Prospects for Farmers' Support: Advisory Services in European AKIS
WP 4 – AKIS ON THE GROUND: FOCUSING KNOWLEDGE FLOWS SYSTEM | Topic 3
Country Report for Portugal

Designing, implementing and maintaining (rural) innovation networks to enhance farmers' ability to innovate in cooperation with other rural actors

The berry networks in Portugal

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AGIM	Socio Professional Association for Small fruits and Business Innovation
AKIS	Agricultural Knowledge and Information System
COAPE	Agricultural and Livestock Mangualde Cooperative
COTHN	National Vegetable/Fruit Technological Centre
SFC	Small Fruit Cluster
DRAPC	Central Region Directorate of Agriculture
DSM	Drosophila Suzuki Monitoring
EIP-AGRI	European Innovation Partnerships: Agriculture and Innovation
FBO	Farmer Based Organization
INIAV	National Institute for Agricultural and Veterinary Research
NUTS	Nomenclature of Territorial Units for Statistics
PRO AKIS	Prospects for Farmers' Support: Advisory Services in the European Agricultural Knowledge and Information Systems
PRODER	Regional Development Programme
R&D	Research and Development
SNA	Social Network Analysis
WP	Work Package

Executive Summary

The case studies described and analysed in this report were selected with the aim of contributing to the PRO AKIS overall goal of exploring and identifying the possibilities, conditions and requirements of rural networks to enhance the farmers' ability to create, test, implement and evaluate innovation in cooperation with other actors, in accordance with EIP-AGRI networks' new model. In addition, the in-depth approach adopted by the PRO AKIS, consisting of a description of relevant knowledge flows within the networks that were selected, broadened the scope of the findings in relation to the above-mentioned goal. The case studies were chosen in such a way as to meet the overall goal of PRO AKIS, provide insights on a set of related research questions, and present relevant cases within the Portuguese context.

The selection fell on the Small Fruit Cluster (SFC) and the Drosophila Suzukii Monitoring (DSM) network. The SFC is a nationwide, multi-actor network composed of several actors, interacting in the small fruit sector in Portugal. It focuses on the creation and exchange of knowledge, information and expertise in this new sector of Portuguese agriculture. The DSM is a spatially well-bound network, covering two NUTS 3 in the central-northern sub-region of Portugal. It is a hierarchical but informal network, led by a coordinating structure (Regional agency of the Ministry of Agriculture) which counts on the involvement of farmers and facilitators (FBOs and profit producer groups). The farmers are the main players in the co-creation of knowledge and active partners in the knowledge storage and exchange aims of this network.

These networks were studied in-depth, resorting to an exploratory-descriptive and participatory approach which consisted of identifying, mapping and interviewing the relevant actors involved. In both cases, the typologies of actors were defined and Social Network Analysis (SNA) was used to depict and describe the social networks of each case study. In addition, relevant examples of knowledge flows within each network were described as well as mapped through sociograms generated by the software used to implement the SNA.

The findings and insights provided by the observation and analysis of the two networks selected show their ability to enhance co-innovation processes based on the multi-actor interaction platform they provide and highlight the importance of incremental innovation processes. In the case of small-scale farmers, findings also point to the development of handmade technologies along with the down-sizing of existing technologies and equipment which do not conform to the features of small-scale orchards (a kind of small-tech innovation). They also show that co-learning and co-innovation processes tend to remain diffuse and informal. Collective learning activities and knowledge co-learning and exchange processes have proven to be relevant to the adoption of 'in the farm', 'better' technologies and farming practices (small scale, not new to the market innovation) at the different stages of the small fruit production system (from orchard planting to post-harvest and fruit storage). The attractiveness as well as cohesion of the networks seem to depend on a good balance between knowledge and quality information demand and supply, and also on the farmers' freedom to join/abandon the networks whenever they want to. The need and demand for experimental (practical) knowledge, which is very scarce in the case of the Portuguese small fruit sector, due to its being a new, non-traditional sector, is proof that Portuguese AKIS is weak as far as applied research and quality advisory infrastructures are concerned. Regarding the EIP-AGRI framework, this study shows it is able to enhance the creation and exchange of practical knowledge, since farmers are viewed as knowledge creating partners and not merely as knowledge up-takers. It also suggests that the EIP-AGRI methodology must be extended to include more informal and multi-subject networks.

1 Introduction

The introduction and expansion of the small fruit sector in Portugal is quite recent. It was launched in the nineties, while its overwhelming expansion occurred in the last five years: the sector grew from a few hectares in 2009 to more than one thousand in 2014. Its recent explosion is largely due to the investment done by new farmers, supported by EU funding to help young farmers settle. Unemployment and the lack of opportunities in other areas that result from the economic crisis in the Southern European countries attracted hundreds of young (under forty years old) farmers, often searching for a new life-style as well. They are mostly highly educated individuals, but with little or no experience in the farming sector. Unsurprisingly, the small fruit sector is currently characterised by a huge demand for knowledge and information and by a strong dynamics to organise and deliver its supply.

The sector is concentrated in two sub-regions: southern and central-northern Portugal. Both sub-regions offer favourable agro-climatic conditions to berry growth and differentiation at European level due to better taste, colour and ripening time. Together, they constitute the national small fruit commodity chain which has international markets as its main destination. However, the two sub-regions present distinctive characteristics regarding the sector organization, the profile of their producers, and the accumulated expertise and ability to mobilize knowledge and to innovate. The southern area is characterised by larger and specialized exploitations, including also FBO producing, in association with a multinational company. Distinctively, the central-north is dominated by small farms, by the mono-production of blueberries and by the sector novelty experience in the area. Hence, the former's position as a supplier of knowledge and skills while the latter is viewed as highly in need of both.

The fact that there is a huge need and demand for knowledge and regional dichotomy in that respect, turned the Portuguese small fruit sector into an interesting case study in the context of PRO AKIS. It is about the building of a new sector largely by inexperienced producers with the support of a few experienced ones on the field. It is an organizational/territorial level of innovation in itself: to raise a novel sector which is knowledge intensive and heavily dependent on global markets' dynamics. Consequently, networking has been intensively used by the sector as a way to address the challenges of organizing small-scale production, particularly regarding providing technical and post-harvesting (assembling and trading) support. A huge number of farmer-based organizations (FBO) has been created for the past five years alongside with the raise in the number of private firms joining two to three partners that mostly informally also try to build networks to achieve critical dimension in terms of product quantity (and quality). Hence, its study represents an opportunity to learn how farmer's networks might be designed and implemented to enhance its members' ability to innovate in cooperation with other actors, both rural and non-rural. And this happens in a context where the current Portuguese and regional AKIS don't have the capacity to meet the high needs and demands for knowledge, information and skills on a novel crop.

One of the general goals of PRO AKIS was to explore and identify the possibilities, conditions and requirements of rural innovation networks that constitute examples for 'European Innovation Partnership Agricultural Productivity and Sustainability' (EIP-AGRI) by increasing farmers' ability to create,

test, implement and evaluate innovation in cooperation with other actors through in-depth case study analysis. The EIP-AGRI (EU SCAR, 2013) relies on the innovation systems approach (Lundval, 1992; Cooke *et al*., 1997; Audretsch, 1998; Asheim, 1999), which envisages innovation as part as well as the result of interactive learning processes involving multiple actors. Within this approach, multi-actors knowledge networks are the ground for innovation processes taking place at the territorial level. Hence, the EIP focus on the networks of producers and users of knowledge, which includes farmers, advisors, researchers, business and other actors whose interaction generates 'new insights and ideas, and mobilise existing tacit knowledge into focused solutions' (EU SCAR, 2013: 25).

The above mentioned general goal of the project developed into several research questions. Therefore, a number of research questions were selected so as to make it possible to do a comparative analysis despite the diversity of networks from various countries that were the object of this study (Germany, Italy, Portugal and the United Kingdom). The key research question elected was:

- Which features of the agricultural/rural networks enhance farmers' ability to co-innovate in cooperation with other actors?

This was supported by the following sub-questions:

- Which factors influence and encourage farmers to enrol in these types of networks?
- How do the selected agricultural/ rural networks link to existing knowledge infrastructures and advisory services?
- Which factors influence the network's stability over time?
- Do these networks contribute to agricultural productivity and sustainability through innovation as expected by EIP-AGRI, and if so, how?

Two rural networks were selected and studied in the case of berry production in Portugal. Both are multi-actors networks, although they are quite diverse as regards their purposes, structure and dynamics. The *Small Fruit Cluster* (SFC) is a broad network, encompassing multiple purposes and actors, with a national scale and sectoral scope. The *Drosophila Suzukii monitoring* network (DSM) focuses on the prevention and control of pests affecting this crop by creating, storing and sharing knowledge at regional level. It relies on the contribution of large groups of farmers led by a public technical-scientific organization.

The SFC network was created in 2013, resorting to public funds. It is led by a sectoral association, which is the main network facilitator along with other three partners. It is a multipurpose network focused on the berry sector organization at national level. Its major concern is to ensure the sector's competitiveness and sustainability. Knowledge and innovation are key factors to achieve these goals, given the huge knowledge and information gaps in the sector caused by its novelty and lack of tradition along with the entry of hundreds of small and inexperienced producers. Therefore, SFC is also (and mostly) a knowledge and innovation multi-actor network with a singular configuration: it tries to benefit from the know-how and expertise of experienced producers, which are mostly located in the Southern sub-region of the country, while transferring it to the less or no-experienced producers in the central-

northern sub-region. Thus, it provides an opportunity to understand the role of clusters as a tool for clustering knowledge generation and diffusion at a localised level (Marshall, 1920). It also helps one understand how that can be done as well as the limitations of doing it, by transferring knowledge from one region to another. In addition, this network presents an opportunity to understand how extra-cluster knowledge exchange and learning can determine the success of intra-cluster flows (Guilianni and Bell, 2005).

The *Drosophila Suzukii monitoring* network (DSM) can be envisaged as a networking tool to create and store knowledge to be used by SFC. Therefore, it conveys a prospect of exploring how knowledge can be co-created and stored by farmers and how these may involve themselves in those processes, developing their abilities to co-innovate along with other farmers and actors, including researchers and other R&D players.

Selected case studies provided the ground to meet research goals and questions, as shown in the following sections of this report. Thus, next section presents the criteria and reasons for selecting the case studies and their delimitation in more detail; section 3 provides a general description of the case studies and their interrelations; section 4 addresses the methodological aspects related with data collection and local stakeholders' engagement in the study; section 5 presents and discusses the results in respect to the goals and research questions; section 6 extends the results discussion to the performance of knowledge flows observed in the two case studies and tries to identify best-fit practices for advisory services in the context of these multi-actors networks; and, finally, section 7 provides final conclusions and policy recommendations.

2 Selecting and delimiting the case-study

The selected Portuguese case studies were already introduced: (1) the *Small Fruit Cluster* (SFC) and (2) the *Drosophila Suzukii Monitoring* (DSM).

The first is a horizontal nationwide network; its coordination structure comprises the main facilitators of knowledge sharing and diffusion processes. It is composed of both experienced and inexperienced producers and a diversified set of other actors, such as: private agricultural advice companies, independent consultants, several FBOs (cooperatives, farmers' groups and associations), up and downstream industry firms, among others.

The DSM is a regionally located, hierarchical but informal network led by a coordinating structure (Regional agency of the Ministry of Agriculture) which also involves farmers and facilitators (FBOs).

The selection of case studies was driven by the twofold purpose of: (1) providing the ground to meet the project goal and the research questions established for the WP4 Topic 3 (which have been introduced in the previous section), and (2) presenting relevant case studies in the context of Portuguese AKIS.

The SFC network is nationwide, involving the full diversity of actors in the berry production sector and is itself instrumental in organising the sector, namely the knowledge and information supply to meet to the current heavy demands of farmers and their organisations. It may be considered a relevant case study in the Portuguese AKIS context, not only because of its national and sectoral importance, but also due to its unique position: on the one hand it shows how FBO-based and private advice can organise themselves in order to meet farmers' needs and demands and, on the other hand, it allows identifying these organisations' limitations in providing quality support to a novel and knowledge-intensive sector. Moreover, in the national AKIS context, this case study makes room to understand who could/should be responsible for (analytical and synthetic) knowledge creation and storing, given the limitation of the former actors (FBO and private sector) to undertake this job. This will bring to the table the on-going discussion about the role of public knowledge and advisory infrastructure in AKIS for Portugal and other European countries.

On the other hand, the SFC network provides the ground to investigate: first, the key research question of understanding which features of the networks enhance farmer's ability to co-innovate in cooperation with actors, accounting for their asymmetry in the knowledge demand patterns and dynamics as well as their interaction with other actors, such as advisors, local governments, researchers and input suppliers, among others; second, it allows to address all the implied research questions that have been enrolled. The SFC offers an opportunity: to learn about the factors which influence different types of producers to participate; to understand how emergent and public funding dependent rural networks can evolve so as to gain maturity and stability; and, to gather evidence on the role played by advisory and knowledge infrastructures in this type of knowledge and innovation networks. In addition, SFC provides a good example for EPI-AGRI, given that the former network has been created to overcome the sector challenges regarding its productivity and sustainability, by investing in creating, co-creating and sharing knowledge, skills and information through collective learning processes, which are the basis for co-innovation at different levels.

The DSM presents a model designed to create and store knowledge that is fundamental both at regional and sector level, when dealing with crop pest monitoring, and one that engages farmers in the process of co-creating knowledge. In fact, farmers' direct involvement in the process of creating knowledge, led by a knowledge and advisory (public) infrastructure institution, represents an opportunity to learn how best-fit practices can be implemented by advisory services within the frame of farmers' networks. In this case study, co-innovation might be less obvious, but it is actually taking place with multiple expressions, as will be reported in the result section.

Networks delimitation was dictated by their features. As shown in Figure 1, the sector is concentrated on two sub-regions: the central-north and the south. Therefore, since SFC is a national level and sectoral scope network, its delimitation overlaps the sector borders. These boundaries are not clearly defined because of the sector dynamics and the limitations of statistical data. Hence, SFC is an open network characterised by the diversity of its actors and the interactions among them. On the other hand, experienced producers as well as other actors, such as FBO leaders and researchers, resort to external-

cluster knowledge, which, at some extent, is exchanged and shared intra-cluster. The latter renders it important to account for the external interactions when studying the network knowledge flows.

Differently, the DSM is a well spatially-delimitated network, located in the area corresponding to the two NUTS 3, Dão-Lafões and Baixo Vouga, in the central-northern region. In addition, the actors enrolled can be listed. The network is coordinated by a public regional agency of the Agriculture Ministry (DRAPC) and the members are farmers, mostly inexperienced berry producers, who were selected by the FBOs and private firms they (the producers) are linked to. As regards these organisations, the latter act as facilitators, identifying those farms which are suitably located for field experiments and the farmers who show an active knowledge exchanger profile as well as the ability to implement and maintain the scientific experimental tests designed to detect the Drosophila Suzuki, the insect responsible for a devastating pest affecting this crop and to store and report the data collected.

Figure 1 shows the geographical location of the sector, as well its differentiation regarding the type of berry specialization profile.

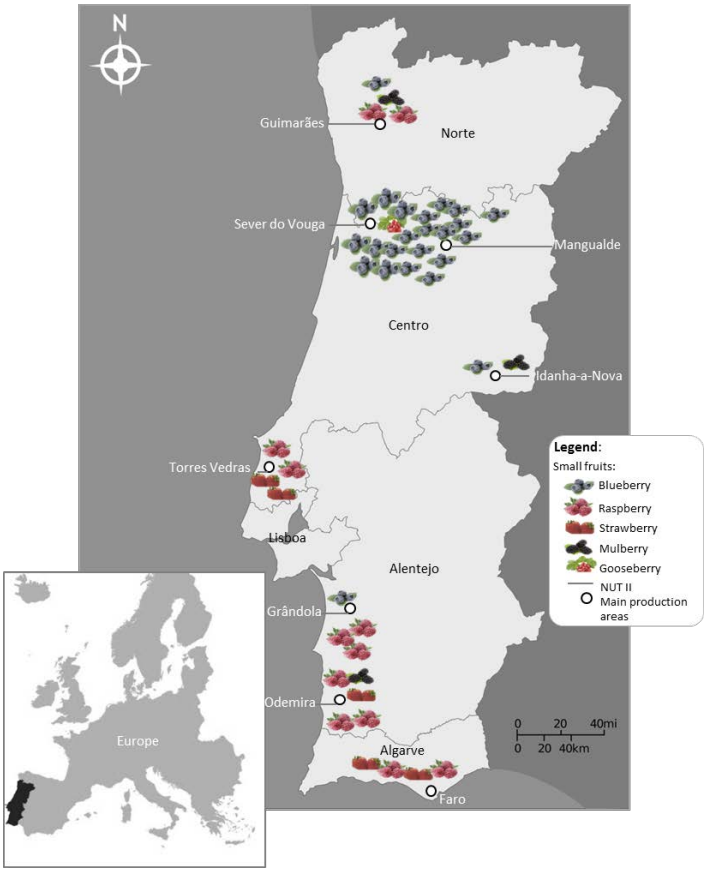

Figure 1: *Main areas of production of small fruits in Portugal*
Source: Authors', based on several data sources

3 General description of the case study

The SFC network was created as an attempt to organize the berry sector at national level, motivated by the already mentioned explosive growth of berry production in the central-northern region by inexperienced producers. The attraction of new producers, mostly young farmers, was initiated by regional local governments that saw in berries, especially in blueberries, an excellent opportunity to develop their municipalities. In this region, the crop was introduced in the nineties, as result of a foreigner initiative that realized the region's agro-climatic competitive advantage of an extended fresh supply period of the berries compared to the seasonal pattern of northern-central Europe. However, only a few producers were successful at that time. In fact, they are now the experienced producers in this region, and key actors in the SFC network.

The local governments' strategy to promote the blueberry - in particular in the municipality of Sever do Vouga, that currently calls itself the capital of the blueberry production - started in the last decade and has been boosted since 2011 by the economic crisis. Many factors contributed to the settlement of young farmers in this region: easy funding provided by the Portuguese rural development program (PRODER); (family) land availability due to farmland abandonment; high crop profitability rates. Together, they created an irresistible mishmash to attract hundreds of young and educated farmers: unemployed, sub-employed or employed (and self-employed) young people just looking for an opportunity to complement household income. The crop novelty in the region and the lack of agricultural experience of the majority of these new farmers originated a dynamics for knowledge and information supply, led by project developers, input suppliers and other professionals, often also inexperienced in the field or driven by short-term profit earnings related to the selling of project design services and inputs.

In parallel, being an export commodity (its domestic consumption is recent and still residual), blueberry production needed to be concentrated to attain export scale. This situation originated a dynamics of agglomeration economy, although it also entailed an increasingly large number of small and fragmented organizations, such as producer groups, farm-based small firms and other business models in general that are also offering technical advice to their members and/or selling advisory services to other producers. Table 1 illustrates the diversity of actors within the Portuguese berry sector.

Table 1: *Major actors and their roles in the small fruit sector*

Actors	Description of their role in small fruit sector
Independent producers	Production
Private companies Micro SME	Berry production, harvest and/or trade Storage, processing and transformation Advisory services (technical support, accounting, marketing, certification) supply Advisory services supply for application to PRODER incentives, direct payment, project installation
Producer groups	Berry production, harvest and trade
Cooperatives	Knowledge transfer (creation, storage, conversion and sharing) Supply of advisory services (technical support, accounting, marketing, certification) Berry harvest and trade
Farmer associations	Support and sectoral promotion
Sectoral associations	Promotion and support of knowledge creation and exchange Support and sectoral promotion Internationalization and innovation promotion

R&D public institutions	Knowledge creation, storage, conversion and sharing
R&D private institutions	Knowledge creation, conversion and sharing
Local governments	Supporting and encouraging enterprising farmers (land banks, business incubators, licensing new projects), territorial marketing
Public regional advisory agencies	Providing support to project installation management and technical advice Knowledge transfer (creation, storage, conversion and sharing)

Source: Authors', based on several data sources

The DSM network can be considered as a SFC outcome, in the sense that the latter gave visibility to the knowledge gaps that threaten crop sustainability and drew the attention to the fact that those gaps needed to be filled. One of these multiple gaps is knowledge and information on prevention and control of crop pests. Some of them can be devastating both to berry production and sustainability of the groves, as is the case of the *Drosophila Suzukii* fly. The onset of this crop pest in the Southern region led to the launching, in the beginning of 2014, of a campaign by the regional agency of the Ministry of Agriculture for the central region (DRAPC) to gather data and information that would allow its monitoring in the central-northern region. In order to implement the experiment, the agency relied on a group of small producers, currently a total of 38, who volunteered to have devices installed in their groves to capture the flies; farmers also agreed to monitor and report results and return the capture devices (to be subject to further analysis, if needed, by the technicians and researchers). The farmers were chosen by the agency with the help of the non-profit and profit FBOs to which they are linked, that acted as facilitators within this co-creation knowledge network.

4 Methods and data collection, local stakeholders' involvement

The first step of the research methodology was to establish exploratory contacts with the key gatekeeper actors via email and phone. These actors have an important role in supporting the establishment, promoting, disseminating and innovating knowledge networks, and include the central and regional agencies of the Ministry of Agriculture, the Coordinating and Regional Development Commissions, independent consultants, researchers and the media, among others. This process lasted approximately for two months, between March and April 2014, with the goal of identifying possible case studies involving farmers and others rural actors' network(s) focused on knowledge and innovation.

A different number of rural and farmers' networks were analysed. However, very few were actually focused on knowledge co-creation and exchange and co-innovation. This type of networks tends to concentrate in the agro-food industry. On the other hand, the team were already familiar with the small fruit sector since it had been selected as case study for another topic of the WP4 of the PRO AKIS, which addressed the challenges new farmers impose on advisory infrastructures and services (Madureira *et al*., 2014). The proximity with the sector highlighted the chance of studying the recently formalised Small Fruit Cluster (SFC). A major goal of the SFC was actually to establish a knowledge and innovation network that would back-up the sector productivity and sustainability. Hence, this farmers-led and multi-actor (rural and non-rural) network constituted an interesting case study to address the goals and research

questions of WP4 in respect to topic 3. In addition, this option made room to explore the synergies between research under topics 1 and 3.

Later, the field work lasted for six months and involved three distinctive phases:

In the first phase, which aimed to understand and map the actors in the small fruit sector, an exploratory study was carried out, that included different steps from the collection and systematization of the latest news and events, taking place in the sector of small fruits, to the direct observation and participation of the researching team in some of those events, such as: meetings of producer groups, the Blueberry National Fair and sectoral workshops related to production and harvesting techniques.

As a result of this work, we were able to identify yet another network within the sector that was also selected for research - the *Drosophila Suzukii Monitoring* (DSM) - a top-down network involving farmers and other stakeholders to create knowledge related to monitoring and control of the Drosophila Suzukii fly, a pest with a serious impact on small fruit orchards.

During the second phase, the team of researchers participated in meetings involving the facilitators for each of the networks (SFC and DSM). Four meetings were held, two with the SFC stakeholders and two with DSM. The purpose of these meetings was: (1) to introduce the PRO AKIS project to the participants, (2) to collect information as to the history of the networks, (3) to describe the facilitator's role undertaken by each of the networks as well as (4) to identify all the actors involved in these networks.

In the third phase, an exploratory-descriptive approach was chosen to gather information about the structure, content and dynamics of each network. For this phase, two different interview guides were constructed, and applied through questionnaires: one for the participants and the other for the facilitators. This script was also applied using a matrix to record relationships and interactions between actors and the flow of knowledge/information, whether in the process of creating, sharing or storing knowledge. These interviews took place on site, lasting on average 60 minutes and were set up by prior contact via email and telephone so that respondents were aware of the objectives of the study and the type of information to be collected. In this stage, we also contemplated the collection of further information by telephone from small-scale farmers (previously identified under Topic 1) in order to understand how this group benefited (or not) from the SFC, through the creation and sharing of knowledge created/shared by the networking and by an evaluation of the role and importance of networks at the organizational level, and to support/promote the development of innovations.

In the case of the SFC network, sample selection distinguished the actors involved, according to the criterion 'role in the network' and contemplated the following groups: 'facilitators', 'suppliers of knowledge' and 'knowledge demanders'. The sample selection was random and ended as follows: three interviews with 'facilitators', nine interviews with 'suppliers of knowledge', and 24 interviews with small farmers ('knowledge demanders').

The interviews carried out within the DSM network targeted 19 farmers, randomly selected from a total of 38, five representatives of the facilitator organizations (one out of six did not respond) and the head of the network (DRAPC).

It should also be noted that AGIM, INIAV and DRAPC constituted the panel of stakeholders in this research, and that, in the cases of AGIM and DRAPC, they were selected for being the network leaders of SFC and DSM, respectively. INIAV, a public national level R&D institution, was selected due to its fundamental role in SFC as the main intra-cluster supplier of quality knowledge and advice.

To carry on the analysis of social network, supporting the flow of information in the process of creating, sharing and storing knowledge, Social Network Analysis (SNA) methodology was adopted (for more detailed description see e.g., Hanneman, Robert & Riddle, 2005 or Wasserman & Faust, 1994). SNA is based on mapping and characterizing the relationships that are established as a result of the interactions between different actors and/or groups of actors (e.g. farmers or AKIS entities). The analysis of the interactions between the actors allows us to look into: (1) interaction patterns within the network; (2) knowledge flows (central actors, direction and intensity). A specific software for SNA, the Ucinet (version 6), working directly with another program, the NetDraw, was used with the purpose of drawing the graphs of the networks under study. The main purpose of adopting the SNA methodology was to obtain well-founded insights regarding key actors and the intra-network and external interactions that explain some of the relevant processes of knowledge creation, sharing and storage, taking place in each network.

5 Results

5.1 Description of berry networks

This section describes the structure, content and dynamics of the two networks.

5.1.1 Structure

Actors, roles, interactions and the networks' configuration

The *Small Fruit Cluster* (SFC) is a horizontal, nationwide, multi-actor network, involving a diversity of actors interacting in the sector. These actors as well as their role in the network are represented in Table 2.

Table 2: *Actors in the SFC network and their roles*

Actors	Role in the SFC network	Description
AGIM	Coordinator and major facilitator	Co-creation, conversion and exchange of knowledge
COTHN	Co-coordinator and national level facilitator	Creation, conversion and exchange of knowledge
INIAV	Public national level R&D	Creation, storage, conversion and exchange of knowledge

Actors	Role in the SFC network	Description
PortugalFoods	National level facilitator	Internationalization and innovation promoter
Experienced producers (independent producers and profit and non-profit producer groups)	Supplier	Co-creation, conversion and exchange of knowledge
Public regional agencies	Supplier	Co-creation, storage, conversion and exchange of knowledge
Private advisor, project developers, up and downstream firms	Supplier	Conversion and exchange of knowledge
Farmer associations, Cooperatives, Profit and non-profit producer groups	Facilitator	Facilitate and support of training and knowledge exchange activities Conversion and exchange of knowledge (technical advice)
unexperienced producers (independent producers and profit and non-profit producer groups)	Demander	Demand and uptake of knowledge
Local governments	Enablers and facilitators	Support and encouragement of enterprising farmers (e.g., bank land, business incubators, licensing new projects), territorial marketing

Source: Authors, based on the fieldwork and complementary data sources

The SFC players can be grouped into four major categories. There is a core group with four organizations that coordinates the network and includes their key facilitators.

A second group of members is a larger and more diverse one, encompassing independent producers, producer groups, small and medium firms of producers and others, cooperatives, farmer associations, private advisors, project developers and up and downstream firms, among others, which are direct or indirectly responsible for the knowledge (skills and information) supply. This group also includes regional agencies of the Ministry of Agriculture and, to a lesser extent, researchers and universities. The experienced producers (independent or members of profit and non-profit producer groups) stand out within this supply-side group. Our rough estimates suggest them to be around 15 people/organizations. The latter are vital to SFC insofar as they are the main knowledge and expertise suppliers, while being simultaneously innovation-led producers, ergo fundamental to encourage co-innovation processes within the network.

The third category of actors comprises the inexperienced producers. This is the largest group, with hundreds of producers, although not all of them participate in SFC activities. Among this group there are some active knowledge searchers, whereas the majority are apparently passive recipients of knowledge and information.

The local governments and local development associations of central-northern region constitute the fourth group of actors in the SFC network. They act mainly as enablers and supporters, by providing, for instance, facilities for training and knowledge exchange actions, supporting the AGIM (the coordinator and leader of the SFC), promoting the settlement of new producers, and acting as lobbyists in favour of the sector.

The facilitation job of linking the experienced producers with the inexperienced ones is done both by the members of the coordination structure and by a numerous group of other facilitators (included in the

second group of actors, for being directly and indirectly related with the knowledge supply). These facilitators operate mainly at local and regional levels and include farmer associations, profit and non-profit groups of producers, cooperatives, private advisors, assemblers and trade firms, among others.

Figure 2 represents the interactions among the interviewed actors of SFC network, based on the SNA methodology for data gathering and mapping.

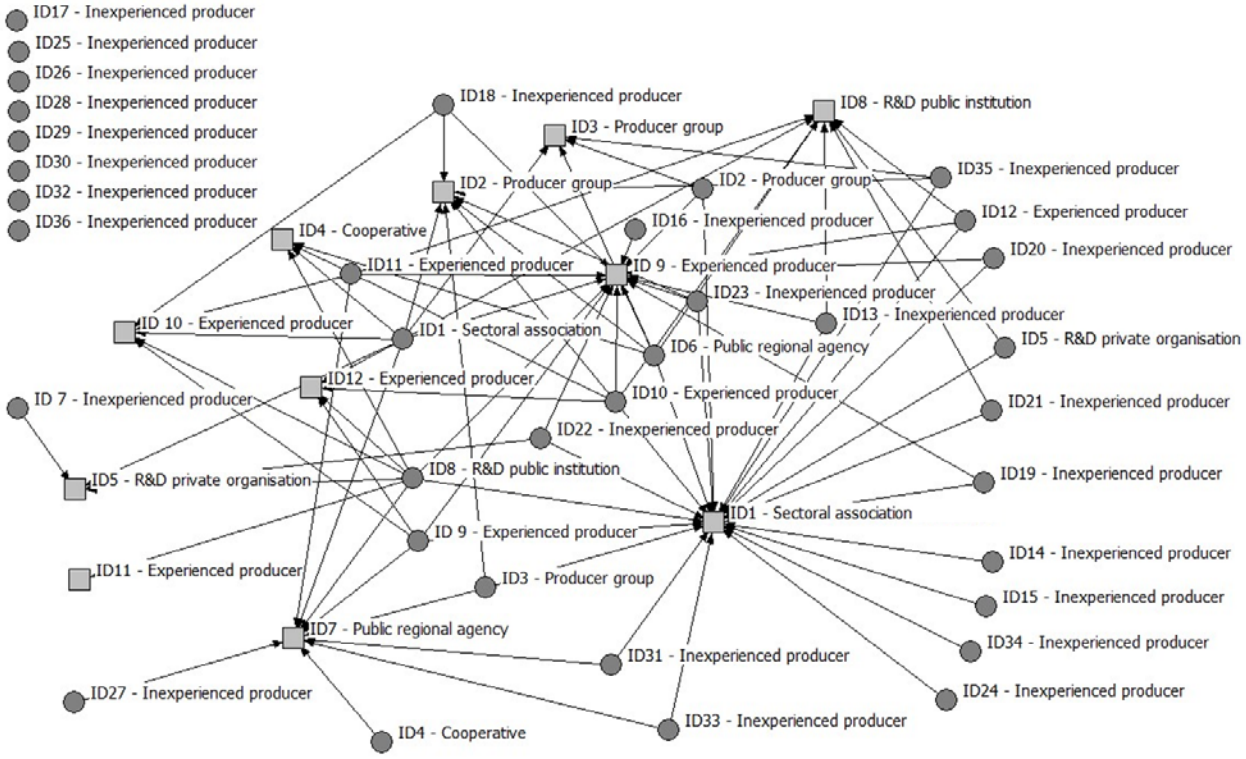

Figure 2: *Interactions among the SFC network interviewed actors*
Source: Authors', based on fieldwork data

In Figure 2, the actors are identified according to their level of experience and type of activity and described as follows: experienced and inexperienced producers, producer groups (both profit and non-profit), cooperatives, the public regional agency of the Ministry of Agriculture (DRAPC) and the three members of the core coordination group of the SFC that are relevant for the knowledge flows within this network, that is, the small fruit sectoral association (AGIM), the R&D private and non-profit organization (COTHN), and the R&D public institution (INIAV). The grey circles are the network nodes, the interviewed actors, and the grey squares represent the actors they referred to be linked with. The grey lines represent the ties with the direction (arrows) that indicates to whom the actors direct their main interactions to.

Although only a sample of the SFC network had been interviewed, it is clear in the figure how central the sectoral association that coordinates the network is; that coordination is led by the AGIM (ID1), located

in the central-northern region, alongside with two other central members: (1) the INIAV (ID8), the public R&D partner; and (2) an experienced producer, a private firm (ID9) located in the southern region. The sociogram described in Figure 2 highlights the dichotomous relationship between experienced and inexperienced producers, in which the later are clearly the demanders for knowledge, expertise and information, and the former play the role of active supply-side exchangers. The figure also underlines the role of the producer groups (ID2 and ID3) and of the regional agency of the Ministry of Agriculture of the Centre region (DRAPC, ID6). On the other hand, the sociogram suggests there are probably a relevant number of isolated, inexperienced producers, since they represent more than 30% of the inexperienced producers that were interviewed. In Figure 2 they correspond to the nodes outside the network (IDs 17, 25, 26, 28, 29, 30, 32 and 36).

As shown by the SFC network sociogram, a relevant feature of the SFC network is its spatial fragmentation, which is clearly illustrated in Figure 3.

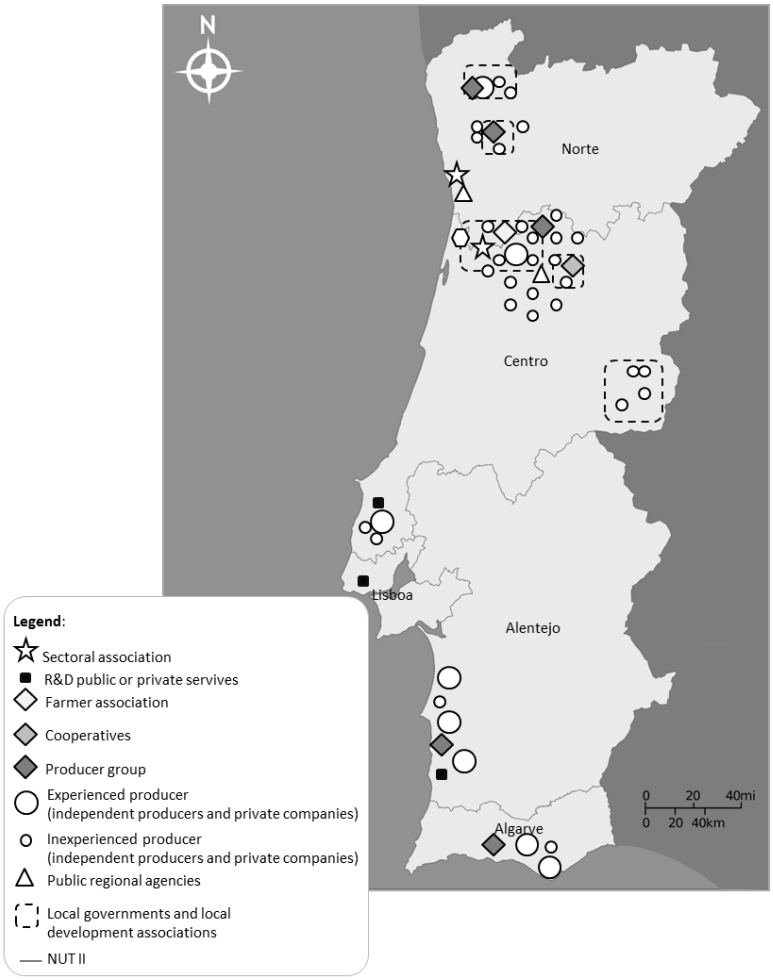

Figure 3: *Spatial configuration of the SFC network's actors*
Source: Authors', based on fieldwork and complementary sources

The figure emphasizes the concentration of intra-cluster knowledge demand in the northern-central region while experienced producers, who are the potential and/or actual quality knowledge suppliers,

are mainly located in the south. On top of this geographic distance, there is a cognitive distance between experienced and inexperienced producers: the former have knowledge needs on a superior stage in comparison with the latter. Less or inexperienced producers are mostly small-scale farmers, looking for basic knowledge and expertise related to topics such as, orchard planting, berry farming practices and cultivation and harvesting techniques. Their main motivation is to be successful in the planting and maintenance of the orchards, ensuring the quality standards required by the buyers or FBO assemblers they are linked to.

Experienced producers are mostly highly educated people or in any way active and even intensive knowledge seekers. Hence, they are demanders for advanced knowledge in the sense that they seek to adapt their groves to the local agro-climatic conditions and to keep in pace with the (global) market trends. They are intensive knowledge demanders, because they need to continuously implement incremental innovation at multiple levels. The incremental innovation process is critical to their success both as producers and as "sellers", meeting the markets' demand. Therefore, they need to continuously optimise their production processes by testing the plants' sun exposure, fertilization dosing/timing and pest monitoring, as well as search for new technologies entailing more advantages as regards orchards' productivity and quality of the berries. Product & marketing innovation is crucial for this group of producers, given that they invest on the differentiation of their berries in respect to their competitors from other European countries. This differentiation entails innovations such as retarding or anticipating ripening time, diversifying and/or introducing new varieties in their orchards.

The co-innovation processes led by experienced producers resulted on the creation of their own networks (Madureira, Gamito & Ferreira, 2014) which are only partially comprised by the SFC network. Collaborative innovation processes implicate interaction among mature producers (most of them integrating the group of the berry pioneers in Portugal) founded on inter-personal relationships, mutual trust and the producers' awareness that, despite being potential competitors, they must cooperate to safeguard the international reputation of Portuguese berries' (informal) brand. Market and R&D partners in these farmer-led collaborative innovation processes are largely outside the SFC, but for a few researchers of the national public R&D institution, the INIAV, which are unanimously acknowledged as an anchor by the majority of the experienced and innovative producers. These usually turn to them when searching for new knowledge or needing to convert scientific one brought in from self-search in websites and other on-line resources available at international R&D institutions, using ICT.

The inexperienced producers are in general passive knowledge demanders; nevertheless, there were some interesting exceptions that were observed during the interviewing process. Lack of experience in farming accounts for some of the passive behaviour, together with the fact that a large number of the new small producers were part-time farmers. It comes as no surprise, then, that they are the main demanders of knowledge and training activities offered by the SFC. Previously to the creation of the SFC, inexperienced producers depended mostly on the advice of private consultants, project developers, input supplies, product assemblers and traders, who had often little experience in the field and/or were looking for short-term profit. That generated the awareness among FBO, local governments, public regional agricultural agencies, as well as some of the experienced producers that there were

sustainability risks for the entire sector, due to poor quality fruits and pest dissemination. These threatens triggered the creation of the SFC in 2013, which, at the time, benefited from available public funding to initiatives for sectoral agglomeration economies.

In addition to the diversity of actors interacting in the SFC network, a pattern of overlapping roles was observed. For instance, it is quite common for the private advisor and/or project developer to be a producer (independent or member of a profit or non-profit producers' group) and/or either member of the board of a farmers' association, too. Consequently, the same individual or organisation (private firm or FBO) often acts as a facilitator, a supplier and a demander of knowledge and expertise within the network. This threefold playing may have its advantages, in that it places the same actor in different positions, thus potentiating his/her collaborative attitude and behaviour; but it may also interfere with the network's stability and cohesion if overlapping roles are influenced by the opportunistic behaviour of actors seeking short-term profit based on the networking opportunities offered by the SFC.

Figure 4 is a sociogram representing the SFC network drawn by aggregating the actors according to their characteristics, which allows for visualising the main features of the actors and their interactions.

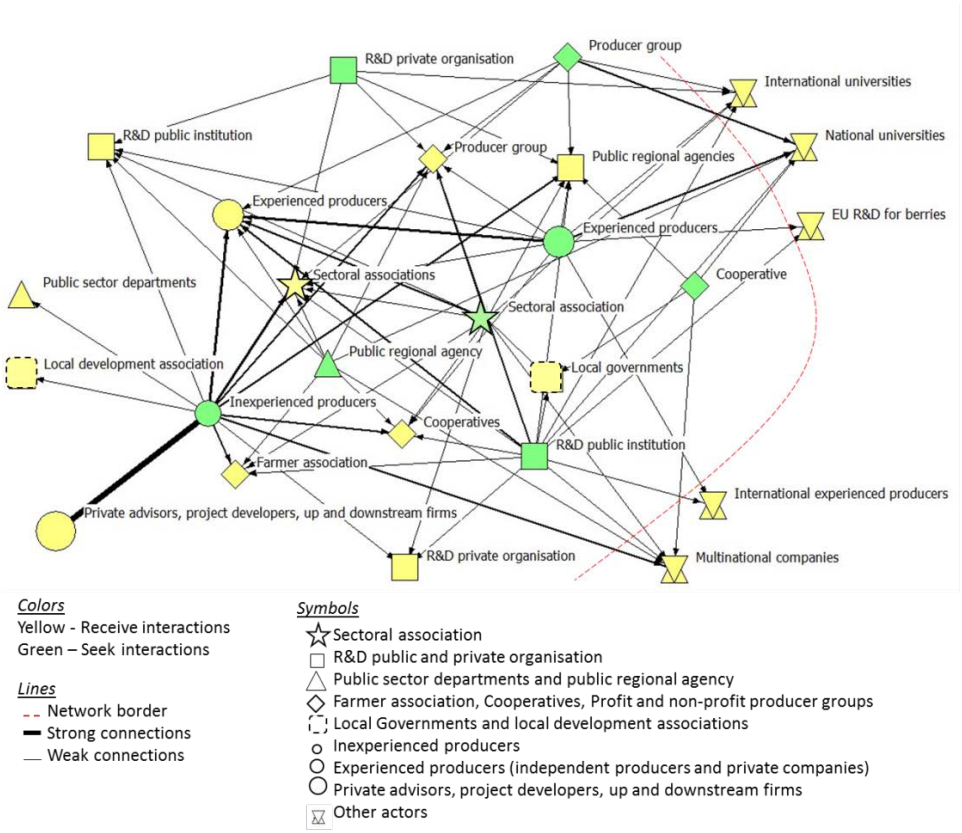

Figure 4: *SFC network interactions according to the categories of actors*
Source: Authors', based on fieldwork data

The analysis of the sociogram underlines four major features of the SFC network: (1)inexperienced farmers' demand for knowledge, expertise and information; (2) the centrality of AGIM in coordinating

the association, which suggests a consistent leadership role; (3) the importance of R&D public institution (INIAV) and the public advisory (DRPAC) from the knowledge supply-side; (4) the importance of the role played by producer groups both as suppliers and demanders of knowledge, expertise and information, providing advice to the inexperienced producers with whom they formally or informally interact; (5) and, the role of experienced producers as key players in the intra-cluster knowledge supply-side, despite some evidence to the contrary (according to some respondents, experienced producers appear to be far from being fully engaged in the network).

Regarding its structure, the *Drosophila Suzukii Monitoring* (DSM) is a spatially well-bounded network, including producers located in two NUTS3 (Dão Lafões and Baixo Vouga). It's led by the DRAPC, a regional agency of the Ministry of Agriculture that is responsible for the design, management and data analysis of a field experiment devoted to gather information for monitoring this crop pest. The farmers, a group of 38 mostly small and inexperienced producers, supported by the facilitators, are in charge of collecting data by preparing and placing the traps in their orchards. The facilitators constitute the third group of actors in the network. There are six partners: (1) three FBO, the AGIM (national level sectoral association), a regional farmers' association and a cooperative; (2) profit producer groups, private firms, all of them berry harvesters and traders, two of them accumulating the activities of input supplier and advisor. Table 3 presents the DSM actors and their respective roles.

Table 3: *Actors in the DSM network and their roles*

Actors	Role in the DSM network	Description
DRAPC	Coordinator and major facilitator	Defining, implementing and coordinating the experimental design to collect data and information on the DS fly monitoring Storing and converting the data gathered into usable information for producers
Farmer associations, Cooperatives, Private firms	Facilitator	Identifying the farmers, monitoring and reporting the data collection process Geo-referencing the exploitations with the adequate location for the experiment (altitude, orientation, parcel size, varieties, year of orchard planting) Providing advice to farmers on how to conduct the testing and raising awareness of the importance of participating Returning capture devices ('traps') to the network coordinator
Inexperienced producers (independent producers and profit and non-profit producer groups)	Producer (data collector)	Preparing the traps, placing them in the orchards, monitoring and returning them (the traps have to stay in the orchards for 4-6 weeks). Reporting the monitoring activity by filling forms (digitally or on paper) including information such as the dates of the trap installation and their location.

Source: Authors', based on the information gathered during the interviews

The idea of creating the DSM network came up during a meeting organised by the DRAPC (the DSM coordinator partner) addressing the topic of berry pest monitoring. This meeting integrated the SFC activities, and illustrates the SFC's ability to enhance farmers' co-operation with other actors in the attempt to solve practical problems through the creation and sharing of knowledge. Inter-personal relationships and previous contacts (relational capital) facilitated the process of the network design, by selecting the action area and the organizations which showed interest in enabling the implementation of the field experiment. The producers' networks were critical to the DSM network creation. These include

both types: the formal ones, such as the FBO; and the informal but stable networks of producers, built on the bonds that small independent producers created with private assemblers and traders who buy their production and/or support them in the process of planting and maintaining orchards.

Figure 5 is a sociogram which depicts the DSM network based on the interviewed actors. It distinguishes the different categories of actors involved as well as the five producer-based networks, led by the organizations already mentioned (ID6).

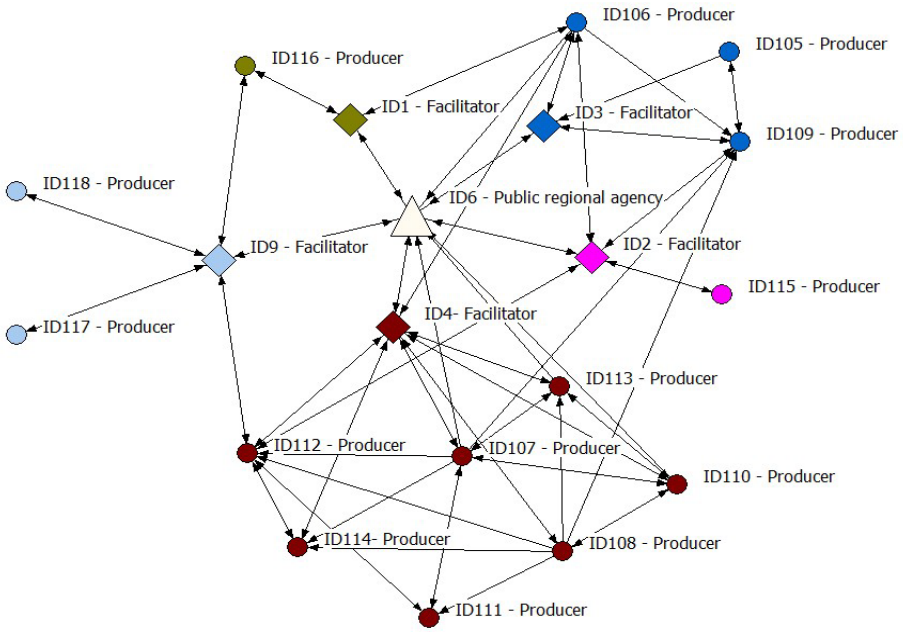

Figure 5: *DSM network according to the categories of actors*
Source: Authors', based on fieldwork data

Figure 5 points out three features of DSM network respecting the actors involved and their interactions: (1) the centrality of the coordinator and major facilitator (the DRAPC); (2) the role of the facilitators (coordinators of the producer-based networks) by linking the producers to the major facilitator; (3) the 'over-participation' of farmers integrated into the formal producer-based network (cooperative) represented with red colour (COAPE); (4) that some farmers, which are mostly new and inexperienced producers, interact with different producer-based networks, revealing their active role as knowledge, expertise and information seekers; and finally, (5) the creation of their own networks by farmers (IDs 105, 106, 109) who rely on the relationships they have shaped with their counterparts in the producer-based networks context in which they are formally integrated despite the networks' frequent failure to meet their knowledge needs.

The Figure also shows that the producers integrated in the COAPE (represented in red) have a high degree of interaction among them, which is largely explained by the following aspects: (1) the presence of farmers with previous experience in the viticulture sector (the traditional sector that was predominant in this area before the blueberry expansion), who are willing to share their know-how with the new and inexperienced farmers; (2) the neighbourly relationships allowed by the geographical proximity and prior

to inter-personnel or familiar ties and mutual knowledge; (3) the business model underpinning this group, focused on a shared goal of producing high quality fruits, built on the compliance with a set of mandatory specifications regarding the employed inputs, the farming practices, and the harvesting and storage (of the berries) techniques. If someone fails the quality target, then the entire group experiences a loss. Therefore, this model, while constraining the farmer's freedom in respect of their production decisions, contains an incentive for strong co-operation. That explains the "over participation" of this group in the experiment, which has been deemed an opportunity of collective learning and training for inexperienced associates by the COAPE leadership. This option gave COAPE producers the chance to seriously interact among themselves very much based on the establishment of producers' informal collaborative learning micro-networks, oriented towards the solving of shared problems that have to do with the cultivating practices and the need for down-scale adjustments to the available equipments (e.g., bird nets or fertiliser dosing).

Nature of the network and governance structure

As it has already been said, the SFC has a national spatial scale and a sectoral scope. It's a multi-actors network, involving the multiple players acting in the small fruit sector and various local governments. The nature of the actors' interactions is primarily horizontal and informal. In spite of the huge diversity of actors involved, it can be envisioned as a farmers-led and bottom-up network. It's a public funding network and *apriori* temporally bound by the funding support period, from 2013 to 2015. Funding is assigned to the knowledge and innovation activities alongside with the support to the sector organization and promotion. Funds are managed by the national level sectoral association, the AGIM, main coordinator and leader of the network.

The governance structure of SFC network is based on the AGIM leadership, which, together with other three organizations, instituted a fourfold partner structure that supports and leads it. Additional partners to AGIM are: (1) a co-coordinator, the COHTN (a national level technological centre, supporting the sector of fruits and vegetables); (2) the INIAV, the main R&D partner; (3) PortugalFoods, which is a private, non-profit and nationwide organisation, focused on the internationalization of Portuguese small-scale production of fruits and vegetables. These organizations are the chief facilitators of the knowledge and training exchange actions entailed by the network by working together with the numerous players intermediating the demand and supply of knowledge and information. Major facilitators have a significant role in mobilising experienced producers, regarding whom inter-personal liaisons appear to be essential to ensure their participation. In fact, producers are motivated to participate in the network by their concern with safeguarding the (good) reputation Portuguese berries enjoy in the export market destinations. The inexperienced farmers are mobilised to participate by the intermediate facilitators, whose job is made easier by the former's acute needs for knowledge and skills to plant, cultivate and harvest the berries. However, as it has already been stated, a significant part of them remain isolated, probably due to lack of time (in view of their status as part-time farmers) and/or their passive attitude towards seeking knowledge and expertise.

The DSM is a spatially bound network of a regional scope. It's also an informal multi-actors network, although it involves significantly fewer and less diversified players by comparison with its SFC

counterpart. The nature of the actors' interactions is primarily vertical, although informal. This network is not funded and depends on the voluntary participation of both the facilitators and the farmers. It's a top-down network that can also be envisioned as a farmers-led one, given that the latter are the fundamental players for the network to work and their participation is voluntary. It's a temporally bound network whose duration depends on weather conditions and on the behaviour of flies, which determine the duration of field experiments. Nonetheless, the experience gained by farmers and facilitators from this network can be re-used as well as expanded or replicated for other experimental pest monitoring-related tests or other purposes, such as growth stage trials to monitor the response of different varieties or local optimization of the ripening time of specific varieties (a trial that is currently going on, which counts on the voluntary participation of some producers across the country).

The governance structure of the DSM anchors on the technical-scientific coordination of the DRAPC, although it is highly supported by the generalised perception, among both producers and facilitators alike, that theirs is an extremely important participation. These actors' strong awareness of the importance of having local knowledge that guarantees the productivity, quality and sustainability of the orchards, explains their commitment without any financial benefits; on the contrary, there are costs involved given their participation is a time-consuming process. They have to learn how to prepare, implement and maintain the capture devices, report the results and ensure that the traps are returned in the end of the trials. It is important to notice that the producers involved, while small-scale and basically inexperienced, are full-time farmers and highly dependent for household income purposes on the profits obtained from small fruits. These features largely explain their commitment to the experiment, regardless of the time and cognitive effort they require.

5.1.2 Content

The networks goals

The *Small Fruit Cluster* (SFC) is an initiative that aims at enhancing the competitiveness and sustainability of the berry sector. These aims were largely motivated by the explosion of small-scale production in the northern-central region, as it has been previously explained. The Cluster isn't explicitly focused on innovation, whereas its promotion is a transversal aim to the network, as can be perceived by reading SFC objectives as presented in their official website (http://clusterpequenosfrutos.pt/, accessed in October 2014). The SFC goals can be summed up as follows: (1) enhancing the creation, co-creation, conversion and exchange of knowledge and expertise in the field of orchard planting and cultivation; (2) collecting and storing information on markets and prices to encourage berry differentiation through product marketing and organizational innovation; (3) promoting and divulgating the sector, namely by increasing domestic consumers' awareness of the berries' qualities. Therefore it constitutes a knowledge and innovation network, especially if one adopts a broad concept of innovation, one that encompasses incremental changes like small improvements in the production and harvesting practices, development of collective learning methodologies for co-creation and conversion of knowledge and information, and organizational and value chain innovation, enhanced by the interaction among farmers and their organizations.

Although innovation is generally thought as a process involving the R&D sector and the industry (up and downstream) as innovation producers and the farmers as their up-takers (hence, involving the production of technology e.g. irrigation equipment and/or the development of new products e.g. transforming of fresh berries), that is not by far the main type of innovation enhanced by the SFC network. The SFC illustrates how social interaction becomes a powerful tool capable of enhancing systemic innovation (Knickel *et al*., 2009), that is mostly incremental in its nature and resorting to processes of imitation and informal collective learning experiences to solve practical problems, within which farmers act as knowledge co-creators and exchangers. Nonetheless, different innovation patterns can be identified, namely when comparing experienced and innovative producers with others that are small-scale and inexperienced. To a large extent, the former rely on incremental innovation processes, products and marketing. In their innovation processes, they combine scientific, synthetic and tacit knowledge (cf. Asheim & Coenen, 2006), aiming at continuously improving their production practices (e.g. irrigation and fertilizer dosing and timing) and adjusting their products to market demand. In the case of mature producers, collaborative innovation processes take place in their own networks, involving other experienced producers (national and abroad), buyers and researchers who are largely outside the SFC. However, their innovation outcomes are used intra-network by some of the small-scale and inexperienced producers through imitation/adaption of innovation processes, facilitated by the SFC, for instances by the technical visits promoted by the network.

The learning activities like the thematic workshops and technical visits made available by the SFC facilitators, when conducted by the experienced producers, enable both inexperienced and experienced ones to innovate. This innovation is also small-scale and low-tech, consisting mostly of changing farmers' attitudes and practices, who feel stimulated by what they perceive as the opportunity to improve in terms of productivity gains, increases in the quality of the fruits and/or decreases in production costs that adopting more sustainable practices (e.g. reducing the use of phytochemicals) generally entails.

Interaction among small-scale producers, enhanced by the SFC activities, creates huge networking opportunities, also involving other actors (e.g. advisors or researchers) that often lead to informal collaborative innovation processes driven by the goal of solving practical problems. Collective learning processes among small-scale producers enhanced by the SFC network are very important for the creation (accumulation and storing) of knowledge about local response regarding varieties of berries and farming practices (e.g. irrigation, plant protection). Available scientific and synthetic knowledge reports to very distant contexts, such as central-northern Europe or US western coast and Canada. On the other hand, networking enhances inter-personnel relationships and social learning processes that are often the result of informal sub-networks led by the small-scale producers. These informal sub-networks offer an effective platform for the co-creation, conversion and sharing of knowledge and information oriented towards problem-solving. In addition, they provide actual opportunities for resource sharing, and consequently cost reduction, especially as product transportation and other logistic operations are concerned. Simultaneously, they are a way of creating agglomeration economies through informal cooperation and product assembling (i.e., examples of marketing and value chain innovation).

The main goal of the DSM network is to create and store regional-based knowledge that allows monitoring crop damages caused by the *Drosophila Suzikii* fly. The prevention and control of crop pests, in particular new ones, such as this, is fundamental to ensure the profitability and the sustainability of berry production. Therefore, the DSM can be mainly identified as a knowledge network built on experimental testing. On top of that, this network is in itself an organizational innovation, given the informal and voluntary participation of the farmers in the experiments and their recruitment and support by the producers' organizations (formal and informal producer networks). On the other hand, the engagement of farmers in the network enhances their co-operation, focused on the knowledge co-creation, as it was already explained when the network structure was described. Hence, it includes collective learning processes which are a powerful trigger for developing the farmer's capacities and ability to create, test, implement and evaluate innovation, while cooperating among them and with other actors, namely advisors and researchers. A number of small-scale process innovations have resulted from the informal co-operation among farmers enhanced by the network, as exemplified in section 5.3. In addition, as it has already been mentioned, the network stimulates the creation of informal subgroups of producers (micro-networks) looking for alternative business models that can be applied to product assembling and trading and also constitute opportunities for organizational innovation, oriented towards marketing and value chain, and efficiency gains resulting from resource sharing.

In addition, the DSM network provides an opportunity for farmers to learn about sustainability best practices in the field of crop pest prevention and control. By creating knowledge about crop pest behaviour, the network increases the producers focus on prevention, hence favouring the reduction of the phytochemicals dosing as well as the farmers' preference towards inputs with lower environmental and health impacts. These changes in the producer's attitude and behaviour regarding plant protection practices allow them to save money as well as increase the quality of the fruits and the potential market value. They also lead to the adoption of more sustainable practices and the creation of opportunities for product/process innovation (e.g. conversion to organic production).

Participants' expectations and compatibility of objectives in the network

In the case of the *Small Fruit Cluster* (SFC), there is clearly a dichotomy in the participants' expectations: (1) on one side, experienced producers expect their participation will help safeguard Portuguese berries' brand reputation; (2) and, on the other side, inexperienced farmers hope to get knowledge, expertise and information that will help them meet producers' and buyers' quality challenges. Hence, despite different expectations for joining the network, the underlying goals of these two types of producers are actually convergent. In addition, individual goals and the collective objective of the network of guaranteeing the competiveness and sustainability of the berry sector are compatible. Therefore, while there are different expectations and goals among individual actors, these appear to concur to the network overall goal, thus giving it social cohesion.

There is, however, a high percentage of small-scale producers who chose not to participate in the network and who, on account of their lack of knowledge and experience and the fact that they work alone, may endanger the collective goal, particularly as regards the sector's sustainability, for they may

adopt less adequate varieties and/or wrong farming or selling practices. On the other hand, some experienced producers joined the network with feelings of distrust and keeping themselves on the sidelines. While the attitudes and behaviour of the latter do not compromise the network overall goal, their full participation, however, could boost its outcomes, namely as far as filling in learning needs of inexperienced farmers is concerned. This situation shows that cohesion inside the network is not a given. SFC presents experienced producers an insufficient offer and is still not able to attract a relevant number of small, inexperienced producers, especially those with less time and/or interest in knowledge demand processes.

The DSM network enhances cooperation and is the result of producers' awareness that the knowledge they need to locally monitor crop pest has to be co-created by them. Given that the crop pest prevention and control is essential if profitability and sustainability of berry production are to be ensured, farmers' awareness creates convergence between individual and collective goals. The positive expectation of producers and the facilitators when joining the DSM network lies largely on the perception of experiencing a good balance between the benefit and cost entailed by their participation. The expected benefits comprise the production of knowledge to prevent and control crop pest, but they go beyond that, with producers expecting to be empowered with the ability to learn how to create, test and implement innovations. They also expect to increase their relational capital, by developing networking with other producers as well as with quality advisors, namely the DRAPC. The facilitator organizations also hold positive expectations. They envisage the producer's participation in the network as an opportunity to increase their abilities to learn how to be 'good producers' and, thus, contribute to the success of small-scale production, that is to say, their own success.

5.1.3 Dynamics

Understanding the networks dynamics entails to analysing its cohesion, which depends on the motivation underlying their members' enlisting or withdrawal, particularly the berry producers'. The network stage is another relevant factor for its stability, which also depends on external factors.

Networks phase and stability

In both case studies, the networks were observed at a starting phase. However, this has different implications, given the different life-cycle of each of the networks. The DSM is a short-cycle time-bound network, whose duration depends on the time needed to design, implement and conduct the experimental test, which takes two crop seasons at most. Afterwards, depending on the success of the first experience, the network model and structure may be re-used for other purposes, whilst probably involving different or additional farmers and facilitators, depending on the farm location features needed for specific field trials. The case of the SFC is different, since its future is currently undefined. To accomplish its goals, the latter has to last for a relatively long period. In face of its novelty and the large number of inexperienced farmers, the success of the sector depends on the network's survival and evolution in a path that enables it to cope with fruit producers' needs and demands for knowledge and information, which are expected to evolve and increase over time.

Therefore, although the DSM network was observed at an earlier stage of its life-cycle, that does not translate to uncertainty regarding its future. The network had more entrants than expected, largely due COAPE's initiative to use it as learning and training opportunity for its associates. The expectations of the participants, both facilitators' and producers', appear to have been fulfilled. The network looks stable. Producers express their satisfaction in being able to implement the testing design and monitor the traps, and did not foresee any problems with the reporting and traps returning phase. Producers seem particularly happy with the learning and social interaction opportunities they were able to get from participating in the network. This includes previous ties with other producers settled nearby and/or family relationships, besides new relationships established in the context of learning or training activities and maintained through the continuation of inter-personnel contacts. These contacts are mostly based on social network interaction (such as Facebook and similar platforms) and on the exchange of e-mails and cell-phone calls addressing the exchange of knowledge and information to solve problems in the orchards or related to berry destination. In both cases, what has triggered the intensification of inter and multi-personnel contacts was the participation in the experiment, which raised doubts, questions but also solutions that enhanced the interaction among producers. This active interaction favoured the collective learning and the knowledge exchange, mostly a tacit one, that enhanced knowledge share and co-innovation processes, focused on the development of small-scale solutions for problems (and associated costs) often raised by the use of equipment and technologies not fitted to the small scale orchards (e.g. developing a device that allows bird nets to be rolled and unrolled without being damaged; another example could be a handmade 'flamethrower' to do holes with the right size in the land cover canvas for nursery plants in the orchard planting phase).

A DSM network feature that is determinant for its stability is the voluntary and informal nature of the enlisting. The producers are free to go whenever they want. They do not have to accomplish the test and failure is not penalized. In addition, they valuate, as shown in the interviews, the liaison with the DRAPC, as a latent resource they can explore when they need quality advice on specific issues. The producers' will to join the network very much depends on their being aware of their role as co-creators of the knowledge they need and on their being able to access and use it later. Facilitators have an important role in that respect, and, by selecting active knowledge seekers and/or exchangers, they potentiate the benefits of the network activity and results to outside producers and farm-based organizations.

The SFC is also at an early stage and so it is not a mature network. Further, it faces a cloudy future with the end of the funding phase, by the end of 2015. Until then, the network is expected to continue its knowledge and innovation activities. These include training and training courses (e.g. on how to prepare and manage the harvesting, apply phytochemicals for crop pest control or prune berry bushes), technical workshops (e.g. on orchards planting, irrigation or pruning), producer and trader meetings, technical visits to best practice exploitations in Portugal and abroad, conferences with experts, exhibition fairs, open-days, among others. In addition, the CFS is implementing infrastructures for knowledge creation and storage, which comprise a demonstration field and a science and technological park (the latter is still in progress).

During the first year of its activity, the SFC carried out more than 60 events related to knowledge and expertise exchange. The events were regularly organized, focusing on different target publics and in different locations to enhance the participation of different types of producers and other actors as much as possible. Participation doesn't entail payment of fees (with the exception of field trips abroad). Producers and other actors have to bear travelling costs and endure the opportunity cost of the time allocated to their participation. The actions are in general attended by a significant number of producers (around 15 to 30, depending on the type of action). They are mostly sought after by inexperienced, young farmers. That appears to be related to young producers' awareness of how important it is to acquire knowledge and information and their ability to obtain it in the formats they are delivered (e.g. workshops, conferences, training sessions) and what is provided (technical information and synthetic knowledge). The already noticed self-exclusion of some of the small and inexperienced producers might also be due to lack of cognitive skills to engage in these new technological-based formats of knowledge and information transmission. In order to be effective (in-depth conversion), these skills need to be complemented by individual work, that is, farmers have to do their own internet research, interact with other producers through social networks, question advisors and so on. In fact, in the course of the interviews, small farmers who use the internet underlined the social value of their participation in these events, for they represent the chance of building their 'own' knowledge and information networks.

The dichotomous nature of the SFC network is also expressed by the stability of social cohesion amongst southern producers vs. the instability faced by the central-northern sub-region. Stability in the southern sub-region derives from a relatively long-term co-operation among experienced producers, based on a mature informal network for knowledge transfer, and well-established commercialization channels which are articulated with international partners, including multi-national companies and experienced traders. In the central-north, the sector is still being implemented and a certain degree of instability is understandable. In this sub-region, it is visible a fragmentation of the sector into multiple FBOs and different types of private companies in search of attaining a certain dimension, which is essential for exporting, and ensuring product quality (an indispensable requirement to export the product). This situation is obviously a constraint to stability in view of the tensions between competition and cooperation goals.

Therefore, a major challenge for SFC is containing this fragmentation and creating a common arena for cooperation among the myriad of organizations that compete with each other to engage new and small farmers, causing mistrust among the players and instability in the sector. A major involvement of experienced producers, who are mostly located in the southern region, might to be a way to bring in stability, for it would prevent small producers from being disputed by competitor organizations who wish to handle their inexperience and strong need for advice and support. Engaging these experienced producers in the network means giving them proper incentives. One of those incentives would be to involve them in the network governance; another, to structure the network to provide advanced knowledge outside the SFC (and even abroad) that producers currently demand. How are these challenges, imposed by experienced producers on the network, to be achieved? One way of doing it is to involve them in the conception, planning and implementation of knowledge activities carried out by network, while attracting more R&D players to it.

5.2 The links between the networks and the knowledge and advisory infrastructure

The scarcity of quality knowledge and information is a problem felt mostly by experienced farmers. As shown in Figure 4, they resort to external sources to SFC, namely international universities that make handbooks, reports and other resources available on-line. The partnership with multinational companies operating in the sector is another way to fulfil (advanced) knowledge needs. In this option, producers have to work in exclusivity, by following the company specifications on the production and harvesting practices and inputs choice, as well as selling their production to them.

Inexperienced producers are both active and passive knowledge seekers. The former are less vulnerable to bad quality advice because they are able to interact with different types of actors and cross-check information; besides, they are more willing to do their own field experiments (testing and evaluating). This group is mostly composed of young, full-time, highly-educated, small-scale producers, with average production areas of 2 hectares. Passive knowledge seekers, especially working part-time and at a very small scale(less than 1 hectare), are more exposed to bad quality advice. The small dimension of their business prevents them from getting private quality advice, which, in the case of the small fruit sector, only now is beginning to emerge.

The weakness and fragmentation of Portuguese AKIS (Baptista *et al*., 2014) has made room for bad quality advice supply, often related to private service providers and input sellers who seek only short-term profit. The lack of quality control of advisory activities provided by these actors is a result of that weakness. As it has already been mentioned, the creation of the SFC has been triggered by the threats to the sector's sustainability perceived by FBOs, public structures and experienced producers who have observed how bad advice services offered to new, inexperienced farmers are. In Portugal, FBOs are currently the major players in the advisory supply to agricultural activities in general, although there are also private quality providers. Public advisory is currently residual, as a result of public policy orientation having transferred these services to FBOs and having ceased to invest in the public sector for the last 20 years. Therefore, the public sector has had to struggle to keep afloat and is facing a severe lack of personnel and financial resources.

SFC illustrates how important FBOs are to provide farmers with advisory services. Nevertheless, the novelty of the small fruit sector and the consequent lack of previously accumulated experience only show FBO s' difficulties when dealing with the knowledge creation and conversion processes, rendering them more evident. The job of FBOs is mainly transferring knowledge. In more mature sectors like winegrowing or livestock production, some FBOs also actively participate in knowledge creation, storage and conversion. However, they rely on knowledge and expertise produced and accumulated over the years by an infrastructure of agricultural applied research and extension that was once public. The disinvestment and progressive abandonment of this infrastructure in the last 20 years created a hole in the Portuguese AKIS. The advisory services have been transferred to FBOs. However, applied research and experimentation activities have been virtually abandoned, although they are essential for the creation, storage and conversion of knowledge for agricultural activities which are locally-specific. In the case of the mature sectors, these activities have been partially undertaken by Higher Education institutions, particularly Agrarian Higher Education Schools of the Polytechnic system. Nevertheless, over

the years, Higher Education has focussed more on laboratorial research on Biotechnology and Agri-environment Sciences and related fields that allow researchers to get competitive funds and publications in highly rated scientific journals. There are no available funds for applied research in agriculture. The situation is not much different in other sectors, although in the industry sector specific technological centres were developed in the nineties. Those have replaced the functions of the public sector to a large extent, while partly benefiting from public funding. However, that has not been the case for agriculture. There has been an almost total disinvestment in the creation, storage and conversion functions of AKIS, with those in charge ignoring the fact that agricultural activities are agro-climatic context specific, which renders it very difficult to resort to knowledge produced abroad without local experimentation and conversion. The small fruit sector in Portugal clearly shows the weaknesses of Portuguese AKIS. It also shows as well that funding the settlement of young and inexperienced farmers absolutely requires that these functions be re-implemented. Experienced producers prefer the State to do it. In their opinion, other models may be taken into consideration but they will have to contemplate an effective public regulation otherwise too much time will be spent searching for and converting knowledge, and young, inexperienced farmers will be easy prey to bad quality advice services and risk seeing their business ventures fail.

Therefore, there is an obvious gap in the creation, storage and conversion of knowledge for agricultural activities in general, which is particularly acute for novel sectors that also lack the tacit knowledge accumulated by farmers in traditional sectors over the years. In the case of SFC, it is obvious it does not have a strong component of knowledge creation, storage and conversion. The coordination structure of the network is aware of it and short term plans include the implementation of an experimental field along with the already implemented demonstration counterpart in the central-northern sub-region. The existence of an experimental station in the southern sub-region that has been supporting the cultivation of small fruits in this sub-region for the last 10 years is referred by experienced producers as an extremely valuable asset to them. The station is coordinated by the INIAV, whose role is instrumental in the processes of knowledge creation, storage and conversion. Hence, SFC's strategy of acknowledging the southern sub-region's vital importance to knowledge flows on the supply-side was evidently a wise option. The challenge has been, as referred in the previous section, to have experienced producers in this area committed to the network. Still, that is not enough, and reinforcement of the role of the public sector in knowledge processes is critical if the sector is to succeed.

Reinforcing that role might involve investing in applied research and advisory structures as well as attracting Higher Education institutions, namely the above-mentioned Agrarian High Schools and Universities with Agrarian Sciences departments, to train qualified technicians, such as agrarian engineers and agronomists. In fact, the link between the Higher Education institutions and the sector consists mainly of training qualified professionals, of whom a small but important number, conduct research field work for final course reports, master thesis, and less often for PhD thesis, in the small fruit exploitations. As such, the participation of universities and other Higher Education institutions could be enhanced through public funding for applied research in the field as well as valuation in academic curricula of research and extension activity abilities and skills inherent to the professionals trained by these institutions.

Without filling the knowledge creation, storage and conversion gap, it will be very risky for public policies to massively attract young farmers to the sector. This happens because most of them might not last long enough to be able to gather and convert fragmented and not locally-specific knowledge in a very competitive and intensive-knowledge commodity sector.

The DSM network, on the other hand, provides some insights on how farmers can be involved in the processes of knowledge creation and storage in an innovative way. Another example is a phenological stage trial that is being carried out across the country by a researcher of a university in the same format: resorting to the informal engagement and voluntary participation of the producers. However, some producers, namely the experienced ones, see these 'voluntary field trials' negatively, since they are time and resources consuming. They say that the State's job. Nevertheless, these experiences could be useful to develop duly funded trials, for instance, adopting the monitor farm model, and promoting 'monitor orchards' in a similar way as is done in the UK (Creaney *et al.*, 2014).

5.3 Processes and dynamics to generate and exchange knowledge for co-innovation

This section identifies and describes knowledge processes enhancing co-innovation in the networks that have been studied. It also describes innovation and its nature, in addition to discussing to which extent the networks that were selected might be seen as examples in the EIP-AGRI framework to increase farmers' abilities to create, test, implement and evaluate innovation in cooperation with other rural actors.

Co-creation, exchange, storage and conversion of knowledge enhancing innovation in the SFC network

Table 4 summarizes the knowledge processes occurring as a result of the multi-actor interactions in the SFC network, identifying the main interacting actors and the methods and supports of the knowledge flows involved.

Table 4: *Examples of knowledge processes, methods, supports and actors involved in the SFC network*

Knowledge processes	Methods and procedures	Supports for the information	Actors involved
Co-Creation	Converting scientific knowledge into synthetic knowledge; Interaction between the tacit and explicit knowledge, resulting in the drafting of technical handbooks.	Technical handbooks (digital and paper versions).	R&D public institute (INIAV) and R&D private non-profit organization (COTHN); Sectoral association (AGIM); Experienced producers.
Exchange	Presentation by invited speakers, comprising both: (a) members of the network, such as experienced producers, leaders and technicians of FBO and private firms, as well as researchers and technicians of the public R&D and advisory; (b) external to the network, such as foreign experienced producers, experts and researchers, large company technicians among others; These presentations take place at events, such as training actions, workshops, seminars and congresses which make room for producers' questions and experience sharing among participants.	Slide show and/or written presentation (digital and paper versions); handbooks, flyers and technical brochures; ICT (social networks, e-mail and cell-phones).	All types of players in the SFC, including coordinators and facilitators; R&D partners; experienced and inexperienced producers.

Knowledge processes	Methods and procedures	Supports for the information	Actors involved
Storage	Elaboration of technical handbooks; Editing conclusions of technical-scientific events.	Handbooks, reports, flyers and minutes; ICT (social networks, e-mail and cell-phones).	R&D public institute (INIAV) and R&D private non-profit organization (COTHN); Sectorial association (AGIM);
Conversion	Implementation by producers of advice and information gathered in formal and informal meetings, entailing changes in their attitudes, behaviours and practices; Converting scientific and synthetic knowledge (e.g. in handbooks) into explicit (experimental) and tacit knowledge.		Unexperienced producers

Source: Authors', based on information gathered during interviews

The co-creation of knowledge results from a process of joint creation and refers to knowledge that can be shared among actors with common interests so that mutual benefits can be obtained and innovation enhanced (Prahalad & Ramaswamy, 2004). The survey on knowledge co-creation processes within the SFC network suggests that the involvement of multiple actors in formal and systematic interaction had an important impact on the creation of explicit knowledge. An example of it is the drafting of technical handbooks on how to plant blueberry orchards and conduct fruit quality management and post-harvest storage. In this case, the actors involved were the SFC members from the R&D sector (INIAV and COTHN), the sectoral association coordinating the network (AGIM) and some experienced producers. External partners to the *cluster* who also participated in these processes were experts from multinational companies with R&D present in Portugal and operating in the small fruit sector. The knowledge flows involved in these processes which resulted in the handbook drafting are presented in the next section.

A central knowledge process within the cluster is the exchange of knowledge, information, expertise and skills. This process was supported by: (1) formal events, such as training courses and actions, workshops, producers meetings, seminars and congresses, and technical visits; (2) and informal interaction occurring during and after the events. The knowledge exchange processes include all types of relevant contents for the sector, while having a particular emphasis on topics related to the techniques and practices of planting orchards and maintaining them (e.g. fertilization, weed control, pruning and plant protection). The main supports for the knowledge and information exchange are the slide-show prints or written presentation delivered by invited speakers and provided by handbooks resulting from the co-creation processes.

The events promoted by the SFC network serve as multi-actor meeting platforms, leading to interaction and knowledge exchange. They appear to be benefiting mostly small-scale inexperienced producers who demand them. The reasons for that have already been discussed in previous sections. On the other hand, these formal events promote socialization among participants, whether during breaks, or at the end of sessions, when participants usually exchange personal e-mail addresses and cell-phone numbers for post-events contact (that can be face-to-face, but are mainly through social networks and cell-phone). Participants aim at exchanging knowledge and information as well as sharing experiences, problems and problem-solving solutions. In this sense, knowledge exchange processes trigger relevant co-creation

processes among small-scale farmers. These processes mobilize available tacit knowledge most inexperienced producers often lack, but that can be potentiated by the exchange of experience and combined with the conversion of explicit technical knowledge acquired at such events and available in handbooks and other material or computer storage media most of them are able to use, given their high education level. This amalgamation of knowledge exchange and co-creation processes is the basis for co-innovation processes, involving mostly incremental innovation resulting from mimic, testing and evaluation processes, that are described in the following sections.

The formal events offered by the SFC network also provide an opportunity for 'fruit tasting', thus generating debates on the advantages and disadvantages of certain varieties, given market needs and consumers' preferences. Hence, while the events tend to focus on technical and production-related issues, harvesting and post-harvesting berry storage, they also stimulate the discussion around the marketing concerns and through that raising small-scale producers' awareness of the importance of keeping pace with market demands.

The SFC network also includes knowledge storage processes which are supportive of co-innovation, handbooks being one of the best examples of storage processes. These examples also illustrate an interesting process of networking innovation underpinning the way the knowledge is produced: combining scientific and tacit one by joining researchers, technicians and producers.

Therefore, the SFC clearly stimulates co-learning processes, which support upstream collaborative innovation processes. The example of handbook production shows how these processes can be potentiated by bringing together knowledge producers and users, while recognising the latter as being also important knowledge creators. On the other hand, the multiplicity and diversity of formal events promoted by the SFC, in addition to the delivering of relevant explicit and technical knowledge, strongly encourage cooperation amongst small-scale producers. This cooperation enhances their role as creators and co-creators of knowledge by converting explicit knowledge through testing and collective evaluation, sharing of both different and similar results obtained from similar varieties, farming practices, technologies and experimental innovations of one's own.

In addition, it is worth highlighting the notion that producer meetings and visits to 'best orchards', in particular, are excellent examples of learning through observation and experimentation. These visits can be promoted within the SFC or occur on the initiative of farmers themselves, and lead farmers to adapt to new agricultural practices on their farms. The pruning of plants is a good example of that. It was possible to observe that farmers' perception about techniques, the equipment to be used, or the time of pruning, implies the knowledge of the specifics of each plant variety, which leads to an intensive search for knowledge. To meet the needs for knowledge on plant pruning (blueberries, black currants), farmers learn by observing (especially in the course of visits to other farms and attendance of training courses) but also by practicing, through imitation and observation as well as interaction with other producers. This underlines the relevance of collaborative learning processes and the opportunities for co-innovation enhanced by the SFC network, despite difficulties and the fact that it has not been operating for long.

The SFC network clearly enhances co-innovation processes. It makes room for strong interaction amongst the multiple players within the sector, thus potentiating both formal collaborative co-learning and innovative processes like handbook drafting, as well as informal co-learning and co-innovation processes. The former focus on production of synthetic knowledge; the latter highlights the importance of informal co-learning, by addressing problem-solving and the generating of small-scale solutions that are often low-tech or downscaling market technologies.

As a result of collective creation, co-creation, exchange, conversion and storage of knowledge different innovation patterns were enhanced. Among them:

- Product and marketing combined innovation, e.g. by introducing new varieties as a way to escalate the times of harvest and/or by introducing new small fruit crops (such as raspberries, blackberries, or gooseberries) to diversify the offer and keep in pace with market demands.
- Product innovation through transformation of fresh berries into jams, fresh juices or liqueurs and their incorporation into other products, such as cookies or other sweets.
- Technological process innovation by adopting 'in the farm' new technologies (not new to markets), for instance, for irrigation.
- Low-tech process innovation, such as developing handmade tools to implant berry nursery plants in the soil, adaptations in commercial bird nets and down-scaling soil drilling equipment to implement nursery plants or equipment for opening holes in the screens to cover/protect the soil.
- Process innovation by adopting new 'in the farm' ways of conducting plants in orchards of blueberries (potted planting) or the adaptation of tutoring systems of raspberries in greenhouses.
- Process and marketing combined innovation comprising, for instance, changes in the methods of production, e.g. from conventional to organic, to enter new markets (a product differentiation strategy).
- Marketing innovations, basically related to consumers' awareness of the properties of small fruits, namely in terms of its health benefits, by conducting product demonstrations with children and elderly people, branding and developing new packaging prototypes.
- Organizational innovations particularly focused on scale economies by assembling the production through collective action organizations which also allow for scope economies through sharing technical advice and for the scaling up of input procurement.
- Network innovations, highlighted by the drafting of handbooks and new models for agglomeration economies.

The diversity of innovations undertook under the SFC network environment highlight the learning and co-learning processes entailed by the strong interaction among actors. It enhances knowledge and experience sharing among producers and between them and other actors, such as researchers, technicians, advisors and private firms among others. As a result, the processes of co-creation and exchange of knowledge grew exponentially by due to the sharing of ideas, experiences, practices, problem-solving solutions, as well as stories/experience's about products, processes and markets. Innovation is evidently an outcome of the network, although it remains small-scale, incremental and low-

tech. Moreover, the *cluster* also enhanced the adoption of technological innovation. Innovation, productivity gains, cost saving and /or product value increase are evident. Concerns over sustainability are more evident among experienced producers, who are able to get a return by controlling product channels and destinations and understand how vital this is for the long-term sustainability of orchards, so sensitive to soil quality and crop pests.

Co-creation, storage, conversion and exchange of knowledge enhancing innovation within the DSM network

Table 5 summarises knowledge processes occurring as a result of multi-actor interactions within the DSM network, identifying the interacting actors and the methods and supports of the knowledge flows involved.

Table 5: *Examples of knowledge processes, methods, supports and actors involved in the DSM network*

Knowledge processes	Methods and procedures	Supports for the information	Actors involved
Co-creation	Experimental field trials; Testing; Evaluating; Interacting	Demonstrations	Coordinator and major facilitator; Facilitators and Producers.
Storage	Data collection and processing	Excel forms (digital and paper)	Coordinator and major facilitator; Facilitators and Producers
Conversion	Conversion of scientific knowledge into experimental (practical) knowledge; of experimental knowledge into tacit knowledge by producers		Facilitators; Producers; Producers outside the network
Exchange	Formal meetings (workshops and producer meetings) and informal ones (face-to-face, social networks and contacts by e-mail and cell-phones)	Presentation in formal meetings; leaflets; crop pest warnings, ICT (social networks, e-mail and cell-phones)	All network actors and external actors, in particular technicians and producers

Source: Authors', based on information gathered during interviews

The DSM network was established to create and store knowledge on how to monitor the presence and the behaviour of the Drosophila Suzukii fly in the blueberry orchards of the central-northern sub-region. Unsurprisingly, processes of knowledge co-creation and storage are central for its structure and content. The co-creation process entailed the conception of a methodology and a field experimental design to collect the necessary information. The task led by the network coordinator, the technical-scientific partner, and the regional agency of the Ministry of Agriculture (DRPAC). With the support of the INIAV, a public R&D institution instrumental to provide knowledge within this sector, the DRPAC converted scientific knowledge into synthetic one. The sectoral association (AGIM), together with other producer groups, non-profit and profit FBOs, were the intermediaries in the knowledge co-creation and storage processes, and were responsible for identifying, selecting and contacting the producers that were to participate in the field trials. The producers acted as the co-creators of the experimental knowledge by preparing and installing the traps in their orchards, guided by the local and regional facilitators. They also contributed to knowledge storage by monitoring, reporting and returning the traps to the network coordinator partner, again, backed up by the intermediary facilitators. It is worth mentioning that the

traps are prepared by the farmers, using waste materials, such as plastic bottles and carton board leftovers.

The storage process developed in three stages. Firstly, the coordinator collected the characteristics of the farms (orchards) to be included in the field trials through intermediate facilitators. At this stage, the facilitators had to fill in an excel form sent to them by e-mail by the coordinator partner. The form requested data on the georeferenced location of the farms, size, varieties and the orchard planting distances (distance between plants and between rows). Producers were in charge of the second stage and had to fill in excel forms (electronic or on paper) identifying the traps, reporting the dates when they were installed, and the number of insects captured by each one. They also had to count the number of flies observed weekly (or the number of insects, if they were not fully able to identify them) and return the traps containing the captured insects at the end of the experiment. Finally, the traps were returned to the DRAPC by the local and regional facilitators to be analysed together with the information reported by the producers.

The DSM network entailed important knowledge exchange processes as well, taking place both formally and informally. Formal actions included workshops, training sessions and formal meetings that were organised by the network coordinator during which intermediate facilitators and producers learned which procedures to adopt, acquiring knowledge about crop pests, fly outbreaks, its behaviour, damages caused; they also learned how to prepare and install the traps, when and where to place them, and when to collect them. In addition, practical knowledge was exchanged on how to monitor other crop pests and control the attacks if they cannot be prevented. On the other hand, as it has already been mentioned, the network stimulated a strong informal interaction among farmers, resulting in an intense exchange of knowledge, and the opportunity to share problems and jointly search for problem-solving solutions. Co-innovation processes were enhanced by this interaction among the producer, bringing about incremental improvements in farming practices and techniques as well as in collaborative cooperation towards problem-solving, namely the already referred examples of the downsizing of technologies and equipments to adjust them to small-scale orchards.

Are the berry networks good examples for the EIP-AGRI?

The SFC network is a good example within EIP-AGRI. It places together R&D players (knowledge producers) and R&D users (producers) and stimulates their systemic interaction, enhancing collective learning processes that anchor co-innovation counterparts. Moreover, it involves other actors like FBOs, private producer groups and up- and downstream firms, as well as local governments, including cooperation at both levels, sectoral and territorial. It acknowledges and engages experienced producers as knowledge creators and exchangers. This is a feature of the network that deserves to be underlined, because it highlights the importance of producers as intensive knowledge seekers capable of converting scientific and synthetic knowledge for the processes of collective learning and co-innovation. An interrelated feature of the network has to do with producers bringing in advanced knowledge gathered outside the cluster in the course of their knowledge seeking activity. This feature is a result of one of the SFC network's weaknesses: its lack of advanced knowledge to meet the needs and demands of mature

producers. This situation, as shown in section 5.2, can be imputed to Portuguese AKIS lacking an applied research infrastructure to comply with its function of knowledge creation. However, the fact that cluster depends on external (internationally produced) knowledge calls the attention to the opportunity of expanding these knowledge and innovation network boundaries to international arenas, by connecting actors of different countries, whenever possible, which can advantageous in both ways.

Due to its being basically a 'subnet' of the SFC, DSM is not an example of an EIP-AGRI network by itself. However, it can be used as an example on how small-scale farmers can be involved within this framework, and play an important role as creators of knowledge and promoters of co-innovation processes, focused on enhancing productivity gains while increasing sustainability of farming practices. Given that small fruits are basically an intensive crop, these networking experiences may prove useful to develop, test and evaluate innovation as regards the sustainability of intensive crop production.

5.4 Knowledge flows within the berry networks in Portugal

Data collection to depict the knowledge flows in each of the two case studies included filling in a data matrix where knowledge processes - co-creation, storage and exchange - were described in association with the content/topics they refer to, and where the involved actors, including external actors to the network, were identified. At the data treatment stage, the knowledge content/topics were systematised into the following broad categories: 'orchard planting', 'maintenance of orchards', 'quality and post-harvest practices' (for the SFC network); and, 'crop pest monitoring and control (DSM network).

The adoption of the data matrix allowed for the collection of interactions between the actors that were involved and interviewed as well as the ones referred by the latter even when not interviewed. The graphic representation of these interactions was done with recourse to the NetDraw program, as explained in section 4, by drawing social networks (referred to as sociograms) that represent network actors as nodes and the interactions and the directions of knowledge flows as lines and arrows.

Knowledge flows (what, how, with whom) within the SFC network

Table 6 presents the knowledge content/topics, systematized by the above mentioned broad categories that were more relevant in the case of the SFC network. On the other hand, Figure 6 illustrates actors' interactions regarding the process of knowledge co-creation for the topics 'orchard planting' and 'quality and post-harvest practices'.

Table 6: *Selected topics for knowledge flows in SFC network*

Large topic	Specific topic
A – Orchard planting	Farm management and fiscal issues
	Orchards plantation distances, plant driving modes, types of orchards (outdoor, greenhouse), potted plants, ridge planting; soil analysis, irrigation needs and water availability
	Selected varieties
B – Maintenance of orchards	Irrigation systems; plants' water demand
	Fertilisation; plants' needs for nutrients

Large topic	Specific topic
	Crop load and fruit thinning
	Pruning
	Plant protection (pests and diseases)
C – Quality and post-harvesting practices	Certification (quality, food safety and health and safety work conditions; global gap)
	Fruit storage (packaging, cooling systems)
	Markets; exportation

Source: Authors', based on information gathered during interviews

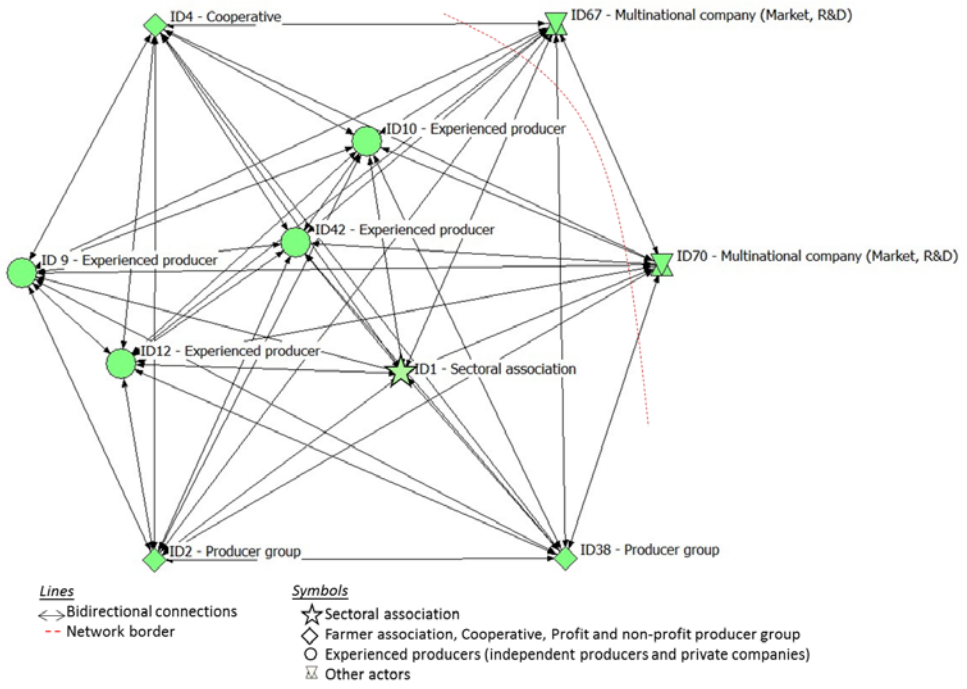

Figure 6: *knowledge flows in the case of the topic 'orchard planting' within the SFC network*

Source: Authors', based on fieldwork data

Figure 6 illustrates the interactions between the actors within the SFC network regarding the co-creation of knowledge for the topics: 'orchard planting' (A), 'certification and post-harvest (C). In this case, it refers to knowledge flows involved in the co-creation of knowledge for the drafting of the two handbooks: *Installation of orchards of blueberries in the North of Portugal* and *Crop management and quality*. The process was coordinated by the sectoral association leading the cluster (ID1) involved the participation of experienced producers (ID9, ID10, ID12, ID42), one cooperative (ID4), two producer groups (ID2, ID38), and two multinational companies (ID67, ID70). The knowledge process leading to the elaboration of the technical manuals highlights the presence of researchers, experts and experienced producers; the latter are also knowledge producers and not merely knowledge demanders/users. Hence, this process underlines multi-actor cooperation to produce synthetic knowledge for less/inexperienced farmers, incorporating experimental and tacit knowledge provided by experienced farmers who are able to deal with scientific and synthetic knowledge as well. It also counts on the contributions of external

actors from the downstream industry, combing R&D and marketing know-how. It is an innovative networking process in itself, leading to an innovative product: the manuals in the sense that they are generated by converting scientific knowledge and simultaneously integrating experimental and tacit knowledge produced by 'learning by doing'.

The social network depicted in Figure 6 shows the central role of the sectoral association that coordinates the *cluster*, by concentrating the gathering, compiling and treating of the data and information provided by the different actors and complemented by a diversity of additional sources. Experienced producers exhibit a close relationship with the sectoral association, which underlines their active participation in the elaboration of manuals. Other actors, such as the cooperative, the producer groups and multinational companies have more peripheral positions. Nonetheless, their involvement was very important, especially because it allowed integrating the supply chain experience and grasping the international dimension of the sector, providing examples of a clear success abroad.

Figure 7 represents knowledge flows within the SFC network, addressing the co-creation of knowledge on the 'maintenance of orchards'.

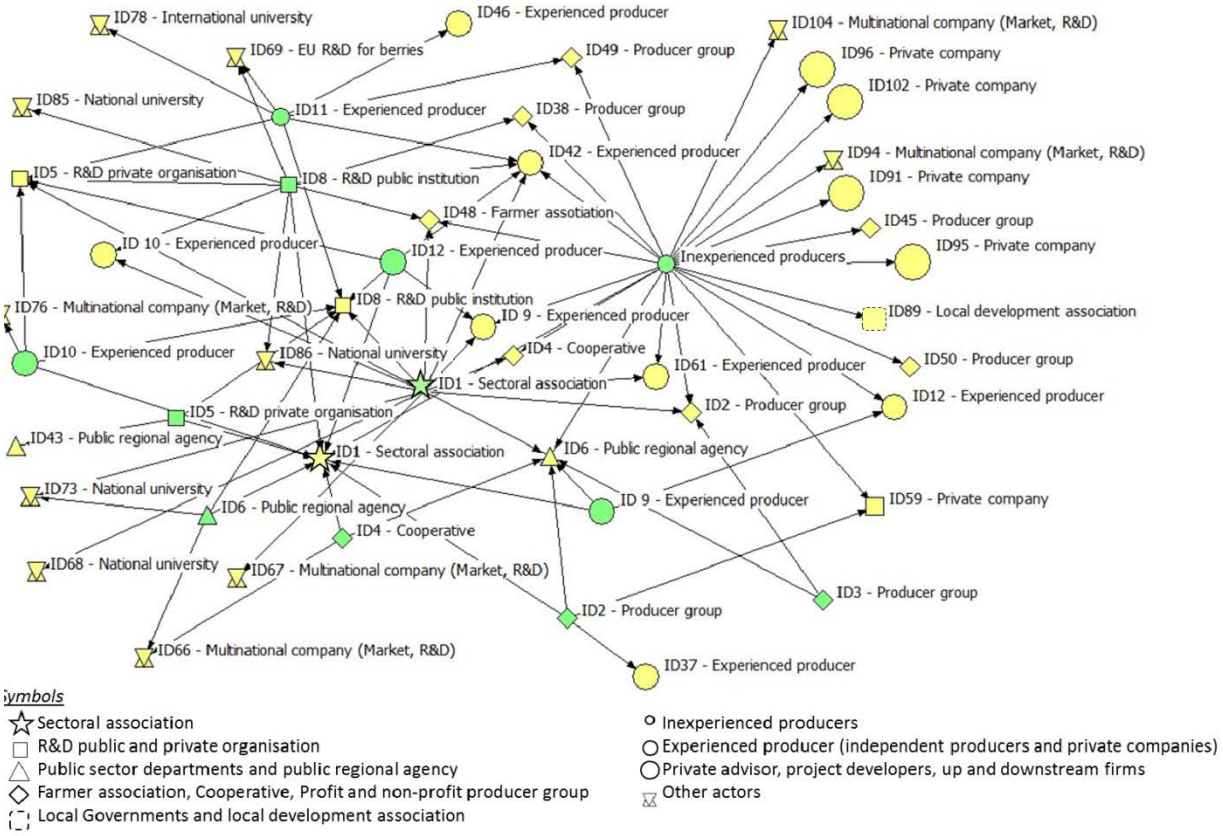

Figure 7: *knowledge flows in the case of the topic 'maintenance of orchards' within the SFC network*
Source: Authors', based on fieldwork data

The social network depicted by Figure 7, as expected, shows quite different knowledge flows as regards the topic 'orchards maintenance', in comparison to topics A and C, given that knowledge processes

involved are co-creation and the exchange of technical and practical knowledge. Besides, the category of 'maintenance of orchards' covers a whole range of subjects. This explains the diversity and high number of actors involved, as well as their classification into knowledge suppliers and demanders. Again, experienced producers turn out to be knowledge creators and suppliers, whereas inexperienced producers are demanders.

In the knowledge creation and supply-side others actors emerge complementary to the central role of the R&D public institution (ID8). They include national and international Higher Education institutions (e.g. universities). In the case of the national institutions, their involvement is mostly the supervision of graduate students conducting their final course essays and MSc thesis at exploitations and less often these institutions involve with producers in collaborate research projects.

Again, the sectoral association (ID1) plays a central role both as emitter and as a recipient of knowledge. As to inexperienced producers, they basically take part in the knowledge exchange processes, although they also play a role in the co-creation processes, in particular in association with the producer groups conducting tests and evaluating activities related to pruning techniques and variety adaptation.

The knowledge flows in the topic 'maintenance of the orchards' include knowledge storage processes, namely the creation of databases built on data resulting from recording information on vegetative stages and plant phenological observation, photographic records and bibliographic searches. The most dynamic actors in this process are the experienced producers, the R&D public partner and the network coordinator (sectoral association, ID1).

To sum up, the knowledge flows here described emphasize SFC network's capacity to enhance collective learning processes that are critical to the sector's sustainability, in view of the huge knowledge asymmetries and gaps, made worse by the sector's being a new one, the massive presence of inexperienced producers and the weaknesses of national and regional Portuguese AKIS. Hence, co-innovation processes are expected to increase and evolve given the cooperation experience made possible by this network, which is a learning experience in itself.

Knowledge flows (what, how, with whom) within the DSM network

In the case of the DSM network, besides potentiating the co-creation and exchange of knowledge in other topics, namely by the innovation it enhances, its focus is clearly on the processes of co-creation and storage of knowledge on the Drosophila suzukii monitoring. In addition, it extends to knowledge exchange processes about crop pest prevention and control regarding this particular pest which enhance farmer's explicit and tacit knowledge co-creation, by testing and evaluating prevention and control of other crop pests and diseases.

Figure 8 shows the social network involved in the processes of co-creation, storage and exchange of knowledge and the actors interacting within.

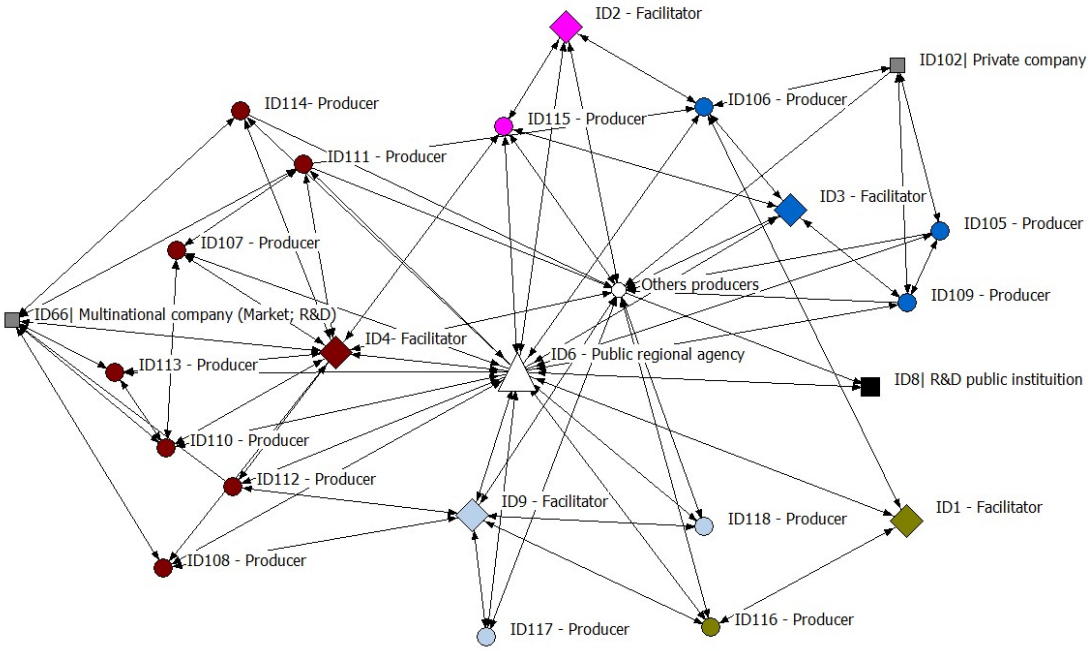

Figure 8: *Knowledge flows involved in the DSM network*
Source: Authors', based on fieldwork data

As expected, the public regional agency leading the field trial has the major role in the knowledge flows. It designs data collection, compiles and treats it and produces the information regarding prevention and control of this new crop pest. The producers involved in the co-creation and the storage processes gather around the public regional agency but also around the producer groups they are linked to, and that mediate the knowledge flows. External actors play an important role in converting and exchanging (broad dissemination) the knowledge generated by the DSM network. This includes, for instance, a multinational company (ID66), a sectoral firm (ID102) and the R&D public institution (ID5).

On the other hand, the knowledge flows are expanded by the informal involvement of other producers that on their own initiative, or motivated by the leaders of producer groups, adopt the procedures developed by the DSM network. Hence, the network boundaries are not so defined as might be believed based only on the formal participation. It is also possible to foresee that co-innovation processes enhanced by the network will go beyond the latter's formal frontiers, given their incremental nature and the informal collaborative cooperation underpinning it in particular.

6 Discuss and assess the performance of the knowledge flows and identify best-fit practices for advisory services

The two networks that were studied focus on enhancing knowledge co-creation, exchange and storage, since they are scarce and play a key role in the sector's productivity and sustainability. By working as

platforms for the interaction among all players in the sector, thus encouraging collective learning processes, these networks, particularly the CSF, appear to be determinant to induce innovation, namely through diffuse and mostly informal co-innovation processes. Their outcomes and benefits can be grouped into four categories:

- 'In farm' innovation (small-scale innovation) by the adoption of 'better' technologies and/or farming techniques and practices, mainly focused on productivity gains as well on crop sustainability (variety choice and plant protection).
- Networking and organizational innovation (non-tech innovation) driven by market sustainability, hence comprising crop profitability concerns which come along with cost savings (e.g. transportation and other logistic costs).
- Collaborative innovation among small-scale farmers induced by specific problem-solving, often involving the need to adjust or down-size technologies and equipment conceived for large-scale orchards. The outcomes in this case being mostly the cost savings and consequently profit gains, determinant for the sustainability of the small-scale orchards, which struggle with the inadequacy of the available technologies and equipment to their (small) dimension.
- Collaborative innovation among experienced producers, mostly medium to large scale, mainly focused on incremental improvements in farming practices and on the selection of best-fitted and market demanded varieties. In this case, productivity gains along with orchard sustainability (depending on soil quality and water availability, as well as on prevention of pest and diseases) are pursued as the basis for profitability gains and market sustainability.

Producers' networking has shown to be fundamental in the case of Portuguese small fruit sector to overcome knowledge gaps and induce innovation. The CSF network is currently the major tool in that respect. However, as shown in the case of CSF and DSM, formal networks were able to induce dynamic interactions among producers and between them and other actors, which has stimulated a myriad of informal and diverse cooperation micro-networks that turned out to be a very helpful (self-) advisory resource for both experienced and inexperienced producers. However, there is a significant difference between the micro-networks of each producer group. Experienced producers connect to each other and to researchers, quality advisory technicians and clients (often through their international traders). They are able to actually use the networking as an effective advisory support due to their experience, skills and relational capital, while being also producers and suppliers of advice to others. Reciprocity, giving and receiving back, seems to be a key factor for the cohesion of producer networks, along with trust in each-other's know-how and skills. Inexperienced producers tend to connect to and support each other in the FBO and private producer groups they are linked to. In every case, ICT are intensively used to support communication flows.

The cognitive distance between experienced and inexperienced producers, as it has already been mentioned in section 5.1, gives rise to failures in the CSF network cohesiveness, ensuing from its difficulties in promoting cooperation between the two types of farmers. In order to be able to overcome this drawback, the CSF network would have to enable more ambitious and innovative cooperation forms.

These could comprise, for instance, 'monitoring orchards', or mentoring programmes to mobilise experienced producers to systematically interact with inexperienced ones. Another fragility of the CSF lies in its being incapable of meeting knowledge demands of experienced producers. This situation is a result of the weaknesses revealed by Portuguese AKIS which, in turn, are the result of public disinvestment in applied research infrastructures, as discussed in section 5.2. This situation is difficult to overcome due to costs in terms of time and money that applied research needs to produce on-time necessary experimental knowledge. On the other hand, knowledge needs in the sector are expected to grow significantly, given that many inexperienced producers are dedicated and highly educated farmers and soon will became mature farmers as well. The trend will be for basic knowledge demands to decrease over time, while demand for more advanced knowledge will increase (e.g. synthetic/experimental knowledge on new varieties or techniques or marketing-related).

Therefore, in addition to the uncertainty respecting funding after 2015, CSF network has actually to evolve to a more sophisticated knowledge and innovation network, able to cope with experienced producers' knowledge demands. The fact they face a tough international competition that can only be successfully won through strong investment in knowledge and innovation (at all levels), makes it more evident the need for quality knowledge supply.

Regarding the DSM network, as it has already been discussed in section 5.3, it constitutes an important tool to the production of experimental knowledge so necessary in the Portuguese case. It's a good example of how producer groups can cooperate with the R&D actors, by bridging the divide between them and isolated farmers. But again, the 'reciprocity law' applies to farmers who are willing to cooperate if gains are perceived. Therefore, these experiments cannot probably be replied without funding as a general frame to gather experimental knowledge, particularly given that the public scientific-technical structures that coordinate it don't have the capacity to expand this mostly voluntary work. R&D structures associated with Higher Education institutions could be an alternative, but again public funding is needed. Although producers might be called upon to pay for some of the costs of knowledge and information, given that this is a very critical resource for them, the fact they have to compete in an international commodity chain renders that contribution an additional cost and one that is difficult to bear. Therefore, funding of agricultural applied research is an issue that should be on top of the agenda in the case of European and Portuguese AKIS.

In addition, the DSM network is a good example of how new and relevant knowledge can be disseminated by the farmers themselves within these informal networks and contacts, alongside with the formal dissemination channels.

7 Conclusions

The case studies that were described and analysed in this report were selected to contribute to the overall goal of PRO AKIS of exploring and identifying rural networks' possibilities, conditions and requirements to enhance farmers' abilities to create, test, implement and evaluate innovations in cooperation with other actors, as stipulated by the EIP-AGRI networks' new model. In addition, the in-

depth approach to case studies adopted by PRO AKIS, by which relevant knowledge flows involved in the selected networks were described, broadened the range of the findings regarding the above mentioned goal.

As a knowledge and innovation network, the Small Fruit Cluster (SFC) proved to be quite enlightening as to the possibilities, conditions and requirements of rural networks to enhance farmers' ability to innovate within a collaborative frame. It also provided interesting insights on the innovations pursued by and achieved in this type of sectoral-focused but territorial-based rural networks.

The possibilities this type of networks offer to implement the EIP-AGRI framework are obvious in the case of the SFC. It is mostly a platform that supports an intense interaction among berry producers and between these and a diversified set of other actors operating and supporting the sector, such as the FBOs, producer groups (profit and non-profit), up and downstream firms and companies, project developers, private consultants, R&D institutions, researchers, technicians and advisers, and local governments. In doing so, this network creates the necessary conditions for the collective learning processes that underpin (co)innovation.

The conditions and requirements for this type of network to be effective, according to EIP-AGRI framework's goals, must include at least:

- Multi-layers within the network, in which one of the layers has to involve farmers that are able to deal with different types of knowledge (knowledge creators), in particular scientific knowledge, so that they are able to interact with R&D partners (the traditional knowledge producers), as well as market partners, up and downstream companies, firms and traders, and do not separate productivity and sustainability (resources & environmental) from market trends an constraints.
- Effective knowledge exchange between the network layers. This implies endowing the network with the instruments and tools that enable actual interaction between experienced/advanced farmers, R&D actors and quality advisors and the less experienced (or with no experience at all). This was not accomplished by the SFC, as discussed in previous sections.
- Multiple-actors, including institutional and personnel actors in order to enhance both formal and informal cooperation. Informal interaction tends to be undervalued but it is currently magnified by farmers' access to and use of effective ICT. Further, informality and co-learning focused on problem-solving tend to be favoured by farmers.
- Network leadership that entails pursuing well-defined goals and in which there is a convergence between individual goals and expectations and collective ones. Orientation towards problem-solving, as suggested by the EIP-AGRI framework, seems to be a way of accomplish it, whereas broad and sectoral (and/or territorial) network-oriented concerns are also required, as in the case of SFC. Further, learning and innovation networks, focusing on very specific problems, might lead to compartmentalised solutions, when problems usually require transversal and multi-subject approaches.

Regarding the innovations pursued and achieved by multi-actor rural networks, it is important to highlight that, in general, they are not focused on radical technological innovation. As shown in the case of the SFC, the network was mainly focused on incremental improvements in farming practices, fruit quality and organizational matters so as to obtain cumulative productivity gains and sustainability increases, alongside with market competitiveness gains. The SFC also provided interesting insights regarding small-scale farmers, who are interested in conventional 'in farm' innovation (an innovation process of adopting technologies, while implementing sustainable and cost-saving practices), but they appear to very interested in incremental process innovation, too, and on developing tailored-made technologies and equipment or down-sizing the one available in the market so that it can be adapted to the their small orchards.

As stated in the introduction, a number of research questions related to the PRO AKIS overall goal were taken into consideration to conduct the case studies, since they have to do with the relevance of rural networks as tools to enhance farmers' co-innovation. The answers to those questions within Portuguese case studies are summarized as follows:

Which features of rural networks enhance farmers' ability to co-innovate in cooperation with other actors?

Both cases, the SFC and DSM, have shown that the opportunity these networks created for collective learning processes, by offering a platform for actors' effective interaction, in particular farmers', was determinant to enhance the latter's ability to co-innovate with each other and with other actors. By gathering farmers around solving a problem that was shared by all, as in the case of the DSM, the network encouraged both formal and informal interaction among farmers and other actors. However, this case has also shown that informal co-innovation processes still prevail and are mostly based on cooperation among groups of farmers. Co-innovation enhanced by the SFC encompasses both formal and informal cooperation; still, informal cooperation among small-scale farmers appears to be its more relevant outcome. The experienced producers from the southern sub-region seem to co-innovate by actually backing-up multi-actor networks, involving other farmers, researchers, traders, and other actors. However, while the SFC has certainly reinforced them, these are mainly farmer-led networks, built prior to the creation of the SFC.

These findings reflect the limitations of Portuguese AKIS with respect to the presence and participation of applied research and advisory related services. Although there is cooperation between farmers and the FBO, profit and non-profit producer groups and firms from up and downstream industry, among others, and in spite of being deemed important (as reflected in many of the sociograms depicted in previous sections), it was clear in the interviews, that farmers would like to have a more direct interaction with public advisors. This, together with the composition of the experienced farmer-led networks, highlights the key feature for these networks to effectively enhance co-innovation processes: their ability to promote co-creation and exchange of knowledge. To sum up, the availability of knowledge in its multiple forms and sources is fundamental to feed these multi-actor interaction platforms. The sectoral nature and novelty of the small fruit sector and its dependency on locally crop-specific knowledge strengthened the need for synthetic and experimental knowledge.

Which are the influencing factors encouraging farmers' participation in this type of networks?

The main factor underlying farmers' joining these networks, as can be concluded from the case study analysis presented throughout the previous sections, is the opportunity to interact with other farmers, advisors, suppliers and researchers, and to obtain knowledge and information they demand and/or need (even if they are not asking for it). So, a good balance between knowledge and information demand and supply is required. Also, the opportunity to access quality knowledge and information is very much valued, especially because farmers, namely those with no experience, are often faced with contradictory advice they find difficult to sort out. The freedom to join or leave the network at any given moment, either because enlisting was not formal, as in the case of the SCF, or because it is possible to leave the network at any time, as in the case of DSM, is a relevant feature to encourage farmers to participate. The fact that most of the activities promoted by the SFC are free of charge is another encouraging factor for farmers' participation and increases the rate of attendance and, consequently, their opportunities to interact with others. If fees were to be introduced, it would certainly reduce the number and frequency of attendances at knowledge- and information- related activities.

How do the selected agricultural/ rural networks link to existing knowledge infrastructures and advisory services?

In both case studies, the participation of existing knowledge infrastructures and advisory services is obvious. As members of SFC's coordinating core, are the relevant R&D partners that can comply with the sector's needs for knowledge, that is to say, the whole advisory sector acting in the field: FBOs, private advisory services and what is left from the public advisory infrastructure. In addition, as a result of the knowledge self-search activity of experienced farmers and leaders of producer groups (usually producers themselves), the network is connected with the international knowledge infrastructures, although not formally. The multinationals in the sector (with R&D activities) also have a say in the production of technical handbooks undertaken by the SFC, as described in sections 5.3 and 5.4.

The DSM case is an example in itself on how the remaining public research and advisory infrastructure was challenged to create this particular network in order to meet the sector's pressing needs for knowledge and information on how to prevent and control serious, damaging crop pests. Both networks underline the concern of the public research and advisory infrastructure to get involved in and help fill in the huge knowledge and information gaps as well as their pro-activity to attain it. Their attitude is acknowledged and rewarded by farmers and other actors, who are all aware of the need to strongly reinforce this infrastructure. FBO-based advisors, who are the basis of the advisory system in Portugal, need to be supported by applied research, quality life-long training and to have access to locally-specific knowledge and information if they are to meet farmers' needs and demands. And since these (needs and demands) are expected to grow and evolve as the sector becomes more mature, it is essential that this aspect is given the attention it deserves, for it is vital to the sector's sustainability and to the survival of many small-scale producers. The latter are not able to afford private consultancy and experience more and more limitations when creating and maintaining their own social networks, targeting knowledge creation and exchange.

Which factors influence the networks' stability over the time?

The factor that seems determinant for networks, such as the SFC, as concerns stability over the time is its ability to evolve in order to meet a growing need for knowledge and information, and one that is also continuously changing. That depends on good leadership and governance, but is more critically dependent on the availability of quality and locally-specific knowledge and information. As it has already been mentioned, in terms of network cohesion and stability, it is essential that there is a good balance between knowledge and information demand and supply. Stable and long-run public funding is vital to ensure that. Funding instability prevents networks from working on a long-term perspective. The SFC is a good example of how bad that instability can be.

Do these networks contribute to agricultural productivity and sustainability through innovation as expected by EIP-AGRI, and if so, how?

The networks that were studied contribute to productivity and sustainability through innovation according to expectations in the EIP-AGRI framework. In fact, they stimulate the farmers' interaction and a dynamic communication with other actors, focusing on learning and exchanging knowledge and information. By stimulating collective learning processes and actors' collaboration (even informally) they create the necessary ground for co-innovation processes. Nonetheless, it is important to highlight that most of these processes, occurring within the networks in question, have diffuse boundaries and are of an informal nature. On the other hand, experienced and active knowledge seekers and converters tend to rely on their own networks. These are different dynamics but both highlight the role of farmers as knowledge (co)creators and draw the attention to the informality of social networks involved.

Hence, it is possible to conclude EIP-AGRI networks might be a good framework to produce and exchange advisory services within-networks to outside farmers, as well as other actors, since the role of farmers as knowledge producers (and not merely as up-takers) is fully acknowledged. Besides, these networks are flexible enough to allow for the enlisting and withdrawal of farmers and other actors, for they do not abide by strict regulations and demands. Understandably, farmers like the informality of social networks, since they are allowed to join and/or leave whenever they want. The same applies to their participation which is done according to their resources (e.g. time availability) and needs. Also important is to allow for small-scale farmers to join the network, which probably implies having different types of networks according to the types of knowledge co-created and exchanged.

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