HOW TO STRENGTHEN INNOVATION SUPPORT SERVICES IN AGRICULTURE WITH REGARD TO MULTI-STAKEHOLDER APPROACHES

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How to Strengthen Innovation Support Services in Agriculture with Regard to Multi-Stakeholder Approaches

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ABSTRACT

The new EU agricultural policy aims to strengthen actors' capacities for innovation by taking into account the complexity of innovation processes. This paper characterizes the key innovation support services (ISS) that support actors in innovating. In the EU AgriSpin project, we analyzed 57 case studies describing innovation processes. We used a common grid to characterize ISS. Our results show that ISS depends on the phase of the innovation. During the initial phases, there is a need for innovative support services (e.g. network building, support for the innovator). In the latter phases, there is a need for more conventional services (e.g. training, credit) at farm, value chain and territory level. Brokering functions and new services are key to supporting actors to innovate by facilitating interactions for the co-production of knowledge, co-design of technologies, and identification of new institutional arrangements.

KEYWORDS: Innovation System, Agricultural Service, Phase of Innovation, Brokering, Innovation Support Service

JEL CODES: Q10, O31, O32, O33, O35, O52

Innovation is a complex process analyzed and supported by using different concepts such as the original 'agricultural knowledge and information system' (AKIS) concept (Röling, Wagemakers, 1998), the more recent 'agricultural knowledge and innovation system' version of the AKIS concept (EU 2012; 2013), or the 'agricultural innovation system' concept (World Bank, 2006; Touzard *et al.*, 2015). Common to these concepts is the understanding that innovation emerges as a nonlinear, social, institutional, as well as a technical process, where interactive learning takes place around a common concern or catalyst for change (Koutsouris 2014; Touzard *et al.*, 2015). This systems approach to agricultural innovation may be described as '*a network of organizations, enterprises, and individuals focused on bringing new products, processes, and forms of organization into economic use, together with the institutions and policies that affect the way different agents interact, share, access, exchange and use knowledge*' (Leeuwis, Van den Ban, 2004). New ideas are developed and implemented by actors who engage in networks and make iterative adjustments in order to achieve desired outcomes (Van de Ven *et al.*, 1999). A systems approach to innovation emphasizes processes in which knowledge and learning is constructed through social interaction (Knierim *et al.*, 2015b).

However, the strategies and methods to support innovation within an AKIS framework remain a challenge (Toillier *et al.*, 2018). More specifically, to support innovation there is a need to provide appropriate services to actors. The required services are diverse (Albert, 2000; Leeuwis, Van den Ban, 2004) in terms of content (technical, economic, social, legal, etc.), and they can be provided by diverse methods (transfer of knowledge, co-construction, participatory development, etc.), as well as by a variety of providers (public, private, NGO, etc.). In this context, the role of agricultural advisory service (AAS) providers has changed. Previously, conventional actors (research, public extension services) were viewed as the main actors to support innovation processes through technology and information transfer. But this view is no longer valid because it failed to address complex problems and to support innovations involving multiple actors. Over the past few decades, international efforts have been made to revitalize AAS through institutional reforms (decentralization, public-private partnerships, privatization, contracting-outsourcing, etc.) (Birner *et al.*, 2009). New actors have emerged (NGOs, the private sector, including private firms and farmers' organizations), promoting and enhancing innovation processes by providing new services and new methods to deliver these services (Labarthe *et al.*, 2013; Leeuwis, Van den Ban, 2004). Compared to the former public sector system, AAS providers today are based on a much more diverse set of actors, with complex relationships among these actors and their clients, and where advice and other service provisions are interlinked (Labarthe *et al.*, 2013; Knierim *et al.*, 2015). Examples of such new services

are: facilitating networking, facilitating access to financial resources, enhancing the articulation of demands by innovation actors, providing institutional support, especially for niche innovations, strengthening capacities for new business skills, and providing general consultancy and backstopping (Mathe *et al.*, 2016).

The services which are needed evolve along the innovation process and might require different actors to be involved in a particular stage of an innovation process, with the involvement aiming to transform or optimize the "system" or the problematic situation (Beers *et al.*, 2014). The coordination (at a given moment) or alignment (across time) of these services is a key issue (Kilelu *et al.*, 2013) because of the diversity of actors and their interactions and because of the progressive co-construction of the demand for, and supply of, services along the complex and non-linear innovation process (Le Coq *et al.*, 2010).

Based on empirical cases investigated in the EU-funded AgriSpin project[1], this paper aims to explore the diversity and alignment of innovation support services (ISS) throughout the phases of the innovation process in the agriculture sector. Hence, this paper contributes to gaining a better understanding of what makes successful innovations in the agricultural sector happen and how to better support innovation with public policy, and especially to identify supportive actions and forms of cooperation that enhance multi-actor innovation processes. The first and second parts outline the theoretical framework and methodology respectively. The third section presents the results, including a cross-analysis of 43 out of 57 case studies of innovation processes. The final part focuses on a discussion of the coordination of ISS.

The framework

Innovation support services (ISS) make innovation happen by fostering interactions and constructing knowledge. The transfer of technology and information framework (Röling, Wagemakers, 1998) considers the client (in the agricultural sector, the farmer) as a passive actor supported by a provider (the advisor) who tells them how to act to improve their firms (the farm). This framework has been fine-tuned by scholars to take into account the diversity of technologies or the diversity of farmers (Rogers, 1983). This framework is still valid to explain the diffusion of simple innovations (e.g. a new variety,

1. The EU-funded AgriSpin project aims to strengthen European capacities for innovation in the agricultural sector by taking into account the non-linear, complex and context-specific nature of innovation processes. www.agrispin.eu

a new chemical). However, this framework fails to explain complex innovation involving a diversity of actors (Leeuwis, Van den Ban, 2004). There is a need to take into account a systemic perspective and to consider service provision as a learning process (Leeuwis, Aarts, 2011; Labarthe *et al.*, 2013; Faure *et al.*, 2014). Within a multi-actor perspective, ISS may result in different kinds of products aimed at achieving a "*wider intervention purpose*" that is closely related "*to the assumed nature of a problematic situation*" (Leeuwis, Van den Ban, 2004). At first sight, the term ISS may be understood either as an organizational body (called a service provider[2]), or as an activity (Albert, 2000). Taking a process perspective and following Gadrey (1994) and Labarthe *et al.* (2013) we consider ISS as activities. These authors propose to conceive a service as an activity based on the service relationship between the supplier of a service and the client. They emphasized the involvement of both the providers and the beneficiaries of the service in the production of the service through regular interaction. Based on the state of the service discussion in the economic and agricultural extension literature (Faure *et al.*, 2012; Labarthe *et al.*, 2013), Mathe *et al.* (2016, p. 6) argue that:

> "...by its nature, an ISS is immaterial and intangible and involves one or several providers and one or several beneficiaries in activities in which they interact to address a more or less explicit demand emerging from a problematic situation and formulated by the beneficiaries and to co-produce the services aimed at solving the problem. The interactions aim at achieving one or several beneficiaries' objectives based on the willingness to enhance an innovation process, i.e. fostering technical and social design, enabling the appropriation and use of innovations, facilitating access to resources, helping transform the environment and strengthening the capacities to innovate".

A comprehensive literature review on support services in agricultural innovation shows that farmers avail themselves of numerous types of services. For example, Kilelu *et al.* (2013) identify six functions of ISS: [1] demand articulation (vision building, diagnosis, foresight), [2] institutional support (institutional change and boundary spanning), [3] knowledge brokering (connecting to knowledge and technology) [4] network brokering (match-making of partners), [5] capacity building (training, coaching, organizational development) and [6] innovation process management (aligning agendas and learning). From another perspective, Heemskerk *et al.*, (2011) identify and discuss

2. Service providers provide immaterial services which are found under different labels in the literature such as advisory services, extension organization, bridging organizations, intermediary organizations, etc. Service providers also provide tangible services such as credit, inputs, etc. In the following text, the term 'service provider' is used to take account of this diversity of situations.

a slightly different set of functions: [1] facilitation (stimulating and assisting the process between stakeholders with the objective of improving the quality of interaction), [2] strategic networking (facilitation of network design and support), [3] mediation (conflict management between stakeholders), [4] technical backstopping (providing advice on economic, social or technical issues), [5] advocacy (informing policy makers and key actors to support policy change), [6] capacity building (equipping stakeholders to play their roles) and [7] documenting learning (stimulating reflection on the innovation process. Based on this literature review we propose to use the ISS typology based on Mathe *et al.,* (2016) and Faure *et al.* (2017) presented in Table 1 – even if the frontiers between ISS are not always clear.

Many actors could provide services to support innovation. Service providers are commonly categorized according to their type: public sector, private sector (companies) and third sector (farmer-based organizations and NGOs). There are several viewpoints regarding this simple classification. For example, Knierim *et al.* (2017) argue that farmer-led organizations are hybrid organizations (public and/or private) and should be considered separately due to their farmer leadership. In fact, service providers may constitute networks of practitioners with complementary skills to support innovations at farm, value chain or territory level. These networks form an innovation support system where providers interact in various ways: cooperation, competition, or coopetition (Dagnino *et al.*, 2007). On the one hand, the articulation of services and alignment of ISS with farmers' demands remains challenging (Kilelu *et al.*, 2013). That is why the different classifications of ISS place an emphasis on specific functions fulfilled by these services, such as the articulation of demand and networking facilitation. Some service providers fulfill the role of intermediaries to act as a bridge between the demand and supply side of the agricultural knowledge infrastructure (Klerkx, Leeuwis, 2008a, 2008b). On the other hand, according to its complex and dynamic nature, innovation processes should be described through different phases of development. Following Wielinga (2009, 2016), the innovation process may be analyzed through phases even if we need to avoid linear thinking and focus on the continuous feedback between the different phases . Taking such a perspective, ISS needs may vary depending on the phases of the innovation, something also put forward by Geels (2002), for example, who shows that the ISS needed depend on the degree of development of the innovation process.

Table 1 – Revised generic ISS activities (based on Mathe *et al.*, 2016; Faure *et al.*, 2017)

ISS functions	Brief definition of function
1. Awareness and exchange of knowledge (ISS1)	*All activities contributing to knowledge awareness, dissemination of scientific knowledge or technical information for actors, hybridization of knowledge. For instance, providing knowledge based on information dissemination forums (website, leaflets), meetings or demonstrations and exchange visits.*
2. Advisory, consultancy and backstopping (ISS2)	*Advisory, consultancy and backstopping-targeted supportive activities aimed at solving complex issues such as a new farming system or new value chain design. The provision of advice (technical, legal, economic, environmental, social etc.) during the innovation process based on demands of actors and the co-construction of solutions all fall in this category.*
3. Demand articulation (ISS3)	*This especially involves services targeted to help actors to express clear demands to other actors (research, service providers, etc.). This is targeted support to enhance the innovator's ability to express his/her needs to other relevant actors.*
4. Networks, facilitation and brokerage (ISS4)	*Provision of services to help organize or strengthen networks; improve the relationships between actors and to align services in order to be able to complement each other (the right service at the right time and place). It also includes all activities aimed at strengthening collaborative and collective action.*
5. Capacity building (ISS5)	*Provision of services aimed at increasing innovation actors' capacities at the individual, collective and/or organizational level. The services may comprise the provision of classical training and of experiential learning processes.*
6. Enhancing/supporting access to resources (ISS6)	*Provision of services for innovators aimed at enhancing the acquisition of resources to support the process. This could be facilitating access to inputs (seeds, fertilizers etc.), facilities and equipment (technological platforms, labs etc.), and funding (credit, subsidies, grants, loans, etc.).*
7. Institutional support for niche innovation and scaling mechanisms stimulation (ISS7)	*Provision of institutional support for niche innovation (incubators, experimental infrastructures, etc.) and for scaling out and scaling up the innovation process. This refers to support for the design and enforcement of norms, rules, funding mechanisms, taxes, subsidies, etc. that facilitate the innovation process or the diffusion of innovation.*

The method

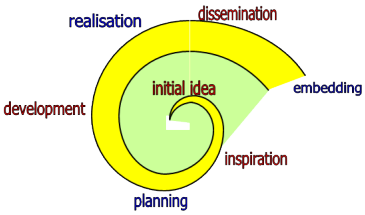
Data Collection

Data for this paper is derived from an action research approach (Checkland, Holwell, 1998; O'Brien 1998; Faure *et al.*, 2014) where a specific exploratory case study method was used. Following the design of the method (Wielinga, 2016) a total of 13 cross visits to 12 European countries were conducted. A cross visit typically lasted three to four days and involved a mixed team of between 7 and 12 project partner members drawn from science and practice. The aim of each cross visit was to analyze ISS in three to five concrete innovation cases proposed by the host organization. The selection of the innovation cases aimed to provide a diversity of situations in terms of the main topics addressed (agriculture sector, food sector, etc.), the scale of innovation (farm, value chain, territory), or in terms of the main actors leading the innovation (Ndah *et al.*, 2016a). Overall, 57 case studies were identified and analyzed. Briefing documents were prepared by the host partners to describe each case. The individual visits associated with each case included interview with key actors, visits to farms and firms, and time dedicated to collective analysis. The documents produced after the cross visit included analysis of the innovation process, provision of ISS, and main outcomes achieved through the cross visit (visit reports, innovation case narratives, timeline and visualized 'spiral of innovation').

Data Analysis: Analytical Frame and Procedure

Guided by the principles of qualitative inductive content analysis (Thomas, 2006; Punch, 2005) we combined two tools to analyze the data: [1] an innovation characterization matrix and [2] an innovation support service matrix (Ndah *et al.*, 2017). The innovation characterization matrix contained information about the thematic of the innovation (farming system, value chain, territorial development, etc.), the geographical scale of the innovation (local, regional, national), the main actors driving the innovation (public, private, etc.), the main issue addressed (lack of knowledge, capacity of actors, coordination between actors, etc.), and the main ISS. This matrix helped us to build a typology of type of innovation and analyze the relationship between the type of innovation and the type of ISS. The innovation support service matrix contained, for each case study, the type of ISS, the content of the ISS, the providers involved and the phases of the innovation process. This matrix helps us to quantify the type and number of ISS depending on the phases of

***Figure 1* – The spiral of innovation with different phases**



Initial idea phase: actors get a new idea because of a problem or an opportunity.

Inspiration phase: Others become inspired and form a warm informal network around the initiative.

Planning phase: Initiators formulate action plans and they negotiate space for experiments.

Development phase: This is the phase of experimentation to develop new practices and to collect evidence.

Realization phase: The innovation goes into full-scale implementation.

Dissemination phase: Effective new practices are picked up by others.

Embedding phase: The new practice becomes widely accepted. What matters is new rules, laws, subsidies, taxes, etc. to mainstream the innovation.

Source: Wielinga, 2016.

the innovation process, and to analyze the potential relationship between the type of ISS and the phases of the innovation process.

There are different ways to describe the phases of innovation. For example, Beers *et al.* (2014) distinguish four phases: inventions, business case, adaptation/adoption by first movers, widespread adoption. However, in line with Wielinga (2016), we used the following phases to analyze the innovation process (Figure 1).

To analyze service provision, for each phase of the innovation we observed how the services were provided in each specific situation. A situation regarding service provision was understood as 'a moment identified in the *spiral* where one actor (or a group of actors) was providing a service to other actors which is considered key to enhancing the innovation process. For each case study, the analysis was a collaborative process among all the cross visit team, assisted by the host team. An additional analysis was made by researchers to be able to compare the results of all the case studies. This analysis was carried out on 43 case studies out of the 57 because critical data were missing or not sufficiently robust regarding the different phases of the innovation process or the mechanisms to provide services.

Results

In this part we present one Irish case study to enable the readers to better understand the articulation between the innovation process and the provision of ISS based on a concrete example. The case study is chosen because we were able to make an in-depth analysis of the innovation process due to the data collected by the Irish AgriSpin partners. Even if the innovation may be considered as incremental, the case confirms the diversity of ISS and their evolution along the innovation process. We have used the same analysis for 43 case studies to generalize our results.

Innovation Support Services: The Case of the Economic Breeding Index

The Economic Breeding Index (EBI) is a single figure profit index, aimed at helping farmers identify the most profitable bulls and cows for breeding dairy herd replacements. It is a breeding decision support tool. EBI uses multiple animal traits which are converted into a € value of extra profit per cow, per lactation. Prior to the development of EBI in the 1990s, some Irish farmers were using a single trait breeding index to help in their decision-making about sire selection, particularly in the dairy herd. Such an index had helped to improve milk yield per cow. However, the single trait index did not help address fertility issues in the Irish dairy herd. Improved fertility was needed to minimize the replacement cost of cows and also, through compact calving, to maximize the use of grass as part of a low-cost input system, and to optimize production. The EBI, through its multi-trait focus, translates the breeding choice incorporating both milk yield and fertility into a € value of extra profit per cow, making this a powerful breeding management decision tool.

In the late 1990s, Teagasc researchers visited New Zealand. They saw work on multi trait indices for genetic improvement that was being carried out there. Subsequently, an expert from New Zealand visited Ireland for a period of time. With the support of the ICBF (Irish Cattle Breeding Federation), Teagasc researchers undertook research and then developed an economic model by using various criteria which underpin the economic breeding values intrinsic to EBI. The index was tested with a few farmers to check its validity and the effects on cow performance. The Teagasc Advisory Service heavily promoted EBI through inclusion in its Dairy Development Program. Extension methodologies included farm visits and consultations, group meetings, and a breeding competition held in 2004. This event was key to convincing other farmers that milk yields would not fall at the expense of increased fertility. At the same time the ICBF worked in conjunction with Teagasc to identify young high genetic merit bulls by using EBI and for selection by private companies. At this stage, a formal consultation group consisting of farmers, breeding companies, the beef industry, research & advisory and Teagasc monitored and suggested improvements in EBI.

In order to extend the use of EBI, other competitions were also held in 2009, 2010 and 2011, organized by Teagasc and sponsored by the Irish Farmers Journal, ICBF and a bank. Discussion groups, facilitated mostly by Teagasc staff and based on peer-to-peer learning, were critical to the dissemination of EBI. There were up to 10,000 farmers participating in such groups. To further embed EBI, Teagasc's advisory service has incorporated EBI targets into its advisory program as key performance indicators of advisory activities

and employed a wide variety of extension methodologies to promote it. Private companies largely promote high genetic merit bulls based on EBI. Banks help by providing credit to farmers to invest in dairy activities based on genetic improvements. Table 2 highlights the various ISS according to the phase of innovation.

This case study clearly illustrates the diversity of ISS beyond the provision of advisory services to farmers to disseminate the use of EBI and highlights the importance of ISS related to 'networking, facilitation and brokerage' at different phases of the innovation process. Table 2 also shows that during the initial phases it is not always useful to think in terms of the classical definition of services (Labarthe *et al.*, 2013). What really matters is not providing a well-defined service but to create space for innovation. That is why we decided to use the term 'innovation support service'. During the final phases, the classical definition of services remains appropriate.

Innovation Support Service and Phases of the Innovation Process

In an attempt to generalize our analysis by taking into account the diversity of innovation processes, we conducted a quantitative analysis of 43 cases that juxtaposes the ISS with the innovation phases. This analysis confirms a broad presence of all types of services across (almost) all phases (Table 3).

Five overall findings from Table 3 stand out. First, more services are provided in the development phase than in any other phase (88 counts). It reflects the fact that intensive activities and an increased need for support activities occur during this phase. Second, 'Networking, facilitation and brokerage' ISS predominate (90 counts) and are allocated fairly evenly over each phase. This finding reflects our focus and interest in multi-actor approaches, which was one of our key selection criteria for case studies. Third, the high frequency of counts (72) for the "Awareness and exchange of knowledge" ISS in almost all the phases reflects a general need for actors to access, produce or exchange knowledge, whatever the phase. This service was based on a mix of mechanisms (informal interaction, active role of key actors to look for and access information etc.) and, still important, 'knowledge transfer' approaches –despite the widely promoted multi-actor and interactive discourse. Fourth, 'Enhancing/supporting access to resources' (especially financial) is key from the actors' perspective at the planning and development phase. Fifth, it is not surprising that 'Institutional support for niche innovation and scaling mechanisms stimulation' is key at the development phase.

Table 2 – ISS according to the phase of innovation, the case of the "Economic Breeding Index"

Phase of the innovation process	Innovation support situation/activity	Innovation Support Service
Initial idea	Visit to New Zealand	Awareness and exchange
Inspiration	Visit of the researcher from New Zealand Support from the Irish Cattle Breeding Federation	Consultancy through research from New Zealand Brokerage (involving Teagasc and ICBF, informal)
Planning	Series of studies carried out by Teagasc	Institutional support to niche innovation (within Teagasc organization to help researchers taking risks) Access to funds (for experimentation)
Development	Teagasc developed the EBI model ICBF collected the data. Experiments with a few farmers to improve cattle performances	Institutional support for niche innovation (to help researchers and advisors taking risks) Facilitation (from Teagasc to support the interactions between farmers, researchers and advisors) Advisory service to farmers
Realization	Farm visits, discussion groups with farmers 2004 competition organized by Teagasc Involvement of private companies to select bulls based on EBI results Multi-stakeholder consultation group	Awareness and exchanges (among farmers) Advisory services to farmers Capacity building of farmers Networking (multi-stakeholder consultation group)
Dissemination	Other competitions organized by Teagasc and sponsored by the Irish Farmers Journal, ICBF and RaboBank. Discussion groups with farmers	Capacity building Access to resources to invest in dairy activities based on the use of EBI (credit for farmers) Networking with media, banks, private companies
Embedding	Incorporation of EBI targets into Teagasc advisory program Private companies promote genetic improvements based on EBI Credit from banks Industry consultation group to monitor EBI process	Institutional support by including new rules in advisory programs Networking and brokerage

Table 3 – Frequency of ISS functions for each phase of innovation in 43 case studies

Innovation Support Service functions	Initial idea phase	Inspiration phase	Planning phase	Development phase	Realization phase	Dissemination phase	Embedding phase	
Awareness and exchange of knowledge	12	9	4	19	10	15	3	**72**
Advisory, consultancy and backstopping	4	7	14	17	7	1	1	**51**
Demand articulation	3	6	4	5	7	5	1	**31**
Networking, facilitation and brokerage	12	17	14	12	14	15	6	**90**
Capacity building	2	3	2	7	10	8	1	**33**
Enhancing/supporting access to resources	2	3	15	16	6	8	1	**51**
Institutional support for niche innovation and scaling mechanisms stimulation	3	2	5	12	2	2	3	**29**
Total	**38**	**47**	**58**	**88**	**56**	**54**	**16**	**357**

Source: Data from 43 innovation cases in 10 countries: Netherlands, Belgium, Denmark, Spain, Finland, Greece, Germany, Italy-Campania, Italy-Tuscany, Guadeloupe, Ireland.

As can be seen from Table 3, all ISS seem to appear across the different phases of the innovation process. Such a result may be a consequence of how the data was analyzed and the cases interpreted, whereby single, concrete services were ordered and assigned to an ISS following the descriptions from the case studies. Table 4 reflects this analytical procedure with examples of concrete services provided at each phase of the innovation process. This provides a more relevant picture of the ISS across the phases of innovation.

Table 4 illustrates the fact that ISS depend on innovation phases and shows that for each function ISS cover a wide range of actual activities. During the first phases (initial idea, inspiration, and to a lesser extent, planning), the services are mainly focused on provoking exchanges, generating new knowledge, and facilitating access to seed funds for key actors to innovate. ISS providers essentially create pathways for actors to connect with other necessary actors in order to develop the initiative further. During the final phases of the innovation process (dissemination and embedding) service provision is more standardized and many services are oriented to farmers to disseminate the innovation based on knowledge transfer or advisory services. We can also observe that services aiming at strengthening farmers' business skills and entrepreneurial attitudes are not common.

Discussion

In this section we discuss (i) the alignment and coordination of ISS including the networking, facilitation, and brokerage function, which is key for the innovation process, and (ii) the factors influencing the alignment and coordination of ISS by taking into account the diversity of innovation and the characteristics of AKIS.

Alignment and Coordination

Based on our results, Figure 2 shows the diversity of ISS along the innovation process. Even if we cannot clearly identify ISS for each phase, we identify different services for the inspiration phase, the planning and development phases, the realization and dissemination phases, and the embedding phase. These ISS are part of our generic seven ISS classes.

The articulation of services and the alignment of ISS remain challenging. First, the demands for ISS emerge gradually in the innovation process and need to be adequately matched with a combination of ISS. Such an evolving demand, depending on the innovation phases,

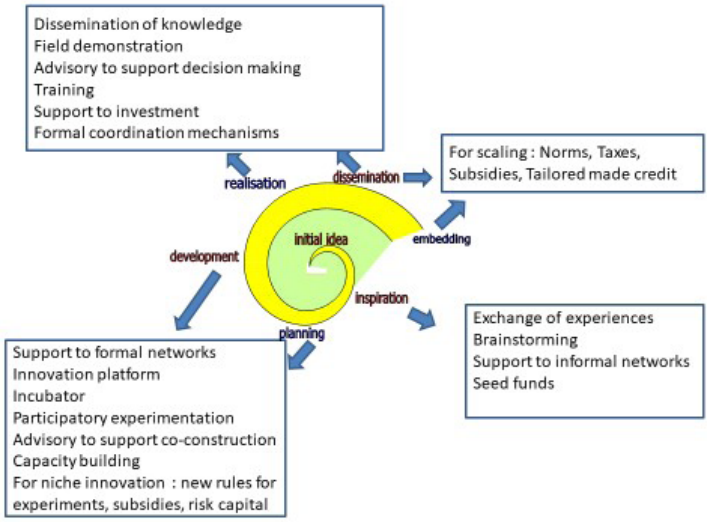
Table 4 – Examples to illustrate ISS across phases of innovation

	Initial ideas	Inspiration	Planning	Development	Realization	Dissemination	Embedding
Awareness and exchange of knowledge	Emergence of new ideas based on research findings, projects or initiatives	External visits and exchanges where innovative ideas are being practiced	Searching relevant information from outside to learn		Knowledge transfer based on experiences from the previous development phase	Information dissemination of technical or management practices regarding farming, processing or market opportunities	
Advisory, consultancy and backstopping at farm level	Key consultancy to generate new ideas at farm level				Advisory services for new agricultural practices and new management practices, consultancy based on stabilized knowledge		
Advisory, consultancy and backstopping at organization level	Key consultancy to generate innovations for organizations Key consultancy to fine-tune ideas Key technical or financial consultancy from outside the network (including research, consultants) to fine-tune ideas				Consultancy based on stabilized knowledge		
Capacity building	Boosting individual competencies, to think outside the box, generate new ideas	Support to key individuals (pioneer, entrepreneur, change agent)			Training program based on learning from the development	Capacity building at a larger scale through regular training based on a more or less participatory method for newcomers	
Demand articulation	Award to identify and valorize innovators. Call for innovative proposals in the organization	Workshop to share experiences Trips and cross visits	Workshops for diagnosis and organizing ideas Workshop for coordinating actions (production, access to market)	Support for the creation of private firms to articulate demand and supply (provide inputs or market products) Support to new farmers' organizations (cooperatives, associations, etc.) to articulate demand and supply (collect, process or market products)			Key consultation to further strengthen and improve demand, e.g. acquisition of a certification scheme to further improve demand by an organic farmer

	Initial ideas	Inspiration	Planning	Development	Realization	Dissemination	Embedding
Networking facilitation and brokerage	Facilitation for emerging informal networks aimed at generating new ideas as well as inspiration		Facilitation of informal network connecting people who matter (pioneer, entrepreneur, and others) or influential people able to move the idea forward Support to temporary association of actors	Strengthening of informal networks Building innovation platforms Organizing permanent workshops Designing participatory monitoring and evaluation	Strengthening networks to become more formalized Steering committee to monitor and evaluate Negotiation with actors who are affected by the change	Facilitation for documenting and facilitating collective learning based on past experiences. Improving multi-level governance at territorial or value chain level	Connecting actors with the outside world to share their experiences and get new ideas (keep being innovative)
Enhancing/ supporting access to resources	Provision of seed money Implementing competitive grants		Implementing incubators to support start-ups and collective action Access to financial resources for experimenting		Access to credit subsidies to invest, especially for newcomers Building alliances to be eligible for access to funding and support from national and international projects or programs Short term financial support to boost the sustainability of the innovation		
Institutional support for niche innovation and scaling mechanisms stimulation	Endorsement of an initial idea from the start by institutions and key actors to encourage and protect the innovation process at the beginning		Space to innovate within the organization or with other organizations Legal authorization to experiment out of the legal institutional framework			Design of new certifications (for products, process or advisors) Identification of certification bodies Communication and marketing	Taxes and subsidies for orienting individual and collective actions New norms for production and processing New indicators for monitoring and assessing advisory services

Source: authors.

Figure 2 – Main type of ISS depending on innovation phases



implies a permanent co-construction of the services to achieve a "best-fit" (Le Coq *et al.*, 2010). Second, service providers act in a variety of ways (cooperation, competition or 'co-opetition') which may make coordination among service providers more complex. Kilelu *et al.* (2013) point out that matching the demand and supply of ISS in pluralistic and privatized systems is a complex process given that there are competing interests and power relationships which, in turn, underscores the need to strengthen farmers' capacities to be able to negotiate with service providers.

In this context the ISS associated with 'networking, facilitation, and brokerage' and 'demand articulation' appear to be crucial across all phases of the innovation process. This highlights the gradual shift from the former expert and top-down model of innovation to a model accounting for more complex processes that require intensified and timely interactions between actors based on pluralistic ISS provider settings. Nevertheless, the corresponding ISS are complex and include several types of activities for service providers. Three issues require attention in order to provide practical guidance to ISS providers:

First, the 'networking, facilitation and brokerage' ISS, while crucial all along, takes different forms depending on the phases, the actors involved, and their needs. This is in line with Klerkx and Leeuwis' (2009) remark that ISS depend on the different requirements of the innovation network in different phases of its development, as well as on the composition of the network in terms of the number of actors, type of actors, and actors' capacities. During

the first phases, ISS are aimed at supporting and facilitating informal and flexible networks or temporary associations of actors. As Beer *et al.* (2014) observed, in the early phases, support for flexible networks, either formal or informal, are more effective and cost-efficient than other types of ISS to facilitate innovation. During the later phases, ISS provide more frequent and efficient support for formalized networks (e.g. formal association, innovation platform). Intense intermediation and institutional dialogue are required to address scaling issues to ensure adequate embedding of innovation in value chains and in local territories and to design and enforce new arrangements towards institutionalization.

Second, our empirical findings show that there is no specific type of service provider solely responsible for this kind of ISS. It can, of course, be provided by a specialized service provider, as shown by Klerkx and Leeuwis (2008). However, specialized service providers dedicated to such an activity are quite rare. In fact, this kind of ISS can also be provided by another type of organization (e.g. farmers' organizations, private firms) interested in pushing forward the innovation process, or by different organizations sharing this function, each of them with a specific coordination task, or different organizations acting at different phases of the innovation process, or finally by a multi-stakeholder innovation platform with a dedicated facilitator. However, some organizations fulfilling a brokering function may have a normative, political or commercial orientation which deeply influences the innovation process (Kilelu *et al.*, 2013).

Third, providing this ISS implies new roles and, to a large degree, unexplored skills for change agents (Koutsouris, 2014). Besides the now well-recognized skills such as good communication, ability to listen and to value farmer's insights, combined with technical capacities and interactional expertise (Ingram, 2008), such individuals have to be able to collaborate with different kinds of actors and develop adequate practices (Nettle *et al.*, 2017). Conventional advisors encounter difficulties in taking over new roles and becoming professional facilitators. Klerkx and Jansen (2010) argue that this is due, among other reasons, to the lack of the right attitude and competencies (especially social competencies) of advisors and their unwillingness to abandon their 'comfort zone'. Brokering functions have yet to be thoroughly described, operationally defined, or well evaluated. Attention should be given to the brokerage praxeology (*i.e.*, theory informing practice, and practices feeding new theory), especially the position of innovation brokers in the different phases of innovation processes (including the specific competencies needed to successfully carry out their tasks). Such an agenda will help to further highlight gaps in our knowledge, as well as strategies to address such gaps and,

thus, in building a solid knowledge base which will be valuable for policymakers, academics and practitioners (Koutsouris, 2017).

Factors Influencing the Alignment and Coordination Mechanisms

Here we address the factors influencing the alignment and coordination of ISS, even if we have not been able to fully validate these results based on our research.

First, our findings indicate that ISS vary according to the types of innovations. However, there are many ways to describe the diversity of innovations. For example, Beers *et al.* (2014) distinguish between systemic innovation and innovation for optimization. Every innovation includes several dimensions: the "hardware" related to the technical change, the "software" related to the changes regarding the values and rules, and the "orgware" related to the new institutional arrangements (Leeuwis, Aarts, 2011). We suggest the use of a generic classification of innovation that might better address the diversity of ISS needed to support innovation with regard to the complexity of innovations. We propose to take into account two dimensions of the innovation:

- the level of technological change required to achieve the desired changes (at farm level, value chain level, territory level). This dimension mainly refers to the "hardware" dimension,
- the level of changes for new coordination among actors (including service providers) required to achieve the desired changes. This dimension mainly refers to the "orgware" dimension.

This analysis leads to four groups of innovations with distinctive characteristics and corresponding ISS, as illustrated in Table 5.

Such hypotheses are in line with the work of Toillier *et al.* (2018). However, our test of such hypotheses using AgriSpin data did not yield clear-cut conclusions (Ndah *et al.*, 2018).

Second, the overall Agricultural Advisory Service System (Garforth *et al.*, 2003) is also key to explaining the diversity, alignment and coordination of ISS. One characteristic is crucial: the degree of integration as opposed to fragmentation of the AKIS (Knierim *et al.*, 2015a). We may identify several situations.

In a few countries we observe an integrated ASS and an "integrated" agricultural service system with a limited number of service providers. In some cases, one dominant service provider is responsible for a wide range of ISS based on an in-depth knowledge of the farmers' needs. It coordinates ISS with

***Table 5* – ISS and type of innovation**

	Low level of coordination	**High level of coordination**
Low level of technical change	The innovation is usually incremental because both technological and organizational changes are light. Here, ISS may largely relate to traditional, individual advisory services and consultancy at farm level or firm level	ISS may emphasize demand articulation, networking or capacity building. For example, such innovations may promote new management practices for farmers based on new advisory services or new value chains based on new marketing practices for existing products
High level of technological change	Such innovations are more likely to be radical changes at farm level or among small processors with secured access to market. There is no need for strong coordination among actors to stimulate the innovation. Here, ISS may be focused on knowledge awareness, technology transfer, advisory, consultancy and capacity building	Such innovations are really challenging and are more likely to be radical. For this group a wide range of ISS is needed. Knowledge awareness and exchange and capacity building services are expected to be needed to serve the high technological demands, while services for networking and facilitation, advisory and consultancy, amongst others, serve the coordination needs of actors

other service providers who may complement the range of services (e.g. Teagasc in Ireland) on a "spot basis". In other cases, a dominant provider (e.g. the farmer-based organization Seges in Denmark and ZLTO in the Netherlands) largely supports innovation processes and simultaneously interacts and coordinates ISS closely with other service providers. Beside demand articulation, networking facilitation, and capacity building, this dominant service provider may offer specific additional services based on its capacity to co-construct the service to better meet farmers' needs. We observed that integrated agricultural service systems usually warrant a comprehensive ISS offer and facilitate strong coordination between actors. However, there is a certain risk to having less opportunity to generate innovative ideas from outsiders.

As a consequence of privatization and decentralization reforms, we observe in many countries a "fragmented" agricultural service system with a large number of service providers, each of them offering a limited number of services, often competing with each other. Whether and to what degree such fragmented ASS may hinder innovation processes depends on the socio-technological complexity of the innovation and the balance between the different components of the ASS: governance, funding mechanisms, competencies

and the methods to provide advice (Birner *et al.*, 2009; Faure *et al.*, 2012). Fragmented ASS with an important number of competing service providers may leave a lot of space for emerging innovations if strong coordination is not needed. In this situation the innovation process could be more easily led by either the private or the public sector. However, as soon as changes in social systems such as farmers' organizations, rural communities etc. are required, there is a strong need for coordination between service providers and other actors to fully support innovation. In some cases, this coordination may effectively exist. For example, in Italy the experience of the Biodistrict shows the key role played by one association to coordinate a wide number of actors from different sectors (agriculture, tourism, national parks). In other cases this coordination is weak. For example, in Greece, the shortage of advisors, along with the lack of links between public extension services, cooperatives, and the private sector, point to the fragmented and inefficient nature of the Greek AIS (Koutsouris, 2014)

Conclusion

Our results highlight the fact that ISS play critical roles in innovation processes in various ways. We showed that during the first phases of a given innovation process (initial idea, inspiration and planning), the actors willing to support innovation mainly need to provide the space and resources for key actors to innovate. During the final phases of the innovation process (development, realization, dissemination and embedding), service provision is more standardized and many services are oriented to farmers to ensure the scaling and institutionalization of the innovation. However, ISS needs in terms of diversity and intensity seem to depend on two dimensions: the level of technological change required to enhance the innovation process, and the level of new coordination mechanisms needed among actors (including service providers). ISS are provided by a large range of service providers and depend on the characteristics (governance, funding, etc.) of the service providers. The mechanisms to align the ISS, and thus to fully support innovation, largely depend on the degree of concentration as opposed to fragmentation of the ASS. Finally, we confirm that "networking, facilitation, and brokerage" functions are crucial across all the phases of the innovation process. There are a variety of mechanisms to operationalize an ISS and a diversity of organizations which may fulfil this role.

Even if we attempt to draw generic lessons based on our analysis, the case studies show that the ISS remain case-specific, and no 'silver bullet' can be provided to support innovation in agriculture. Birner *et al.* (2009) describe such

a situation with the expression "from best practice to best-fit" when analyzing extension and advisory services to provide recommendations to improve these. The cross-cutting recommendation for innovation support practitioners and policymakers is, therefore, that targeted diagnoses with regard to innovation phases and types, together with the characteristics and functions to be fulfilled by the support systems, may precede proposals for improving innovation support services. With our results, we hope to lay the bases for such diagnoses.

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