost exclusively from the State, the IPPs have the role to create and disseminate scientific and technological knowledge, so that this may be incorporated into the daily lives of people. However, the diffusion and the transfer of technology, efficiently, for the intended audience are a main challenge for these institutions (Bassi et al., 2014).

There is a difference between the average productivity obtained from producers and the potential of crops. Although there is technological information available to increase productivity, not all producers have access to it or, in other cases, do not put it into practice. This turns out to be a problem of technology transfer and knowledge exchange. One of the reasons may be due to failures in prospecting demand for technology, a problem that precedes the transfer process itself. It is possible that there is an imbalance between the development of technology and the real needs of its potential users (Araújo, 1979; Fujisaka, 1994). In addition to the difficulties of technology demand-mining and transfer, it is necessary to demystify the idea that the use of technology requires high investments and capital contribution (Oliveira, 2012).

Technologies are nothing more than tools and machines to solve problems or to make solutions simpler without necessarily requiring expensive resources. As diffusion is the process by which innovation is disseminated by certain means or channels to members of a social system, with the aim of reducing time between the generation and the adoption of technology (Rogers, 1962). While transfer of technology is a set of actions that seek to incorporate instrumental resources to increase production and productivity generating economic, social and environmental impacts (Dereti, 2009).

It is the transfer that ensures the applicability of technologies generated (Embrapa, 2016). At this stage, it is expected that technologies will be easily adopted, which is not always the case. In the case of Embrapa, technology transfer to farmers is made by two processes: Technology Transfer (TT) and Knowledge Interchange (IC). In this process, the company seeks to build knowledge in conjunction with several segments of the industry, to promote sustainability in Brazilian agriculture in respect to environmental, ethnic and cultural diversity of the country (Embrapa, 2016).

The company has 17 central units in Brasilia, capital of Brazil, 46 decentralized units, 4 virtual laboratories abroad (Labex), them being in the US, in Europe, in China and in South Korea and 3 international offices in Latin America and Africa. In view of its structure of units and projects, the Embrapa Agrobiology Unit was chosen to deepen the analysis of the technology transfer process. Embrapa Agrobiology Unit has a technical staff consisting of 150 collaborators, including assistants, technicians, analysts and researchers. Its main research lines involve the biological fixation of nitrogen technique and undergo agroecology and organic production, microbiology and biological inputs, recovery of degraded areas, molecular genetics and biochemistry (Embrapa, 2016).

Given the challenge faced by Public Research Institutions in the technology transfer process, it is possible to propose the problem to be studied: How does the technology transfer process occur in the Agrobiology Unit of the Brazilian Agricultural Research Corporation (Embrapa)? To answer to the research problem explained, this study aims to describe and analyze the technology transfer process at the Embrapa Agrobiology Unit, located in the city of Seropédica in the State of Rio de Janeiro.

From this introduction, the literature on TT in IPPs and TT in agricultural research and technological innovation has been revised. Following this, the Embrapa Agrobiology Case and the methodological procedures used in conducting this study were presented. Subsequently, the results and the discussion of these were presented regarding the prospection of technology demand, as well as the process of technology transfer occurs. Finally, final considerations were made, appropriating conclusions, followed by limitations and propositions for the continuation of this study.

2 Literature Review

2.1 Technology Transfer in Public Research Institutions

Since the 1960s, there are studies attempting to define the concept of technology (Galbraith, 1967; Skolimowski, 1966). The concept of technology is associated with what is being transferred in a process of technology transfer (Bassi et al., 2014). It can be scientific knowledge or another kind of knowledge as long as it is organized and has practical applications (Galbraith, 1967). For Skolimowski (1966), technology is associated with a process of creating new realities. Technology transfer is associated not only to a tangible product, but also to the knowledge that is generated and how it is applied (Bozeman, 2000). This study considers that technology and knowledge are intrinsically interconnected.

All technology needs to be transferred through a process that goes from its developer to the technology user. However, there are many problems in this transfer process, one of which is the non-adoption of the technology by the user. This can occur because of inadequate transfer or due to a technology development process independent from the user (Fujisaka, 1994). Another problem is the acceptance of technology that goes through the evaluation of the potential user. It is important to be aware that adoption occurs in a social context that has local characteristics and this should be taken into consideration from development until transfer (Johnson, Gatz & Hicks, 1997).

Under the more traditional approach of TT, it can be said that there is little or no participation of the target audience in the process of building technology. This makes it difficult to adopt technology, either because of the lack of credibility (Johnson, Gatz & Hicks, 1997) or because the technology does not meet the real needs of the user. Fujisaka (1994), argues that often a technology is not adopted since it is inferior or equivalent to the current practice of the user, once it does not match its reality or has not been transferred to the appropriate audience and in a correct way. Research itself is not sufficient to meet the real needs of the user. An adequate transfer of the results of the investigation is necessary to guarantee that the end users adopt the new technology or the generated knowledge (Sulaiman, 2002). There is much criticism in literature about this transfer process, putting into discussion the poor implementation of these technologies and the use of technological packages (Acoba, 2001).

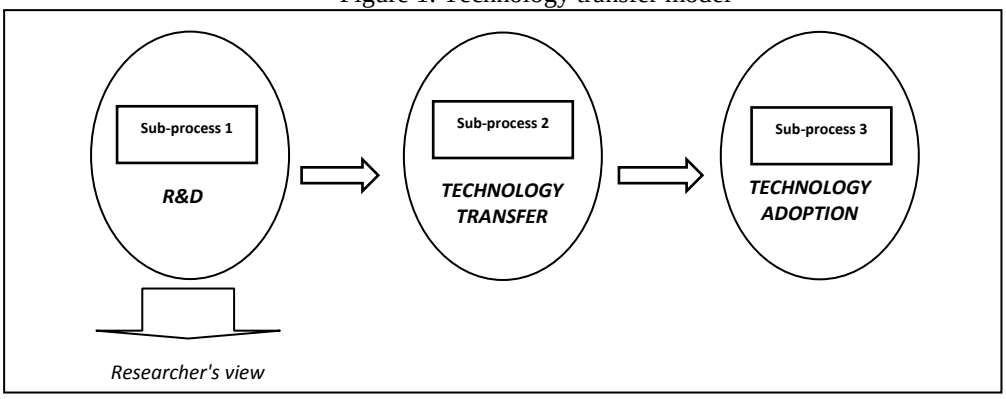
It is important to present a distinction between communication and transfer of technology. Communication refers to any message exchanged between two parties, while transfer relates to innovation exclusively; to the conduct and this may or may not be accepted by the potential user (Rogers & Shoemaker, 1974).

2.2 Technology Transfer in the Brazilian Agriculture

In a more contemporary approach, the transfer of knowledge is a critical factor essential to advancement in productivity (Janis, 2003). In Brazilian agriculture, in the classic model of extension, technology transfer is accomplished through an extensionist agent. This agent makes the link between the research center and the farmers through a unilateral process. This is the same model, originated in the United States, which lasted in underdeveloped countries of Latin America for many years, not only in Brazil. The purpose of this model developed by Rogers (1962) was to bring to producers through methods and tools new ways to increase productivity. However, this occurred in a convincing and persuasive process for farmers to adopt the technology by means of a ladder of adoption (attention, interest, evaluation, trial and adoption), proposed by Rogers (1962).

In this model, the Technical Assistance and Rural Extension Agent (Agente de Assistência Técnica e Extensão Rural - ATER) had the role of transferring packages of techniques or of knowledge, so that the methods and techniques could be strategically organized to facilitate this adoption (Wagner, 2011). The diffusionist model (Rogers, 1962), is based on a linear process composed of three fundamental stages: generation and validation, technology transfer and technology adoption (Figure 1). The technology is developed "for" the farmers and other interested actors. The technology or technological packages are then developed in the company and transferred to the user, and at the end, the adoption of the technology is expected to result in higher productivity or economic gains.

Figure 1: Technology transfer model



Source: (Rogers, 1962).

The classic and diffusionist models of TT began to be questioned, since 1980. Then, the proposal of several new models focused on the interaction between technological, institutional, social, economic and environmental aspects initiated (Embrapa, 2014). This model presupposed a participatory, interactive and interdisciplinary approach. The different perspectives contributed to the already developed knowledge and technologies being interpreted and adapted, considering the social context.

Several factors involved in the transfer process have received more attention (Howells, 2006). Another approach given in the literature about TT, is the collective construction of knowledge. Since the 1990s, Gibbons et al. (1994), proposed a new way to produce knowledge (novelty production approach). This proposal considers, from the process of knowledge

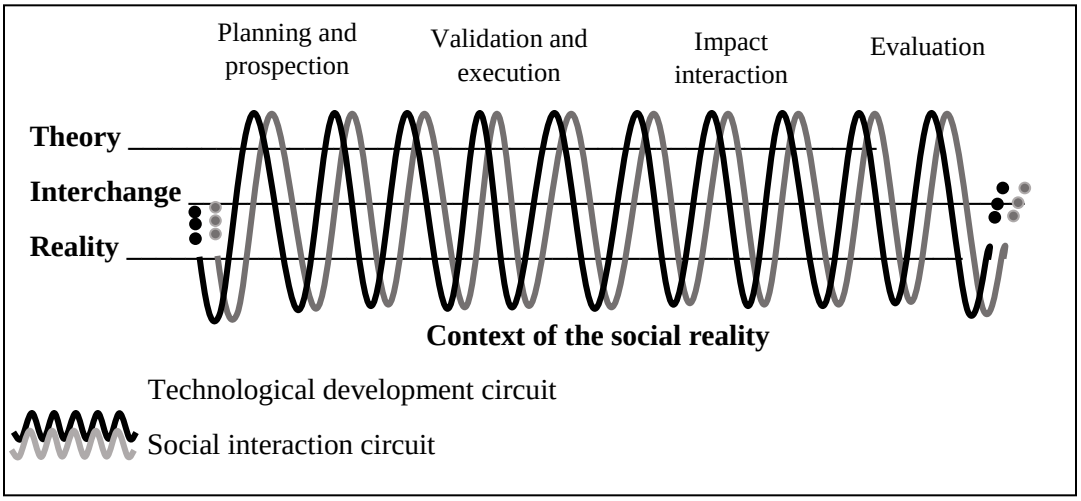
construction, the social context in which it will be applied. This model focuses on the participation of the farmer and other partners and not on the development of technological packages for potential beneficiaries. The model of collective construction of knowledge in the TT include Universities, ATER, farmers, market, government agencies, NGOs, suppliers of inputs and Embrapa.

The different actors considered must be involved in the process of knowledge construction, since all perspectives are addressed, as well as the social context of knowledge application. In this model, as defended by Gibbons et al. (1994), dialogue and interaction are the key elements. Thus, it ceases to be a linear model of production of knowledge and technology. For Heberlê (2012), this practice of collective construction of knowledge is more effective than formal contacts or mediated by technical devices of any nature, for example TV, internet or publications.

However, in practice, the diffusionist model of TT still prevails. Despite advances, a model that considers more the real needs of the user and less market offer (technological packages) has not yet started, thus, in spite of the effort of creating a dialogue between the factors, the reductionist vision prevails, focusing only on the dissemination of research results (Schlottfeldt, 1991).

There is, then, the helical model of Heberlê (2012), which considers a sequence of cycles articulated by science and society. According to the author, the model can be divided into four stages: planning and prospecting; executing; validating and interacting and impacting assessment. This study focused on the execution stage. In it, the cycles represent the continuity of the phenomena and the information feedback, as occurs in the agricultural research. In this proposal, social interaction and research cannot be separated (Embrapa, 2014).

Figure 3: Helical Model of Heberlê or DNA



Source: Heberlê (2012).

The State plays an important role in this process, especially in Brazil where agriculture plays a strong contribution in the country's economy. The economic growth of countries around the world needs to be driven by innovation and this requires the role of the State with the implementation of public policies and investments (Mazucatto, 2014). This is an idea that goes

beyond the traditional role of regulating or intervening in the market, but a role of encouraging both private companies and Public Research Institutions in the exercise of innovation.

3 Methodological Procedures

A qualitative approach was adopted to research the problem which was "how the process of technology transfer occurs in the Embrapa Agrobiology Unit". The qualitative research deals with interpretations of the social reality, having as its main prototype an in-depth interview (Gaskell, 2002), as occurred in this study.

The research has described the process of technology transfer, interchange and collective construction of knowledge in the Embrapa Agrobiology Unit. For this, an exploratory research of the Headquarters Unit of Embrapa was made and furthered in the analysis of the Embrapa Agrobiology Unit, considering its history, characteristics, key activities and lines of study. This stage adopted documental search procedures which include a consultation of the social balance sheet for the year of 2015, the Referential Mark and the Electronic Portal. The case study was adopted as a search strategy, from the perspective of Yin (2005), whose subject was the Embrapa Agrobiology Unit which is in the city of Seropédica in the State of Rio de Janeiro, Brazil. The case study is a research strategy that focuses on the understanding of the dynamics present in specific scenarios, possibly, from them extracting qualitative evidences (Eisenhardt, 1989). The case examined in this study is described in topic 3.1.

It was adopted as a data collection instrument, which structured interviews carried out through September to October 2016 with the head of technology transfer of the studied unit, a researcher and an analyst at the Technology Transfer Department (DTT) from the Embrapa headquarters Unit. Each interview had an average duration of 1 hour. Subsequently, they were transcribed in full, resulting in a document of thirty pages. The conduct of interviews was done through a structured script divided into groups of questions in three pre-defined categories of analysis, namely: the role of technology transfer; (2) the organizational structure of the TTICC area; (3) TT process which was subdivided into two sub-categories: (3.1) strategies and delivery ways and (3.2) methods and tools.

By the nature of the data collected, a qualitative treatment was used for the elaboration of the analysis (Bardin, 2011). The analysis of data followed the following steps: pre-analysis (organization and systematization), exploitation of data (coding, classification and categorization of data) and interpretation and judgement of the researcher. A summary of the methodological procedures used in this study is presented in Table 1.

Table 1 – Summary of the Methodological Procedures

Stage	Method	Comments
Approach to the problem	Qualitative research	• Interpretation of the opinion of the interviewees.
Type of Research	Descriptive and Exploratory	• Descriptive (Technology Transfer and Knowledge Exchange Process) • Exploratory (Embrapa)
Procedure	Documental Research	• March Referential TTIC • Social balance 2015 • Embrapa's Electronic portal on the Internet.
	Study of a single case (Embrapa)	• Embrapa's Agrobiology Unit
Data Collection	Structured Interviews with researchers in technological transfer (Use of semi-structured script) = 4 Hours of Interview	• Deputy Head of Technology Transfer (Seropédica-RJ) • Researcher in the Department of Technology Transfer and Knowledge Exchange (Brasilia/DF) • Analyst Department of Technology Transfer (Brasilia/DF)
Analysis of data	Transcription and Analysis of content (Bardin, 2011)	Categories of Analysis: • Role of Technology Transfer and Knowledge Exchange; • Organizational Structure Area; • Process: Strategies and Forms of Delivery Technology and Methods and Tools.

Source: Self elaboration.

After the procedures of data collection and analysis, the study object of this research is presented, the case of the Embrapa Agrobiology Unit.

3.1 The case of the Embrapa Agrobiology Unit

The headquarters of Embrapa, located in the capital of Brazil, is linked to the Ministry of Agriculture, Livestock and Food Supply (Ministério da Agricultura, Pecuária e Abastecimento - MAPA). It develops, in conjunction with the National Agricultural Research System (Sistema Nacional de Pesquisa Agropecuária - SNPA), a genuine Brazilian model of tropical agriculture and livestock, seeking to overcome barriers that limit the production of food, fibers and energy in Brazil. It declares itself as a technological innovation company focused on generating knowledge and technology to the brazilian agriculture and livestock.

Embrapa operates throughout Brazilian territory and develops scientific cooperation programmes (Labex) in North America, Europe and Asia, in addition to technical cooperation in Africa and South America. The Embrapa Agrobiology Unit is one of the 47 decentralised Units of Embrapa. Nowadays, research at the Unit is divided into three main thematic clusters, namely:

(1) The new forest code; This code was instituted by Law number 12651 of 2012 and established changes in land use in Brazil. This brought new guidelines about the permanent protection of areas and of legal reserves. The group which operates within the unit, seeks to identify gaps in research beginning from the identification of impacts on the productive, social and environmental segments and the contribution to the compliance with the new law.

(2) The Low Carbon Agriculture Plan (Plan ABC), is centred around the study of the effects of the emissions of greenhouse gases due to Brazil's goals in stopping the emissions of 1 billion tons of CO_2 to the atmosphere. This goal is a signed agreement from the United Nations Conference on Climate Change in 2009. The role of agriculture is to contribute to the recovery of degraded pastures; crop-livestock-forest integration; No-tillage and Biological Nitrogen Fixation (FBN). Embrapa has researchers of worldwide references in FBN, which are developing activities in this purpose.

(3) The National Plan of Agroecology and Organic Production (PLANAPO) established within the sphere of the Federal Government, the implementation of public policies focused on agroecology and organic production, in several aspects such as in agricultural credit, support, promotion and in science and technology. In this plan, four main axes are covered: production, Agro-biodiversity, knowledge, commercialization and consumption.

Each of these core groups encompasses several researchers, them taking part in one or more cores depending on his area of expertise. In total, the Unit has about 150 employees, including assistants, technicians, analysts and researchers. Embrapa, in all its units, employs 9,767 people. Embrapa Agrobiology is a production Unit which produces a lot of knowledge and translates it into technologies, products and processes. The Embrapa Agrobiology Unit is a worldwide reference in FBN studies, as the example of its results can be mentioned by the savings provided in the non-use of nitrogen fertilizers in the soybean market. It estimates that this saving can be of around 10.3 billion dollars per year with the substitution of inoculants.

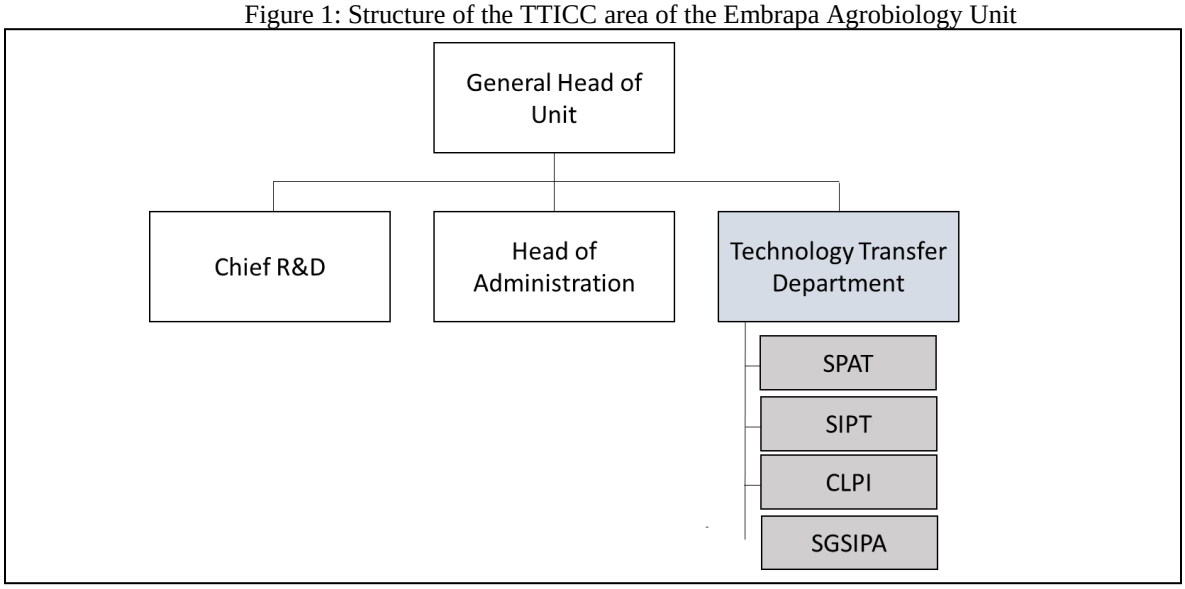
4 Analysis and Discussion of Results

4.1 Reorganization of the Technology Transfer Area

The area of technology transfer at Embrapa has gone through a restructuring process (Interviewee 2). This has contributed to many changes in how the transfer of technology is made. One of the impacts of these changes occurs in the organizational structure of the area. Nowadays, the Embrapa Agrobiology Unit is divided into three macro processes, which are: Research and Development (P&D), Chief of Administration and Finance, and the Technology Transfer Department (DTT). This study aims to analyze specifically the DTT, which is divided into four coordinations, namely: Sector of Prospecting, Articulation and Evaluation of technologies (SPAT), Sector of Implementation of the Programming of Technology Transfer (SIPT), Local Committee of Intellectual Property Rights (CLPI) and Sector of Management of Agroecological Production Integrated System (SGSIPA). These coordinations work together, not occurring, in practice, a very clear division among them (Interviewees 1 and 3).

Figure 1 presents the organizational structure of the TTICC area of the Embrapa Agrobiology Unit. The SPAT is responsible for the evaluation of the technologies in ex-ante studies, as in the prospective scenario, while technology is still being developed. SIPT in turn, is responsible for the evaluation of technology in studies *ex-post*, when it is already in contact with farmers in the experimental fields. In this case, the impact of technologies on society is evaluated. The SIPA is an exclusivity of the Embrapa Agrobiology Unit, as it is a management system for "Fazendinha Km 47", a self-sustaining model of Agro-ecological and organic basis. In each of these coordinations, there are supervisors and researchers working together (Interviewee 1).

Figure 1: Structure of the TTICC area of the Embrapa Agrobiology Unit



Source: Self elaboration.

Since the creation of Embrapa, the company has received support from the Technical Assistance and Rural Extension Company of the Government of the Federal District of Brazil (Empresa de Assitência Técnica e Extensão Rural - EMATER) for technology transfer. Through this partnership, Embrapa has had direct contact with farmers and producers in the transfer of technology. However, from 1990, the partnership ceased to exist and, for about twenty years, Embrapa has been an essential partner in the TT. This caused many of their technologies to be on "shelf", since they were developed without direct contact with farmers (interviewee 2).

From this phase, Embrapa felt the need to develop technologies with the participation of the farmer. For this reason, the headquarters of Embrapa, the area of Technology Transfer (TT) underwent a restructuring process which resulted in the creation of the department about seven years ago. Some units of Embrapa already worked according to the new restructuring, but management of TT only officialized that specific framework (Interviewee 3). With the structuring of the area in the headquarters, this process has been disseminated to other Embrapa units.

4.2 The role of Technology Transfer: focus on the participation of the producer

This new phase of the TT has been marked by a search of dialogue with the final agriculturist and the multiplying agent. It was a milestone reference which deals with Embrapa´s relationship with the society (Interviewee 2). Since then, the role of the transfer has been explained from three pillars: (1) Technology Transfer (TT), which allows the generated results and products to reach the productive sector and society as a whole; (2) The interchange of knowledge, which allows technology and knowledge already developed to be interpreted and adapted by means of specific realities and particular values; and (3) The collective construction of knowledge, which seeks to build knowledge along with farmers, co-partners of the transfer process. There are therefore the three pillars which are technology transfer, interchange and collective construction of knowledge (TTICC).

As the research area develops its studies, the area of technology transfer, construction and interchange of knowledge (TTICC) has been responsible for dialoguing more closely with the

public of interest and with society, either through prospective studies or technology implementation (Interviewee 1). The role of TTICC is to build technological dialogue with society, which is different from communicating, since this is the core responsibility of communication. In this new context, the TTICC is responsible for capturing the demands of society, studying its scenarios and identifying what the needs are. From this, these informations are translated into research. The research points out that knowledge is not built only on the basis of books, but also acquired from the farmers.

It is possible to exemplify technology transfer in this Unit, whose main highlight is the production of Brazilian agriculture inoculants. As illustrated, the production of a compound with selected and studied bacteria, when in contact with the roots of plants is increases the fixation by the optics of nitrogen. To a certain extent, this knowledge is transferred to society through courses for farmers or Agents of Technical Assistance and Rural Extension (Assistência Técnica e Extensão Rural - ATER), or even, licensing structures for companies that develop studies and partnerships for technical assistance.

In TT, Embrapa's main public of interest is the extender or the multiplier agent. He or she may be a community leader or a coordinator of an association. This person is the individual who transmits the knowledge to the cooperatives or communities. This multiplier agent then becomes the instructor of a certain community. Only in specific situations does Embrapa work directly with the farmer, as an example, in the National Plan for Innovation (Plano Nacional de Inovação - NDA) for family farming. In this case, the company receives funds from the federal government to carry out training actions directed to farmers. This does not have the intent to be some sort of technical assistance, but an empowerment that Embrapa gives to the farmer in first instance so that he may become a multiplier agent.

Embrapa does not have sufficient resources to directly reach all farmers. So nowadays, the target has been the multiplier agents, they are the disseminators of technology and who transfer knowledge to the tip (producers). A farmer will not always return to the company once, twice or three times to continue training, but the multiplier agent does. So, the current proposal is the continuing education of these agents. Embrapa is seeking to identify where it has been working, what its productive chain is and for which technology it has been trained. That is, Embrapa is mapping these agents so that it makes it possible to work with them in the future, if case necessary, in a continuing education.

The focus on multiplier agents has become stronger with the establishment of DTT, but some Embrapa units have already worked that way. The Embrapa Cerrados Unit, for example, is a reference of this link between EMATER agents and the company. This ends up being more effective by the fact that multiplier agents are within the company in a continuous training program.

The major difference is that Embrapa rather than developing knowledge or technology and then transferring it, hopes to discuss together with the producer what the best way might be. It is about doing "with" the producer and not "for" the farmer. There is a big difference in that, especially in the way technology is addressed and how it goes to the language of the producer. In the old model, the company transferred a technology, but the producer needed something before. So, there is a work to be done together so that it is possible to understand the reality of the producer, the real need and the impacts that a certain technology can cause.

In this new phase of TT, the exchange of knowledge stands out, which is a way of building together. This is more than the transfer. It is a logic of collective construction in which

researchers work together with producers to generate knowledge and to transfer it. It is the producer who knows in fact the place and the context of the problem, then it he who brings several information to the Embrapa researchers. For example, in a process of rainwater capture, it is the producer who knows the place's rainfall history. Then, Embrapa begins to adapt and to transform this technology and to enter the reality of the producer. Without this interchange of knowledge, that is not possible. Thus, this new focus and this new way of constructing research and transferring it to the producer is highlighted.

This exchange of knowledge and experience occurs during the entire process, even during the validation of the technology. The multiplier agent takes knowledge to producers and, later, he returns to Embrapa with the results. This process already generates new knowledge and this gives feedback to the actions of the research. It often works with social technology leading Embrapa to a farmer's knowledge based on common sense which then turns into research. Innovation arises from an original knowledge of the farmer, which is then transformed into scientific knowledge.

4.3 The technology transfer process

The process of technology transfer is very diverse and there is still a culture of shelving/storing technology. A shelved research means that Embrapa produces the research and then transfers it to the farmer, without any involvement of the farmer in the development process. However, the company has been working to change this culture, since many have recognized that there is no transfer without the direct dialogue and participation of the farmer in the process (interviewee 2). A trend in this new way of doing transfer is the use of the farmer's own properties. For a long time, Embrapa used the Technological Reference Units (Unidades de Referência Tecnológica - URT), where transfers were made through demonstrations, working as a kind of experimental field. However, Embrapa´s URTs prefers the TT on the farmer's property. Therefore, the farmer feels part of the process and is involved in this transfer process.

TTICC can be done in different ways, if they are within the Embrapa's Manual of Forms of Delivery and Results. Embrapa has worked with six main ways, which are presented as follows (Embrapa, 2016).

(1) Courses for multipliers, which is organized and carried out by the Unit or in partnership with other Units and other institutions, registered internally, giving certificates containing study time, content and duration of at least 8 (eight) hours, as described in the new Embrapa's Manual of Events. Certificate can be given at the Unit's premises or in external locations.

(2) Field Day, which is an event aimed at practical demonstrations or imagery (field day on TV) of the results of the research or of the technologies developed, adapted or adopted by Embrapa, through visits to experimental fields of the Company, technology showcases, Agro-industrial plants and demonstration areas. The multiplier agent or the producer visits the stations, for example, the organic vegetable station, the seedling station, until arriving at the production field of vegetables themselves. This is one of the main TT instruments that Embrapa has.

(3) Technical lecture, which is a presentation of technical or a scientific topic, with the purpose of promoting the shared knowledge in an indoor and outdoor event of the Unit, with a minimum duration of 45 minutes.

(4) Incubation Process, which is a technology transfer process that encourages the creation, development and consolidation of competitive companies, through the adoption of modern administrative practices and the uptake of innovative technologies.

(5) Learning Unit, which is the primary way Embrapa transfers technology. It is about separating a part of the Embrapa's field to receive the farmer. In this part, the company researches and receives farmers to carry out the transfer. But the company has come to realize that some farmers believe that "the soil of Embrapa is better", so the tendency is that farmers may take their own ownership to be a learning unit. Thus, they become a partner and along with it, the company develops knowledge. In the Unit of Embrapa Agrobiology, there is a learning unit called "Fazendinha Km 47" that has an area of 80 hectares. It receives about 1800 visitors annually in its courses, field days and technical lectures for the interchange of knowledge and experiences among undergraduate and graduate students, researchers, professors, multiplier agents and farmers.

(6) Observation Unit, which is a space that allows the observation or validation of results generated by Embrapa or its partners, in their evaluation phase, in different environments and times. The installation of the Observation Unit can be made through Embrapa or in partnership with other organizations, in their own areas or through third parties, with the collaboration of producers, cooperatives, public or private research institutions.

(7) Demonstrative Unit or Technology Reference Unit is a space for result demonstration from technologies generated and/or adapted by Embrapa and partners, in the form of final product. It can be installed inside or outside Embrapa's Unit, but under its supervision, in partnership with education, research and technical assistance and rural extension agencies (private or official). It acts as an irradiating center for technology transfer and for the interchange of knowledge, in general, associated with training and capacity-building efforts of multiplier agents. Rather than giving a packet of seeds to the producer, for example, Embrapa makes the demonstration of the use of the seed, in situations with and without the use of seed for which the producer can learn in theory and in practice, in a visual way.

Embrapa is pleading other two forms of delivery which are the systematization of experience, in which it works together with the farmer to systemize and plan. And, the other, is the formation of socio-technical networks, in which interchange of knowledge occurs, that is, the exchange of knowledge of the company's researchers with farmers or agents. In addition to fairs and exhibitions that have been new forms of TT. In this case, instead of representing a unit in this event, Embrapa is represented and takes technological solutions to these events that are the most attractive of all units. This is a proposal to work in networks, which is something that Embrapa is also focusing very much on, both among units and among external partners. There are projects in which other units are involved, because each researcher has his own contact network. Each unit has its own expertise, in the case of Agrobiology it is socio-environmental and rural development, but Agrobiology needs to work in unison with other units to develop its projects.

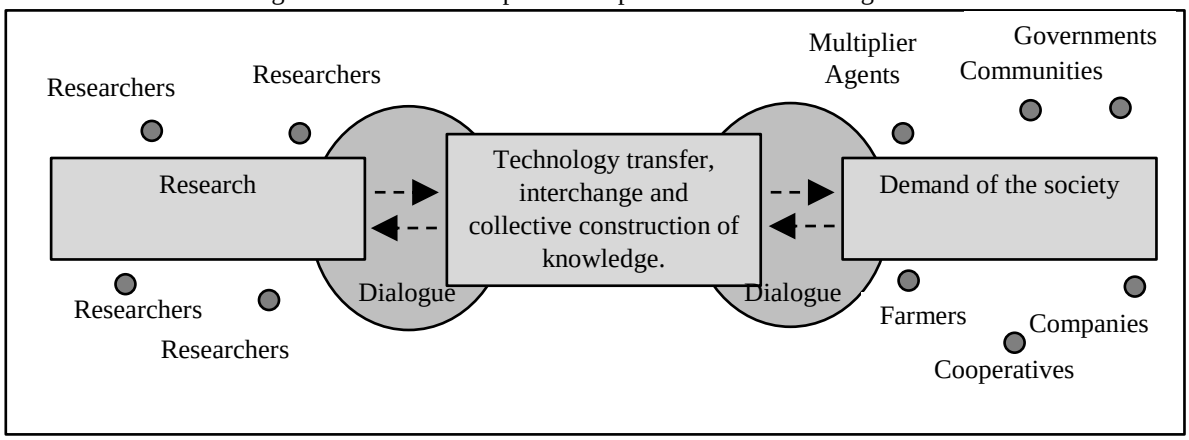
In addition to the forms of delivery (1 to 7), Embrapa has a commitment to society, which is its annual publication, since 1997, of a social report. This balance sheet shows Embrapa's results for the year and is available on the Internet for those who are interested. And, finally, it can be said that scientific publications are also a way to transfer knowledge. Embrapa has its own scientific journal and it also publishes in other journals in Brazil and worldwide. This is also a form of socialization of the developed knowledge.

Many of these forms of delivery are used, but it is important to say that the validation of a given technology only occurs along with producers and cooperatives or other public that is of interest. So, when a technology is launched, it already has farmers' expertise because they participated in the construction process. Therefore, it does not become a novelty to them, because

it was developed altogether. They participate in the project and this is most interesting. In the case of programs aimed at specific publics such as "Brazil Without Poverty" (Brasil Sem Miséria), the public is of family producers, which then Embrapa adopts as a form of delivery to the Learning Reference Unit (Unidade de Referência de Aprendizagem - URA). In this case, the company builds a URA together with the producers and they learn together with the company how to use the technology. From this, these URAs have become showcase models of the developed technology and a space for training other multiplier agents.

Each unit has its own mode of operation, but the Embrapa Headquarters Unit is trying to create a more institutional process and more methodological procedures. Still, each unit is free to act in the way it considers best. However, the Headquarters tries to be a guiding force on these actions. Figure 1 illustrates the process of production of technological solutions, in which technology transfer has a key role. The demands of society go to the TTICC, which in turn, feedback research and technology transfer, then gives it back to society. The importance of dialogue between society and research stands out in this process, which can occur via interchange of knowledge and collective construction. The contact made between the researcher and society always passes through the area of technology transfer.

Figure 1: TTICC in the process of production of technological solutions



Source: Self elaboration.

Although it is not the focus of this study, it is important to note that the actions made with society are accompanied and monitored to see if farmers are adopting certain knowledge and if it is causing economic or environmental impact in the community around them. From then on, Embrapa uses a methodology to assess the and to measure the adoption of technology and its results at the given time. It is based on that result that the company may say in its social balance sheet how much a technology has increased productivity in farmers' properties, for example.

4.4 The Role of the State in Innovation at Embrapa

About the State's role in innovation, it was clear to identify that it has greater responsibilities than regulating and creating laws. Embrapa needs to know how far it can go, who owns the right to intellectual property and this is also the role of the State. But there is also another side which is that to foster innovation through the resources and conditions given to

Embrapa for research in agriculture. In addition to fostering dialogue with society, Embrapa and with companies, mainly.

Research and innovation depend on good conditions provided by the State. Without the support and incentive of the government, there are no conditions for research and for generating results. The role of the State is to provide the resources for making this happen and that role has been carried out along the trajectory of Embrapa despite the restrictions in recent periods due to the economic crisis (Interviewee 1).

5 Final Considerations

The aim of this study was achieved, since there was a possibility of describing and analyzing the technology transfer process at Embrapa Agrobiology Unit, located in the city of Seropédica, Rio de Janeiro. It is concluded that Embrapa has been committed to involving the farmer in the process of interchange, collective construction of knowledge and technology transfer. The farmer has become the focus of this process, reducing the development of "shelf" researches, increasing the participation of the farmer or of the multiplier agent.

It is also concluded that Embrapa is dedicated to bringing knowledge to the most important people involved in this process: the farmers. For this, in a new phase of technology transfer, the multiplier agent has become the focus, since there is a greater possibility of taking demands, working closer to the company and disseminating knowledge to other farmers, whether they are cooperatives, communities or associations. It is also concluded that the transfer of technology by itself is not enough to promote transformation, it is therefore necessary to exchange knowledge with farmers and a collective construction in the research. This is what has resulted best and is what Embrapa has invested its efforts on.

The importance of studying and knowing the process of technology and knowledge transfer to the public of interest should be highlighted, and especially the reasons why this technology or knowledge are often not adopted by the public. It was possible to identify that Embrapa has noticed the difficulties of farmers and realized that the best way the best way of transforming technological solutions and knowledge into innovation is by involving the farmer in the process of construction and of transfer. Thus, the farmer gives greater credibility to the technology or generated knowledge, because this is something that he himself helped build.

In the sphere of contemporary institutional knowledge management, Embrapa has had as its main point of departure the demand and the needs of society. For this, it has created means to ensure the participation of different actors, because they signal the construction of technological solutions and of innovation and they are the ones who know the real situation. However, this is a recent progress within Embrapa that has evolved and generated results. Thus, research, science and technology institutions must go beyond technology transfer and must ensure the involvement, participation, and interaction of the public of interest to promote significant change, social, economic and environmental development and transformation. Embrapa observed this from the referential framework that included technology transfer, interchange and the collective construction of knowledge.

In addition to contributing to the development of products, processes and technologies for the economic, social and environmental development of Brazil, Embrapa has been outstanding in generating knowledge for the advancement of science. Its results have had impacts not only nationally, but worldwide. Embrapa has played a key role in Brazilian agriculture as well as in

livestock, mainly, in supporting governmental projects and in the implementation of public policies.

It is concluded that Embrapa has been committed to raising the process of technology transfer to the same institutional dimension of the R&D macro-processes; integration of R&D, TT, communication and business since the beginning of the innovation management process; the promotion of dialogue with partners in the definition of TTICC strategies, considering the characteristics of the different audiences and the diversity of agroecosystems; has stimulated the protagonism of social actors as subjects of the innovation process and valued and supported local innovation networks in the TTICC process, as proposed in its guidelines in the Referential Framework.

This study contributed to reflections about the TT process and how it can be used by different actors, along with the role of the State in innovation. However, some limitations were found, among them, the fact that only internal members of Embrapa were interviewed, limiting the view of the TTICC staff and without knowing the multiplier agents' opinion and other actors involved in the process. In addition, it is a qualitative research that is subject to the interpretation of the researcher.

Thus, it is suggested for the advancement of this research, the interviewing of other actors involved in the TTICC process internally and externally to Embrapa, as well as the heads of other departments. It is believed that the opinions of farmers and agents, as well as of the government itself could complement the analysis of this process. The analysis of the farmers' opinions would be interesting to investigate and what are the troubles faced in adopting technologies as well as why they are often not adopted. Thus, another possibility would be to search on how they could be transferred more efficiently, dedicating more time and people to the systematization of the experience.

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