

University-Enterprise Technological Cooperation and Sustainable Innovation

Daniela Althoff Philippi, Emerson Antonio Maccari, Claudia Brito Silva Cirani

Doctoral Program in Business Administration, Universidade Nove de Julho, Brazil
E-mail: daniela_philippi@yahoo.com.br

Abstract

Technological cooperation between universities and enterprises can benefit to both and, consequently, the society. This paper aims to identify the benefits of technological cooperation between the College of Agriculture Luiz de Queiroz – Esalq – University of São Paulo – USP (Esalq USP) and an enterprise of the agricultural sector. There is a paucity of studies on the technological cooperation related to sustainable innovations, especially in Brazil. Therefore, we conducted a study on a start-up (enterprise that this research is about) that operates in the biological control of pests as a sustainable alternative to traditional methods

Since its foundation, the enterprise, which was indicated by the World Economic Forum as one of the world's most innovative companies, – has placed technological cooperation as an essential instrument for the development of its sustainable innovations and for its recognition nationally and internationally. Our research was based on a case study and it showed that the greatest innovation was the use of a wasp (*trichogramma*) that parasites on eggs of insect pests, preventing the growth of caterpillars in field crops (soybean and sugarcane).

The main benefits of the cooperation between the enterprise and Esalq USP comprised the use of physical space access to basic research, easier access to credit, access to equipment, strong bond between the company and the university, the maintenance of a beneficial partnership, and the increased possibility of developing sustainable products. The relevance of the benefits of technological cooperation with Esalq USP led the company to extend its cooperation to other educational and research institutions. Currently, the company shows an organizational setting and a strategy that grant access to basic research through cooperation with those institutions and develop innovations through economic and operational feasibility of discoveries to produce goods generated from laboratorial studies at large scale (mass production) reducing costs and increasing output volume.

Introduction

Technological cooperation between universities and enterprises can bring benefits to the parties involved and to the society. In Brazil, however, such cooperation is still recent and few studies have been conducted on this subject. In addition, there is lack of studies, both nationally and internationally, on start-ups created from academic research that maintain cooperative arrangements and that, at the same time, are based on sustainable innovation.

This study was conducted on an enterprise, a start-up founded from research developed at Esalq USP, which is recognized for its policy on sustainable innovation in the agriculture sector. After 12 years of existence, the company has kept its partnerships with Esalq USP and it has extended its cooperation to other universities and a research institute,

which led to its leading position in the country in the biological control of pests in soybean and sugarcane.

The goal of this paper was to identify the benefits of technological cooperation between Esalq USP and a company that operates in the agricultural sector with sustainable innovations. The focus on the relationship with Esalq USP is based on the fact the company was created from research conducted at the University. Initially, we presents the literature about cooperation between universities and companies, the National Systems of Innovation and sustainable innovation. Next, we show the methodological procedures, results, and conclusions.

Literature review

The cooperation between universities and industry began to receive attention from academic studies mainly in the 1960s, from the studies of Sábato and Botana (Sábato & Botana, 1968) in the Latin America. The authors evaluated the interaction among the private sector, industry and the government as a means boost growth of developing countries. The studies resulted in the “Sábato Triangle Model” where corners are occupied by the government, the productive structure (business or industry) and the scientific and technological infrastructure of a country (Sábato & Botana, 1968)..

The model indicates that, in addition to a robust scientific and technological infrastructure, it is necessary to transfer research results to the production structure with the government support of funds and its regulatory power.

In the 1980s, the concepts of “National System of Innovation” (NSI) was presented by Freeman and Lundvall (Motta & Albuquerque, 2004). NSI emphasizes the interaction between its agents (organizations and institutions such as universities and research institutes, government and business) to attain technological development (Freeman, 1995). It is also important because of the network of information of relationships for a company to implement innovations (Lundvall, 1992).

As a progress of Sábato Triangle Model, and linked to the NSI concept, in the mid 1990s, the “Triple Helix Model” was created by Henry Etzkowitz, from an observation about the performance of the Massachusetts Institute of Technology – MIT and its relationship with the conglomerate of high-tech enterprises in its surroundings (Valente, 2010). The objectives and structure of the Triple Helix Model are basically the same as those of the Sábato Triangle Model, but the actors – universities, government and industry – have a network interaction with different understandings and attitudes and they share responsibilities in scientific and technological development without hierarchical relationships (Etzkowitz & Leydesdorff, 2000). For Henry Etzkowitz, the interaction among the three actors allows to create a system of sustainable and durable innovation in modern economies (Valente, 2010).

Models such as the Sábato’s Triangle and the Triple Helix, studies on NSI related to their establishment in several countries underscore the importance of the interactions among the elements.

The interaction of the university and research institutes with enterprises has been increasingly emphasized as a driver for scientific advances and, consequently, economic and social development for developing countries.

Technological advances make the market increasingly competitive and lead enterprises to excel, which can be achieved by innovation. Innovation through cooperation between the university and enterprise has become an alternative for companies searching to remain competitive, contributing to the country's competitiveness as a whole.

Cooperation between universities and companies may involve technology transfer – TT. TT is the transfer of knowledge generated by the university to an enterprise that enables

it to innovate and expand their technological capabilities, ensuring competitive advantage in the marketplace (Closs & Ferreira, 2012).

TT can be classified as formal and informal. Formal TT refers to the transfer of a research result as a patent or a license to use the technology, including property rights, while by informal TT does not include such expectation (Grimpe & Fier, 2010). Informal TT can be contact between academics and business members through conferences, joint publications, academic consultancy and other informal contact, conversations and meetings (Grimpe & Fier, 2010), besides the technical assistance and joint research (cooperatives) (Bradley, Hayter & Link, 2013). It is noted that

The growth of the cooperative agreements between research institutions and business institutions represents, therefore, a new trend placed by the society. The study of these arrangements, notably its structure and its management, may contribute to the development of innovative management models, supporting the consequent economic and technological growth of developing countries (Costa, Porto & Feldhaus, 2010).

The transfer of intellectual property has also been studied through the creation of new businesses (start-ups) by identifying the reasons why some universities generate more start-ups than others to transfer their intellectual property such as the performance in emerging areas of the economy and profit participation by the information owner (Di Gregorio & Shane, 2003). The TT investigated here is classified as formal TT.

A start-up can be considered a university spinoff, that is, a company created by students and post-doctors based on research conducted at the universities (Bercovitz & Feldmann, 2006), and can be characterized as formal or informal TT.

In the cooperation process between universities and companies, studies that link the success of the university and its researchers to the success of projects comprise : (1) gathering the necessary resources to found a company to exploit uncertain new technology is easier when the university's status enhances the entrepreneur's credibility (Di Gregorio & Shane, 2003); (2) companies that have cooperative relations with renowned scientists from universities have positive impacts from this relationship on their productivity, the development of products and on their integration in the market (Zucker & Darby, 2001); (3) the presence of experts and engineers of a particular field affects positively the activity of the spinoffs and its capacity to create radical innovations (O'shea, Allen, Chevalier & Roche, 2005).

Regarding agreements between universities and business institutions and innovation or sustainable organizations, there is a paucity of studies in the international and national literature about the subject and also studies that investigate sustainable start-ups.

There is still a myth by many entrepreneurs that investments in sustainable businesses do not provide return. On the other hand, some studies that show companies that pursue new technologies can originate start-ups with capacity to challenge conventional criteria, reduce costs and increase revenue. These studies predict that in the future only companies that have sustainability as a target will have competitive advantage. There are stages in which companies can plan and anticipate challenges through innovation focused on sustainable development – SD.

Companies that anticipate the introduction of SD goal become “avant-garde companies”, which encompass the following steps: (1) perceive challenges as an opportunity, concerning obligations, laws, specific standards (the company that anticipates or is a pioneer can create opportunities with innovation, gain advantage by pioneering, opening markets, achieving technological domain and can even create new products and/or services and become a supplier); (2) create sustainable value chains (supply chain involved in the SD

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concept that could also open way for innovation), (3) design sustainable products and services (taking into account in their projects for products and process the social, economic and environmental dimensions of SD); (4) develop new business models (developing new form of delivering, distributing and aggregating value, which change the basis of competition), (5) create new platforms for action (related to SD to remain ahead of competition) Nidumolu, Prahalad & Rangaswami, 2009).

Social innovation and start-ups as alternatives that go beyond the former corporate models, incapable of creating sustainable change models (Kanter, 1999). The start-ups or spinoffs, arising from academic research, can add sustainable innovation to their business as a result of the cooperation process between research institutions and business institutions. Currently, the universities that have agricultural subjects have increasingly been involved the concern with SD into their activities.

Sustainable innovation requires a new thinking about innovation that contributes to the achievement of SD.

Sustainable innovation is the introduction [...] of the products, production processes, operating methods or business, new or significantly improved for the organization and that takes economic, social and environmental benefits compared to relevant alternatives (Barbieri, Vasconcelos, Andreassi & Vasconcelos, 2010).

Sustainability has three dimensions: economic, social and environmental. In the business environment the term “the triple bottom line” is used to show the importance of achieving sustainability, which implies that the enterprises have to expand their traditional economic focus by including the environmental and social dimensions in order to create a more sustainable business [UNEP], 2013).

Thus, we observe the emergence of orientation of production activities in terms of innovation and sustainability, based on the limits and predictions serious. The effort must involve NSI and the Triple Helix Model al together.

Methodological procedures

The study was regarded as a qualitative and as a case study, because it is an empirical and in-depth study of the relationships, processes and phenomena that were based, predominantly, on testimony and information of respondents (Minayo, Deslandes, Neto & Gomes, 1994; Flick, 2004; Eisenhardt, 1989; Yin, 2001). The study was also exploratory because it aimed at familiarization with the phenomenon or a new perception about it and the discovery of new ideas (Babbie, 1998; Eisenhardt, 1989).

Data were collected based on secondary (literature and documents) and primary sources (interviews) from Esalq USP and the company.

We investigated the benefits of creation and history of the start-up in the innovation processes, mainly the relationship between Esalq USP and company. We also analyzed benefits of its implementation regarding SD. As the research was about the cooperation between universities and industry, we selected, by an intentional and non-probabilistic sample (Selltitz, Wrightsman & Cook, 1974) the Professor, Researcher and Coordinator of the Insect Biology Laboratory of Esalq USP, where the research was conducted and that keeps a relationship with the company. We also selected one of it's the founders of the enterprise.

The interviews were semi-structured and the organizational documents were consulted on the company's website, and the bibliographic sources were obtained mainly from the Fast Company Magazine and the World Economic Forum [Fast Company], 2012; [WEF], 2014).. After transcribing the interviews, the collected data were grouped into different sources to

identify motivators, facilitators and barriers related to the creation of the start-up and its innovation processes, especially in the cooperation between the company and Esalq USP, as well as the benefits of its implementation in relation to SD. The most significant contents of the interviews, documents and references for a systematic analysis were identified as the research objectives. The data of primary and secondary sources were triangulated and analyzed together (Flick, 2004).

Results

Despite the benefits that technological cooperation between universities and enterprises create for both institutions and the society, mainly when there is a link with start-ups and sustainable innovation, research and practice of these concepts together are little explored.

Thus, this paper aimed to identify the benefits of technological cooperation between Esalq USP and a start-up in the agricultural sector that originated from this cooperation and operates with sustainable innovations.

With the paucity of studies that address technological cooperation related to sustainable innovation, this study presents a case study of a start-up that has worked for 12 years with biological control of pests as a sustainable alternative to the traditional method.

The founders of the company were graduate students at Esalq USP and used to work at the Laboratory of Insect Biology of the Entomology and Acarology Department, where they developed research on biological control of insect pests (FOUNDER AND PARTNER OF THE COMPANY AND TEACHER OF ESALQ).

The company can be considered a start-up and a spinoff (Bercovitz & Feldmann, 2006), because it was created by scholars (who were founders and partners of the enterprise) based on their research during graduate school at Esalq USP.

Esalq USP has, throughout its 105 years of existence, contributed decisively to the technological advancement of Brazilian agriculture by training human resources and generating results through research in Agricultural Sciences. Currently, the institution offers specialization courses and hosts the National Biofuels Pole, The Rural Producer Home and an Agro and Zootechnical business Incubator – EsalqTec [USP/ESALQ], 2013). Distributed in 13 departments with highly qualified faculty, Research and Extension consists of 250 professors, who develop more than 500 research projects in 120 laboratories on campus, generating knowledge, processes and products to the society [USP/ESALQ], 2013).

Initially, the company operated in the biological control of the major pest of the sugarcane, the sugarcane borere, and expanded the pest control to other grains, such as soybean and other crops. Today, in addition to maintaining partnership with Esalq USP, the enterprise has expanded cooperation with universities and with the Brazilian Agricultural Research Corporation – EMBRAPA (FOUNDER AND PARTNER OF THE COMPANY).

During the company's history, technological cooperation has been crucial for the development of sustainable innovations earning it recognition in the national and international scenarios. The enterprise was nominated by the World Economic Forum as one of the most innovative companies in the world for the revolutionary use of wasps in biological control of pests in agriculture.

The greater innovation of the company was the use of a wasp (*trichogramma*) that parasitizes on the eggs of insect pests, preventing the formation of caterpillars in field crops (soybean and sugarcane). This innovation provided to the enterprise a great differentiation towards its market competitors, because this method is more sustainable for pest control than the traditional method of using pesticides and the biological method adopted by other

enterprises – notably for the use of wasps before the larvae become caterpillars, which makes the process more productive (FOUNDER AND PARTNER OF THE COMPANY).

The innovation is unique because the larva does not evolve as in other methods for biological control. Compared to the use of the pesticides, the innovation requires a single application instead of three, as occurs nowadays in many crops due to the increase of pesticide-resistant insect populations as a result of the successive use of these chemical products (FOUNDER AND PARTNER OF THE COMPANY).

To this economic efficiency can be added the environmental and social performance. The innovation developed by the enterprise led to a major market change, because it is highly competitive in its performance and because other companies are seeking to develop similar technologies, in addition to being a sustainable alternative.

Some universities generate more start-ups than others and it is attributed to the emerging areas of the economy where they operate (Di Gregorio & Shane, 2003), as in this study case, biotechnology as it uses living organisms (insects) in pest control. The concern with SD is constantly increasing in agriculture for food production.

It is understood that the valuation and biotechnology development, along with the expertise of the enterprise's founders and the consolidation of the academic research at Esalq USP that led to the opening of the company and its sustainable innovations.

The cooperation with Esalq USP, the participation in the Innovative Research in Small Business Program (PIPE) and in the Support for Research in Companies Program (PAPPE) allowed the enterprise with the support from the Foundation for the Research Support of the São Paulo State (FAPESP) to be established and to search for innovations.

According to the Founder and Partner of the enterprise, the company participated in various phases of PIPE, with increasingly larger amounts through FAPESP and Esalq USP, with technical and financial assessments approved. This mechanism facilitates the opening corroborate other studies (Di Gregorio & Shane, 2003) on the aspects that lead some universities to generate more start-ups than others.

The formalization with Esalq USP was performed with projects sponsored by FAPESP, through the Professor in charge of the project provided academic support, according to the Founder. The cooperation with Esalq USP granted access to resources for the company's innovative activities, since, according to Founder and Partner of the company, the project required the cooperation with researchers and allowed the company to use laboratories at the university.

Another benefit generated by the cooperation was the use of the physical space of Esalq USP during the initial phase of the enterprise's activities. During the first and a half year, the company was in the lab and in the next five years in the physical space of the technology incubator that, at the time, was disabled. The company occupied rooms, where it settled. The equipment was purchased through the projects sponsored by FAPESP and were initially at the university. After five years, with the consolidation of the company, all the equipment became an asset of the company (FOUNDER AND PARTNER OF THE COMPANY).

The expertise of the researcher and advisor of founder of the enterprise, who is also the coordinator of the laboratory where the research was developed as well as the reputation of a renowned university as Esalq USP were also mentioned in the interviews as benefits of the cooperation for the insertion of the company into market and its current performance. These aspects also contributed to the success of its products. This corroborates findings of previous studies (Zucker & Darby, 2001) that companies that develop a cooperation relationship with renowned scientists of universities have positive effects of their products and their insertion into the market. The conclusions reinforced previous studies in which the presence of renowned scientists positively affects the activity of spinoffs leading to the

creation of radical innovations, which was proved by the capacity of the enterprise's founders to create innovative technology (O'shea, Allen, Chevalier & Roche, 2005).

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Another aspect mentioned in the interviews was the strong support provided by Esalq USP during the commercialization of the product. The association with Esalq USP, a renowned academic and research institution, provided great support to the establishment of the enterprise as well as the marketing of the product, once Esalq USP has a strong reputation in the agricultural sector and is the most respected institution in this field in Brazil (FOUNDER AND PARTNER OF THE COMPANY).

Another factor evidenced in the interviewees was the feeling of gratitude and partnership between the company and Esalq USP that, supported by FAPESP and according to the founder and partner of the company, have taken the company to events abroad allowing to show Brazilian technology for biological pest control and also to create opportunities to meet with potential clients.

The cooperation between the company and Esalq USP has led to a concern with SD due to conduct and knowledge transferred to the founding members. This concern was evident in the interviews. Population growth and the necessary support to agriculture to provide food considering the "limits for growth" drive the search for greater sustainability in agriculture. In terms of the scope of SD (Barbieri, Vasconcelos, Andreassi & Vasconcelos, 2010), the benefits the company's innovation in the research, based on the interviews, were:

- environmental – the use of the company's innovation prevents the local contamination, which usually occurs with the spray of the pesticides (inflicting people and other areas) and also in terms of the biological balance with the release of parasitoids;
- social – organic food, handling (employees), avoiding contamination and poisoning;
- economic – biological control is usually cheaper than pesticide use. Furthermore, due to resistance of pests, pesticides are applied three times more than before.

Thus, compared to the use of pesticides, the use of the company's technology shows less environmental contamination, reducing risks to people involved in the process and lowering costs of pesticide applications. Regarding the scope of SD benefits, the company proves that a business can be sustainable and profitable (Nidumolu, Prahalad & Rangaswami, 2009) and that sustainability can lead to competitive advantages and radical innovations, placing the company as "avant-garde". In the case of the company, there is a claim for sustainability and lower costs, reducing, therefore costs to the growers.

To become an "avant-garde", the company underwent the stages mentioned in the literature (Nidumolu, Prahalad & Rangaswami, 2009), however, its Founder and Partner stated that there is no direct influence of laws in the company's innovation process. Therefore, the stages that the company underwent were specified based on the interviews: (1) creating opportunities with innovation, conquering competitive advantage with its pioneering, (2) creating a sustainable value chain (starting with its inception at Esalq USP and with the cooperation with other institutions to develop basic research and through the development of packaging and the different commitment employed by agents); (3) conceiving and creating sustainable products (considering the scope of SD), (4) developing new business models, the way the company was started and the extension of its cooperation, the way of distributing products, that is, the enterprise does not focus only on the product itself, but on alternatives to increase its demand through the development of new packaging to facilitate the transport by agents; (5) creating new platforms for actions (the search for basic research, extending the cooperation to other institutions, besides Esalq USP, with the creation of packaging, the continuous search for improvement, hiring a researcher/professor of a prestigious university to integrate its Research and Development – R&D team, facilitating the communication with the university).

Thus, the company is an example of a consolidation of a new business model based on the cooperation with universities and research institutes. To meet this purpose, the company currently maintains cooperative agreements with other universities and a research institute, providing the production process in large scale reducing costs.

The constant search for innovations through its cooperation ensures the company the condition of “avant-garde”. Its inception was already based on this concept with high qualification of its founders and partners and a direct connection with a renowned researcher in the field and with the entire cooperation and support of the most prestigious institution in studies on agricultural sciences in Latin America. The concept evolved internally and extended to the technological cooperation.

Conclusions

Start-ups, as the one investigated in this research, are companies that can be originated from academic research (spinoffs). They strengthen the cooperation process with universities and research institutes and provide a new dynamic to SD.

The company's innovations created from research in educational and research institutions, particularly at Esalq USP, greatly reduce the negative impacts to the environment and favor a number of consumers by turning academic research into viable products for commercialization, by processing and adapting them into the “scales of production” and finally into innovation.

There is a lack of studies on start-ups and spinoffs with the same purpose of the case study presented here and, some authors claim that there are divergences in the literature regarding the reality of the company. Therefore, further studies are suggested to better understand the innovations from cooperative agreements between research institutions and business institutions related to the paradigm of SD.

We hope that our results expand the studies on cooperative interactions, and because it is a case of excellence related to SD, we expect that our results inspire organizations and universities to the practice of cooperation allied to sustainable innovation. The case shows how the university can contribute more effectively to the society, since the basic research that could remain within the “walls of the university” is “the basis” for the company's successful innovations, which have significantly reflected to SD with potential to contribute even more in the future.

For future studies involving the company, it is suggested to check the factors analyzed in this study about Esalq USP, indicating whether the behavior differs from those identified in cooperation with other institutions (universities and/or research institutions). Studies that address all the variables of this research are also proposed, given that the literature addresses many of these variables separately. Success stories like the company presented here need to be further investigated to contribute to the theory and practice of other organizations.

The company addressed in this study is closely linked to the university since its inception as a start-up and spinoff, therefore, its history can be extended to other universities and research institutes, considerably increasing the possibility of more and successful innovations.

The study also highlights that the State, represented by FAPESP in this case study, plays an essential role in encouraging the achievement of technological cooperation and creating spinoffs. Therefore, efforts for the consolidation of technological cooperation allowing to obtain expected and potential benefits encompass the use of the NSI and the Triple Helix Model.

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