TRIPLE HELIX IN AGRICULTURE CONTEXT. THE CASE OF PRUNUS NETWORK IN BEIRA INTERIOR REGION

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ABSTRACT

The Triple Helix, as spiral model of innovation that contains multiple relationships in different processes of knowledge enhancement, is a model that, leveraged by the dynamics of interaction between the different institutions and stakeholders, benefits from the role of universities as centers of excellence in education and science, from the private sector as co-creators of knowledge and human capital pickup as well as from the public sector supporting the legal framework and technical support besides the sectoral and territorial political supports. In the business context, especially in rural matrix territories, farmers have developed a crucial role in local development, promoting new development dynamics, not only as producers and employers, but also as investment attractors and stimulating the creation and transfer of knowledge. The reflection on the perspective of the Triple Helix observed in the productive framework of the agricultural sector is not firmly established or settled. In this context, this paper aims to discuss the model of the Triple Helix based on relations between the Academy and R&D-Agricultural Production-Government spheres focused on the sector of stone fruit, using the region of Beira Interior as case study. This region stands out for the many changes that have led to the establishment of interdependencies of the agricultural sector, research and education centers and various economic and social agents with a relevant role in the development of sector of stone fruit. Thus, this work aims to map the regional actors with an active role in sector and, on the other hand, to present the dynamics of institutional interactions that attained the creation of the PRUNUS network - resources and human capital enhancements.

KEYWORDS: innovation networks, knowledge networks, rural development, stone fruit

1. LITERATURE REVIEW

The Triple Helix system is settle by an approach to the institutional interaction but breaking the dyad traditional relationship between the government and industry spheres (Lowe, 1982; Sabato and Mackenzie, 1982) to an increasing triadic relationship among the university-industry-government spheres (Etzkowitz, 1993); Etzkowitz and Leydesdorff, 1995). The hybrid role of these spheres and their interaction is generator of new social and institutional formats that enhance the creation, transfer and application of knowledge and works as driver of

innovation and economic development of regions (Gama, 2001). The Triple Helix system defends three fundamental principles (Etzkowitz *et al*., 2007; Etzkowitz and Ranga, 2010):

a) The prominent role of the education and science sector in close collaboration with the business community and the government as a leader of innovation dynamics;
b) Promotion of collaborative relationships between the three institutional spheres in which the innovation policy is increasingly a result of institutional interactions and not a top-down imposition.
c) In addition to its traditional role, each sphere plays a new complementary role, performing new functions that are source and driver of innovation.

In the Triple-Helix perspective, the strengthening of the academy role arises from its contribution to the socio-economic development of regions, alongside its traditional missions (teaching and research). This empowerment is result of strengthening political relations between university-industry, normally encouraged by policy measures of resources enhancement, as well measures to encourage of entrepreneurship in the academic community and in territory. The combination of new models and formats to teach and research in universities, results in the creation of new companies more demanding in the promotion of a culture to generate and share knowledge, technologies and resources (Campbell et al 2004; Feldman and Francis, 2004; Boardman 2009; Wang and Shapira, 2012; Inzelt 2004; Geuna and Nesta, 2006; Lawton Smith and Bagchi-Sen, 2010; Geuna and Rossi, 2011; Svensson et al, 2012), counteracting the linear model of innovation (Godin, 2006). This institutional perspective may present different positions for different institutions, for example, the industry as driving force, the government as regulator of social and economic mechanisms and universities as provider of human capital and knowledge producer; henceforth the transition to the knowledge-based society underlines the importance of interactions between different actors putting the challenge to the partnership and leadership of joint initiatives. The transition of this model for the evolutionary perspective advocated by Nelson and Winter (1975), Etzkowitz and Leydesdorff (2000) and Leydesdorff (2000) stands out by the functional interaction processes between science and markets and the institutional interaction between the public and private institutions, generating new strategic interactions and networks that can generate new innovation environments.

The concept of Triple Helix innovation systems presented by Ranga and Etzkowitz (2013) highlights the systemic interaction between the actors of the Triple Helix and an integrated view of knowledge and resources flows. From this perspective, the consolidation of non-linear interactions between the different actors can generate new combinations of knowledge that support innovation, especially at a regional level. This view emphasizes the endogenous potential of territories centred on the role of different actors and their relations with an economic development strategy based on knowledge and following a "bottom up" approach. Thus, there is an expansion of the concept of the Triple Helix: "knowledge", "innovation" and "consensus space" that show the process and the mechanisms by which institutional spheres co-evolve in the dynamics settle for regional development based on knowledge.

The literature suggests the existence of the relationship between innovation and geographic space, anchored in the endogenous characteristics of the territory and supported by relationship established internally and with other external organizations (Alberto and Rodriguez, 2012). The territory takes the role of institutional support, as well as promoting the interaction between the stakeholders (Gama, 2001): dynamic business owners and entrepreneurs (informed and open to the outside), the availability of scientific and technological infrastructure (universities and research centres); associations of companies, sectorial and regional development; national, regional and local government bodies; associations of municipalities; or even the local community, i.e. the major actors of innovation. The enhancement of that dynamics enables the adoption of local development strategies, in which the territory is active agent of innovation and at the same time is an input of innovation (Madureira *et al.*, 2013a; Madureira *et al.*, 2013b.). It is widely recognized that don't exist universal measures for knowledge-based regional development, given the different conditions and specificities of different territories (Etzkowitz and Ranga, 2010).

In rural regions, the organizational matrix thickness is reduced, which may influence the Triple Helix system (Tödtling and Trippl, 2005). According the specifics of these territories, it is important to consider the sectorial specialization, institutional architecture and patterns of the main innovation. The regional specificity must be seen as a resource and not as a limitation for development (Gløersen and Dubois, 2010), planned based on available local resources, among which the social capital, the dynamics of formal and informal networks stablished, the cooperation culture and the ability to learn and co-create knowledge (Nuur and Laestadius, 2010). Skogseid (2007) and Skogseid and Strand (2011) point out three main features underlying the innovation process in rural areas:

a) institutional capacity (knowledge and resource mobilization);
b) collaborative networks (identification of local needs and funding support actions); and
c) promotion of a development strategy based on available resources and development of external links.

The 'Europe 2020' strategy endorses that policy makers consider one agenda for the territories able to promote the smart, sustainable and inclusive growth based on their smart specialization able to contribute to economic development, improve innovation processes and foster a greater involvement of the actors in the governance strategy. Agreeing with Shuman *et al.* (2001), that argue that collaborative networks seem to improve the ability of farmers to participate and learn interactively, it is important to foster the creation of knowledge for solving common problems in cooperation with other farmers and other stakeholders. In the perspective of the Triple Helix, Etzkowitz and Leydesdorff (2000) highlight the role increasingly performed by the academy, specifically participating in problem-solving networks. These networks often appear to address structural weaknesses in the regions due to the public disinvestment in research. The literature review also assigns an important role of multi-actors networks in identifying problems and solutions based on experience and knowledge, giving the example of farmers as important actors (Madureira *et al*., 2015). In rural areas, these actors promote new leadership models in innovation networks based on a strong collaborative action with other players, especially local municipalities, R&D institutes, public agencies, sectorial and territorial associations, researchers, and others (Madureira *et al*., 2013b).

This work discusses the model of the Triple Helix in the stone fruit sector, using the Beira Interior region as a case study. The intervention strategy for this sector involves the collaboration of three spheres: the government (with the representation of local, regional and national organisms); the academy and R&D actors (universities, polytechnics institutes and research centres); and the sphere of agricultural production that includes farmers, producers and sectorial associations.
The Triple Helix system applied in this context is explained by the interaction between the different actors and the presentation of the main roles developed in the Prunus network context. This paper also covers the global strategy for the stone fruits sector focused in these pillars: production, experimental testing, storage and marketing, promotion and dissemination.

2. METHODOLOGY

The methodology of this work was based essentially on the establishment of exploratory contacts with the different actors' involved, direct observation and participation in meetings, leaded by ESA-IPCB, which is comprised in the Academy sphere. This process took place between June 2015 and February 2016, with the aim of identifying possible gaps and problems associated to the production of stone fruit. This objective pursuit led to the creation and strengthen of a network of collaborative process that culminated in a group of new projects globally designated by Prunus. This term *Prunus* come from botany taxonomy, genus name, of different species of stone fruits, as example *Prunus avium* for cherries, *Prunus persica* for peaches, *Prunus domestica* or *Prunus insistitia* for plums. So, one of the main objectives was to establish a network focused on the principle of co-creation of knowledge and to work as a lever for innovation, knowledge creation and diffusion. This network is aimed to contribute to the promotion and sustainability of the sector, specifically the production of cherries and peaches. The formalization of the network consists of a diversity of stakeholders and includes producers associations, namely APPIZEZERE (Association of Integrated Protection and Sustainable Agriculture of Zêzere river) and AAPIM (Farmers

Association for Mountain Fruits Integrated Production), local authorities (Municipality of Covilhã and Fundão), universities and research centers, as ESA-IPCB (Agriculture School of the Polytechnic Institute of Castelo Branco), UBI (University of Beira Interior), CATAA (Centre for Agri-Food Technological Support), CBP (Centre of Plant Biotechnology) and Trade associations, namely CERFUNDÃO and Qta de Lamaçais, as well as individual fruit growers, joining the main stakeholders of stone fruit production in the Beira Interior region. In a perspective of the Triple Helix model becomes interesting to study this case, since it breaks with the traditional model of the university as a leader of innovation processes, being the leadership replaced by farmers and Farmers organizations in different initiatives here presented.

3. CASE STUDY: THE PRUNUS NETWORK AND THE STRATEGY TO DEVELOP THE STONE FRUIT SECTOR IN BEIRA INTERIOR

3.1 The landscape of stone fruits sector in Beira Interior region: from the territory to the actors of the Triple Helix

The region of Beira Interior is characterized by soil and climate conditions favourable to peach and cherry productions. It is the main productive region of these fruits, containing 1640 ha of peach trees (INE, 2014) and 2230 ha of cherry trees (INE, 2014), which represent 45% of the national area of peach production and 39% of the cherry productive area. At the same time, there is a fruit production tradition in this region since the 60's. During that period, the fruit production activity increased as result of Government actions through a Development Plan II at national level and regional level, where the most important one was the apple production. Since the 90's, the cherry regional production occupied the main chair and today are recognized as the best cherries over the country. The Beira Interior is the main Portuguese peach production region since 2007 (INE, 2015). The importance of the stone fruit production has never been strengthened with the creation of an Experimental Unit that could supply the innovation needs of farmers.

Nevertheless favourable developments are observed, not only with the increase in production area, but also by the increasing productivity of both cultures (INE, 2014). Tradition enables the technical knowledge of the region, both at the producer level and at the level of the organizations supporting the production, and both in terms of associated companies. Simultaneously, there are traditional marketing channels installed from short circuits, especially in the case of the cherry, to organized circuits in which the multiple sector agents introduced formal relationships for scaling up the production and achieve other markets. This region has production and market dynamics resulting from changes in recent years related to the introduction of new production technologies, introduction of new varieties, adoption of new and more profitable driving procedures and the use of irrigation, benefiting from public investments, including the irrigation of the Cova da Beira. These were important factors for the development of the sector and its territory.

The configuration of spheres that characterize the stone fruit sector is focused on territory and knowledge enhancement and the experience of each actor, supported by political and regulatory framework, financial support and availability of resources for scientific, technological structures that support production, testing, human resources qualification and promotion of knowledge transfer (Figure 1).

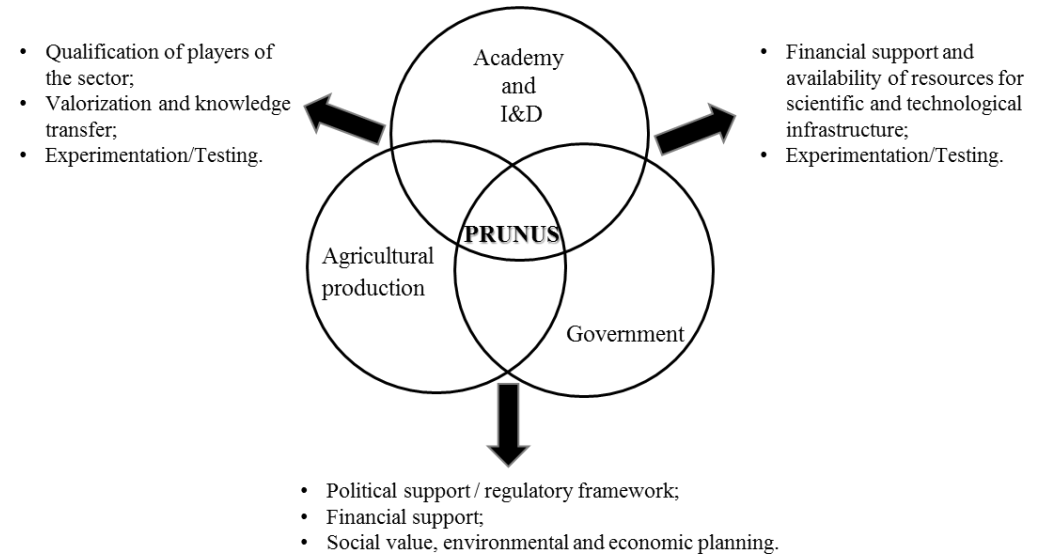

Figure 1 –Configuration of the Triple Helix system of the stone fruit sector in the Beira Interior region.

The different actors of the stone fruit sector in the Beira Interior Region are shown in Table 1, organized by the spheres: Academy and R&D-Agricultural production-Government.

Table 1 – Actors involved in the stone fruit sector in Beira Interior region

Academy and I&D	Agricultural production	Government
Universities and research centres: • ESA-IPCB (Agriculture School of the Polytechnic Institute of Castelo Branco); • UBI (University of Beira Interior); CATAA (Centre for Agri-Food Technological Support) • CBP (Centre of Plant Biotechnology)	• Cherry and peach producers • Trade associations: Sociedade Quinta de Lamaçais; CERFUNDÃO - Embalamento e Comercialização de Cerejas da Cova da Beira, Lda • Producers associations: APPIZÊZERE - Associação de Proteção Integrada e Agricultura Sustentável do Zêzere; AAPIM - Associação de Agricultores para a Produção Integrada de Frutos de Montanha • Sectorial association: COTHN - Centro Operativo Tecnológico Hortofrutícola Nacional	• Local authorities: Municipality of Covilhã and Fundão • Regional authority: CIBSE - Comunidade Intermunicipal da Beira e Serra da Estrela • National authority: DRAPC – Direção Regional de Agricultura e Pescas do Centro; MAFDR – Ministério da Agricultura, Florestas e Desenvolvimento Rural

As part of the Triple Helix system, the sphere of the Academy and R&D (education and science sector) in the region of Beira Interior has been provider of specialized knowledge on stone fruit. The Agriculture School of the Polytechnic Institute of Castelo Branco provides training in the agronomy areas. The University of Beira Interior is especially engaged within this market providing engineering or technical solutions. This sphere also include the CATAA and CBP. The main mission of CATAA is to promote research, develop and implement new technologies, encourage the modernization and diversification of products and manufacturing processes. CBP is a centre of research and experimental development. This sphere takes a leading role in the regional economic development, as recommended by the Triple Helix model.

In the sphere of agricultural production, arises in addition to producers and producer organizations, the associations and other organizations that provide technical support and promote the stone fruit sector. At the government level, the local authorities develop an important role encouraging and boosting the national government to the design of

tailored policies, support programs, creation of incentives for innovation and implement measures to develop rural areas. The case of "Measure 1 - Innovation" of the Rural Development Programme 2014-2020 (RDP 2020) is possible, through its action 1.1, creation of Operational Groups (GO). This action is intended primarily to implement and strengthen the links between research, farmers, rural communities and companies, associations and other organizations and Advisory Services, that support the goals of the European Innovation Partnership (EIP) to support innovation, productivity and sustainability of the agricultural sector.

In order to meet the challenges of "Measure 1" of the "RDP 2020", the main stakeholders of the Beira Interior region develop a new dynamic of cooperation with the establishment of an informal network. This network is designated as "PRUNUS- resources and human capital enhancements" The PRUNUS network is horizontal, at regional scale and involves different actors who actively interact in the stone fruit sector.

3.2 Prunus network: the strategy and ambition

According to the Triple Helix system, the spheres that make up the Prunus network are characterized by a blurring of institutional boundaries. This dilution corresponds to the transition to a model in which different actors take new roles and/or missions, that is, the "capitalization of knowledge," as described by Etzkowitz (2008). The sector of agricultural production, in this network, establish partnerships with academy and R&D for research and participation in projects, which corresponds to a greater ease of obtaining funds. At the same time, the academic sphere becomes a territorial development lever due to their capacity for create and transfer knowledge to the productive sector. Also becomes a relevant economic agent not only due by their involvement in socio-economic development of the territory, but due to their ability to produce more scientific knowledge, denying the idea that the increase of diversification of their role can contribute to decrease their ability to produce knowledge (Gibbons *et al.*, 1994). At local and regional level, government institutions act as partners, as decision-making partners and in changeling resources and proactive initiatives, either sectorial or territorial.

The inter-institutional dynamics observed between the different actors took as strategy for the development of stone fruit sector the prior identification of the knowledge needs, particularly in terms of production, testing, storage, marketing, promotion, and dissemination, as identified in Table 2. The needs identified resulted in the submission of a number of initiatives to "Measure 1.1 - Operating Groups", called: *Prunus TECH*, *Prunus BOT*, *Prunus PHYTO*, *Prunus FERTIS*, *Prunus EXPERT*, *Prunus DEMO*, *Prunus POST* and *Prunus UP*. These aim to help to:

- Increase the fruits utilization, including waste products and plant residues of orchards;
- Evaluate the production potential of the orchards;
- Monitoring and control weeds by economic and environmental sustainable methods;
- Promote of ecological balance and plant health with the anticipation of alternative responses to limiting the use of plant protection products with alternative control methods;
- The optimization of irrigation systems, particularly with deficit irrigation and organic and mineral fertilizers, to promote the sustainable production and the rational use of natural resources;
- Valorization of experimentation, creation and knowledge transfer related to adaptation and new varieties, rootstocks, training systems, fertilization, among others techniques related to the production, taking into account consumer trends;
- Promote conservation studies and life extension and reduction of waste of fruit products;
- Encourage the investment in promotion and marketing territorial, able to enhance innovation and develop new product based of the stone fruit.

Table 2 – Main problems identified by actors in the Triple Helix and solutions proposed under the Prunus network

Priority	Initiative	Which problems are in the base of the action?	Which are the solutions proposed?
Production	**Prunus TECH**	1. Identification of phytosanitary problems in potentiated orchards with fruits that are deposited on the ground; 2. Need to use food supplements in small ruminants during the summer	• Conception of an autonomous robotic equipment to withdraw the orchard fruit in the soil, reducing the pressure of the disease / pest; • Promote the use of a product without current value (fruit waste) for animal feed.
	Prunus BOT	3. Lack of real knowledge about the production potential of the orchards; 4. High costs in weed control.	• Design of an autonomous aerial robotic system devoted to: a) recognition and fruit classification and quantification of production; b) test an adjustable spray high to remove accuracy dominant weeds.
	Prunus FITO	5. Evaluation and monitoring of phytosanitary problems related with pests and disease recently introducing in Portugal. 6. The need to mitigate their impact on crops.	• Monitor the pest cycle / disease in order to correctly position the intervention with greater effectiveness; • Evaluate different control methods minimizing the use of chemicals.
	Prunus FERTIS	7. Problems limiting the production, especially the nutrition of nitrogen and phosphorus in the case of cherry and magnesium in the case of peach trees and the low content of organic matter in the orchards.	• Optimization of deficit irrigation and recovery of waste; recovery of waste for the conservation of soil organic matter.
Testing	**Prunus EXPERT** **Prunus DEMO**	8. Absence of experimental fields that allow investment optimization in the activity, with the inherent risk reduction at the level of agricultural investment.	• Installation of an experimental field that allows: a) evaluating the potential and adaptability of new cultivars and rootstocks; b) testing innovative cultivation techniques; c) testing, demonstrating and disseminating new equipment's; d) performing operational demonstration activities.
Post-harvest and commerciali	**Prunus PÓS**	9. Lack of knowledge about the effectiveness of processes for the conservation of peaches and cherries, as well as the use of packaging which preserve the fruit in its peak quality for the longest period.	• Optimize storage processes; • Develop active and / or intelligent packaging appropriate to extend the period of consumption of endogenous fruit in the Beira Interior region using new technologies and materials.
Promotion and disseminatio	**Prunus UP**	10. Absence of a territorial strategy planning and infrastructures to support agricultural activity, particularly peach.	• Promote actions that linking the regional fruit production sector and tourism; • Valuing the local biodiversity associated with the fruit sector in the region; • Create a territorial marketing strategy and enrich the image of the local products.

Figure 2 illustrates the diversity in relation to the contexts and scope of each initiative, who proposed and who is a leader. Interestingly, most of the proposal initiatives were designed by a bottom-up process, with a horizontal prevalence and a mix of formal and informal interactions between the different actors of the Triple Helix system.

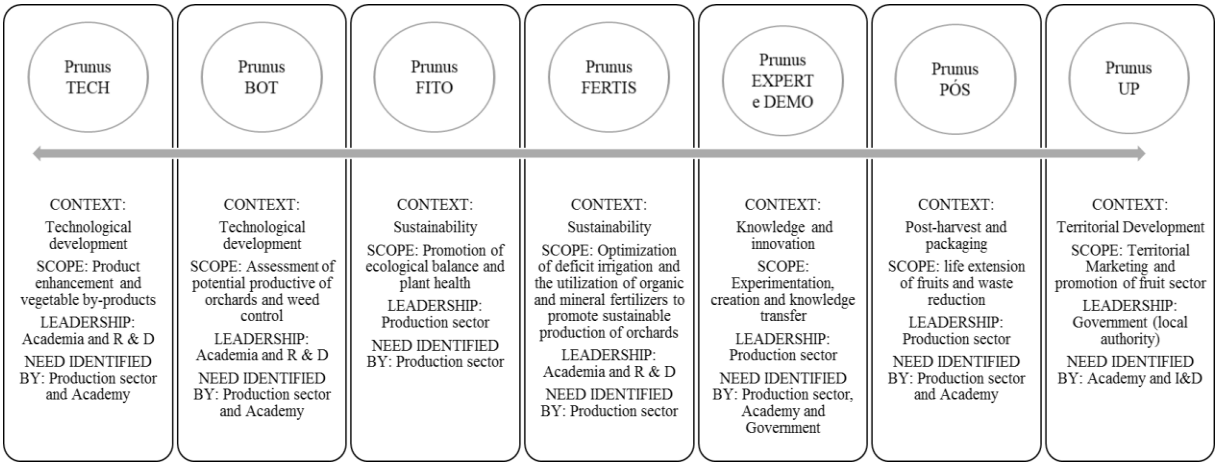

Figure 2 – Contextualization of Prunus network initiatives.

According to Figure 2, it stands out the fact that most of the actions involves partners from all spheres of Triple Helix. This suggests that each initiative arises from the collective learning process and the need to strengthen farming systems, knowledge sharing and co-innovation in the agricultural production. This is crucial to promote the territorial and sectorial developments.

4. CONCLUSIONS

With this research was possible to detect an institutional attitude aimed to deepen relations between the academia and governmental spheres with the productive sector, especially the farmers, boosting new dynamics of research and the development of a new approach to identifying needs and common solutions for strategic sectors of the territory. Indeed, the spheres of Triple Helix in the perspective of the Prunus network, assume an supporting attitude of inter-relational dynamics, promoting the development of the sector fruit production in the Beira Interior region. This sector is increasingly demands in knowledge. This network presents as main objective the ability to strengthen territorial activities related to the peach and cherry production and its sustainable development. The Prunus network presents itself as a cohesive structure and the proactive involvement of each partner is strong.

The main findings of this research indicate that, in the Triple Helix system, the collaboration through networking among government, academy and farmers is the toll and it is essential for creation new knowledge and promote innovation in the stone fruit production sector, recognized by the importance of the territorial endogenous potentialities and the process of knowledge-based regional.

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