TECHNOLOGY TRANSFER: AN INTERDISCIPLINARY PROCESS

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Abstract

This article describes the importance of technology transfer process (TT) for public research institutions and its necessity to be planned from a research project design. It also presents a comparative analysis of technology transfer process between the Brazilian Agricultural Research Enterprise (Embrapa) and the Agricultural Research Service (ARS). Therefore, a descriptive study was conducted with the use of printed and electronic documents. Interviews were also developed with employees associated to this process in strategic and operational levels for both institutions. Results demonstrate that both institutions rely on a structured TT process. However, this process is more effective in ARS than at Embrapa. One of the most probable causes supports that the research model used in ARS is the reverse linear model (demand pull), which considers market demands in the development of research projects, while Embrapa works with the research linear model, where TT process begins only after obtaining the research result. The papers suggests, in order to make the TT process more effective, Embrapa could consider the demands of its targets audience and planning the TT actions where elaborating its projects conjoint.

Keywords: Technology transfer; Embrapa; ARS; Interdisciplinarity

Introduction

Agricultural technologies, according to Atkinson et al., (2003) present a special challenge for public institutions technology transfer

programs which must balance the technology commercialization objectives with humanitarian goals or applications for specialty cultures.

According to Pineiro (2007), agricultural activities have been developed, mostly by public institutions and universities, taking into consideration that many of the agricultural technologies and a great part of knowledge created had little market value. However, since the late 1970s, this scenario has changed. Agricultural technologies have become physical products, such as agricultural machines or pesticides. The exponential growth industries led to a fast expansion of private enterprises that create, manufacture and sell technology (Rubensteinand & Heisey, 2005; Pineiro, 2007).

These changes further complicated the mission of public research institutions, forcing the public sector to change and still keeping a main role in agricultural research. National research institutions are slowly trying to adapt to these new circumstances, redefining their positions and priorities.

For Rubensteinand & Heisey (2005), the agricultural technology transfer in public research system to the private system, represents, in theory, a way to do more with less. The transfer of public sector technology has several goals: to bring public R&D benefits to potential users, find ways for public institutions to pursue their mission in a scarce resources time, influencing the direction of technology development and increase research funds through licensing proclamations.

The Brazilian Agricultural Research Enterprise (Embrapa) is the main public institution of Brazilian agricultural research. Embrapa acts as a network, with 47 research units distributed in Brazil. In addition, coordinates the National Agricultural Research System (NARS).

The Agricultural Research Service (ARS) constitutes the leading agricultural research institution in the United States. ARS acts as a network with 4 regional research centers and 6 major centers of human nutrition research. Geographically, ARS operates in 8 regions in the country. Considering the importance of these institutions and the responsibility to find solutions for world agriculture, using public resources, it is extremely important they be supported on an efficient process to transfer their research results. Thus, the objective of this study is consists of to describe and analyze comparatively the technology transfer processes used by them. The paper is structured in five parts: the first one devoted to introduction, the second one for the importance of technology transfer process in public institutions. The third part presents a characterization of Embrapa and its technology transfer process. The fourth brings the same information to the Agricultural Research Service and the fifth part ends with papers conclusions.

The importance of technology transfer process in Public Research Institutions

According to Pallone & Wanda (2006) and Mello (2000), Public Research Institutions (PRIs) are designed to meet specific demands, becoming technological tools for socio-economic countries development, associated to government programs, which its social legitimacy occurs based on the efficient implementations of their public duties and the public perception for activities by means of society.

This point of view is supported by Muscio, Quaglioneb & Vallanti (2013), which consider there is growing awareness in industrialized countries about the importance of scientific research in the theoretical framework for a technological change and an economic competitiveness. Since the late 1970s, there was increasing pressure for universities and research institutes to develop industry research and establish closer links with the enterprise community (Muscio, Quaglioneb & Vallanti, 2013).

Chaimovic (2000) explains that science does not plan to, but that investment in science should be planned. The way that relates the discovery to invention is large, demand creation of new technology and requires huge investments. It is the production chain, and not knowledge, what determines the public investment option in technology and innovation. The limits of public investment research in PRIs - and therefore the separation of public knowledge to innovation - establish challenges which, will depends on the supply chain and need to be agreed with the strong participation of PRIs in the definition of investment policies.

Rapini et al., (2006) state that research carried out in PRIs and contribute to increased absorption capacity, establish links with international sources of technology, contributing to evaluate which technological developments are available and establish which industrial sectors entry is difficult. Furthermore, scientific research serves as a support for domestic industry, allowing entering in relevant industries for development.

The public research institutions develop their research following the standards of established research model. The most widely used model is the linear model and interactive model. In linear model, the development, production and commercialization of new technologies are seen as a well-defined time sequence, which originates in the research, involved in the product development phase and leads to the production and eventually marketing (Campos, 2006). In interactive model the linear sequence between research, development, production and marketing is just one of the innovation possibilities. The relationship between scientific and technological research follows several ways, and, unlike the linear model, innovations rarely start the search.

According to Schaun (1981), technology transfer is the consecration of all the energy used for the knowledge generation and the security of research validity, via technology adoption; hence why it is believed that among factors limiting the adoption of technologies generated, there is how to transfer them. Understanding this problem arguably is the need to consider the technology transfer process as an interdisciplinary process involving the relationship between the various actors in this process.

The possibility of the technology generated is not in agreement with the social system reality desired to be modified, it can be attributed mainly to the lack of integration between research-user (Wildner, Nadal & Silvestro, 1993). In addition, Fujisaka (1994) points as one of reasons, the fact that technology is a result of a poorly formulated research problem, that is, users do not face the problem that researchers assumed. This finding leads to the need of establishing a strong integration between the different actors involved in the process of technological innovation, aiming to make possible the technology adjustment to the conditions in production units (Tagliari, 1984).

In this context, Schwartzmann (2002) describes that we are facing an important paradox: Brazil spends most of its research resources in applied activities, but the results are not used or appear as they should appear. For Schwartzmann, this situation stems from a condition known as shelf research, where the search result never gets to turn into a marketable product or a practical operating procedure (Schwartzmann, 2002).

According to Rosa Neto (2006) the process of technological development, should be viewed as a whole, observing the adaptability conditions of access and interest of your target audience in order to identify the demands to facilitate the decision by research in relation to the generation/adaptation of new technologies.

Rosa Neto (2006) states that technological development the process, should be viewed as a whole, observing the adaptability conditions of access and interest of your target audience in order to identify demands to facilitate the decision by the research in relation to the generation / adaptation of new technologies. That's why; Dereti (2009) suggests the inclusion of technology transfer action plans, from the design of R&D projects to increase the transfer effectiveness, considering the participation of potential users and the identification of transfer opportunities for technologies developed.

The process of technology transfer at Embrapa

Technology transfer at Embrapa aims to provide the knowledge and technologies generated by research units to different society segments. The Department of Technology Transfer (DTT) was created with the aim of systematizing the TT strategies along the units. However, due to the

existence of other administrative units that coordinate some sub-TT this process does not have a central coordination.

The TT strategies at the institution are developed in a decentralized way by the research units, which develop them according to what they consider is the most appropriate.

The research at Embrapa is developed by its 46 decentralized units of research. Each unit researches a topic or product. The portfolio of each decentralized unit designs are created according to the rules and guidelines of the Central Unit. But the form and results of transfer methods are not centralized. Each unit has its own TT process.

The more shapes used by Embrapa for technology transfer are: Farm days, observation units, courses, conferences, technical and scientific publications, electronic media and partnership contracts.

The main forms of contract are: Use of licensing; Direct sale; Technical Cooperation; Service assessment; Consulting and Transfer Research Material.

For a better understanding of the process of technology transfer at Embrapa, semi-structured interviews were conducted with two crowded managers from the Department of Technology Transfer (DTT), unit responsible for part of the institution's technology transfer process.

According to respondents, the transfer can occur in both contractual way through publications, licensing, patenting, technical courses, conferences, demonstration and observation units, technology showcases, business plans, radio and TV programs and little libraries. These activities are developed in research units that generated the technologies or processes.

The technologies are licensed for production and marketing for interested partners, the private sector. Each research unit manages its own TT process.

All the research projects should be developed to meet the edicts of institution. Projects can be developed only by Embrapa or in partnership, but always in accordance with the topic research proposed by the institution. This procedure suggests the use of the linear model research, which can often result in technologies that do not meet demands of users. Normally, the future users are only consulted at the validation stage of technology.

The TT process is mostly directed to basic research. The Institution has encouraged the development of applied research, however, still has not reverse this reality. The reverse model of TT, search the market needs, which serves as idea generator to direct R & D. From an identified need in the market, a new process or product is developed, in order to meet the identified needs. Develop technologies to meet demands identified facilitates the transfer process of these technology and maximizes public resources for research.

The TT process was not considered effective by respondents, because it is done in a decentralized way and use of policy guidance or standardized rules. According to the interviewees, only a few units have technical and strategy to carry out this process efficiently. As stated before, although research units have a better understanding of its target audience, the lack of standardization for actions can lead to disjointed them among units professionals and headquarters, affecting the exchange of information and experience, and at the same time, provokes that Embrapa can be seen in a fragmented way for society.

In perception, no need to deploy some improvements in this process, in order to make it more efficient. The suggested improvements were: Development of a TT guiding policy; Definition of process governance; Redefinition of job profiles; Optimization of integration between R&D and TT; Identification of network demands for technologies and TT shares; Qualification and organization of knowledge and technologies by demands; Identifying best practices and strategies for TT and impacts evaluation for technologies, strategies, R&D program and technological developments in regions and territories.

For these improvements suggestions, it is noticed that the TT process is still in its initial phase at Embrapa Headquarters, which confirms the perception of Heberlê & Sapper (2007) that at Embrapa, it is not clear the relationship that involves the steps generation and technology transfer. This deficiency, combined with the lack of actors in rural areas in Brazil, can become a vulnerable spot for the institution.

On this basis, it is important for Embrapa to have an effective TT process so to reduce the time between the knowledge production and technologies and their availability to users. Based on the concepts of Eldred & McGrath (1997); Garnica & Torkomian (2009) and Schaun (1981), the transfer process success depends in a great way on clearly defined and managed TT methodologies. Thus, it is important that Embrapa could have a structured TT management process, with a clear definition of roles and responsibilities for all employees involved.

The technology transfer process in ARS

The transfer activity in ARS is coordinated and implemented by the Technology Transfer Office (TTO), which has the responsibility to obtain patent protection for the intellectual property, developing strategic partnerships with external organizations, and performing other results transfer activities research and technologies to market (ARS, 2013).

The TT program is centered on approval policies and procedures, and provides service to researchers through their coordinators of technology transfer, which make the link between researchers, managers, ARS, TTO,

partner universities and the private sector, and negotiate technology transfer agreements.

The technology transfer is performed by: technical publications, scientific papers and reports; plant germplasm liberation to the public; transfer of research materials for external researchers; formal partnership agreements; licensing, patents, plant variety certificates and biological materials protections; meetings with industry organizations and universities, workshops and farm days; and Personal Information.

Agreements with external, public or private organizations are made by contract. The main TT arrangements are used:

Confidentiality Agreement: It enables the exchange of confidential information and data between parts in order to verify the interest of a future research agreement or license.

Material Transfer Agreement: Guides the transfer of research materials between two organizations, without transferring ownership - the materials are only loaned to the scientist.

Cooperative Agreement R&D (CRADAs): Conjoint research with at least one non-federal partner with research capacity and availability of financial resources for research. Aims to create or improve a commercial product and includes the creation, protection and licensing of intellectual property related to the research effort.

Transfer Research Material Agreement: Allows materials transfer, without involvement of joint research between parts. It could take a deep study, to be conducted with a cooperative agreement of R&D.

For a better understanding of ARS technology transfer process, were conducted semi-structured interviews with 7 employees of the institution - 3 managers TTO and 4 researchers from different areas and locations.

According to respondents, the research results transfer, can occur either through a formal agreement or scientific activities, such as the presentation of papers in technical meetings, scientific publications, patenting, licensing, led by TTO.

Technologies developed by ARS are licensed for production and marketing to interested private sector partners. The TT process is managed through annual metrics that include formal agreements, publications and other technology transfer means.

Also according to the respondents, the majority of researches are done to meet the user’s demands, which suggests that there will be difficulties in the TT process, since the technology was developed to meet an existing demand. In the case of research developed to meet the Government demand, users are consulted throughout the process, from start marketing in annual scientific meetings, formal and informal presentations, and through informal communication.

The TT process is directed to applied research. Basic research is carried out to a lower proportion. Leaders of the National Program constantly monitor the market needs and it has been taken into account for formulating research plans.

Respondents have different perceptions about the internal characteristics of the institution, contributing a good performance in R&D and Transfer. Taking into account the answers presented, we note that transparency, clear definition in objectives and the role of the institution, the structure and employees expertise are important elements to the good institutional performance

By means of answers presented, we can conclude that the process of technology transfer in ARS is well structured and has a strong central coordination. The technology transfer process begins with the research project, which projects are developed to meet user demands, a fact that facilitates the results transfer.

Conclusion

Although when Brazil and United States are two countries with different levels of economic, social and technological development, there is an evidence of some similar postures adopted by Embrapa and the ARS, the technology transfer process. Instruments used, both, formal (contracts) and informal (publications, conference, etc) are very similar. According to Araújo (1979), these instruments are more efficient in the communication process, because luring the citizen interest for technological advances, but do not lead to effective transfer and technology.

Technology transfer process begins at the time a project is developed. In this case, we conclude that this process is more effective in ARS, as it develops its projects to meet specific user's demands, while Embrapa serves primarily the guidelines of the institution or the Federal Government.

In this aspect, Croxton (1999), states that users need to be involved at all stages of technology development. Conventional approaches have focused very heavily on researchers and technical experts identifying problems and possible solutions and then trying to transfer them to agricultural environments. Croxton (1999) states that when there is the participation of users and local knowledge are used as a starting point, the probability of research result in technologies meet the needs prioritized by the users is much higher.

Siegel, Waldman & Link (1999) define that, as well as in Brazil, also in the United States public institutions have been criticized for being more adept at developing new technologies than transfer them to the private sector. According to authors, this can be a critical factor in maintaining global competitiveness of US enterprises. The private sector has expressed

frustration with the obstacles that prevent the marketing process, especially with disputes over intellectual property rights.

The technology transfer process is challenging and critical in public research institutions. It has been the focus to ensure that results of its R&D are available and accepted in the market. That reasons, suggests Embrapa, following the example of ARS, for strongly considering the user's demands in their research planning and includes TT actions when defining their projects, recognizing, with any doubt, that transfer technology process is an interdisciplinary process.

Having a structured process TT is important to Embrapa, which can identify more effectively the demands of the chain and thus develop projects aimed at meeting these demands and thereby legitimize itself increasingly in society.

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