Social and Technological Transformation of Farming Systems:

Diverging and Converging Pathways

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Papers

Workshop Theme 1: Innovation, knowledge and learning processes

Workshop 1.1 Generating spaces for innovation in agriculture and rural development

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A successful innovation process is considered as resulting from people's specific activities and an enabling environment which together contribute to 'generating spaces for innovation'. What can be done to lower the thresholds for actors with a view to their contribution to the flourishing of innovative initiatives in agriculture and rural development? This was the central question for this workshop. Manifold field studies on innovation processes in the domain of agriculture and rural development have, among others, demonstrated the importance of participatory approaches for e.g. technology development, the importance of knowledge exchange among peers e.g. farmers' field schools and the importance of social learning and 'co-construction of knowledge' in innovation processes. Nevertheless, both the EU and the World Bank have underlined that research is insufficiently related to practice, i.e. on the one hand, science-driven innovations remain on the shelf due to no/little dissemination activities while, on the other hand, farmers' needs are not addressed during innovation generation, and hence innovations are not relevant (enough). In parallel, innovative ideas from practice are not captured and spread, i.e. local or practice generated innovations with strong potential for dissemination are not recognised or diffused and a shift from science-driven to innovation-driven research has not yet taken place, implying that the institutional, methodological and behavioural changes that are required for such a shift are not yet comprehensively explored, and relevant findings and experiences are not systematically documented and assessed. Nowadays, an agricultural innovation system (AIS) is seen as a network of organisations focused on bringing new products, new processes, and new forms of organisation into economic use, together with the institutions and policies that affect their behaviour and performance. From an innovation systems perspective, several actors are seen as relevant to agricultural innovation, including entrepreneurs, researchers, consultants, policy makers, suppliers, processing industries, retailers and customers. An actual example for the support of innovation processes is the European Innovation Partnership (EIP) approach. The EIP adheres to the 'interactive innovation model', which focuses on forming partnerships. Such an approach not only helps co-creation of innovation processes, but also speeds up the introduction of innovative ideas, and it is expected to support the targeting of the research agenda as well as relevant research to switch to a problem-solving mode. In this respect, a group of actors in the system referred to as intermediaries, brokers, facilitators, etc. have emerged. The main responsibility of this group of actors is to assist agricultural entrepreneurs in coping with challenges such as articulating their innovation needs, contracting appropriate services for support of their innovation projects and successfully executing these projects. Such intermediaries are seen as a bridge between the demand and supply side of agricultural knowledge infrastructure; intermediaries are seen as actors assisting stakeholders to overcome information, managerial, and cultural and cognitive gaps, in relation to innovation process. In this workshop, papers on the roles and activities of this type of actor were especially invited while more general papers on the broader institutional conditions for the 'generation of space for innovation' were also welcome.

Stimulating innovations: building bridges and generating spaces

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Abstract: This paper aims to summarise the main features of the AgriSpin project. The project is being financed by the *Horizon 2020* research program of the European Commission aiming at contributing to system-oriented innovation research in agriculture and as complementary to the policy instrument EIP AGRI. The idea behind EIP AGRI is that innovation emerges from interaction between stakeholders. Following this idea, the focus of attention shifts from diffusion of innovations to ways for creating space in which interaction might lead to innovation as a co-creative process. The AgriSpin project ("Space for Innovations in Agriculture") comprises 15 organisations in 12 EU countries cooperating for a period of 2½ years (March 2015 – October 2017) to address questions pertaining to advisory work in relation to the stimulation of innovations at farm level. This paper aims to describe the main features of the project focusing on its conceptual background and methodological challenges whilst also pointing to some remarkable results (pearls and puzzles) that can be observed so far.

Key words: Innovation, innovation support services, networks, partnership, AgriSpin, EIP.

Introduction

Currently there is concern about a number of issues/ bottlenecks pertaining to the generation, dissemination and use of innovation in agriculture such as (EU SCAR 2012, 2014; World Bank 2012):

a) Research is insufficiently related to practice, science-driven innovations remain on the shelf due to no/little dissemination activities
b) Farmers' needs are not sufficiently addressed during innovation generation, hence innovations are not relevant (enough)
c) Innovative ideas from practice are not captured and spread, i.e. local or practice generated innovations with strong potential for dissemination are not recognized or diffused
d) A shift from science-driven to innovation-driven research has not yet taken place, the institutional, methodological and behavioural changes that are required for such a shift are not yet comprehensively explored, findings and experiences are not systematically documented and assessed.

Such tasks were included in the mandate of state/public funded bodies aiming at bridging the gap between agronomy-science and farming practice, i.e. mainstream or 'conventional' extension.

Since the 80s, public extension has been found to suffer from a number of shortcomings, so many countries started implementing and experimenting with different processes (decentralisation, contracting/outsourcing, public-private partnerships, privatisation etc.) in the provision of extension services, resulting in pluralistic advisory services (Alexopoulos et al., 2009; Cristóvão et al., 2012). Recently though, in their exploration of current developments in

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extension, Cristóvão et al. (2012) highlight the importance of a "new extension approach aiming at participatory, group learning and networking with extension agents acting as facilitators" (p. 214); nonetheless, facilitation is "largely underdeveloped especially on the part of European extension organizations" (p. 219). Furthermore, European Agricultural Knowledge and Information Systems (AKIS) show a high diversity (Knickel et al., 2009; Hermans et al., 2015; Knierim et al., 2015). Thus the provision and performance of extension varies considerably.

Given such issues pertaining to agricultural innovation enhancement within the EU, the EU Innovation Policy for Rural Development currently pursues the establishment of the European Innovation Partnership AGRI (EIP). This policy instrument relies on partnerships and 'bottom up initiatives', mainly through 'Operational Groups', in order to bridge the gap between actors across the value chain (especially between research and practice) and facilitate the co-generation of innovations through the employment of facilitators/ innovation brokers (Regulation (EC) No. 1305/2013; EU-SCAR 2012, 2014; Hermans et al*.,* 2015). The next section elaborates on the theories and concepts backing the authors' understanding of the 'facilitating the co-generation of innovations' through building bridges and creating spaces.

Discourse on innovation support: an overview of literature

During the last decades, a number of new systems of innovations (SoI) approaches have emerged in the non-agricultural literature which see innovation in a systemic and interactive way, i.e. that innovation emerges from networks of actors as a social (and institutional) as well as a technical process, a nonlinear process and a process of interactive learning (Koutsouris, 2014). These approaches build on networks as social processes encouraging the sharing of knowledge and, notably, as preconditions for innovation. Communities of Practice (CoPs), for instance, are described as people engaged in a process of collective learning in a shared domain of interest (Wenger et al., 2002). Such concepts and approaches focus on processes instead of the emphasis on structures. Knowledge is conceived as being constructed through social interaction – i.e., not transferred but instead continuously created and recreated. Thus, particular attention is given to (social) co-ordination and networking. Moreover, in order to avoid or to overcome gaps (cognitive, information, managerial or system) resulting in network and institutional failures (Klerkx et al., 2012) growing attention is given to various types of (process) 'intermediaries or facilitators'. For example, Van Lente et al. (2003) distinguish 'systemic intermediaries' as actors working mainly at the system or network level to facilitate actor interactions; Haga (2009) argues for the need to orchestrate networking enablers and thus for 'mediators' or 'brokers' as 'independent players' in networks aiming at a) acting as points of passage to external actors outside the network, bringing in experience and expertise, and b) building internal network resources and network structure - upon which network governance and processes depend; and Shea (2011), cites Gagnon according to whom "...knowledge brokers, networks, and communities of practice are innovative ways to disseminate and facilitate the application of knowledge. Integrated exchange, involving active collaboration between researchers and knowledge users, built on trust and frequent interactions, holds particular promise." Finally, Howells (2006) in his well-known working definition prefers to employ the term 'innovation intermediary' for *"[A]n organization or body that acts as an agent or broker in any aspect of the innovation process between two or more parties. Such intermediary activities include: helping to provide information about potential collaborators; brokering a transaction between two or more parties; acting as a mediator, or* *go-between for bodies or organizations that are already collaborating; and helping find advice, funding and support for the innovation outcomes of such collaborations."*

In agriculture, based on SoI approaches there has been a conceptual shift from the TOT model to network and systems approaches such as the agricultural knowledge and information systems (AKIS) (Röling & Engel, 1991; Rivera & Zijp, 2002) and, more recently, towards agricultural innovation systems (AIS) (Klerkx & Leeuwis, 2008a; Klerkx et al., 2010; Leeuwis, 2004). Contrary to Rogers (1962, 2004), these approaches claim that the process of innovation is messy and complex; new ideas are developed and implemented by people who engage in networks and make adjustments in order to achieve desired outcomes (Van de Ven et al., 1999). Nowadays innovation studies increasingly focus on learning itself, with emphasis on facilitation and the processes of human interaction from which learning emerges (LEARN Group, 2000; Röling & Wagemakers, 1988).

In this respect, intermediaries aim to assist agricultural/ rural entrepreneurs in coping with challenges such as articulating their innovation needs and contracting appropriate services to support their innovation projects and successfully execute these projects. A typical AIS is constantly evolving towards adopting a multi-stakeholder learning approach to withstand global challenges and includes a wide range of actors such as scientists, farm advisory services, services, farmers/farmers' groups as well as innovation support services. Intermediaries thus aim at enhancing the interaction between such varieties of actors. Such intermediaries are thus seen to act as a bridge between the demand and supply side of agricultural knowledge infrastructure (Klerkx & Leeuwis, 2008a, 2008b); they focus on 'exploration', i.e. sharing and synthesising, and thus the creation of new knowledge (Levinthal & March, 1993; Murray & Blackman, 2006). Their major role is that of the co-learning facilitator (usually found in literature as 'facilitators' or 'innovation brokers') aiming at the development of shared meaning and language between dialogue partners in order to stimulate change and develop solutions and innovation. The engagement of stakeholders in dialogue, despite its difficulties and its time consuming nature (since (social) learning and change are gradual), is necessary so that critical self-inquiry and collaboration will be achieved.
Summarising, Klerkx and Leeuwis (op. cit.) identify three major functions of an innovation broker: a) demand articulation, b) network formation and c) innovation process management (Kilelu et al., 2011).

Nevertheless, despite Hekkert et al.'s (2007) argument on the important contribution of innovation brokers in innovation systems the topic has not been extensively embraced by the agricultural academic and research community with the notable exception of the Dutch agricultural sector (e.g. Hermans et al., 2013; Klerkx & Leeuwis 2008b, 2009a, 2009b; Klerkx & Nettle 2013; Klerkx et al., 2010; Klerkx & Jansen, 2010; Wielinga & Vrolijk, 2009). For example, in his study on the changing role of government in the Dutch agricultural sector, Wielinga (2001) recognised the crucial role of networks and intermediate actors who fuelled those networks in the decades in which the sector became extremely innovative, and warned that in the neoliberal market conditions this function got lost and should be rehabilitated. He thus underlines that innovation emerges from networks, and no network can function well without a "Free Actor" who has space to do whatever is necessary to keep key actors in the network connected. Additionally, a large scale experiment with over 120 networks of farmers in animal production showed that such networks could very well become innovative, provided that the initiative was their own, and they were facilitated in a way that was appropriate for such networks. Such facilitation requires tools that differ from what is common in project management (Wielinga et al., 2008, 2009).

Furthermore, Wellbrock and Knierim (2014) have shown that collaborations start with informal get-togethers of motivated individuals interested in a certain development trajectory in their specific area. Through these informal get-togethers, different stakeholders are given the opportunity to exchange their ideas, share their knowledge and together develop new ideas and projects. This process of joint reflexivity is arguably a crucial component of learning; it is joint reflexivity that leads to shared understanding as people learn to work together to address their development goals. The informality of the initial meetings seems important in providing a non-threatening space in which to exchange ideas and learn about each other. Such encounters can be considered to have occurred initially in an institutional void (Hajer, 2003). One could further argue that institutional voids are necessary for innovation (Wellbrock et al., 2013a, 2013b), because they allow stakeholders to negotiate new, joint ways of working together and to formulate new institutions that can be agreed upon by all partners in the collaboration (Wellbrock et al., 2013b; Wellbrock & Roep, 2015).

The AgriSpin project aims at relating concepts to practice and to enrich theory from practice through the in-depth exploration of a series of innovations at farm level with special focus on what support service providers actually do to stimulate such innovations.

The AgriSpin Project

In the AgriSpin project 15 organisations in 12 EU countries cooperate for a period of 2½ years (March 2015 – October 2017). Twelve partners in the consortium are farmers' organisations and farm advisory services, with an intermediate role between farmers, researchers and other stakeholders; the remaining three partners are scientific institutes with a focus on knowledge systems in agriculture. The project is funded by the Horizon 2020 Program of the European Commission. The project will be half-way when the IFSA conference takes place. This paper aims to summarise the main features of the project, as well as some first pearls and puzzles collected so far from the perspective of science-related members of the project consortium. With this paper, we present 'work in progress' and various aspects (for example, the cross-visit methodology) are continuously being reviewed and improved.

Rationale

The idea behind the approach of the AgriSpin project is that all partners have their own experiences, ideas and approaches for supporting innovations at farm level, which are worth sharing with others; a silver bullet for stimulating innovations does not exist. Every partner is working in a context that has been historically grown and that has its cultural particularities. But there is a lot to learn from studying these different innovation systems, and that is what the project intends to facilitate.

The focus is on regional innovation systems. This is because in many countries there are considerable differences in cultures, organisational structures and even policies between different regions. The institutional environment has considerable influence on the capacity of a region to find new answers to emerging challenges. When we assume that good initiatives for innovations are everywhere, the thresholds for taking the necessary actions for bringing such initiatives into practice vary a lot in different regions throughout Europe. Stimulating policies such as subsidies for experiments or mitigating risks can lower such thresholds, while restrictive rules and lack of civil acceptance make them higher. Dialogue with the 'enabling environment' about its role and possible measures is therefore an important component of the project as well.

The main project activities

The project consists of three steps:

a) First, all partners were asked to deliver a story that would illustrate a typical innovation process in which they were involved. This would provide a baseline for comparison later on: how did partners describe innovation, and what –in their opinion- mattered most during the innovation process? It will be interesting to follow if, and in what way, these views change in the course of the project due to the intensive interactions taking place.

b) The second and major step is the organisation of cross visits. Most partners are hosting one cross visit. During 3-5 days a visiting team, composed of colleagues from other partner organisations, studies a number of innovation cases, presented by the host. This team visits farmers and other key actors, and tries to understand the process that has taken place. In a wrap-up meeting the visitors give feedback about what they have observed.

c) In the last part of the project period all partners are required to participate in cross-cutting reflections and to enter into dialogue with their regional authorities and other major actors related to innovation in agriculture, to explore possibilities to profit from what has been learned during the cross visits. Furthermore, the methodology will be offered to other interested parties.

The Book: stories from all corners, to start with

As aforementioned, for this initial book, the partners were asked to write a story of an innovation process in which they were involved. Partners were strongly stimulated to frame it as a story telling how it started, what happened after the first initiative, and how far the initiative has come. Additionally, the authors were asked to include their own analysis of what made the difference in this story. The kind of examples the partners came up with, the terminology they used, the concepts and the assumptions beyond these stories all tell us something about what the partners think about what matters most in innovation processes. Next we summarise the pearls and the puzzles as they appear in the stories.

Summary of pearls

- *Innovations can be technical, organisational and social:* all angles are valid and interesting.
- *Initiators can be anywhere:* the initiative for an innovation process can come from an entrepreneur, an advisor, a researcher, a politician or anyone else. It does not seem to matter where the first idea came from, as long as the partners in the process embrace it and make it their own.
- *Innovation support is about building bridges:* connecting partners who carry the initiative with those who can support the process in one way or the other. This appears to be the recurrent role in practically all stories.

Summary of the puzzles

- *Reflection on the dynamics is needed.* How do support agents make a difference? It appears hard for the authors (mostly these support agents themselves) to clarify this question. If a new structure has been installed to connect major actors, when does this structure become effective? If soft skills are important for the backpack with which support agents approach their partners, what skills do they need and what tools can they apply?
- *What can be done if bridge builders are lacking?* Some stories show that intermediate structures are lacking. This does not necessarily mean that bridge builders are not there, but the threshold for doing what needs to be done is high. The puzzle is: how to lower this threshold?
- *The underlying assumptions are to be clarified.* It will be most helpful for the joint learning process to dig deeper for the assumptions partners make about innovation processes. This first exercise of the project makes clear that it is not so easy for the partners to make this type of reflection. It will be most interesting to follow what all the intensive interactions that are foreseen in the AgriSpin project will do to the way partners think and act.

Examples of cross visits

While finalising this paper (early April 2016), 7 out of 13 cross visits have taken place. According to the AGRISPIN methodology, during each cross visit a number of cases (3-5) are explored in-depth focusing on: (a) innovation process; (b) actors and networks; (c) environment and (d) characterization of innovation. For such an in-depth exploration a methodological approach for peer-to-peer cross visits, aimed at exploring innovations at farm level, deriving lessons from successes and failures, inspiring each other and initiating improvements in the existing support system is constantly developed/ improved.

The exploration is based on semi-structured interviews with the farmers as well as other actors (notably, support services) involved in the innovation at hand. Interviews are carried out based on a number of questions addressing the four aforementioned elements (a) to (d). Following the cross visit visitors discuss the innovation case with the help of a number of tools (notably time-lines and the innovation spiral) in order to (re)construct the innovation trajectory.

Based on such exploration of each innovation case, the cross visit team concludes with an overall assessment of the cross visit (i.e. of all the innovation cases examined) in terms of (x) Pearls; (y) Puzzles and (z) Proposals, presented and discussed with local stakeholders during a symposium organised on the last day of the cross visit. The preliminary results of two of the cross visits, i.e. Guadeloupe (France) and Tuscany (Italy) are outlined below.

Synopsis of the Guadeloupe cross visit

In Guadeloupe a policy-induced set of innovation processes was studied. Hence, there was a two-level innovation case setting: a) the RITA («*Réseaux d'Innovation et de Transfert Agricole»* - agricultural innovation and dissemination networks) program as such; and b) 3 cases of innovative agricultural diversification measures (in citrus, yams and bee production) enhanced by the RITA.

The RITA program has enhanced the cooperation of various agricultural organisations at both the regional institutional level - so that the decision makers know better about each other - and the farm level - where a concrete cooperation among the technical staff takes place. In particular the agents of the agricultural chambers are more aware of further actors operating for the sake of farmers. Equally a better knowledge of the work of CIRAD and INRA has been gained. A further gain is the involvement of political decision makers comprising both the representatives of the national ministry of agriculture and of the regional department council. Currently a very important shift of responsibility is to be realized through which the RITA programme will be transformed from a national top-down and ministry governed intervention into a regionally anchored, EU funded instrument. So far RITA was successful in building bridges among the various actors so that there is mutual knowledge about agency possibilities and limits with a specific focus on science-practice interfaces. RITA has also created new spaces for actors like specific farmers' organizations to formulate their research interests and needs (e.g. in livestock production). However, given the relatively short time of the program's existence, no concrete results can be assessed at this level of innovation process.

With regard to the problem of the Citrus Greening disease three innovative strategies were explored: an individual one, a science-practice cooperation and a governmentally supported business approach. Meaningful bridges among various actors, such as the Chamber of Agriculture, a producers' organization and the research body CIRAD, were observed in the second case. However there was obviously no fast and satisfying answer to the problem. So individual actors who once relied on citrus production looked for either new fruits and crops or alternative livelihood strategies. The scientifically promoted idea of eliminating the affected citrus trees was not at all supportive for the creation of spaces for innovation - rather the contrary!

The production of yams is important in Guadeloupe as one of the population's staple foods. Although confronted with severe challenges from both ecological and market aspects there is an on-going interest amongst farmers to produce yams despite the lack of productive and resistant plant material. A long-standing research line on yams from INRA has failed to bring the expected breakthrough. Supported by RITA a new network has been created linking a farmers' organization with CIRAD and supporting especially one farmer in making field trials with interesting plant material (building bridges). Around these field trials a field day was organized that successfully created spaces for the meeting and the exchange of various actors in the sector and also attracted new farmers who were interested in getting engaged in commercial yams production.

The case that revealed the widest and most concrete impact is the beekeeping and queen-breeding one of the beekeepers' organization. Here, the organization was almost at the level of job creation through the production and sales of a variety of locally bred bee-queens. Moreover, the organization had lobbied successfully within municipalities for the maintenance and the reestablishment of hedges and other naturally flourishing sites in order to provide bees with fodder sources. This has built bridges among various actors within a regional, landscape level. In addition, through the establishment of a shop for beekeeper equipment (and for honey and honey related products) and through offering training courses for beekeeping, the organization creates spaces for innovative practices.

The cross visit aroused the attention of the local decision makers. They participated in the discussions. After the visit it was decided that the second phase of RITA should be approved.

Synopsis of the Tuscany cross visit

In Tuscany a number of innovation cases were visited and studied. As with the case of Guadeloupe, a two-level innovation setting was observed: on the one hand the work of ARSIA/Tuscany Region and on the other the specific innovative cases visited. ARSIA (The Regional Agency for Development and Innovation in Agriculture and Forestry) was a technical and scientific agency for the region of Tuscany until January 1st, 2011 when ARSIA was abolished and all activities were transferred to the responsibility of the Tuscany Region. ARSIA and the Region played/play a significant role in terms of a) actively promoting policies at the regional level; b) encouraging links between stakeholders, notably between scientists and researchers and between farmers and rural communities, mainly through the setting up of round tables; c) participating in international projects and putting together relevant regional projects and d) funding specific farmers' investments. These points were verified at least as far as the case studies visited in Tuscany are concerned (see below). The Agency/Region were/are involved in a wide range of activities including social farming, agritourism, biodiversity, forestry, phytosanitary services, animal production, artisanal production, (typical) local products and products of geographical indications, marketing, training, etc.

However, the lack of advisory service and of coordination of the regional AKIS is profound after the abolishment of ARSIA. This, in turn, has resulted in a) a lack of structured links between actors - thus the increased importance of personal relationships, b) the lack of a clear vision on the part of the Region (for example, who to support - large or small-scale farmers, what to support and which innovations are appropriate for each farmers' categories etc) and c) sometimes, the lack of recognition of the Region's contribution into innovatory projects and the understanding of its role as merely a funding provider.

The cases visited in Tuscany concerned: a) the Floriddia farm (the rediscovery and cultivation of ancient wheat varieties and the production of organic bread and pasta); b) the Maremma cooperative (production of the Pecorino Toscano PDO cheese with nutraceutical properties implying the restructuring of the whole animal farming management system); c) a winery producing high quality wine and engaged in activities in order to valorise local varieties, control inputs and allow for traceability and d) the University of Pisa actively involved and driving a social farming project.

Interesting points drawn from the case studies are as follows:

a) The role of ideology (organic farmers/ Floriddia), ethical commitment (organic farmers; social farming) or local identity and fame/branding (wines) in the initiation/triggering of innovations;

b) The commitment of the initiators to their innovation, despite in some cases problems with economic viability of the project, personal time and expenditure, etc.;

c) The involvement of university staff in these projects (although on a personal basis) - except in the social farming case in which the university is the heart of the innovation;

d) The attempts in all cases to establish networks with relevant actors during innovation initiation and now to expand them, notably:

i) in the organic farming network (related to the Floriddia case) the role of such networks in both dissemination (local farmers network to cultivate the ancient cultivars and have formed a wider network comprising farmers, scientists, bakers, processors, consumers, marketeers/distributors, doctors and other medical and health specialists, etc. to support the case) and policy making (national law on biodiversity for which a national network played an

important role and the refutation of the EU Commission proposal on seeds based on the resistance of a pan-European network) should be stressed and ii) in the case of social farming efforts that led to the national law for social farming.
e) The need for innovations as responses to market demand (high quality wines, Pecorino cheese with nutraceutical properties); social demand and sensitization (social farming, organic farming) or scientific progress (cheese with nutraceutical properties and the related new animal production management systems, biodiversity and the preservation of local seeds and breeds, new technologies allowing for soil, inputs and overall production management and traceability in viticulture and wine-making);
f) The step-by-step introduction of innovations in cases of complex changes (new animal farming management for the production of cheese with nutraceutical properties; from quality related concerns to environmentally-friendly cultivation techniques to high-tech precision farming and traceability systems in wine production) and the adoption of the changes by younger farmers eager to experiment with the assistance of the university staff in the first case.
g) The need to secure the economic viability of the businesses in all cases, the equitable distribution of costs and benefits (between the members - animal breeders, and the cheese producing cooperative) and the contribution to local, sustainable development (for example, less working hours in order to increase employment in Floriddia; the environmental, social and economic role of animal farming in Maremma and the low prices of the organic social farming products in the local market).

Reflections half way

The aim of AgriSpin is to learn from each other and with each other about ways to support innovations at farm level. In this respect, thus far, our work within the AGRISPIN project has revealed a number of interesting points worthy of further exploration.

Many examples confirm that successful innovations are often the result of synergy among three dimensions: technical, organizational and institutional. Innovations are a combination of implementation of new technologies and practices (hardware), new knowledge and ways of thinking (software) and new institutions or organizations (orgware).

It has been shown that the first spark for an innovation can arise anywhere in a knowledge system. Clearly our stories do not support the idea that was common for quite some time that innovation flows from the source (research) to the end users (farmers), and that the job of innovation support consists of transferring knowledge. The multiple triggers of change (ideological, technical, market, scientific, policy, etc.) should also be underlined, along with the fact that new ideas come about when actors adopt a reflexive stance towards their own situation. Reflexivity implies challenging conventional thinking, problematizing aspects and developing novel interpretations.

Networking has also been shown to be an effective way of coordinating a shared activity and crossing boundaries, disciplines, organisations, hierarchies and scales. It can increase the number of actors (individuals and groups) who share an innovative idea and directly contribute to the formulation of projects and policies. Networks are thus spaces which bring together those involved in purpose-driven learning and knowing processes, allow for the creation of synergies and encourage (social) learning and innovation.

The need for facilitation becomes very obvious. Facilitation organizes the learning environment and learning processes. It allows for critical discussion among participants around an activity or experience they share and, over time, deeper levels of understanding, inquiry, and innovation can be created within the participant network; it thus produces more effective learning in participants' domains of existence.

Further study and clarification is needed and a number of issues are to be explored further within the AgriSpin project: a) why do some innovations become successful while others get stuck?, b) what the support service providers actually did to help farmers realise an innovation and c) can particular phases of an innovation process be identified and what is needed and helpful in each phase? It will also be interesting to explore partners' theories-in-use and where the interaction in the project will lead in terms of concepts and approaches.

Based on the detailed analysis of all the 13 cross visits, the project has collected best practice examples and will make them available to a wider public; the aim is to enable local, regional, national and European actors involved in supporting innovations at farm level to improve their practices and support services and thus to create space for innovations. Additionally, the project will develop a toolkit of best-fit innovation practices and support services across Europe which can be used by stakeholders to strengthen their innovation capacity. It will provide new insights and ideas on how to improve innovation and demand driven research in the agrifood chain. In this respect, in the second phase of the project partner organisations will organise relevant seminars with authorities and other key actors in their region.

Finally, colleagues who meet each other several times in intensive cross visits build up relationships which can lead to new joint activities. The start has been made, but it is still too early to predict how this will evolve. The space for a professional network that lasts after the project has ended has been created.

References

Alexopoulos, G., Koutsouris, A., & Tzouramani, E. (2009). The financing of extension services: a survey among rural youth in Greece. The Journal of Agricultural Education & Extension 15(2): 175-188.

Cristóvão, A., Koutsouris, A., & Kügler, M. (2012). Extension systems and change facilitation for agricultural and rural development. In I. Darnhofer, D. Gibbon and B. Dedieu (Eds.) Farming Systems Research into the 21st Century: The New Dynamic (pp. 201-227). Dordrecht: Springer Science.

EU-SCAR (2014). Agricultural knowledge and innovation systems towards 2020. Standing Committee on Agricultural Research (SCAR): Collaborative Working Group AKIS-2. Brussels.

EU-SCAR (2012). Agricultural knowledge and innovation systems in transition - a reflection paper. Standing Committee on Agricultural Research (SCAR): Collaborative Working Group AKIS. Brussels.

Haga, T. (2005). Action research and innovation in networks, dilemmas and challenges: two cases. Artificial Intelligence & Society 19: 362-383.

Haga, T. (2009). Orchestration of network instruments: a way to de-emphasize the partition between incremental change and innovation? Artificial Intelligence & Society 23: 17–31.

Hajer, M. (2003). Policy without polity? Policy analysis and the institutional void. Policy Sciences 36: 175-195.

Hermans, F., Stuiver, M., Beers, P.J., & Kok, K. (2013). The distribution of roles and functions for upscaling and outscaling innovations in agricultural innovation systems. Agricultural Systems 115: 117-128.

Hermans, F., Klerkx, L., & Roep, D. (2015). Structural conditions for collaboration and learning in innovation networks: using an innovation system performance lens to analyse Agricultural Knowledge Systems. The Journal of Agricultural Education and Extension 21(1): 35-54.

Hekkert, M.P., Suurs, R.A.A., Negro, S.O., Kuhlmann, S., & Smits, R.E.H.M. (2007). Functions of innovation systems: a new approach for analysing technological change. Technological Forecast & Social Change 74: 413–432.

Howells, J. (2006). Intermediation and the role of intermediaries in innovation. Research Policy 35: 715–728.

Kilelu, K., Klerkx, L., Leeuwis, C., & Hall, A. (2011). Beyond knowledge brokerage: an exploratory study of innovation intermediaries in an evolving smallholder agricultural system in Kenya. RIU Discussion Paper 13. London: DFID.

Klerkx, L. & Leeuwis, C. (2008a). Balancing multiple interests: Embedding innovation intermediation in the agricultural knowledge infrastructure. Technovation 28: 364-378.

Klerkx, L., & Leeuwis, C. (2008b). Matching demand and supply in the agricultural knowledge infrastructure: experiences with innovation intermediaries. Food Policy 33: 260-276.

Klerkx, L., & Leeuwis, C. (2009a). Establishment and embedding of innovation brokers at different innovation system levels: insights from the Dutch agricultural sector. Technological Forecasting and Social Change 76: 849-860.

Klerkx, L., & Leeuwis, C. (2009b). Shaping collective functions in privatized agricultural knowledge and information systems: the positioning and embedding of a network broker in the Dutch dairy sector. The Journal of Agricultural Education and Extension 15: 81-105.

Klerkx, L., & Nettle, R. (2013). Achievements and challenges of innovation co-production support initiatives in the Australian and Dutch dairy sectors: a comparative study. Food Policy 40: 74–89.

Klerkx, L., Aarts, N., & Leeuwis, C. (2010). Adaptive management in agricultural innovation systems: the interactions between innovation networks and their environment. Agricultural Systems 103: 390–400.

Klerkx, L., & Jansen, J. (2010). Building knowledge systems for sustainable agriculture: supporting private advisors to adequately address sustainable farm management in regular service contacts. International Journal of Agricultural Sustainability 8(3): 148-163.

Klerkx, L., Van Mierlo, B., & Leeuwis, C. (2012). Evolution of system approaches to agricultural innovations: concepts, analysis and interventions. In I. Darnhofer, D. Gibbon and B. Dedieu (Eds.) Farming Systems Research into the 21st Century: The New Dynamic (pp. 457-483). Dordrecht: Springer Science.

Knickel, K., Brunori, G., Rand, S., & Proost, J. (2009). Towards a better conceptual framework for innovation processes in agriculture and rural development: from linear models to systemic approaches. Journal of Agricultural Education and Extension 15(2): 131-146

Knierim, A.; Boenning, K.; Caggiano, M.; Cristóvão, A.; Dirimanova, V.; Koehnen, T. et al. (2015). The AKIS concept and its relevance in selected EU member states. In: ooa 44 (1), S. 29–36. doi: 10.5367/oa.2015.0194.

Koutsouris, A. (2014). Exploring the emerging intermediation roles (facilitation and brokerage) in agricultural extension education. International Journal of Agricultural Extension (Special Issue), February 2014: 21-37.

LEARN Group (2000). Cow Up A Tree: learning and knowing processes for change in agriculture; case studies from industrialised countries. Paris: INRA Editions.

Leeuwis, C. (2004). Communication for Rural Innovation: Rethinking Agricultural Extension. Oxford: Blackwell Science.

Leeuwis, C., & Aarts, N (2011). Rethinking communication in innovation process: creating space for change in complex systems. The Journal of Agricultural Extension & Education 17: 21-36.

Levinthal, D., & March, J. (1993). The myopia of learning. Strategic Management Journal 14: 95-112.

Murray, P., & Blackman, D. (2006). Managing innovation through social architecture, learning, and competencies: a new conceptual approach. Knowledge and Process Management 13: 132–143.

Rivera, W., & Zijp, W. (2002). Contracting for Agricultural Extension. International Case Studies and Emerging Practices. Washington D.C: CABI Publishing.

Rogers, E.M. (1962, 2004). Diffusion of Innovations. New York: Free Press.

Röling, N., &. Engel, P. (1991). The development of the concept of agricultural knowledge and information systems (AKIS): implications for extension. In W. Rivera and D. Gustafson (Eds.) Agricultural Extension: Worldwide Institutional Evolution and Forces for Change (pp. 125-139). Amsterdam: Elsevier.

Röling, N., & Wagemakers, M.A.E. (Eds.) (1998). Facilitating Sustainable Agriculture: participatory learning and adaptive management in times of environmental uncertainty. Cambridge: Cambridge University Press.

Shea, B. (2011). A decade of knowledge translation research - what has changed? Journal of Clinical Epidemiology 64: 3-5.

Van de Ven, A.H., Polley, D.E., Garud, R., & Venkataraman, S. (1999). The Innovation Journey. Oxford: Oxford University Press.

Van Lente, H., Hekkert, M., Smits, R., & Van Waveren, B. (2003). Roles of systemic intermediaries in transition processes. International Journal of Innovation Management 7: 1-33.

Wellbrock, W., & Knierim, A. (2014). Unravelling group dynamics in institutional learning processes. Outlook on Agriculture 43(3): 187-191

Wellbrock, W., & Roep, D. (2015). The learning rural area framework: a heuristic tool to investigate institutional arrangements supporting collaboration in rural areas. Sociologia Ruralis 55(1):106-124.

Wellbrock, W., Nienaber, B., Kriszan, M., Nadler, R., Roep, D., & Frys, W. (2013a). Arranging support of collective learning and innovation in German rural regions. In C. Tamasy and J. Revilla Diez (Eds). Regional Resilience, Economy and Society (pp. 41-58). Surrey: Ashgate.

Wellbrock, W., Roep, D., Mahon, M., Kairyte, E., Nienaber, B., Dominguez Garcia, L., Kriszan, M., & Farrell, M. (2013b). Arranging public support to unfold collaborative modes of governance in rural areas. Journal of Rural Studies 32: 420-429. doi 10.1016/j.jrusrstud.2013.10.002.

Wenger, E., McDermott, R., & Snyder, W. (2002). Cultivating Communities of Practice (Master's thesis). Cambridge. Harvard Business School Press.

Wielinga, H.E. (2001). Networks as Living Tissue: A Study on Knowledge, Leadership and the Role of Government in Dutch Agriculture since 1945 (PhD Thesis). Wageningen University, Hertogenbosch: Uilenreef Publishers.

Wielinga, H.E., Zaalmink, B.W., Bergevoet, R.H.M., Geerling-Eiff, F.A., Holster, H, Hoogerwerf, L., & Vrolijk, M. (2008). Networks with free actors: encouraging sustainable innovations in animal husbandry by using the FAN approach. Wageningen: Wageningen University and Research.

Wielinga, E., & Vrolijk, M. (2009). Language and tools for networkers. Journal of Agricultural Education & Extension 15: 205–217.

World Bank (2012): Agricultural Innovation Systems: An investment source book. Washington: World Bank.

How to implement effective and efficient agricultural innovation support systems? Some insights from an European cross – country analysis

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Abstract : It is acknowledged that innovations in agriculture and rural development need to be adequately fostered. Within a system approach applied to this matter, the role of people and organisations able to catalyze innovation through bringing together of actors and facilitating their interaction is growing in relevance. In such a model the intermediaries are assumed to play a key role in developing social impact and sustainability outcomes for regional rural development. In this perspective, the European Innovation Partnership for agricultural productivity and sustainability (EIP-AGRI), which can be perceived as a platform based on interaction among farmers, researchers, and advisors/extensionists, represents a useful tool for a better understanding of applied innovation processes. Grounded in the activities performed within the EU AgriSPIN project, in this paper we attempt to contribute to the identification of effective and efficient approaches for the implementation of the EIP-AGRI strategy. Specifically, we present some preliminary findings on the functioning of EIP-AGRI system and Operational Groups across five European regions and countries (Italy, Poland, Germany, The Netherlands, and Belgium), by comparing different implementation modalities of the EIP strategies. With this analysis, we aim to portray the practical implications for agricultural innovation support systems. In addition, we interpret the role and the actions undertaken by public authorities in supporting such innovation systems in their regional contexts. Finally, we try to explain the enabling dynamics behind institutional uptake of these innovations into the local public support systems, by addressing the issue of "institutional change" at both regional and local levels.

Keywords: Innovation systems, sustainable agriculture, knowledge networks, innovation support systems, innovation brokers.

Introduction

In the agricultural sector, innovation is vital for sustainable economic, social and ecological development. Efforts to overcome the numerous barriers to effective innovation and cooperation are thus central to the public interest and justify public investments. To that end, the need for a systemic approach to innovation in agriculture and rural development is becoming largely acknowledged. The innovation system framework has been developed through decades of intellectual debates and featured relatively recently within agricultural science and rural development studies (Pant & Hambly Odame, 2009). In this development context, agricultural innovation does not result in a one dimensional, linear knowledge dissemination and adoption process, but rather it depends on learning among multiple stakeholders (Leewis & Van de Ban, 2004). An agricultural innovation system (AIS) is characterised by structural elements and dimensions, according to the scale of the system being looked at. Since their identification (Edquist, 1997), innovation systems have been categorised as national or regional according to the unit of analysis (Wieczorek et al., 2012).

A broad definition of structural elements of the system (Johansson & Johnson, 2000) comprises all the parts and aspects of an economic structure and the institutional set up affecting learning, searching and exploring: the production, marketing and finance system. Among the structural elements of innovation systems, it is acknowledged that actors and their interaction play a crucial role in such systems. Wieczorek et al., 2012 identified categories of actors based on their role in the economic activity: civil society, government, NGOs, companies/enterprises, knowledge institutes (universities, research centres, schools) and the one they call “other parties”. Among the last one are included innovation and knowledge intermediaries and brokers, as well as consultants. These insights from agricultural innovation studies have urged policy makers and rural development professionals to adopt different way of performing agricultural extension services (Chowdhury et al., 2014).

The different actors of the AIS thus need to interact with each other: an agricultural innovation system can be strengthened by facilitating collaboration in a network of farmers, extension officers, policy makers, researchers and other actors in the agricultural system (Klerkx et al.. 2013; Swaans et al., 2014). Thus, there is the need to enhance the support in this direction.

AIS is promulgated to undertake reforms in the knowledge and innovation support structures and requires operational concepts and tools in order to achieve a real institutional change based on partnership development (Spielman et al., 2009; World Bank, 2012). To that regard, there are a wide variety of policy instruments to support innovation processes, such as research funding, patent regulations or industry standard inducing innovation (Borràs & Edquist, 2013). Recently, the literature has indicated that these mechanisms need to be complemented with “systemic instruments”. Such instruments are oriented towards stimulating a co-innovation approach and orchestrating an adequate combination of individual innovation policy instruments and actors of the innovation system. Moreover, the desired institutional change which characterises AIS operationalisation, needs to ensure on-going adaptation that takes into account learning and experimentation among individuals, organisations and networks as a core development strategy.

In this context, where collaboration among actors in order to speed up innovation needs to be adequately fostered, the European Innovation Partnership for Agriculture Productivity and Sustainability (EIP-AGRI) (COM, 2012), which has the aim of stimulating such a co-innovation approach by fostering synergies between the Rural Development pillar (RD) of Common Agricultural Policy (CAP) and Horizon 2020 policies, can represent a new operational tool to contribute to the desired institutional change. Within this frame the AgriSPIN Project (N°652642) is one of the thematic networks funded under the H2020 EU research programme. It starts with the overall aim of improving innovation intermediary practices and support systems in European agriculture and to provide support to the EIP initiative. The Project also acknowledges that the role of intermediaries should be addressed to support innovation as a collective process of putting knowledge into practice, and achieving multi-stakeholder social, economic and environmental goals (Chowdhury et al., 2014).

This paper is grounded within the activities of the AgriSPIN Project and is aimed to better understand how the co-innovation approach of the EIP works, how it is translated into practice and which kind of barriers it presents. Moreover, we looked at the role of innovation support agents in fostering this approach.

The paper is structured as following: after an introduction of the EIP-AGRI overall approach and an explanation of research methods, the different strategies of EIP implementation in five case study regions and countries will be addressed and compared. We will then discuss their characteristics. To conclude, we will address the issue of the "institutional change" which is needed to foster innovation but also presents several obstacles for its realisation.

The EIP-AGRI overall approach

The Europe 2020 Flagship initiative "Innovation Union" specifies EIP as a new tool for speeding up innovation through linking existing policies and instruments. Consequently, the EIP-AGRI is aimed at fostering a competitive agriculture and forestry sector by promoting the open innovation concept that is based on the interactive innovation model. This concept implies collaboration between various actors to make best use of complementary types of knowledge in view of co-creation and diffusion of solutions/opportunities ready to implement in practice.

The EIP-AGRI falls within two frameworks: CAP - rural development with focus on knowledge transfer, cooperation and counselling, and Horizon 2020 with its thematic networks and multi-actor projects. The EIP follows a bottom-up approach, in which the participants can organise an Operational Group (OG) around a concrete problem from their daily practice. Within an OG farmers and growers, consultants, researchers, entrepreneurs and/or other actors organise themselves around a particular issue, seek solutions and work together on specific innovations. The farmer and his/her question are central to the entire process. Such OGs carry out projects aimed at testing and applying innovative practices, technologies, processes and products with the aim of strengthening the link between research and practice.

The involvement of farmers and growers has the advantage that more research-based practice will inform innovation, that there is more interaction between farmers and growers themselves and that scientists learn more about how their research results are used in practice. Through their participation in OGs producers are co-owners of the innovation process rather than an object of study.

The EIP-AGRI also points out the importance of a supporting environment to incentivise innovation projects. Various types of support are considered important, in particular if done by persons well connected to the agricultural world and who are well networked. These correspond to different professions, such as innovation brokers (people who help to start up a specific group and prepare the project) and facilitators or intermediates (people who help to facilitate the project) and, more generally, innovation intermediaries.
Implementation of the EIP in member countries is started in different periods and follows different modalities. According to a recent update of the Commission, 94 member states/regions will be implementing the EIP within their 2014 - 2020 Rural Development Programmes with regular calls for OG projects. (http://ec.europa.eu/griculture/rural-development-2014-2020/country-files/index_en.htm).

Methods

In order to identify effective and efficient approaches for the implementation of the EIP-AGRI strategy, we started with a preliminary study of such approaches, by realising a cross country, comparative analysis. Within this groundwork we selected five examples, among European regions and countries, of implementation of EIP-AGRI: Italy, with a focus on Veneto Region; the Shlezwig-Holstein Region in Germany, the Flanders Region in Belgium, the Netherlands, and Poland. These examples were selected according to the differences they presented while approaching EIP-AGRI implementation as well as because they have different organisational structures regarding extension services in agriculture and the management of the RDP. These differences allowed us to cover a broad, although not complete, spectrum of the current situation in Europe.

The data were gathered through a desk research of public documents, papers and direct, semi-structured interviews to relevant actors of each of the five cases. We interviewed people who are directly involved in the implementation strategy of EIP in their region or country (regional and provincial officers, responsible for regional and national EIP service points) and the profile of the interviewees was selected according to the institution in charge of implementing the EIP. The interviews were conducted according to a list of guiding questions aimed at deepening the organisation of the Agricultural Knowledge and Innovation System (AKIS), the overall approach for EIP and the rules for its implementation; for example how the calls for OGs are managed and the role of innovation support services in implementing EIP strategy.

The questions were elaborated with regards to those aspects potentially useful to understand the EIP as an operational tool for better understanding applied innovation processes. We then compared the different scale of management of the EIP system and its functioning, how the EIP fits into RDPs, the management of OGs and their funding and the role of extension/advisory services within the EIP System.

Cross-country analysis

In the following sections results of the cross-country analysis will be presented. These result are organized following the list of guiding questions asked during the interviews.

Poland

The AKIS in Poland is managed at national level and it's characterised by the presence of the most relevant actors engaged in innovation and knowledge creation and transfer in agriculture. There are several research institutes and universities providing scientific knowledge and the central government is involved with several ministries. Advisory services represent a determinant actor, with very strong and direct relations with farmers and their organisations. The AKIS has a linear, top-down approach and appears to lack capacity in terms of coordination among different actors; farmers are, until now, seen as "clients" by advisory organisations. In July 2015, in order to strengthen the knowledge flow between AKIS actors, as well as to support the implementation of the EIP-AGRI, the National Network for Innovation in Agriculture and Rural Areas (SIR) was established. The SIR is a National Network, centrally coordinated by the Agricultural Advisory Centre in Brwinów. Regional Authorities, with Regional Centres of Agricultural Advisory Services, are regional coordinators of this network. The SIR was in charge of the organisation of an open forum for all actors interested in innovation in agriculture, as well as of the animation of the potential partners of the EIP Groups.

In order to provide coordination, the National Centre for Innovation was created within the Agriculture Advisory Centre. The SIR and the professional advisors of the National Centre organised targeted focus groups in order to identify strategic priorities and key areas of the National Innovation Partnership at the National level. The focus groups worked on thematic issues considered as priorities for the agricultural sector in Poland and the thematic areas on which OGs will present their projects. These priorities are: crop production, animal production (including animal welfare), organic farming, environment protection and agribusiness. The brokerage is performed by the National Network and by the centre; it is integrated within the policy of rural development because innovation support and the funding of EIP OGs are framed within the national RDP.

Innovation will be supported through a package of measures of the RDP: the measure 16 (cooperation) and the measure 1 (knowledge transfer and demonstration), but also measures related to investments on the farm will be taken into consideration. Poland originally planned to fund 90 OGs; pragmatically, 25-30 will be funded and the first call is expected to be opened before the end of 2016.

Germany - Schleswig-Holstein Region

Schleswig-Holstein is a small region in Northern Germany and its AKIS is composed of a small number of actors. There are two research organisations involved: one university which specialised in basic, scientific research and one public research institute of applied science. In addition there is a Chamber of Agriculture as well as 7 farmers' schools and several private advisors. These actors are partially connected: the Chamber of Agriculture is linked with the advisors but advisors are not interested in university research, as they considered it too far from the needs of farmers; the scientific knowledge providers of the AKIS do not work closely together with farmers' advisors.

In 2014, in order to support the local innovation process in agriculture, the Ministry (MELUR) set up the Innovation Office EIP Agrar (coordinating body). It is hosted by the Schleswig-Holstein Chamber of Agriculture in Rendsburg. On one side, the Innovation Office supports the Ministry in the implementation of the new EIP agricultural policy instruments and coordinates project work. Simultaneously, the Innovation Office provides OGs with information, assistance and support in the planning, implementation and execution of their project ideas. Networking between groups within Schleswig-Holstein and cooperation in Northern Germany with the regions of Lower Saxony and Mecklenburg-Western Pomerania is another important task. Active public relations work ensures the exchange of information on project results and it supports the desired transfer of knowledge into practice.

Selected EIP Innovation Projects may be product innovations, such as the development of new types of product, or process innovations, which update existing technologies or tools, for example in a regional context. The implementation of EIP in the region is carried out according to the "bottom up" principle, i.e., the need for innovation comes ideally from practical demand and agricultural practitioners play a leading role in the development of solutions.

In order to follow this principle, in 2014, the EIP Agrar Office initiated networking between people and organisations who participated in a "call for innovative ideas" opened by the ministry. The Office acted as brokers and this helped the formation of 20 groups working on 20 projects. In the second phase, a jury was established which selected 17 out of the 20

projects and groups to be funded. The selection criteria reflected the rural development priorities and the "sustainability goals" of Schleswig-Holstein region.
The 17 OGs founded in June 2015 are still active and the projects will be funded for three more years. A peculiarity is that these first OGs were not funded by RD funds but with other resources; this has to do with the fact that when the region started the process the RDP was not yet approved. However, the second call will be under the measure 16 “cooperation” of the regional RDP.

The Office is the principal innovation broker and provides support to OGs at different stages of the project development, by facilitating people and by working together as a team, providing information on how to get money and on other administrative matters. The Office still supports individuals and groups who have questions about EIP project proposals, who are looking for project partners, or who require further assistance within the OGs by providing information on funding opportunities, assistance with applications, mediation with research partners and assistance with administrative processing.

The Netherlands

The Dutch AKIS or DAISY, which stands for the Dutch Agricultural Innovation System is a Public-Private research partnership. It is also known as the ‘golden triangle from the polder’ or the ‘triple helix’ uniting research, business, and government. According to the Chief Scientific Officer real management of the AKIS is absent. The system expands by itself and with implicit incremental changes. On the other hand the current government recognises the general importance of DAISY and in particular the interaction and cooperation within its ‘golden triangle’ as an important asset and an example for other sectors.

In relation to the knowledge and innovation policy DAISY functions thanks to the presence of the following 5 factors:
Concentration of information within Wageningen University & Research Centre that is responsible for the actual operational knowledge system;
The embeddedness of research in a consensus-seeking (polder) democratic society with a high concentration of information content for optimal policy making within the golden triangle of industry, knowledge institutions, and government;
Innovation, especially aimed at sustainability, is for policy makers a governance instrument that is continuously mixed with e.g. regulations or subsidies;
Correlation between innovation demands and innovation policies and regulations (for example, no support for organic farming without agreed standards). This development is seen as a necessary fine-tuning process of policies;
Research is conducted in the form of open interaction and information transfer, which means that outsourcing or tendering can be complicated within this particular knowledge system.

Within this context each province in the Netherlands has to set up its own sustainable innovation agenda, which has to be seen as a document for the long-term agricultural ambitions and priorities of the region. For example, the three Nordic provinces of the country: Friesland, Drenthe and Groningen have written their common agenda in order to face the common challenges and objectives within the current programme. This implies a new role for the provinces in which they have to try out and experiment with new approaches.

Implementation of RDP by the Dutch provinces has been translated into three measures for sustainable and innovative agriculture at the local level: training, workshops and entrepreneurial coaching; physical investment in innovation, promoting sustainability among young farmers and cooperation within the framework of EIP-AGRI OGs. Furthermore, the eligible innovation themes in the Netherlands that have to be implemented at the provincial level have been selected by the National Rural Network and Support Unit for the EIP-AGRI. The Unit also provides assistance to regional authorities, innovation brokers and project initiators.

The inclusion of EIP-AGRI within a broader innovation support system in the Netherlands for now means looking at the state of play of programming, calls, tenders, and difficulties surrounding the implementation of the European Agricultural Fund for Rural Development (EAFRD) at the provincial level in the Netherlands. Until now it has been difficult to execute a combination of measures around an EIP-AGRI and OGs under the national tender regime. Nevertheless, within the 12 Dutch provinces 11 out of 12 regional authorities will execute the EIP-AGRI strategy. The ambition is to establish 90 operational groups in the Netherlands. First calls were expected for late 2015 or early 2016 but are now postponed to the period May – June 2016.

Innovation experts and knowledge brokers from the farmer organisation LTO, Wageningen University, the Dutch golden triangle of agro-food and horticulture sectors, the national government, and the provinces have established a “help install the EIP”-team in order to smoothen the implementation of EIP strategy. Also they have defined the details for EIP-AGRI project approval of the operational groups. In addition, they have extended the rural development network and national EIP platform providing support (current members of EIP-AGRI team plus Netherlands Enterprise Agency, Ministry of Economic Affairs) together with an independent expert team of innovation brokers for judging, evaluating and ranking the proposals.

It should be acknowledged that in the Netherlands the approach of stimulating innovations through networking around bottom-up initiatives in not new and this could facilitate the implementation of EIP. An example is the network programme financed by the dutch ministry of agriculture and carried out by Wageningen University, based on the experimentation among 120 animal husbandry networks of the “Free actors in network” approach (Wielinga & Vrolijk, 2009). After the end of the project, between 2008 and 2013 the Ministry of Economic Affairs established a subsidy scheme for such bottom-up initiatives.

Italy –Veneto Region

In Italy, the managements of European funds for agriculture and rural development is an exclusive competence of the Regional Governments and their Managing Authorities; because of this, the implementation of the EIP Strategy is also assigned to Regions. The process, at national level, is to generate an intense debate between regional stakeholders, the Ministry of Agriculture and actors of the “innovation chain”.

The implementation process presented some criticalities, such as the dominant role of some actors in the creation of partnerships and the low interactivity in knowledge and innovation transfer. These criticalities highlighted the importance of the function of innovation brokering

in order to foster the adoption of innovations. To date, all Italian regions have concluded the process of consultation with the EC for the approval of their RDP.
AKIS in the Veneto Region is not a formal organisation, the actors collaborate in an informal network. Farmers and their forms of representation (product organisations and farmers' associations/unions) are recognized as the main actors of the regional AKIS and they appear connected both with universities and secondary agriculture education schools.

The research side of the AKIS is represented by three Universities with their departments of agriculture and animal husbandry. Both disciplines collaborate with the departments of urban and landscape study of these universities themselves; the agricultural landscape as a whole is considered an important resource for the economy of the region and because of that all the scientific areas dealing with this topic (agricultural production, veterinary science, landscape planning etc) need to be adequately coordinated. In Veneto there also exists a regional headquarters of the Council for Research in Agriculture and Agricultural Economics (CREA).

A key role in the AKIS of Veneto is played by Veneto Agriculture, the "regional agency for innovation in the primary sector". The agency is an instrumental body of the Regional Administration and offers training for agricultural advisors, information actions for farmers and testing of innovations within its experimental farms located throughout the region. In addition to training and information, Veneto Agriculture will be in charge of the coordination of the AKIS in Veneto. The regional government as well as the other actors of the system (especially universities and farms) acknowledged that the governance of the system had been lost over time and therefore the need for coordination was strongly expressed.

The region started to work on the implementation of the EIP-AGRI in 2010, when a permanent forum on innovation in agriculture was established; the regional agency played a crucial role in the coordination of this network. The aim of this forum was to define a common regional strategy for innovation in agriculture and to help the regional government to start and manage the process towards OGs. For the definition of the areas of activity of OGs, the region decided to not identify any priorities, in order to guarantee the bottom-up approach as expected by the Commission. Innovation is, in any case, a cross-cutting objective in all measures of the RDP .The choice of valorization of the bottom up approach on the one hand guaranteed an openness in the evaluation of the project proposals, but could also represent a complication from a procedural point of view, especially for the definition of the selection and evaluation criteria to apply. The region planned to fund 27-30 OGs; the calls are expected to be published before summer 2016 and will remain open until October 2016. For new-born OGs, the regional government is considering other sources of funding for the implementation of projects, eg the EAFRD.

Veneto Agriculture will be in charge of the support service for the establishment of the OGs and for the writing and finalisation of the projects. It will also provide support to the regional government, even in the evaluation phase of the proposals, that will occur in two steps: a commission composed of the agency and external evaluators will select the best proposals; a second commission will decide which proposals to fund, taking into account the general guidelines of the region. The Regional Agency assumes the role of innovation broker for the setting up of OGs.

Belgium – Flanders

For a better understanding of the Flemish AKIS it is important to consider it within the context of the Belgian Federation State and the fact that policies on research (partly), innovation, education and agriculture are regional instead of national matters. The vision of the Flemish government is that agriculture is not an isolated entity. AKIS and the supporting policies should provide links and crossovers to ICT, food and other sectors in the bio-economy.

Within the Flemish AKIS several actors are involved in agricultural research: universities, the Institute for Agricultural and Fisheries Research (ILVO), university colleges and experimental stations. When it comes to the extension services the Flemish government organizes collective information or activities and (co-)funds training courses by approved centres. The provincial authorities have complementary activities, for example experimental farms and education initiatives. Other services that aim for individual information and guidance are in general offered by private organisations (especially the Flemish Innovation Centre for Agriculture and Horticulture) or private services with additional government funding (such as the farm advisory system).

The agricultural support system covers a very broad field of activities and most relevant actors in Flanders are the farmers' organisations. Other actors within the support system are knowledge networks and study clubs, and cooperatives. There is also a general and agricultural education system; in addition to the general secondary education there are around 20 technical and vocational schools that offer an agriculture- related education.

The Flemish RDP 2014-2020 is an instrument with a wide range of measures to stimulate and support competitiveness and sustainability and one of these measures is related to EIP. In this setting, the Flemish EIP-AGRI Service Point acts as an intermediary in the EIP-AGRI network to strengthen communication and cooperation between everyone who is interested in innovation in agriculture. Representatives of the EIP-AGRI in Flanders are working at the Flemish Ministry of Agriculture and Fisheries. The call for the OG is based around the two main themes of the regional government: Conservation Objective and Programmatic Approach Nitrogen (IHD / PAS), but can also be based on other topics relevant for the aims of the EIP-AGRI for agricultural productivity and sustainability. How each OG complements existing innovative initiatives must be made clear and each OG should also examine whether knowledge on the subject is present at the practical centres of the Institute for Agricultural and Fisheries Research, and how this knowledge is used. If the knowledge is not used, it must be thoroughly justified by the OGs.

Within the available Flemish rural development budget, at least five OGs can be selected for financial support. All submitted projects will be evaluated by a committee of experts and the maximum grant per OG is €30,000. The first call is expected from September the 1st, 2016 onwards and at the latest on 1st December 2016, but the Flemish government will launch several calls during the programme period.

Flemish EIP network that is supporting the creation of such OGs is accessible via the Flemish Rural Network that is located in Brussels. The Flemish Land Agency (FLA) is the 'service point' thereof. The FLA is as External Autonomous Agency, part of the policy area Environment, Nature and Energy of the Flemish government. Rural development, countryside and minerals policy, Manure Bank and Project Realisation are the core divisions of the FLA. In addition to its headquarters in Brussels, FLA has two regional divisions: Western Region, with offices in Ghent and Bruges and Eastern region, with offices in Leuven, Hasselt and Herentals. Additionally, the Platform for Agricultural Research - Agrolink Flanders, functions as a stage for the local innovation brokers working towards implementation of the EIP strategy. In fact, Agrolink Flanders wants to be the recognized contact point for the agro-industry, research community and policy in agriculture and horticulture. It is the main Flemish forum for consultation and agreements between agricultural research and innovative agricultural actors in order to encourage their entrepreneurship. The platform represents a partnership between 17 Flemish universities and knowledge institutions.

Table 1 - Comparative table of EIP Models

	Management	Coordination	EIP within the RDP	Manage-ment of OGs	Funding of OGs	Role of extension/advi-sory services
The Netherlands	EIP framed within the national RDP but the interpretation and implementation of objective happens at the regional (provincial) level.	EIP National Service Point in cooperation with the National Rural Network, which will host the OGs within its platform.	Funds reserved but co-finance is required at the local level.	Framed at the local (provincial) level and supported by the national EIP Service Point.	Funding comes from the national RDP but has to be co-financed at the regional level.	Support, evaluate and judge plans. Besides setting up of a help team and national coordination of innovation broker networks database.
Belgium (Fanders)	Regional management due to the national state formation at federal level.	Rural Network Flanders and the Ministry of Agriculture are taking the place of the EIP strategy implementation at regional Flemish level	EIP is framed within the Flemish RDP, which follows the EU prescriptions for the RDP and CAP.	The OGs are managed at the local level and have to report to the Flemish Ministry of Agriculture. The OGs also have to be integrated into existing AKIS system	There is regional Flemish budget to finance a fixed number of OGs with funds from the national RDP	These have to actively participate in the support of innovative processes and setting up of research projects. Also knowledge transfer and brokerage are important tasks.
Poland	National, central coordination and management	Coordination at national level; the agricultural advisory centre (SIR) coordinate EIP and I-B	Measure 16 and 1 of the national RDP	The central office do the activity of brokerage (makes actors connect, discover innovative ideas, help on project drafting etc)	OGs will be funded by measure 16 of the national RDP	Central role and involvement. The agricultural advisory centre coordinate both I-B and the networking.
Schleswig-Holstein	Regional coordination under national guidelines	Coordination at regional level; there is an EIP Office (EIP-Agrar) that coordinate OG and play the role of I-B (centralized by the office)	First OG born before the RDP 2014-2020.	The central office do the activity of brokerage (make actors connect, discover innovative idea, help on	As first OG were born before the RDP 2014-2020, they were funded with other regional funds. Conversely,	Central role and involvement. The office collaborate with advisors (the chief of the office is an advisor too)

				project drafting etc)	the second call for OGs will be managed under the regional RDP.	
Veneto	Regional coordination under a national framework.	Absence of a central office, The strong position of a Regional Agency in coordinating activities has to be underlined.	EIP is mainly ruled within the regional RDP.	OG will be managed within the regional RDP. The Regional Agency assume the role of coordination of I-B	OG will be funded through a package of measures (16, 1 and 2). Two separate calls for the setting up of the groups and for project funding	The Regional Agency will support OG both for the setting up and project building; the role of advisory services in these phases is not specified.

Discussion

The results of our research, although they only include five examples, show different models of implementation of the EIP. Despite the common guidelines provided by European legislation, it is clear that regions/countries can adopt different strategies, also in relation to their internal organisation. Hence, in this section we will examine some key elements of EIP implementation as described in table 1, underlining the main peculiarities of each element and, where present, the barriers or difficulties characterizing the different approaches.

Management and coordination of the EIP

The scale of the EIP system is strongly dependent on the form of administrative organisation of different countries and the EIP implementation is managed both at national and regional levels with different intensity of centrality. All member states we analysed have defined national guidelines for EIP implementation but the practical management and the definition of an operational strategy is in most cases entrusted to the sub-government levels: for example, in Italy the regions are the ones who organise the implementation, in the Netherlands it is the provinces. One example of completely centralised management is Poland: there is a national strategy for EIP, which is managed by the government and the National Advisory Centre. Almost all countries decided to set up coordination offices for the EIP. In other countries (eg Belgium), specific contact persons have been identified within existing governmental/state organisations who are in charge of the coordination of EIP. In some cases (eg Schleswig-Holstein) the office is working on the EIP Service Point model installed in Brussels, by providing different kinds of support for establishing OGs such as networking, innovation brokerage, helping with project drafting, etc. These offices are coordinated nationally or regionally, according to the implementation modality chosen for the EIP. Essential for the right functioning of the system is the coordination among the different organisations involved: according to most people we interviewed, coordination in the governance of the EIP is often a critical point.

EIP and rural development: management and funding of OGs

In each region/country EIP is framed under the national or regional RDP, which follows the EU prescription. With the exception of Schleswig-Holstein region, which funded the first 17 OGs with other EU funds, in all region/countries the groups will be mostly funded under measure 16 of the RDP, although a co-financing is planned in some cases (i.e Belgium and The Netherlands). Most regions and countries identified some innovation priorities for their agricultural sector and the activities of OGs will be framed within these topics; in most cases these priorities reflect those of the Rural Development and of the EIP strategy. A different approach was followed by Veneto Region, which chose not to identify any innovation priority in order to favour the bottom-up approach and open innovation processes. According to the Veneto regional government, the identification of specific priorities would have influenced the project proposals, the composition of OGs and would have favoured some agricultural sectors over others. The Rural Development rules allow both the funding of the setting up of the groups and of the projects implementation phase. In this regard, in the cases analysed, we found different operating modes. In some case there are singular public calls which will fund both the setting up of the OGs and the projects; in other cases there will be two separate calls, one for the setting up and the other for the realisation of the projects. One commonality among all the cases is the planned duration of projects (at least three years) and the total amount of money for each OGs (ranging from 30,000 to 50,000 euro).

EIP and support services

The role of extension/advisory services in the EIP implementation appear to be crucial in the different phases of the implementation of EIP strategy. In most cases, extension/advisory organisations are directly involved in the coordination of innovation brokerage activities, in helping those who are interested in OGs to find partners and building of a project together. Moreover, they will support managing authorities during the process of selection and evaluation of the OGs and projects. In Veneto, where there are no public extension and advisory services, these functions will be performed by the Regional Agency for Innovation in the primary sector (Veneto Agriculture).These activities will be mostly funded with RDP technical assistance funds. Based on the cases analysed, we observe a general tendency to centralise the innovation brokerage activities, directly involving advisory organisations both in coordination and operational actions. The centralisation of such actions guarantees the institutional acknowledgment of the role of the advisory organisations as important innovation facilitators and brokers. To make this system work well, there should be a strong coordination and communication flow between the central offices and those placed and embedded in the territory.

Conclusions

The EIP for agricultural productivity and sustainability, can represent a useful tool for a better understanding of applied innovation processes. Our preliminary analysis of some of the EIP implementation modalities, confirms that the role of people and organisations able to catalyze innovation through bringing together of actors and facilitating their interaction is growing in importance.

Comparing the different models of the EIP we can stress the engagement of regional and national governments in transposing this new European approach to innovation in agriculture; also the involvement of support services in the designing of the strategy underlines the willingness to cooperate in order to achieve a more coordinated innovation support system.

European countries are starting now to experience the EIP implementation and more time is needed in order to understand if the adopted strategies will result in the desired outcome. However, this preliminary analysis allows us to understand how different regions and countries interpreted the interactive innovation approach within the EIP and this represents a starting point for further research and insights.

The development of innovation support services requires continued local experimentation, adaptation and learning (Klerkx, Hall & Leewis, 2009). Such innovation support services are an integral part of the AIS (Klerkxs, Aarts & Leewis, 2010; Faure, Rebuffel & Violas, 2011) and, to achieve the desired institutional change, there is the need to overcome barriers or gaps that can hinder collaboration (österle et al., 2016). Together, and within the EIP, other tools enabling dialogue and effective collaboration should be encouraged. For example, under the frame of AgriSPIN activities, a so-called “Multiplier Group” will be established, whose members will be European regions’ managing authorities and advisory organisations. The aim of this Multiplier Group is to provide advice on how to better assure the uptake of the interactive innovation approach in European agricultural support services. One of the tasks of the group is to improve national and regional innovation support services within RDP and to suggest possible new operational schemes for the implementation of the EIP.

The project progress could add more insights as to how to address EIP, foster its operational translation in European countries and encourage the overcoming of institutional barriers to innovation uptake.

References

Borràs, S., & Edquist, C. (2013). The choice of innovation policy instruments. Technological forecasting and social change 80: 1513-1522.

Chowdhury, A.H., Hambly Odame, H., & Leewis, C. (2014). Transforming the roles of public extension agency to strengthen innovation: lessons from the National Agricultural Extension Project in Bangladesh. The Journal of Agricultural Education and Extension 20(1): 7-25. doi : 10.1080/1389224X.2013.803990.

European Commission (2012). Communication from the Commission to the European Parliament and the Council on the European Innovation Partnership "Agriculture Productivity and Sustainability".

Edquist, C. (1997). Systems of innovations: technologies, institutions and organisations. London: printer.

Jacobsson, S., & Johnson, A. (2000). The diffusion of renewable energy technology: an analytical framework and key issues for research". Energy policy 28: 625-40.

Faure, G., Rebuffel, P., & Violas, D. (2011). Systemic evaluation of advisory services to family farms in west Africa. The Journal of Agriculture Education and Extension 17: 325-339.

Klerkx, L., Hall, A., & Leewis, C. (2009). Strengthening Agricultural Innovation Capacity: are Innovation Brokers the Answer? United Nation University. Working paper series no.19.

Klerkx, L., Aarts, N., & Leewis, C. (2010). Adaptive management in agricultural innovation systems: the interaction between innovation networks and their environment. Agricultural Systems 103(6): 390-400.

Klerkx, L., Adjei-Nsiah, S., Adu-Acheampong, R., Saïdou, A., Zannou, E.T., Sakyi-Dawson, O., Van Paassen, A., & Naderlof, S. (2013). Looking at the agricultural innovation platforms through an innovation champion lens. An analysis of three cases in Africa. Outlook on agriculture 42(3): 185-192.

Leewis, C., & Van de Ban, A. 2004. Communication for rural innovation: rethinking agricultural extension. Oxford: Blackwell Science.

Österle, N., Koutsouris, A., Livieratos, Y., & Kabourakis, E. (2016). Extension for organic agriculture: a comparative study between Baden-Württemberg, Germany and Crete, Greece. The Journal of Agriculture Education and Extension. doi: 10.1080/1389224X.2016.1165711.

Pant, L.P., & Hambly Odame, H. (2010). Creative commons: non proprietary innovation triangles in international agricultural and rural development partnership. The Innovation Journal: the public sector innovation journal 15(2).

Schut, M., Klerkx, L., Sartas, M., Lamers, D., McCampbell, M., Ogobonna, I., Kaushik, P., Atta-Krah, K., & Leeuwis, C. (2015). Innovation platforms: experiences with their institutional embedding in agricultural research for development. Expl Agric. Cambridge University Press.

Spielman, D.J., Ekibor, J., & Davis, K. (2009). The art and science of innovation system inquiry: applications to sub-saharian african agriculture. Technology in Society 31(4): 399-405.

Swaans, K., Boogaard, B., Bendapudi, R., Taye, H., Hendrickx, S., & Klerkx, L. (2014). Operationalizing inclusive innovation: lessons from innovation platform in livestock value chains in India and Mozambique. Innovation and development 4(2): 239-257.

Wieczorek, A., & Hekkert, M. (2012). Systemic instruments for systemic innovation problems: a framework for policy makers and innovation scholars. Science and Public p
Policy 39: 74-87.

Wielinga, H.E., & Vrolijk, M. (2009). Language and tools for networkers. Journal of Agriculture Education and Extension. Vol 15(2): 205-217.

World Bank (2012). Agricultural Innovation Systems. An investment sourcebook. Washington DC: The World Bank.

Agricultural networks across EU: what are the key features to enhance farmers' ability to learn and to innovate in cooperation with other actors?

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Abstract: Multi-actors networks are increasingly used by farmers to link between them and to be interactively connected with other partners, such as advisory organisations, local governments, universities and non-farm organisations. Given the importance assigned to the agricultural innovation by EU resorting to the networking between the research chain actors and the farmers, a strong focus on enhancing the creation of learning and innovation networks is expected. In this context it is relevant to have information about the features of such networks that enhance farmers' ability to learn and to innovate in cooperation with other actors. The main goal of the paper is to contribute to the understanding of which features of agricultural or rural networks enhance the farmers' ability to learn and to innovate in cooperation with other actors, by identifying the influencing factors encouraging the farmers' enrolment and the influence of network stability. The additional goal of the paper is to provide insights into the way these networks link to R&D infrastructures and advisory services. Five case studies comprising heterogeneous networks were conducted in Italy, Germany, Portugal and the UK. The results highlight aspects that show decisively the networks' ability to provide effective learning and innovation platforms, including bottom-up functioning, informality, leadership and power balance, along with the participation of facilitators when networks are large and heterogeneous. These networks focus on innovation exploitation and depend on the existence of a support subsystem, namely a functioning R&D and advisory services infrastructure. They can fill in gaps in this infrastructure, but they cannot replace it.

Keywords: Agriculture, knowledge and innovation networks, agricultural knowledge and innovation systems (AKIS), multi-actors networks, EIP-AGRI

Introduction

The role of 'horizontal' multi-actors networks for the rural development has been emphasised by Murdoch (2000). This type of network enhances farmers' learning and innovation behaviour through social interaction and collaboration by joining heterogeneous actors (Hartwich & Scheidegger, 2010; Saether, 2010; Murdoch, 2000) and by enabling their link with formal external entities sourcing knowledge and information (Isaac, 2012; Klerkx et al., 2010; Prell et al., 2010).

On the other hand, the regional innovation systems approach (RIS) that envisages innovation as being the outcome of interaction and collective learning processes, which are systemic by nature and that take place in specific spatial contexts (Lundval, 1992; Cooke et al., 1997; Audretsch, 1998; Asheim, 1999), are now acknowledged, namely by the European Innovation Partnership on agricultural sustainability and productivity (EIP-AGRI), as the new paradigm to promote innovation in the agricultural sector. The European Innovation Partnerships (EIPs) are a novel framework launched by the European Union (EU), in the context of Europe 2020 strategy for growth and jobs (CEC, 2013), to tackle major societal challenges, such as the sustainable increase in food production, by putting together the researchers and the innovation exploiting actors. The EIP-AGRI states that the multi-actors' knowledge networks are the ground for innovation processes which take place at the territorial level. Hence, the EIP-AGRI activities focus on enhancing the networking of producers and users of knowledge, comprising farmers, researchers, advisors, business and other individual and collective actors whose interaction generates 'new insights and ideas, and mobilise existing tacit knowledge into focused solutions' (EU SCAR, 2013, p. 25).

The approach adopted by the EIP-AGRI emphasises the role of farmers as knowledge co-creators by creating and mobilising tacit knowledge. This approach is an alternative to the model of innovation-diffusion established by Rogers (1962). This model is based on a clear dichotomy of functions between researchers and farmers: researchers are the producers of scientific knowledge and technologies and farmers are the adopters of these technologies (e.g. new seeds, fertilisers, machines and equipment), which incorporate the scientific knowledge. Within this linear model of transferring knowledge, the advisors or extension technicians play a key function: the knowledge transfer between researchers and farmers, mainly in the form of new technologies (Schneider et al., 2012; Saether, 2010; Scoones &Thompson, 1994).

The EIP-AGRI approach, built on the interaction of heterogeneous actors and on the ability of different actor's to co-create knowledge by mobilising tacit knowledge along with scientific and other forms of codified knowledge, is supported by the agricultural innovation systems theoretical perspective. The innovation systems and related research defines innovation as an outcome of open-ended interactions among heterogeneous actors combining knowledge from many different sources (Wood et al., 2014; Klerkx et al., 2010; Conroy, 2008; Klerkx & Leeuwis, 2008). In addition, other authors emphasise the importance of incremental innovation focused on problem solving (e.g. Kroma, 2006) or on the constant minor adjustments and improvements (e.g. Hall, 2009) that farmers make to be successful.

In rural areas networks are increasingly being used by farmers to link between them and to be interactively connected with other partners, such as advisory organisations, local governments, universities and non-farm organisations. Information and Communication Technologies (ICT) facilitate networking, namely when it is used to share and exchange knowledge. Given the importance assigned to innovation by the EIP-AGRI, and by the recent new wave of rural development programmes (RDP), a strong focus on supporting the creation of agricultural/rural learning and innovation networks is expected in the next few years. However, there is little knowledge on the features and configuration of the best performing innovation networks (i.e. those enhancing farmers' innovation behaviour) which account for different problem-solving (e.g. adapting to climate changes, introducing novel crops or how to obtain incremental gains of productivity in mature sectors) and for different farming systems and farming styles across Europe. An additional, and relevant, research gap is the lack of knowledge regarding the interface between the networks that exploit innovation and the knowledge support subsystems that underpin it (Saether, 2010; Edquist, 2005), which comprise the R&D, education and training and advisory/extension regional infrastructures.

The FP7 EU project PRO AKIS encompassed among their goals exploring and identifying the possibilities, conditions and requirements of agricultural and rural innovation networks that might constitute examples for the EIP-AGRI. A set of five case studies, for in-depth analysis, was selected across different European countries. Diverse networks were studied, addressing different problems with quite different configurations, which reflected the heterogeneity of problems and the regional contexts, namely the quality of R&D and advisory infrastructures which the network embeds on (Knierim et al., 2015).

A common methodological approach was followed in the different countries relying on: semi-structured interviews with the network members (or a sample of them) depending on the network's size; interviewing actors from the R&D infrastructures and advisory services found relevant in the different cases and participant observation by attending meetings and events organised by the networks.

The main aim of the paper is to contribute to the understanding of which features of agricultural or rural networks show determinant to enhance the farmers' ability to learn and to innovate in cooperation with other actors, namely by identifying the influencing factors encouraging the farmers' enrolment and the influence of network stability. The additional aim of the paper is to provide insights into the way these networks link to R&D infrastructures and advisory services.

Selection of the case studies and data collection methods

The case studies were selected in each country based on an inventory at country or regional level (depending on the type of AKIS - centralised or decentralised) of the existing agricultural or rural knowledge and learning networks which showed innovative network models by themselves and appeared to have the features to enhance collaborative innovation.

The networks investigated (see Figure 1) included: (a) policy-induced agricultural innovation network in Brandenburg, Germany ('Adapting seeds to climate change'); (b) the 'Anti-Mafia innovation network: from land to fork' (abbreviated as 'Anti-Mafia') - a rural network situated in the Northern part of the Campania region in southern Italy; (c) the 'Cluster of Small Fruits' (CSF), a sectoral and nationwide Portuguese network; (d) a berry pest-monitoring local network, situated in the central-north of Portugal and (e) the 'Monitor Farms' which are farmer-driven networks set up by the Scottish Monitor Programme and implemented by the Scottish government with delivery partners including levy bodies such as Quality Meat Scotland (Madureira et al., 2015).

An exploratory-descriptive approach was chosen to gather information about the structure, content and dynamics of each network. Two different interview guides were constructed and applied through questionnaires, one for the network actors and the other for the facilitators. The interview guides were translated to involved country languages and applied through personal interviews. The number of interviews were around 30 for farmers and 15-20 for the advisors and actors from the advisory and knowledge infrastructure.

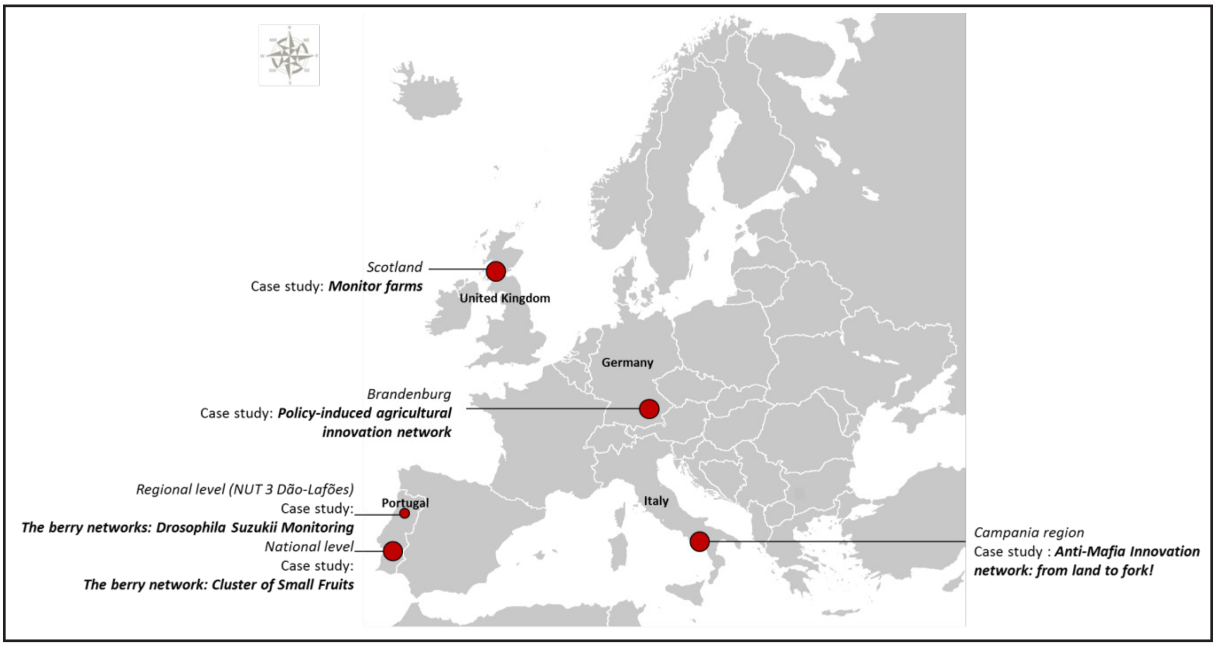

Figure 1*:* Location of cases studies by country. *Source: Madureira et al., 2015*

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The case studies

Policy-induced agricultural innovation network in Brandenburg, Germany

This network was situated in Brandenburg and involved researchers, farmers, associations and a public authority. It was set up in the context of a project, funded by the German Ministry of Education and Research, and focussed on developing innovative strategies for adoption of practices to counter climate change. Concretely, the studied project and network aimed to test and evaluate crop seed varieties under different climatic conditions. The planned activities were carried out on time, and the project can be considered successful in terms of its realised activities and goals. After a stable working phase of five years, despite an interest in its continuation by a majority of its members, the network dissolved in 2014 due to a lack of available funds for any follow-up network. It was established and ran within a period of public service downsizing in related fields and with a complete lack of public advisory services.

In terms of agricultural production, a structure of big farms is characteristic for Brandenburg, as a result of the history of collectivised farming. In 2010, the average farm size in Brandenburg was 240 ha (compared to an average of 56 ha in Germany as a whole). The four participating farms collectively operate over 1000 ha, with the largest farm operating over approximately 500 ha. With this, they all fall into the biggest 6.4% of farms in Brandenburg. The four farms have professional management and are strongly market-oriented. More detailed information on this case study can be obtained in Boenning & Knierim (2014).

Anti-Mafia Innovation network: from land to fork! Italy

The Italian case study focusses on the emerging rural innovation network in the so-called *Land of Fires*, an area in the Northern Campania region (Southern Italy) that is infamous for the socio-economic and environmental impacts of more than two decades of waste crisis. The network involves cooperatives who work on land which has been confiscated from the Mafia: environmental activists, associations, public and private actors (citizens and companies) fighting against dispossession and contamination of territories, and against Mafia culture. The study analysed the "economic heart" of this emerging network which is also a smaller formal network: the consortium of five social agricultural cooperatives called NCO (Nuova Cooperazione Organizzata) that was founded in 2012. They practise mostly organic agriculture, avoiding pesticides and inorganic fertilisers, adopting crop rotation systems to replace nutrients in the soil. They minimise and recycle the farm waste making compost for fertiliser. The cooperative also tries to regenerate and use local seeds and plants, sometimes in cooperation with a regional research institute, becoming both users and custodians of biodiversity in connection with local knowledge and the farming communities. The NCO cooperatives advance social inclusion, through the agricultural work of disadvantaged people (those with mental health problems, former prisoners, immigrants and the unemployed), with the ambition of becoming sources of “ethic economic wealth”. In addition, they focus on direct selling by getting closer to consumers to build a short food supply chain. The innovative land use of NCO involves a cognitive and cultural re-orientation that assumes a purely non-instrumental relationship with the environmental and territorial resources, the labour force and with consumers.

In spite of the existing regional agricultural advisory services, which are still publicly funded, the network lacks specialised technical advice and extension services for organic farms, which the cooperatives mainly access through external sources and informal channels (other cooperatives and farmers). Other relevant sources for knowledge and information are downstream firms and organisations, such as plant and seed suppliers and private control bodies for organic certification. More detailed information on this case study can be obtained in Caggiano (2014).

The berry networks in Portugal

The Portuguese case studies included: the *Cluster of Small Fruit* (CSF) and the *Drosophila Suzukii Monitoring* (DSM) network. The first is a horizontal nationwide sectoral network established in 2013; 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 actor such as private agricultural advice companies, independent consultants, several FBOs (cooperatives, farmers’ groups and associations) and up and downstream industry firms, amongst others.

The DSM network, established in 2014, is a regionally located, hierarchical but informal network led by a coordinating body (Regional Agency of the Ministry of Agriculture) which also involves farmers and facilitators.

The CSF network involves the full range of actors in the berry production sector and is itself instrumental in organising the sector, specifically the knowledge and information supply to meet 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 farm-based organisations (FBOs) and private advice can organise themselves in order to meet farmers' needs and demands and, on the other, it identifies these organisations' limitations in providing quality support to a novel and knowledge-intensive sector.

The second network, DSM, presents a model designed to create and store local-specific knowledge that is fundamental at both the regional and sectoral levels (when dealing with crop pest-monitoring) and one that engages farmers in the process of co-creating knowledge. The DSM is geographically a well-defined network, located in the central-northern region of Portugal. The network is co-ordinated by a public regional agency of the Agriculture Ministry and the members are farmers, mostly inexperienced berry producers, who were selected by the FBOs and private firms that they (the producers) are linked to. The private firms act as facilitators, identifying the farms which are suitably located for field experiments and the farmers who are actively exchanging knowledge as well as having the ability to implement and maintain the scientific experimental tests designed to detect the *Drosophila suzukii* (the insect pest responsible for devastating this crop) and to store and report the data collected. More detailed information on this case study can be obtained in Madureira et al. (2014).

Monitor farms in Scotland, UK

In the Scottish case study 'monitor farms' were investigated as an example of an agricultural innovation network. The Scottish Monitor Farms Programme is delivered by the Scottish Government in collaboration with delivery partners. Delivery partners include levy bodies (Quality Meat Scotland, DairyCo and Home Grown Cereal Authority), National Farmers' Unions Scotland and the Scottish Organic Producers Association. Between 2009 and 2013, 18 monitor farms were established by the Scottish Government and the delivery partners. To date a total of 40 monitor farms have been initiated in Scotland, funded mainly through the Scottish Government's Rural Development Programme Skills Development Scheme. The monitor farm strategy stated that improvements to knowledge transfer to the Scottish agricultural industry lay at the heart of the programme.

Different farmer types participate in the monitor farm network, representing the range of enterprises in the geographical area of the monitor farm, as well as young farmers and new-entrant farmers. Many participants were known to each other prior to the initiation of the network, from other groups or memberships, or from farming in the same area. The selection of topics covered in the monitor farm meetings is relatively farmer-led as they are determined by the management group made up of 5-8 participating farmers that want to become more involved.

There are many links between the monitor farm programme and existing knowledge and advisory services, not least due to the role of the programme facilitators (many of whom are agricultural advisors), and through the wider network including invited specialists, industry representatives and student/researcher attendees. The network provides an opportunity to bridge gaps in advisory services, for example, providing practical on-farm demonstrations. As the objective of the monitor farm network is to develop best practice through on-farm changes, the processes and dynamics developed to generate and exchange knowledge for co-innovation focus on communication, knowledge exchange and co-creation, for example through the informal discussion and sharing of ideas and experience between monitor farm participants. More detailed information on this case study can be obtained in Creaney et al. (2014).

Results

The networks configuration: structure, goals, actors and their interaction

Table 1 presents a comparative description regarding the main features defining the structure of the five studied networks. It illustrates their diversity with regard to the contexts of their origins and its establishment. It is noteworthy that even in those cases where the initiative for the network creation was top-down these tend to function through a bottom-up approach, with a prevalence of horizontal and a mix of formal and informal interactions (see Table 2).

Table 1: Networks structure

	'Adapting to climate change', DE	'Anti-Mafia', IT	'Cluster of Small Fruits', PT	'Berry pest monitoring', PT	'Monitor Farms', Scotland
Context for establishment	Research programme	Collective action	Sectoral initiative	Institutional but 'ad hoc' initiative	National programme
Initiator	National research	Local care cooperatives	Local authority	Government department	Government
Geographical scope	Regional	Local	National	Local	Local
Temporal scale	2009-2014	Established 2012	Established 2013	2013 - 2015	2011 - 2014
Scope/field	Specific problem oriented – agricultural	Territorial oriented-multi-sectoral	Novel sector oriented – agricultural	Specific problem oriented – agricultural	Sector oriented – agricultural
Leadership	Science-led network	Cooperative-led network	Farmers-led network	Facilitator-led network	Farmer and facilitator-led network
Funding	Public funding	Self-funded	Public	Self-funded	Public with industry contributions

Source: adapted from Madureira et al., 2015

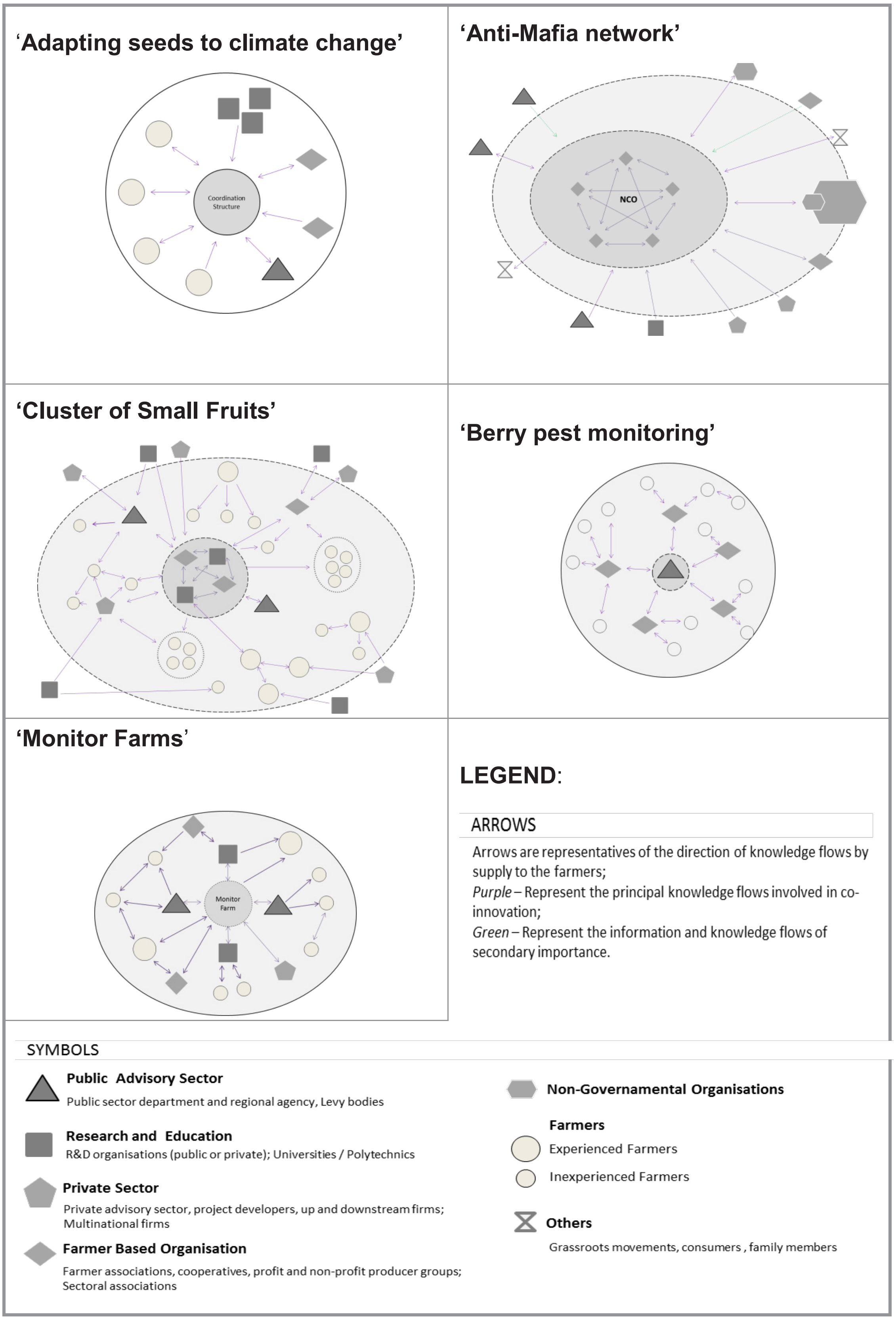

Figure 2: Actors and their main interactions. *Source: Madureira et al., 2015*

Most of the networks are individual, one-off or even ad hoc initiatives, with the exception of the Monitor Farms programme in Scotland. This suggests that networks are still not regarded as essential collective learning, advisory and co-innovation tools for agriculture and rural development, or that the official frames within which they sit do not fit the needs of the actors on the ground.

Figure 2 depicts, in a simplified way, the respective interactions of the main actors in the knowledge flows underpinning the various networks.

Figure 2 also illustrates the configuration of each of the studied networks, highlighting its boundaries, type and diversity of actors involved and their main interactions in terms of knowledge flows. The policy-induced innovation agricultural network in Brandenburg ('Adapting seeds to climate change') has well-defined boundaries due to its formality as a result of being a research-project based network, led by scientists and involving a lower number of participants. In contrast, the 'Anti-Mafia innovation network' is not a clearly bounded network, involving a multitude of actors, both in type and number that interact in a multi-directional way through formal and informal communication channels. The stability of the network is assured by the well-defined leadership structure defined by the cooperatives consortium that acts as the turntable of the multiple and diverse knowledge flows underlying the broader network. The main knowledge flows in the 'Cluster of Small Fruits' underline the presence and role of small-scale and inexperienced farmers. These farmers demand knowledge and information from the interaction opportunities provided by the network, either in an isolated manner or jointly with private and farmer-based producer groups, both formally and informally. This is not a bounded network, but involves knowledge flows into and out of the network, namely involving pioneer innovation-led farmers that demand knowledge from outside the cluster e.g. from R&D institutions with ICT resources. In this case, a core structure is fundamental to ensure the functioning and stability of the network, composed of four diverse but complementary actors: a sectoral farmer-based organisation, two R&D entities and an internationalisation facilitator organisation. The knowledge flows underlying the 'Berry pest monitoring' shape clearly this network. This is not surprising given that the main goal of this network is the co-creation and storage of explicit knowledge. The overall picture of knowledge flows in the 'Monitor Farm' networks relies on a diverse group of farmers and other actors gathering around the 'monitor farm/farmer'.

Influencing factors of the farmers' enrolment and of the network stability

The absence of fees as well as the informal nature of the enrolment into the network appear to be key aspects of the farmers' enrolment in the networks. We noted that farmers are generally willing to bear travelling expenses and time opportunity costs, and appear to be satisfied with the gains of their participation, namely in the cases of Monitor Farms and the Portuguese berry networks. An additional factor relevant to the farmers' enrolment is the existence of previous informal relational capital and trust (social capital), which also shows determinant to the network stability (Madureira et al., 2015).

The previous inter-personal and professional relationships and mutual understanding between the farmers and the scientists involved within the 'Adapting seeds to climate change' network was decisive for the enrolment and stability of the network (Boenning & Knierim, 2014). In the case of the 'Anti-Mafia' network, previous contacts, interactions and inter-personal relationships between the founder cooperatives have also shown to be helpful in building the trust needed to establish the consortium. In the broader network, led by the consortium, stability comes from shared values derived from anti-mafia attitudes and belief in a social alternative economic model to the sustainable development of the region of the 'Land of Fires' (Caggiano, 2014). The inter-personal relationships and trust amongst the pioneer berry producers and strong ties with researchers and other actors (such as advisors and traders), has been a critical feature to enable coping with the tensions and imbalances present in this network. These are due to the participation of a large number of inexperienced farmers, with knowledge needs and demands, who are very dependent on the pioneers and their informal networks for support.

The 'Monitor Farm' networks in Scotland also provide evidence regarding how farmers value informal and neighbourhood connections. Previous personal and professional relationships and contacts enhance the adherence of farmers to the monitor farm (and respective farmer). The social aspects of participation appear to be of special value in this case, where the 'free meal' and opportunity to socialise with friends and acquaintances, as well as to enhance personal social networks, act as a determining enrolment factor (Creaney et al, 2014).

The value that farmers assign to previous informal relationships and to the opportunity to socialise with peers and other experienced professionals provided by the networks should be highlighted given that it can be shown to be a determinant feature in the success and effectiveness of learning and innovation within agricultural and rural networks.

A further important aspect related to the networks' dynamics in terms of their social cohesiveness is how they address tensions, namely around cooperation versus competition, when the members (i.e. farmers) are competitors. In this case, previous relational and trust capital showed to be a decisive factor, although this tension can be surmounted by identifying and focussing on shared goals (Madureira et al., 2015).

Network linkages with the R&D and advisory services infrastructure

The linkages between the different studied networks and the respective national and/or regional R&D and advisory services infrastructure is summarised in Table 2.

Table 2: Links between networks and knowledge and advisory infrastructure

Networks	Knowledge and advisory infrastructure				
	Public Advisory Sector	Research and Education	Private Advisory sector	FBOs	NGO
'Adapting seeds to climate change', DE	○	◉		○	
'Anti-Mafia', IT	○	◉	◉	○	◉
'Cluster of Small Fruits', PT	○	○	○	◉	
'Berry pest monitoring', PT	◉	○	○	◉	
'Monitor Farms', Scotland	◉	○	◉	○	

Legend:

○ Links
◉ Main links

Source: Madureira et al., 2015

The links identified in Table 2 underline the networks' ability to mobilise and to integrate this infrastructure (R&D and advisory sector) in two alternative directions: (a) benefiting from it in situations where advisory services are present, as is the case with the Monitor Farms in Scotland and (b) benefiting advisory services by filling gaps resulting from the weakness or even absence of advisory infrastructures due to public services downsizing policies, such as is the case of the Portuguese berry networks and the 'Adapting seeds to climate change' network in Brandenburg region.

The role of place-based innovation networks for the creation of local knowledge (scientific and synthesised) is underlined by the cases of 'Adapting seeds to climate change' in Brandenburg region, the 'Berry pest monitoring' in the centre-north of Portugal and the 'Monitor Farms' in Scotland.

Cross-country comparison of the cases studies

All the networks involved the cooperation of a varied range of actors, providing examples of multi-actor networks which enhance the farmer's innovation capacity in cooperation with other rural (and non-rural) actors through social interaction and collective learning. The studied networks were all, with the exception of the Italian case, focused on the agricultural sector. The 'Anti-Mafia' was a rural network involving and integrating a diversity of sectors, including social and health care, agriculture and ecological restoration.

None of the selected networks has received support from the respective country's Rural Development Programmes (RDPs). The innovation network for developing climate change adapted seeds (in Germany) and the Monitor Farms in Scotland were funded through national funds. The Portuguese 'Cluster of Small Fruits' (CSF) network was funded by EU structural funds. The NCO cooperatives that constituted the core of the Anti-Mafia innovation network decided to invest in agriculture as a way to give economic sustainability to the network, by reducing its dependency on public funds for health and social services that are often delayed and discontinued. The *Drosophila suzukii* Monitoring (DSM) network case in Portugal was not funded by public or private funds, and depended on the voluntary time and work contributions of the involved actors (researchers, technicians, facilitators and farmers).

A common denominator across the networks studied, with the exception of the Italian case study, is that they all filled gaps in Agricultural Knowledge, Information and Innovation System (AKIS) in the regions and/or sectors in which they are situated. The network studied in the Italian case also filled a gap in the regional/local AKIS (advice for organic farms), although the reasons for the establishment of this network were rather different and broader in comparison with the other case studies. The four cases illustrated quite diverse network models reflecting the agricultural/rural diversity across Europe, the different AKIS at regional/national level, and the diversity of problems and potential solutions that the innovation agricultural/rural networks can address.

The comparison of case studies highlighted that multi-actors' networks are actually able to deliver advisory services within innovative formats that overcome some of the limitations of the conventional advisory systems. They enable multi-topical advice, enhance the farmers' role as creators, co-creators and converters of knowledge, and reduce the distances (geographical and cognitive) between farmers and other actors such as researchers and experts. It also showed that somewhat different network arrangements are possible to address similar problems/solutions. This diversity is due to contextual differences and the available options (e.g. with regards to funding).

Concluding remarks

The set of selected case studies illustrates a diversity of knowledge and innovation networks regarding their goals, structure, and the number of actors and the type of their interactions. However, they all show that multi-actors' networks are in fact an effective tool to bridge the actors from the research chain with the farmers, advisors and other rural stakeholders, by reducing cognitive distances between these heterogeneous actors and valuing tacit and local-based knowledge. How might these ties and interactions be reinforced? The evidence gathered suggests that there are aspects in the network's configuration which influence the farmer's decision to enrol and to develop the ability to learn and innovate in cooperation with other actors. These factors include the following:

- Bottom-up functioning, in spite of the more or less hierarchical structure of the network, bottom-up functioning has shown to be a 'natural' feature of these networks, explained by the way they work, with little degree of formalised ties and interactions, but focused on a well-defined and shared goal.
- The informality of the ties and the interactions is very much valued by their members and allows linking the network with a number of knowledge and information flows related to other formal and informal networks where the actors participate too, increasing the network performance in terms of farmers capacity building for learning and innovating.
- Networks need a good leadership power balance and this tends to rely on previous relational capital amongst the core members of the network, inter-personal and institutional trust, along with personal leadership abilities.
- The networks comprising a high number of actors, in particular when they are heterogeneous e.g. farming styles, cognitive abilities related with learning and innovation, or farming structures, need good facilitators who need to be persons (or entities represented by persons) able to facilitate actors' involvement and their interaction.

The linkage between these knowledge and innovation multi-actor networks and the R&D and advisory service infrastructure, has shown they are often filling the gaps on the regional AKIS, derived from the disinvestment in many of the EU countries on applied research (e.g. the seed trial or the demonstration fields) and on the public advisory services (Knierim et al., 2015). However, they cannot replace these infrastructures and they actually depend on them. Networks filling these gaps, such as the 'Adapting seeds to climate change' in Brandenburg region or the Portuguese berry networks, depend on key actors linked to these infrastructures, evidencing that these are their underpinning support subsystem. The flexibility and informality demanded by the innovation networks is not compatible with using them to replace structures needing regular funding and continuity in their activities.

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References

Asheim, B. (1999). Interactive learning and localised knowledge in globalising learning economies. Geo Journal 49: 345-352.

Audretsch, D. (1998). Agglomeration and the Location of Innovative Activity. Oxford Review of Economic Policy 14: 18-29.

Boenning, K., & Knierim, A. (2014). Designing, implementing and maintaining (rural) innovation networks to enhance farmers' ability to innovate in cooperation with other rural actors. Case study report on a policy-induced agricultural innovation network in Brandenburg. Report for AKIS on the ground: focusing knowledge flow systems (WP4) of the PRO AKIS project. November 2014. Online resource: www.proakis.eu/publicationsandevents/pubs

Caggiano, M. (2014). Designing, implementing and maintaining (rural) innovation networks to enhance farmers' ability to innovate in cooperation with other rural actors. Anti-Mafia innovation network: from land to fork! Report for AKIS on the ground: focusing knowledge flow systems (WP4) of the PRO AKIS project. November 2014. Online resource: www.proakis.eu/publicationsandevents/pubs

Commission of the European Communities (CEC) (2013). State of the Innovation Union 2012 - Accelerating Change. Brussels: Commission of the European Communities, COM (2013), 149 final.

Conroy, C. (2008). The nature of agricultural innovation. In S. Snapp and B. Pound (Eds). Agricultural Systems: Agroecology and Rural Innovation for Development. San Diego, California: Academic Press.

Cooke, P., Uranga, M., & Etxebarria, G. (1997). Regional innovation systems: institutional and organisational dimension. Research Policy 26: 475-491.

Creaney, R., McKee, A., & Prager, K. (2014). Designing, implementing and maintaining (rural) innovation networks to enhance farmers' ability to innovate in cooperation with other rural actors. Monitor Farms in Scotland UK. Report for AKIS on the ground: focusing knowledge flow systems (WP4) of the PRO AKIS project. November 2014. Online resource: www.proakis.eu/publicationsandevents/pubs

Edquist, C. (2005). Systems of innovation: perspectives and challenges. In Fagerberg, J., Moery, D. C. & Nelson, R. R. (Eds). The Oxford Handbook of Innovation pp. 181-208. Oxford: Oxford University Press

EU SCAR (2013). Agricultural knowledge and innovation systems towards 2020 – an orientation paper on linking innovation and research. Brussels.

Hall, A. (2009). Challenges to strengthening agricultural innovation systems: where do we go from here? In I. Scoones and J. Thompson (Eds). Farmer first revisited: innovation for agricultural research and development. Rugby: Practical Action Publishing.

Hartwich, F., & Scheidegger, U. (2010). Fostering innovation networks: the missing piece in rural development. Rural Development News 1/2010: 70–75.

Isaac, M. E. (2012). Agricultural information exchange and organisational ties: the effect of network topology on managing agrodiversity. Agricultural Systems 109: 9–15

Klerkx, L., Aarts, N., & Leeuwis, C. (2010). Adaptive management in agricultural innovation systems: the interactions between innovation networks and their environment. Agricultural Systems 103: 390–400.

Klerkx, L., & Leeuwis, C. (2008). Matching demand and supply in the agricultural knowledge infrastructure: experiences with innovation intermediaries. Food Policy 33: 260–276.

Knierim, A., Boenning, K., Caggiano, M., Cristóvão, A., Dirimanova, V., Koehnen, T., Labarthe, P., & Prager, K. (2015). The AKIS concept and its relevance in selected EU member states. Outlook on Agriculture 44: 29–36.

Kroma, M. M. (2006). Organic farmer networks: facilitating learning and innovation for sustainable agriculture. Journal of Sustainable Agriculture 28: 5-28.

Lundvall, B. (1992). National Innovation Systems: A Comparative Analysis. Oxford: Oxford University Press.

Madureira, L., Ferreira, D., & Pires, M. (2014). Designing, implementing and maintaining (rural) innovation networks to enhance farmers' ability to innovate in cooperation with other rural actors. The berry networks in Portugal. Report for AKIS on the ground: focusing knowledge flow systems (WP4) of the PRO AKIS project. December 2014. Online resource: www.proakis.eu/publicationsandevents/pubs

Madureira, L., Koehnen, T., Ferreira, D., Pires, M., Cristovão, A., & Baptista, A. (2015). Designing, implementing and maintaining agricultural/rural networks to enhance farmers' ability to innovate in cooperation with other rural actors. Final Synthesis Report for AKIS on the ground: focusing knowledge flow systems (WP4) of the PRO AKIS. May 2015. Online resource: www.proakis.eu/publicationsandevents/pubs

Murdoch, J. (2000). Networks – a new paradigm of rural development? Journal of Rural Studies 16: 407-419.

Prell, C., Reed, M., Racin, L., & Hubacek, K. (2010). Competing structure, competing views: the role of formal and informal social structures in shaping stakeholder perceptions. Ecology and Society 15: 34, http://www.ecologyandsociety.org/vol15/iss4/.

Rogers, E. M. (1962). Diffusion of Innovations. New York: Free Press.

Sæther, B. (2010). Agricultural extension services and rural innovation in inner Scandinavia. Norwegian Journal of Geography 64: 1-8.

Schneider, F., Steiger, D., Ledermann, T., Fry, P., & Rist, S. (2012). No-tillage farming: co-creation of innovation through network building. Land Degradation & Development 23: 242–255.

Scoones, I., & Thompson, J. (1994). Knowledge, power and agriculture: towards a theoretical understanding. In I. Scoones and J. Thompson (Eds) Beyond Farmer First: Rural People's Knowledge, Agricultural Research and Extension Practice pp 16-32. London: Intermediate Technology Publications.

Wood, B. A., Blair, H. T., Gray, D. I., Kemp, P.D., Kenyon, P.R., Morris, S. T., & Sewell, A. M. (2014). Agricultural Science in the Wild: A Social Network Analysis of Farmer Knowledge. PLoS ONE 9(8): e105203. doi:10.1371/journal.pone.0105203

New knowledge networks of small-scale farmers in Europe's periphery

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Abstract: In this paper we assess the integration of new entrants to small-scale farming into agricultural knowledge and innovation systems (AKIS), in four study sites located on Europe's periphery (Bulgaria, Poland, Portugal, and the United Kingdom). Utilising qualitative case studies undertaken in 2013, we assessed the knowledge acquired to inform three new activities being undertaken by study participants: agricultural production; subsidy access and regulatory compliance; and farm diversification (specifically agritourism). Findings were assessed in relation to network structure, demonstrating clear patterns in new knowledge access: formal 'agricultural advisors' identified in the case studies were sought primarily for codified managerial knowledge which was delivered through centralised networks. In contrast, production and diversification knowledge were exchanged through 'distributed' and 'decentralised' networks, where a range of actors were involved across varying geographical distances. Findings thus suggest that state-funded services for small-scale farmers are largely embedded in traditional, linear models of knowledge transfer, and confirm earlier research that small-scale farmers are under-serviced by formal advisory services. However, new entrants employ more flexible, multi-actor approaches to production and diversification, much of which was 'free' in terms of financial cost, but not necessarily freely available to those without substantive social capital lodged in communities of place and practice. In all four cases, we found that small-scale farmers utilise formal advisory services primarily for accessing subsidies (e.g. completing application forms), rather than acquiring production knowledge. The authors argue that by utilising the limited state funding allocated to advisory services for small-scale farmers primarily to enable these farmers to access subsidies, important opportunities for the 'generation of space for innovation' can be lost.

Key words: AKIS, farm advisory services, networks, new entrants, PRO AKIS

Introduction

Small farms play key roles in maintaining the environment, society (including employment) and culture (preserving traditions, manufacturing traditional products), as well as creating favourable conditions for animal welfare (European Parliament resolution of 4 February 2014 on the future of small agricultural holdings (2013/2096(INI), 2014). These contentions are supported by special provisions within the European Union's Rural Development Programme (RDP) to promote farm development and business diversification (e.g. the Small Farmer Scheme and RDP funding to provide economic development advice to small-scale farmers, European Commission, 2013). Despite this recognised importance of small-scale farming, structural changes in European agriculture favour larger-scale farms (Zegar, 2012; European Commission, 2011). Smaller scale farms not only lack economies of scale, they are more likely to be occupied by older, less business-oriented farmers (Zagata & Sutherland, 2015) and frequently represent semi-subsistence farms (Davidova et al., 2013), which function primarily as buffers against poverty rather than as productive commercial businesses.

Widespread privatisation of agricultural advisory services across Europe in recent decades has further disadvantaged small-scale farms: as Kidd et al. (2000) point out, private advisory services may disproportionately serve those who can afford them (i.e. larger scale farms). In line with this, Labarthe & Laurent (2013) argue that reduction in public extension services across Europe has disproportionately impacted on small-scale farms, which are less visible as clients. A review of the Farm Advisory Services similarly found that the main beneficiaries were large-scale farms (European Commission, 2009). The Farm Advisory Service (FAS) review also found that in 14 member states, advice on Cross Compliance was the sole focus of the FAS (European Commission, 2009). The FAS review thus implies a transition towards advisory services focused on 'managerial knowledge' (i.e. the knowledge and skills to manage resources, grants, legislation and bureaucracy, (Koutsouris, 2008), rather than adoption of new technologies. The report thus provides evidence that in many European countries the role of the FAS in 'generating spaces for innovation' is limited to enabling access to funding.

Although important, access to the FAS represents only one aspect of contemporary agricultural knowledge systems. Agricultural innovation is conceptualised as occurring through networks, including entrepreneurs, researchers, consultants, policy makers, suppliers, processing industries, retailers and customers. Recent research has emphasised that both local knowledge and scientific knowledge are important for achieving sustainability in agricultural systems (Curry & Kirwan, 2014; Kania & Kapłon, 2014; Labarthe & Laurent, 2013). Instead, innovation and up-take of new farming technologies or practices are widely accepted as resulting from iterative engagement in nonlinear knowledge networks or systems.

In this paper, we focus on newly established knowledge networks of small-scale farmers. Integration into new networks for the purpose of gaining knowledge suggests active intentions to change farming practices, adopting new or established innovations. To ensure the assessment of new knowledge networks, the research focused primarily on new entrants to small-scale farming. The research is structured to address the types of knowledge small-scale farmers access, the types of networks characterising these new networks and the role of formal advisory services in these networks. We demonstrate this through research on three major knowledge topics: commodity production; access to subsidies and business diversification knowledge (specifically agritourism).

Conceptualising new knowledge networks

The concept of 'agricultural knowledge and information systems' (AKIS) was developed and widely popularised in the 1980 and 1990s, comprising the idea that farmers exchange and produce knowledge in conjunction with a number of sources, which include research, agricultural advisors, and education/training and support services (Röling, 1988; Röling & Wagemakers, 1998). Röling & Endel (1991) defined AKIS as:

> "The persons, networks and institutions, and the interfaces and linkages between them, which engage in or manage the generation, transformation, transmission,

storage, retrieval, integration, diffusion and utilisation of knowledge and information, and which potentially work synergistically to improve the goodness of fit between knowledge and environment, and the technology used in agriculture".

In recent years the AKIS concept has been appropriated to address European policy concerns about innovation, and re-termed 'agricultural knowledge and innovation systems', reflecting an ideological shift towards innovation (Dockès et al., 2011). Within the overall AKIS concept, a number of different conceptualisations of information, knowledge, types of knowledge and innovation can be operationalised (i.e. the AKIS construct is overarching, rather than presenting an established conceptual approach). When assessing knowledge exchange and development, two general forms of knowledge are typically identified: tacit (implicit) and codified (explicit) knowledge, a distinction which can be traced back to Polanyi (1958). Implicit knowledge or 'know how' is acquired through practise and experience, and is not necessarily related to cognitive learning (e.g. riding a bicycle). In contrast, explicit or codified knowledge can be easily reported and documented (e.g. through scientific reports), although it may require translation into more adapted knowledge, suited to practical application (EU SCAR, 2012). Nonaka and Toyama (2003) identified four types of knowledge creation which ideally follow on from and build upon each other:

- Tacit or implicit knowledge is acquired through *socialisation,* which means that the learning person is directly and actively exposed to an environment that induces personal experiences (i.e. 'hands-on learning').
- Through communication about these experiences, tacit knowledge is articulated and becomes explicit – a step that is called *externalisation*.
- Sharing this explicit knowledge with knowledge from other people, systemising and integrating it, requires *combination* activities.
- Then, using the explicit and combined knowledge practically in new situations induces a fourth 'embodying' step, called *internalisation,* where the (new) knowledge becomes tacit or implicit at a higher level (Nonaka & Toyama, 2003)

As such, tacit knowledge most easily spreads within social networks, which enable the collective sharing of ideas and activities for common aims. In contrast, codified knowledge translates mental frameworks into symbols, and is therefore more easily made explicit (e.g. through textbooks and websites) (Knickel et al., 2008).

The different types of knowledge are associated with different types of network. Smedlund (2008) draws on Baran (1964) and Barabási (2002) to identify three primary types of networks, which link to different types of knowledge. Centralised networks, featuring a central node through which all knowledge flows, are most useful for 'routine problem solving' (e.g. explicit, standardised knowledge, such as advice on general regulatory issues). Codified knowledge is most likely to be transmitted in this type of network, representing 'know why' and 'know what'. A central node can channel this information (e.g. an agricultural advisor), or individuals can access it directly, through transmittable sources such as books and websites. In contrast, 'distributed networks' are dense networks of ties where primarily tacit knowledge is exchanged. Distributed networks resemble 'communities of practice' or 'networks of practice' (e.g. peers who exchange personal knowledge to varying degrees). As such, these networks depend on 'social capital' – simply defined as "networks together with shared norms, values and understandings that facilitate co-operation within or among groups" (OECD, 2001:41). The third type is decentralised networks, with multiple nodal points connecting diverse individuals. Decentralised networks thus involve knowledge from outside of peer groups to connect disparate groups and their associated knowledge. Smedlund (2008) associates this type of network with the acquisition of what he terms 'potential knowledge' (e.g. of future or cutting edge innovations). Gatekeepers link diverse groups; brokering these boundaries can be an important function. These types of networks are characterised as being in constant change and asymmetric, as the actors involved have considerable differences (e.g. business size). Klerkx & Proctor (2012), in their empirical application of Smedlund's work, found that the distinctions are less distinct in practice.

Methods

In this paper, we assess the knowledge embedded in new farming networks in four contrasting case studies in Poland, Bulgaria, Portugal and the United Kingdom. The cases were selected as part of the PRO AKIS (Prospects for Farmer's Support: Advisory Services in European AKIS) 7th Framework Project, funded by the European Commission. The selected case studies addressed a diverse range of small-scale farmers. They include new-entrants and semi-subsistence farmers in Plovdiv region, Bulgaria; small-scale farmers diversifying into agritourism in the Carpathian Mountains of Poland; newly established small-scale blueberry producers in the central-north region of Portugal; and new-entrants to crofting on the west coast of Scotland (UK). The four cases have in common the establishment of new knowledge networks[1], as well as the small scale of the farms involved relative to national farming characteristics. We have not attempted to standardise a definition of small-scale farming, utilising instead the accepted definitions of small-scale farming in the study sites. As Davidova et al. (2013) note, there is no commonly accepted definition of a small-scale farm.

Table 1: Study participants

	Farming participants	Stakeholders/ Key Informants	Age range of farmers	Farm size	Main Activities
Bulgaria	17	4	Under 40	3-6 ha	Mixed horticulture
Poland	15	5	All ages	3-9 ha	Agritourism
Portugal	25	6	Under 40	Less than 1.5 ha	Blueberries
United Kingdom	21	8	All ages	0-20 ha plus common grazing	Mixed livestock, horticulture, diversification (including agritourism)

Owing to the differences in land capability, the definition of small-scale farming applied in this research ranged from less than 1.5 ha in Portugal to less than 20 ha in the United Kingdom (not including access to common grazing of over one hundred ha in some cases). The case studies also represent different 'types' of small-scale farm: semi-subsistence farms were most common in the Bulgarian case, small-scale commercial farms particularly evident in the Portuguese case and to a degree in the other three countries, and hobby farming - more

[1] In the UK, Portuguese and Bulgarian cases, the farmers interviewed were new entrants. In the Polish case, the study was of existing farmers who had recently diversified into tourism provision i.e. new entrants to agritourism, rather than farming per se.

common in the UK case. Owing to the diversity of production systems across the four cases, not all case studies explored networks relating to all three topics. A joint analytical framework was developed collaboratively by the researchers to ensure that the interviews had sufficient similarity in terms of topics covered for comparative analysis. Findings were analysed qualitatively according to the analytical framework, and compiled into English-language reports which followed a standard template (www.proakis.eu). This paper is based on those reports.

Case studies

In all four cases, research was undertaken in regions where there are larger scale farms, but small-scale farms are common. In all of the cases, both public and private advisory services serve small-scale farms as a subset of the total farming population in the associated region. For further information on each individual case, see the PRO AKIS website (www.proakis.eu).

In Bulgaria, the case study focused on young people accessing RDP funding to establish new farms (typically small-scale vegetable or orchard production) in Plovdiv Region. Owing to the restrictions on new entrant supports (Measure 112), the study participants were all less than 40 years old with newly established farms and were undertaking farming on a full-time basis, primarily on rented land. The average size of the farms in the region is about 6.8 ha.

Figure 1: Location of case study regions (Source: Maduriera *et al*., 2014)

In Portugal, the case focused on new entrants who were taking up small-scale soft-fruit production (i.e. blueberries) in central northern Portugal. The crop was introduced to the region in the 1990s, with limited success. Efforts were renewed in the late 2000s, through initiatives developed by local governments to utilise RDP Measure 112 to address unemployment and land abandonment. Owing to the small geographical scale of most horticultural enterprises, to identify small-scale farms the Portuguese sample was restricted to small-scale blueberry producers with less than 1.5 hectares, earning less than 25,000 Euros/year from agricultural production, and who had established their farm post-2007, with at least one harvest. These farmers market their produce collectively into international markets, certified by GlobalGAP.

In Poland, the research focused around advisory service provision to small-scale farms which were developing agritourism enterprises in the Carpathian Mountain region. The participants in the Polish case were located in three Carpathian provinces (Malopolska, Podkarpackie and Silesia) and selected to represent a range of agritourism providers which had been operating for between 3 and 16 years.

In the United Kingdom, the case study centred on new entrants to crofting, a traditional form of small-scale farming (typically involving sheep and cattle production, but also tourist accommodation and market gardening) on the islands of Skye, Harris and Lewis (Scotland). Participants could be of any age, but were selected on the basis that they had occupied a legally established croft for less than 12 years.

Characterising new knowledge networks

The research focused on knowledge networks associated with three topics: state grants and subsidies, commodity production, and diversification into agritourism. It is important to note that all of the farmers in the study accessed a number of different sources of knowledge. The associated networks evolved over time, typically starting with a single entry point, based on recommendations from family or neighbours. As such, the networks presented here overlap and have been simplified for presentation purposes.

Accessing grants and subsidies

Knowledge enabling access to subsidies can be termed 'managerial' knowledge (Koutsouris, 2008), in that it relates primarily to completion of administrative forms. Subsidies accessed included measures to support young farmers, subsistence farming, agri-ecological measures, diversification, local development and the single farm payment. Assistance with completing these applications was usually supplied on a one-to-one basis with a formal agricultural advisor, typically working either for the state advisory service or a private advisory company. In a few cases the applications were completed by NGOs (e.g. environmental charities assisting with applications for agri-environmental grants). For both private and public sector advisory services, the applicant typically had to pay a fee or percentage of the resultant grant to the advisor. The exception was Bulgaria, where public advisory services provide this assistance cost-free, but payment is required for use of private consultancy companies.

Knowledge of state subsidies represents 'codified knowledge', with the guidance notes and application forms publically available through websites. Owing to the perceived complexity of these applications, the small-scale farmers in this study typically opted to have experts complete their forms for them. This was despite the online availability of information and a high level of educational achievement; participants also reported working with advisors out of fear of making mistakes, not wishing to jeopardise an important source of farm income. The function of the advisory services thus becomes to 'translate' the codified knowledge available on state websites into usable form, which then led to successful applications. Form completion is offered as a service - the advisor simply completes the form using data garnered from consultations with the farmers involved and their own tacit knowledge; *externalisation* of this tacit knowledge and translation into a form usable by the farmer does not appear to occur -

the skill of form completion remains with the advisor. As such, the networks formed are centralised in nature, with advisors acting as central knowledge hubs. The farmers involved thus return annually for similar services.

Small-scale farmers have a choice of who to go to for assistance in accessing subsidies and grants (i.e. 'know who'). For those establishing new farm holdings, this is often the first point of entry into formal knowledge systems; new farmers typically act on recommendations of family members and neighbours, who base their recommendation on the successfulness of their own past applications (i.e. 'know who' based on reputation for 'who how'). Facilitating subsidy access was the primary use of state agricultural advisory services by study participants: state-funded[2] advisors in Bulgaria, Poland and the UK reported spending the majority of their time on these tasks. In Portugal their role was minimal, owing to a very limited availability of state advisory services in general. In each of the countries, private advisors also offer these services, utilising different fee for service models. In Bulgaria and Portugal, fees for service are based on the success of the grant application – payment is proportionate to the amount of funding received, whereas in Scotland, there is a one-off fee for the application. In both cases, the fee for service creates an incentive to write a fundable application, rather than one which particularly suits the farm set-up or farmer's skill, owing to the desire for customer retention. There is also an incentive to go with 'tried and true' options (i.e. a tendency not to innovate), as evaluators are more likely to fund established approaches.

Accessing production knowledge

In contrast to subsidy access, there is a wide variety of means to access production advice, including formal education, training courses, open days, work experience, magazines, books and through the internet. Study participants also accessed advice from public, private and NGO-funded agricultural advisors, agricultural pharmaceuticals stores, neighbouring farmers, family members with agricultural experience, accountants or accounting companies, seedlings importers, processors, scientific institutes, producer associations and non-governmental associations. This section presents findings from the Bulgarian, Portuguese and UK case studies.

By far the most common source of production knowledge in the Bulgarian and UK sites was friends and neighbours (i.e. tacit lay and local knowledge). As such, the knowledge was located primarily in distributed networks of dense interpersonal ties. Portugal was an exception because blueberry production is new to the region – there was therefore limited local knowledge on which to draw. In this case, the creation of an education and mentoring group (the 'Small-Fruits Cluster' (SFC)) by farm business organisations and profit and non-profit producers groups, translated and disseminated knowledge to new entrants. Because the blueberries were marketed jointly at national level, poor standards of production in the study site were negatively impacting on the overall reputation and quality of Portuguese blueberry production, marketed jointly through GlobalGAP; experienced farmers from southern Portugal were thus motivated to act to address this problem in central Portugal, forming and participating in a decentralised network.

[2] Although the former state-funded advisory services in the UK are now largely privatised, SAC in Scotland continues to receive a block grant from the Scottish Government to subsidise advisory service provision in remote rural areas.

In all three sites, provision of production advice was a secondary activity for state-funded advisory services. In both Portugal and Bulgaria, advice on production was part of the ‘package’ of services available to participants who had already achieved RDP funding. However, almost all of the Bulgarian respondents indicated that although they retained their relationships with their formal advisors for advice on business planning and project implementation, they were not using them for their production activities. In Portugal, the study participants indicated that they would have liked to access production advice from the state advisory sources (i.e. it was a trusted source) but this was no longer available. The quality of production advice provided by private consultants to the blueberry producers in the Portuguese case study was highly questioned, owing to their lack of practical experience: the advisors were perceived as invested in securing the success of the application, but were less concerned about choice of varietals or adapting the business plan to land capability, leading to substantial complaints by study participants. Instead, the SFC was specifically established to address the problem of poor quality production knowledge being transferred from private advisors to new entrant farmers. In Scotland, state-funded agricultural advisors were more likely to be identified as credible sources of knowledge relating to production, because many of the advisors were operating their own crofts. They thus achieved credibility through a combination of codified and tacit knowledge, although in some cases this tacit knowledge was not deemed sufficient to address location-specific production issues. When small-scale farmers did access advisory services for assistance with production, it was typically to acquire specific pieces of codified knowledge, such as soil analysis. State advisory services in Scotland and Bulgaria were also involved in facilitating the spread of tacit and codified knowledge through group events (e.g. farm open days). In Portugal this function was fulfilled by farming organisations. As such, advisors were involved in knowledge brokering, enabling the *externalisation* of tacit knowledge through targeted *combination* activities.

A further issue for small-scale farmers was the cost of advice. Study participants reported that private consultancy companies are not often accessed by small farmers for production advice because it is perceived as expensive. Instead, input suppliers, such as agro-pharmacy stores, accounting companies and import trade organisations are accessed. In Bulgaria, there is an agro-pharmacy store in almost every village and small-scale farmers use such stores not only for acquisition of the required inputs but also for consultancy on various diseases or pests on the plants they grow. These consultancies are generally cost-free, but linked to purchase of recommended inputs. As trained agronomists located in the local community, they combined tacit and codified knowledge, and were part of the farmers’ distributed networks.

This combination of tacit and codified knowledge was similarly sought out when accessing the expertise of friends and neighbours. A pattern of overlapping roles, or ‘hybrid knowledge’ amongst chosen local advisors was observed. For instance, recently some of the longer term Portuguese blueberry producers have become private advisors and/or project developers and may also be members of the board of a farmers’ association. Consequently, the same individual often acts as a facilitator, a supplier and a demander of knowledge and expertise within the network – thus engaging with multiple roles in the distributed network. In the UK site, local veterinarians who are also crofters can provide this combined knowledge. The distributed networks characteristic of production knowledge networks thus include a range of actors, primarily based on tacit knowledge but also including a degree of codified knowledge. However, this knowledge was not automatically available to everyone who wished to join the networks, particularly in the Scottish case; longer term crofters were not always willing to share their expertise with newcomers. In these cases, social capital associated with long-standing family relationships was necessary to activate these connections.

Within this range of actors in the network, knowledge of recent scientific or technological advances is peripheral – relatively few innovations in production were introduced. The knowledge exchanged by farmers was primarily tacit (i.e. the ‘know how’ associated with animal husbandry and horticultural production). However, in some cases, farmers also sought codified knowledge directly from source material (e.g. blueberry producers searched for new varietals online).

Accessing knowledge about farm diversification

In the cases studied, provision of tourist accommodation was the most common form of diversification, but ‘agritourism’ can also include tourism packages, educational farms, and farms for children and seniors. We focus here on knowledge relating to developing tourist activities and marketing. Knowledge on these topics can be acquired through individual consultations, workshops, study trips, training, and cooperative networks. In this section, the data comes from the Poland and UK case studies.

The two cases represent opposite extremes in terms of organised state involvement. In Poland, the National Agricultural Advisory Centre – a governmental institution subject to the Minister of Agriculture and Rural Development - is responsible for collecting and processing knowledge, and then transferring it to advisory institutions that directly interact with farmers. The Branch of Agricultural Advisory Centre in Krakow has specific responsibility for both rural tourism and agritourism. Knowledge related to agritourism and innovative activities are transferred initially to specialists at provincial Agricultural Advisory Centres, as well as representatives of Agricultural Chambers, agritourism associations, and, since 2004 (when Poland joined the EU), with Local Action Groups. There is thus a largely centralised network within the Polish advisory system, which transfers knowledge between divisions and ultimately to farmers directly on an individual basis. However, the National Agricultural Advisory Centre also works to establish decentralised networks: every two years it brings together a wide range of organisations for an agritourism conference. There is also some evidence of decentralised networks facilitated by agritourism providers’ associations, which organise fairs, conferences and exhibitions. Distributed networks of agritourism providers do not appear to exist, partly because of the distance between agritourism operations but also because immediate neighbours would be in competition with each other. Instead, both tacit and codified knowledge are accessed through a combination of centralised and decentralised networks.

In contrast, knowledge exchange in the Scottish case is almost completely separated from the state-funded agricultural advisory system. The exceptions are a small number of developments which have been facilitated through the Scottish Rural Development Programme. Instead, tourism activities undertaken by farming participants are developed on a largely *ad hoc* basis, through decentralised networks, which include formal business development advice provided by rural development agencies, accountancy advice on tax, architectural services, group marketing through the Scottish Crofting Federation, and informal connections to agritourism providers in other regions. These can be providers in other parts of Scotland through the Scottish Crofting Enterprise website or connections within the previous locales of the new entrant crofters. Specific knowledge on diversifying into tourist accommodation appears to be obtained partly through 'trial and error' (i.e. *socialisation*), whereby the accommodation is constructed and lessons subsequently learned through market experimentation. Respondents also frequently drew on networks and skills established before becoming crofters (ranging from joinery to previous tourist service provision). In terms of the networks accessed, these are numerous and relatively informal, in so much as it likely that each crofter involved in diversification has a different network which they interact with for knowledge exchange. As such, networks are decentralised.

Concluding discussion

The study confirms earlier findings that small-scale farmers are under-serviced by formal advisory services (Kidd et al., 2000; Labarthe & Laurent, 2013). When these formal advisory services do interact with small-scale farmers, it is primarily to enable access to government funding, through top-down service provision in centralised networks. As a result, there is limited scope for innovation in terms of the method of interaction, or the originality of the associated application. Findings are also consistent with Ingram (2008) and Sutherland et al., (2013) who argue that privatisation of advisory services puts pressure on advisors to develop grant proposals which are more suited to the farmers' preferences than achieving the aims of the grant application. In addition, this one-to-one method, with the expertise retained by the advisor, reinforces historic top-down knowledge transfer patterns, which Smedlund (2008) argues are not suited to most forms of innovation.

In seeking production knowledge, the participants in this study often relied on 'hybrid actors': individuals with both codified and tacit knowledge. Although presented as cost-free, this knowledge typically comes at a price. Input suppliers, for instance, are typically trained agronomists, who have knowledge of what inputs are available and but offer advice oriented towards product sales. However, Sutherland et al., (2013) found that the commercial, NGO or private status of the source of advice was less important, in terms of credibility and trust, than the history of positive interactions with the advisor in question. Similarly, Kaberis & Koutsouris (2012) found that the trust could develop over time, particularly in situations where inputs were changing rapidly (e.g. new regulations and changing pesticide needs). Input suppliers offering biased production knowledge will not retain trust, although the subtleties between different potential recommendations may not be observed.

The selection of advisors – both formal and informal – thus appears based on a combination of personal relationships and access (both in terms of cost and physical proximity). Other local experts included retired veterinarians and former collective farm employees, who similarly combined tacit and codified knowledge. Although this advice was also cost-free it was not necessarily freely available, requiring social capital to access in some cases. Individuals require reasons to share their commercial business knowledge, particularly with potential competitors. In the Portuguese case, expert farmers were motivated to provide assistance to newcomers because their markets were threatened by the newcomers' poor quality production. Scottish farmers were more reluctant to share their knowledge, until the new entrants demonstrated willingness to undertake experiential learning through group events (i.e. to engage in *socialisation*). Small-scale farmers themselves were sometimes hybrid actors, bringing considerable knowledge to farming from off-farm employment or training. This was particularly important for diversification of the farm business, enabling them to make the 'bridging' connections characteristic of decentralised networks. We suggest that there is scope for considerable further development of these resources within agricultural innovation systems, through providing training and opportunities for these recognised local leaders, and facilitating mentoring activities.

Limitations

The number of study participants involved with formal advisors represents the deliberate sampling strategy of the researchers, rather than a feature of small-scale farms in the study sites. Owing to the overall focus of the PRO AKIS project, participants were primarily those who had accessed formal advisory services (public, private or NGO funded). As such, the participants as a whole represent 'active knowledge seekers'. However, the advisors interviewed for this study concurred that the majority of small-scale farmers in all four of the study sites had no engagement with state or private agricultural advisory services. We therefore assessed how those small-scale farmers who do engage with advisory services structure these interactions, in relation to other sources of knowledge. The cases are also very different. Although qualitative research by nature is not generalisable, identifying similar findings in cases located in four corners of Europe suggest that the issues identified are not limited to the case study sites.

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References

Curry, N., & Kirwan, J. (2014). The role of tacit knowledge in developing networks for sustainable agriculture. Sociologia Ruralis 54: 341-361.

Davidova, S., Dwyer, J., Erjavec, E., Gorton, M., & Thomson, K. (2013). Semi-subsistence farming – value and directions of development. European Parliament, Directorate-General for Internal Policies Policy Department B Structural and Cohesion Policies. Agricultural and Rural Development. Retrieved from http://www.europarl.europa.eu/RegData/etudes/etudes/join/2013/495861/IPOL-AGRI_ET(2013)495861_EN.pdf

Dockès, A-C., Tisenkopfs, T., & Bock, B. (2011). Reflection paper on AKIS. Accessible at: http://ec.europa.eu/research/agriculture/scar

European Commission. (2009). Report from the commission to the European Parliament and the Council on the application of the Farm Advisory System as defined in Article 12 and 13 of Council Regulation (EC) No 73/2009. Retrieved from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0665:FIN:en:pdf

European Commission. (2013). CAP Reform – an explanation of the main elements. Memo, Press Release Database. Retrieved from http://europa.eu/rapid/press-release_MEMO-13-621_en.htm

European Commission, Agriculture and Rural Development. (2011). What is a small farm? EU Agricultural Economic Briefs, Brief No 2. Retrieved from http://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCMQFjAAahUKEwiIluPF64TGAhXDWhQKHdOlAFs&url=http%3A%2F%2Fec.europa.eu%2Fagriculture%2Frural-area-economics%2Fbriefs%2Fpdf%2F02_en.pdf&ei=_gZ4VaWfHsO1UdPLgtgF&usg=AFQjCNEcM6vdfPMLdwJ1kv9ThKlAjLObWQ

European Parliament. (2014). European Parliament resolution of 4 February 2014 on the future of small agricultural holdings (2013/2096(INI)) Retrieved from http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P7-TA-2014-0066+0+DOC+XML+V0//EN

European Parliamentary Research Service. (2014). Future of Small Farms. Retrieved from http://epthinktank.eu/2014/02/15/future-of-small-farms/

EU SCAR. (2012). Agricultural knowledge and innovation systems in transition – a reflection paper, Brussels. Retrieved from file:///C:/Users/ls40359/Documents/Papers/Smallscalefarming/EUSCAR2012.pdf

IFAD. (2014). Legacy of IYFF 2014 and the way forward. Retrieved from http://www.ifad.org/events/iyff/legacy.pdf

Ingram, J. (2008). Agronomist-farmer knowledge encounters: an analysis of knowledge exchange in the context of best management practices in England. Agriculture and Human Values 25: 405-418.

Kaberis, N., A Koutsouris, A. (2012) Reflections on the 'expert syndrome': a Greek case study on extension education. In: Producing and reproducing farming systems: new modes of organisation for sustainable food systems of tomorrow (10th European IFSA Symposium), Aarhus, Denmark, 1-4 July 2012.

Kania, J., & Kapłon, A. (2014). Zrównoważenie produkcji rolniczej w wybranych gospodarstwach województwa małopolskiego (Sustainability of Production in Selected Agricultural Holdings in the Malopolska Province). Roczniki Naukowe SERiA XVI: 134-140.

Kidd, A.D., Lamers, J.P.A., Ficarelli, P.P., & Hoffmann, V. (2000). Privatising agricultural extension: caveat emptor. Journal of Rural Studies 16: 95-102.

Klerkx, L., & Proctor, A. (2012). Beyond fragmentation and disconnect: networks for knowledge sharing in the English land management advisory system. Land Use Policy 30: 13-24.

Knickel, K., Brunori, G., Rand, S., & Proost, J. (2008). Towards a better conceptual framework for innovation processes in agriculture and rural development: from linear models to systemic approaches. 8Th European International Farming Systems Conference Proceedings. Clermont-Ferrand, France.

Koutsouris, A. (2008). The battlefield for (sustainable) rural development: the case of Lake Plastiras, Central Greece. Sociologia Ruralis 48: 240-256.

Labarthe, P., & Laurent, C. (2013). Privatization of agricultural extension services in the EU: towards a lack of adequate knowledge for small-scale farms? Food Policy 38: 240-252.

Madureira, L., Koehnen, T., Pires, M., Ferreira, D., Cristóvão, A., & Baptista, A. (2015). Advisory services for small-scale farmers: how effective are their responses to farmer needs and demands? WP 4 – AKIS on the ground: focusing knowledge flow systems. Topic 1 Synthesis Report. Retrieved from www.proakis.eu

Nonaka, I., & Toyama, H. (2003). The knowledge-creating theory revisited: knowledge creation as a synthesizing process. Knowledge Management Research & Practice 1: 2-10.

OECD, (2001). The well-being of nations. The role of human and social capital. Centre for Educational Research and Innovation. Organisation for Economic Co-operation and Development. Retrieved from http://www.oecd.org/site/worldforum/33703702.pdf

Polanyi, M. (1958). Personal Knowledge. Towards a Post-critical Philosophy. London: Routledge & Kegan Paul.

Röling, N.G. (1988). Extension science: information systems in agricultural development., Cambridge: Cambridge University Press.

Röling, N.G., & Engel P. (1991). IT from a knowledge system perspective: concepts and issues. The Edited Proceedings of the European Seminar on Knowledge Management and Information Technology. Kuiper, D, Röling ,N. (Eds) pp. 10. Department of Extension Science, University of Wageningen, The Netherlands,

Röling, N.G., & Wagemakers, M.A.E. (Eds) (1998). Facilitating Sustainable Agriculture: Participatory Learning and Adaptive Management in Times of Environmental Uncertainty. Cambridge: Cambridge University Press.

Smedlund, A. (2008). The knowledge system of a firm: social capital for explicit, tacit and potential knowledge. Journal of Knowledge Management 12: 63–77.

Sutherland, L-A. (2015). EIP-Agri Focus Group. New Entrants into farming: lessons to foster innovation and entrepreneurship. Discussion Paper. Retrieved from https://ec.europa.eu/eip/agriculture/sites/agri-eip/files/fg14_new_entrants_starting_paper_2015_en.pdf

Sutherland, L-A., Mills, J., Ingram, J., Burton, R. J. F., Dwyer, J., & Blackstock, K. (2013). Considering the source: commercialisation and trust in agri-environmental information and advisory services in England. Journal of Environmental Management 118: 96-105.

Zagata, L., & Sutherland, L-A. (2015). Deconstructing the 'young farmer problem in Europe': towards a research agenda. Journal of Rural Studies 38: 39-51.

Zegar, J.S. (2012). Rola drobnych gospodarstw rolnych w procesie społeczniezrównoważonego rozwoju obszarów wiejskich (The role of small farms in the socially sustainable development of rural areas). Problems of Small Agricultural Holdings 1, pp. 129-148. University of Agriculture in Krakow.

Stimulating innovation opportunities through shared and unique connections of intermediaries within advisory networks

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Abstract: Agricultural advisers are key intermediaries embedded within complex knowledge networks comprised of farmers and a range of private, industry and government stakeholders. Privatisation of extension increases opportunities for market based extension services while changing the role of government and creating new challenges for knowledge sharing within networks. While privatisation of extension has received considerable attention with respect to implications for public and private good, less consideration has been given to structural and relational implications for knowledge sharing. This study therefore considers the question 'how is knowledge sharing enabled in privatised extension networks?' To examine this question an empirically based case study was undertaken involving five industry extension advisers, referred to as Regional Extension Coordinators (RECs). This team was set up two years ago by Australia's dairy industry peak body, Dairy Australia, to fill a gap in extension coordination and services left by the withdrawal of government extension services. Social network analysis in combination with qualitative data was used to identify the knowledge sharing relationships of RECs within their team as well as each REC's individual extension network. Findings show that the composition of each Regional Extension Coordinator's (REC's) network reflects differences in their professional backgrounds, for example whether their previous roles were in government or agribusiness. Knowledge sharing opportunities for the REC team include creating opportunities to access each other's unique contacts, identifying team strategies for working efficiently with contacts they have in common, and developing approaches for working more effectively with network contacts considered 'not very enabling'.

Keywords: Adviser networks, relationships, knowledge sharing, Australian dairy extension

Introduction

Agriculture extension provides critical support for farm productivity and knowledge sharing (Faure, et al., 2012; Pragar et al., 2016). The public sector has traditionally been responsible for extension delivery due to assumed 'public good' value and benefit (Umali-Deininger, 1997). While extension has and continues to play a vital role in supporting adoption of innovation and technology, its economic and social value are difficult to measure in practice (ibid). Globally, neoliberal policy and a 'user pays' ideology have driven structural transformation of extension services in favour of pluralised, privatised, competitive market based options that reduce government investment (Klerkx, et al., 2006; Hunt et al., 2012; Cristóvão et al., 2012; Knuth & Knierim, 2013; Pragar et al., 2016).

The process and pace of transition from public to privatised extension has varied globally and by sector. The Australian dairy sector supported a combination of public and private extension for longer than many other farming sectors, however since 2014 Dairy Australia (DA) has taken greater responsibility for industry extension using a farmer levy funded delivery model referred to as the 'regional interface'. This is now the structure through which resources are invested in the leadership, planning, coordination and engagement activities to drive adoption of innovation on regional dairy farms (Dairy Australia – Adoption and Innovation Strategy Information Paper. July 2013, p 208). The 'regional interface' includes both public and private sector providers delivering extension services to ensure farmers have access to the information, tools, methods and capability needed to run successful dairy farm businesses and ensure the industry continues to be vibrant and successful (ibid). While economic concepts of public good, private good and market failure continue to be debated with respect to extension, there is limited attention given to implications of structural and relational reorganisation of extension services driven by business principles and specific terms of exchange. Attention to structural and relational opportunities and constraints in increasingly pluralised extension networks is important for addressing rising challenges of collaboration and coordination between extension actors representing multiple institutional contexts (Klerkx & Nettle, 2013). The coordination of privatised extension providers to serve the needs of a diverse range of farmers creates new facilitation and brokering challenges for advisers (Koutsoursis, 2012) and the need to understand how individuals and organizations within their extension networks are connected. This study is an empirical examination of structural and relational opportunities and constraints within a recently established, industry funded extension team whose role is to foster coordination of dairy extension delivery across the state of New South Wales, Australia. Using a mixed methods approach combining social network analysis and qualitative data, the case study of five members of the Dairy Australia Regional Extension Coordinator team (New South Wales) was carried out in 2016 based on the research question "how is knowledge sharing enabled in privatised extension networks?

Context: location and people

Location

The study is focused on a team of five Regional Extension Coordinators working within dairy production regions of New South Wales (NSW) comprised of three coastal and two inland regions (see Figure 1). These dairy regions are geographically dispersed and situated in areas with fertile soils, flat to undulating land contour and good access to water.

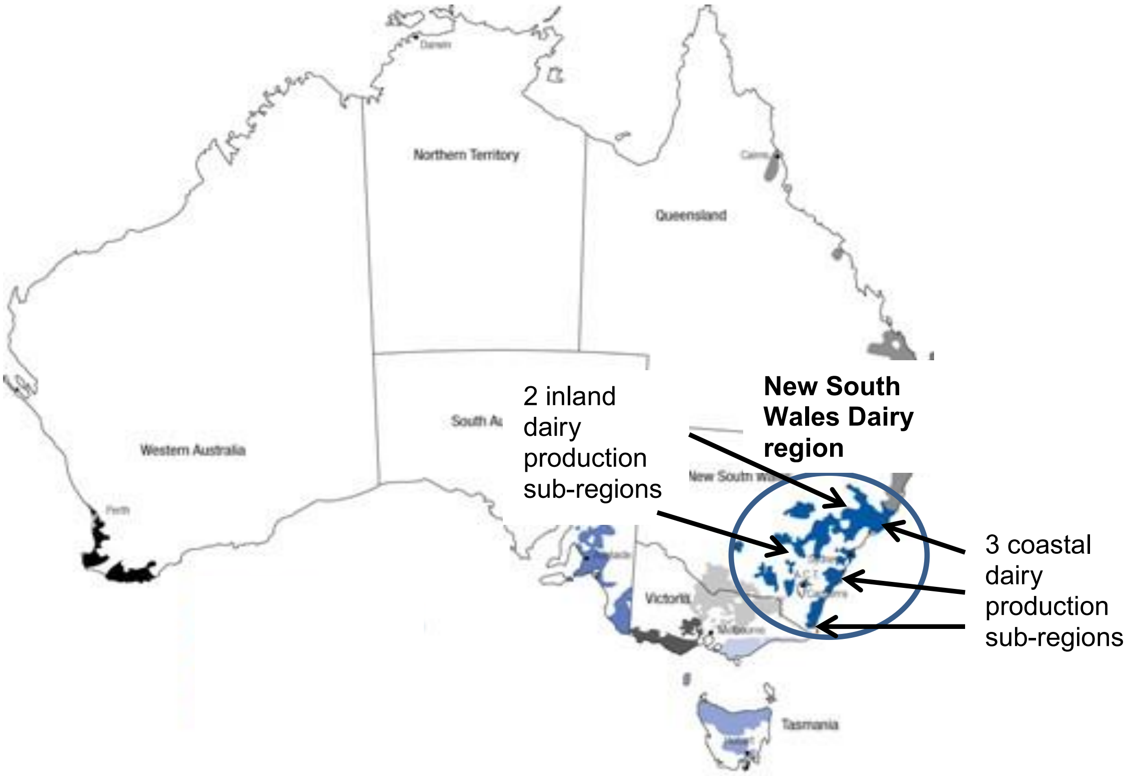

Figure 1: Location of the Australian New South Wales Dairy Region *(Source http://www.legendairy.com.au/dairy-farming/our-industry/our-regions)*

The NSW dairy industry is currently based on approximately 500 farms with an average herd size of 280 cows. Annual milk production is over one billion litres of which 70% is consumed domestically. NSW produces 8% of Australia's milk volume with a gross production value of almost $500(A) million (Kempton, 2015).

Stakeholders in the New South Wales dairy extension network

Stakeholders involved in New South Wales dairy extension network include extension providers, farmers, industry, agribusiness, government agencies, research and education institutions. Within this mix of stakeholders the role of extension providers has traditionally been to facilitate farmers' access to knowledge, information and technologies that support more productive, efficient and sustainable farming practices (Faure, et al., 2012; Koutsouris, 2012). In this intermediary role extension providers need to interact widely with clients and other professionals to maintain their own knowledge competency. They must also have well developed relationship skills that enable others to capture learning opportunities.

Dairy Australia (DA) is a national industry-owned Rural Research and Development Corporation (RDC) accountable to its farmer members and to the Australian government. DA invests a combination of farmers' levy and government funds across the dairy supply chain to ensure that the industry is profitable, sustainable and competitive. It operates regionally through eight Regional Development Programmes (RDPs) across Australia, including Dairy NSW. Each RDP is responsible for providing and coordinating regional extension, education and professional development services for dairy farmers and sub-regional Regional Development Groups RDGs. RDPs also provide funding for group projects which may involve discussion groups and local research trials. Each RDP has a regional manager and a team of extension field staff who collaborate with farmers, government agencies, milk processors and a broad range of rural professionals (agribusiness, consultants and veterinarians).

Public sector interest in New South Wales extension policy and its delivery includes the Department of Primary Industries (DPI) (the government agency responsible for increasing the productivity and resilience of the agricultural sector through agricultural productivity research across livestock, plants and natural resource management areas) and Local Land Services (LLS) that operate in eleven sub regions of New South Wales (to provide farmers, land managers and communities with technical and advisory knowledge on a range of rural topics and issues). Public sector institutions with education and research interest in extension include vocational training institutes (Technical and Further Education (TAFE)), universities and the Commonwealth Scientific and Industrial Research Organisation. (CSIRO).

Private sector interests in extension include agribusiness (suppliers of milking equipment, animal breeders, seed, fertiliser, general farm supplies, livestock agents, technicians), consultants (providers of general farm management advice as well as specialists in agronomy, nutrition and irrigation), financiers (banks and accountants), veterinarians, milk companies and milk supply field officers. Declining government investment in research, development, education and extension is currently shifting responsibility for these functions to the private sector (Kempton, 2015).

Conceptual framework

Extension background in Australian

Up until the 1990's public sector provision of agriculture extension developed alongside research capacity and together made a critical contribution to Australian agriculture. Extension services were considered to be 'of major importance to (farms achieving) higher production and lower costs (Williams, 1968 quoted in Hunt, 2012: 14). Prior to the 1990's extension was regarded as a credible and valued profession supported by academic training and research (ibid). Provision of more pluralised forms of extension was also encouraged such as public/private partnerships and fully privatised consultancy (ibid). After 1990 rapid structural changes implemented by government devolved research responsibility to industry based Rural Development Corporations. This coincided with the 'retreat' of government from provision of public sector extension and capacity and skills development of extension professionals resulting in 'weakened extension capability' and 'disconnection in the RD&E feedback loop' (ibid:16).

Structural changes in favor of privatised extension services have major implications for extension professionals and access to knowledge support by the agriculture sector. Traditionally, free publically offered extension was provided outside the constraints of user-pays market driven principles and largely involved one to one relationships between advisers and farmers. Privatisation now means that advisory relationships are based on business and market principles of exchange. Employees in hierarchical government structures are increasingly at 'arms-length' from farmers and undertake development and research rather than extension roles. To make sense of such changes for the knowledge creation and sharing functions of extension, Adler et al.'s (2008) framework (see Table 1) distinguishes between the implications of community, hierarchy and markets' principles according to social mechanisms, control imposed, goal alignment, exchange of resources, terms of exchange and extent to which terms of exchange are explicit or not. The framework highlights that hierarchical principles, which are traditionally applied to public provision of extension, are underpinned by control embedded in authority and are effective for sharing codified knowledge but weak for sharing new or tacit knowledge (typical of adoption challenges involving complex agricultural innovation). Market principles are underpinned by user-pays, price competition and opportunities to appropriate value. Incentives to create new knowledge are dependent on its commercial value as well as demand generated by consumers willing and able to pay for it. Community principles are underpinned by mutual trust that fosters knowledge sharing and facilitates learning in situations involving risk and uncertainty (and therefore of increasing importance within agriculture decision making).

Table 1: Framework of community, hierarchy and market principles *(Source: Adler et al., 2008)*

	Community	Hierarchy	Market
Social mechanism is:	Trust	Authority	Price competition
Control exercised over:	Inputs	Process/behaviour	Outputs
Fits tasks that are:	Interdependent	Dependent	Independent
Best supports goals of:	Innovation	Control	Flexibility
What is exchanged?	Know-how	Obedience to authority	Money or barter
Terms of exchange specific or diffuse:	Diffuse[1]	Diffuse/specific	Specific[2]
Terms of exchange made explicit:	Tacit	Explicit	Explicit

For extension providers the increasing influence of market and hierarchical principles impacts on the structures and institutions they are now working in in ways that not only impact on their relationships with farmers but also on the maintenance of informal collegial interactions. Coordination across new business structures introduces new challenges relating to consistency and quality of knowledge products and services and increases opportunities for conflict of interest as advisers compete for a limited pool of clients.

While structural change due to privatisation of extension is a ‘given’ under prevailing economic and political contexts it brings structural and relational consequences that are difficult to measure using standard empirical tools. Understanding how advisers are experiencing privatisation within their professional networks is an opportunity for both policy makers and industry strategists to consider some of the critical consequences.

Social capital

For the purposes of this paper Lin’s ‘structural perspective on social capital’ (1999, 2001) is used to understand how location, position and the effects of both weak (open) and strong (close/closed) relational ties affect social network relationships. Lin suggests that ‘social

[1] *Generalised reciprocity refers to unspecified exchange but an expectation of future exchange or return of favours.*
[2] *Specific reciprocity refers to exchange of agreed resources.*

capital refers to resources embedded in a social structure that are accessed and/or mobilised in purposive actions' (2001:29). This definition highlights three critical elements – firstly resources may potentially be shared that have either material or symbolic value (including for example physical farm inputs, information, knowledge and money[3]). Secondly these resources are embedded within and must be accessed through social structures[4] (for example farm management expertise is available from advisers who may be self-employed or employed within organisations, have been highly trained in universities and have acquired practice based experience through social interactions with farmers and other professionals). Thirdly, social capital is mobilised for a purpose (for example farmers seek advice to ensure their farm businesses are profitable). Mobilisation of social capital may be instrumentally motivated (to gain social capital) or expressively motivated (to maintain social capital) (Lin, 2001). Structural constraints and agency of actors determine whether opportunities for mobilising social capital can be realised (ibid). This view of social capital focuses on how resources are valued, accessed and mobilised in social networks including what resources are deemed relevant and where they can be found. For example strongly connected network members who trust each other and interact frequently are well positioned to give and receive resources. Conversely weakly connected network members with limited access to resources are at risk of missing opportunities to develop the potential of their livelihoods and wellbeing. The gradation of strong to weak ties aligns with concepts of bonding, bridging and linking (High et al., 2005; Fisher, 2013) used to differentiate opportunities for sharing resources horizontally and vertically in a given social context. Bridging social capital is associated with brokers, or intermediaries such as extension providers, whose role is to connect otherwise unconnected individuals or groups in order to access valuable resources such as information and knowledge (Howells, 2006).

Access and mobilization of information and knowledge sharing through collaboration

Adler and Heckscher (2005) argue that the prevailing ascendancy of market principles in economics and policy gives rise to individualism that is contrary to the maintenance of communal norms of interdependence and trust that underpin collaboration. Within an extension network, farmers, advisers, service professionals (amongst others) regularly exchange technical, economic, environmental and social information and knowledge that directly impacts on the efficiency, profitability and sustainability of farming. While provided by the public sector the sharing of knowledge by extension advisers was typically an open process. Advisers working across different farms freely shared their knowledge of what new practices worked or not. This provided opportunities to influence rates of adoption as well as learn from others' mistakes. Privatisation of extension knowledge reduces opportunities for open sharing of both knowledge and experience as this becomes a private asset and a source of competitive advantage (Hunt, 2012).

Methodology

Social network analysis (SNA) is a method for describing the structure of relationships within groups, communities and organisations (Cross & Parker, 2004; King & Nettle, 2013). Formal and informal relationships are represented visually in social network models (sociograms) using lines (edges) to show a relationship between nodes (vertices or graph points) according to a specific relationship of interest (between individuals and/or organisations). A relational connection provides the potential for resources, both tangible and intangible, to be shared (Wasserman & Faust, 1994; de Nooy et al., 2005). Social networks are formed for many

[3] Lin (1982, 1999) refers to resources as including wealth, power and status.

[4] Social structure is determined by positions, authority, rules and agents (ibid).

reasons (Wasserman & Faust, 1994; Scott, 2013) and are based on an explicit relational question relevant for a specific purpose. Findings cannot be generalised beyond the implications relative to this question. SNA data is presented in sociograms (network maps) in which each connection (node) is situated as a graph coordinate in two dimensional space.

For this study the boundary of the empirical case was formed by relationships of five members of the Dairy NSW REC team and who they regarded as their 'top 30' contacts.

The relational questions used to identify network ties were:

> 'In your extension capacity, who are the most important 30 people you talk to in the dairy industry (not including people who work in your same organisation)? Followed by:
>
> 'What organization do they belong to?

The contacts named by each REC were combined to create a network model for this extension team. To assure confidentiality each contact's name and relationship was ascribed a numerical value. The data was processed with SNA software, Pajek. Data was also collected about frequency of interaction with each contact and perceptions of whether each contact is 'enabling' or 'not very enabling' of collaboration. The social network of all five REC's resulted in a network of 98 nodes and formed a core-periphery structure (see Figure 1). The network model includes 17 core nodes representing contacts shared by at least three REC's. Before finalising the network models, feedback was sought from each REC as to whether the draft SNA models 'made sense' to ensure that the data was of sufficient quality for the next stage of analysis.

Findings

The Dairy NSW Regional Extension Coordinators' network

A social network model based on extension relationships of five members of the Dairy NSW REC team is shown in Figure 1. It forms a core/periphery structure based on 98 nodes. The five respondents are marked with letters (nodes within the small circles) and their contact nodes (alters) are indicated with numbers. Nodes shared by at least three RECs are located in the network core while nodes that are unique for each REC are located in the network periphery. Nodes shared by only two RECs are located between the core and the periphery. Eleven role groups were identified in the network and are indicated by colour (see Key for Figure 1 roles).

The network 'core'

The core[5] contains 17 nodes who represent critical extension knowledge capability and influence within this network. The core includes seven farmers, four milk company field officers, three government employees, two consultants and one educator. Of these the most highly connected are nodes 41, 26, 60, 10, 19 and 34 who include three government employees, one farmer, one consultant and one milk company field officer. The connectivity patterns of these network members suggest they are network 'stars' (Cross & Parker, 2004). Network 'stars', or central connectors, are people highly sought out by other network members

[5] *Nodes : 41,26,60,10,19,34 (Core star nodes); S,G,J,M,R (RECs); 83,55,62,30,86,84,20,80,69,16,50 (Core nodes potential stars and/or brokers*)

for their expertise, experience and skills. Their presence provides credibility and status for the wider network and they are critical for enabling information and knowledge to flow efficiently and effectively to other network members (ibid). Most network ‘stars’, although not all, are well known and highly visible to other network members.

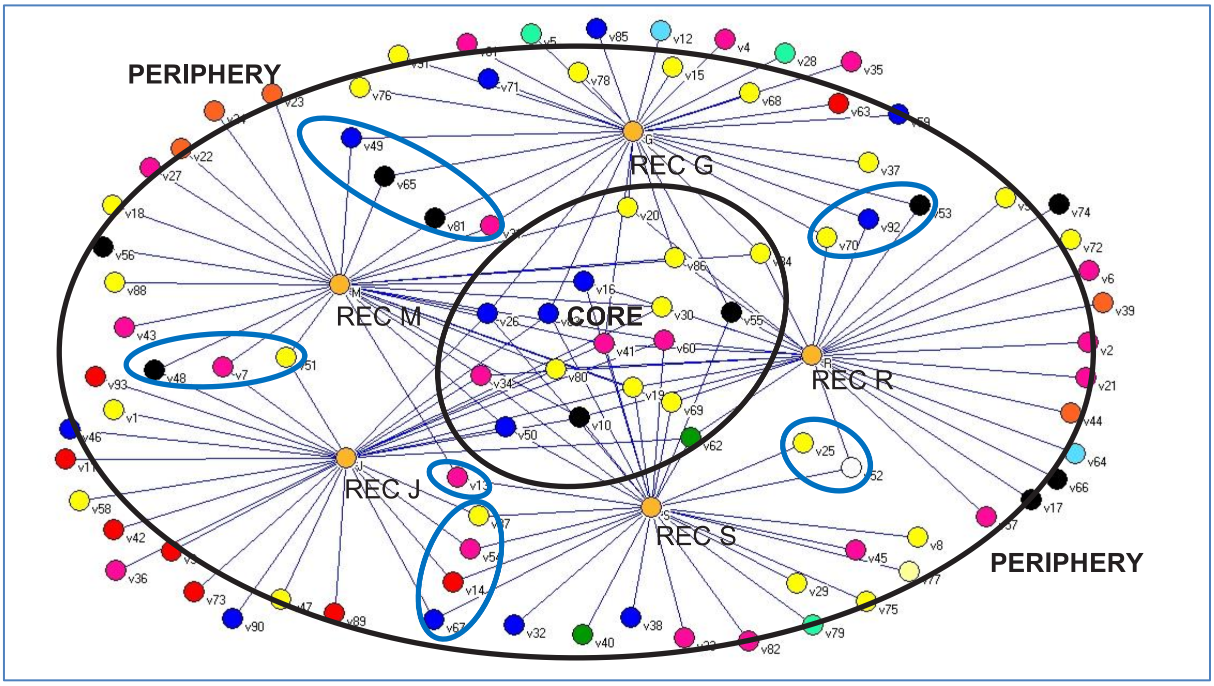

Figure 1: Core/periphery network model of ‘top 30 extension’ contacts for the NSW REC team (December 2015). Core nodes within the central back circle are shared by at least three RECs. Blue circles between the core and the periphery indicate nodes shared by only 2 RECs. Unique connections for each REC are shown on the black outer periphery circle.

Key for role groups in Figure 1 (numbers refer to how many of each role group are present in the network)

DA REC (5)		Researchers (5)	
Farmers (26)		Veterinarians (3)	
Government DPI, LLS (21)		Educators, TAFE (2)	
Milk Company representatives (14)		Technicians (2)	
Consultants (10)		Industry Advocacy (1)	
Agribusiness (8)		Other (1)	

The other eleven core members include six farmers, three milk company field officers, one consultant and one educator. While not as highly connected as the 'stars' they are centrally positioned and provide network connectivity and intermediation opportunities for the network. Their location in the network enables them to coordinate and control the flow of information and knowledge with individuals or groups that may otherwise not have access to the network's resources.

Shared contacts between the core and the periphery

Between the network core and periphery connections shared by only two REC's are shown in blue circles (see Figure 1). Not all RECs share nodes with other RECs but this appears more likely between those whose work regions are in closest physical proximity (e.g. REC R and G; REC J and S). REC M, who has the greatest number of ties (8) shared with other RECs, is a state-wide specialist available to advise on land, water and carbon and is therefore working across all dairy regions. The highest number of shared nodes between RECs outside the core is four. Shared contacts are mainly consultants, farmers, government employees and milk company representatives who are sources of information and advice for the RECs.

Unique network contacts.

The dairy industry of NSW is geographically wide spread which means that RECs are working long distances from each other. Unique connections for each REC are shown on the peripheral circle in Figure 1. RECs' unique ties represent 40% of all network contacts and are based on contacts within their work regions. Their unique contacts are highest with farmers (30%), then local government employees (24%), milk company representatives (15%) and consultants (11%). RECs' connections with these four role groups comprise 80% of all network connections. The role distribution of unique connections for each REC is shown in Table 2. The similar contact patterns of REC J, G and S is because they each hold dairy extension coordinator roles but in different locations. REC R is the overall team leader with responsibility for strategic issues and team oversight rather than on farm extension delivery. Both REC R and M work across all regions and their leadership roles require connections to researchers which are reflected in their 'top 30' contacts. The significant proportion of REC J's unique contacts with agribusiness reflects his previous employment in this sector. Sharing unique network contacts between team members provides opportunities to develop expertise and knowledge.

Table 2. Roles of unique contacts

Network Role	REC R	REC M	REC J	REC G	REC S 8	Total (%)
Consultant	6	5	1	3	2	17 (11%)
Milk Officer	2	5	6	7	7	22 (15%)
Farmer	10	9	8	10	7	44 (30%)
Educator			1		2	3 (2%)
Government	8	8	6	5	9	36 (24%)
Industry	1					6 (4%)
Researcher	2	3				5 (3%)
Agribusiness			8	1		9 (6%)
Bankers/Accountants						
Vets				2	1	3 (2%)

Agronomist					1	1
Nutritionist				1		1
Knowledge developer						
Technician	1			1		2
Other					1	1
Total Contacts	30	30	30	30	30	150

Network access and mobilisation of resources

The success of extension work is dependent on access to information and knowledge resources. Perceptions and experience of others' willingness to collaborate is an indication of their confidence that interactions within those relationships will facilitate access to knowledge and information that allows them to achieve extension goals and tasks.

Perceptions of collaboration

RECs were asked to indicate whether they perceived each of their 'top 30' contacts to be 'enabling' or 'not very enabling' of collaboration based on their perceptions of approachability, willingness to share information and confidence in their working relationship. The results for the combined 98 contacts named in the NSW REC network model are shown in Table 3. The majority of extension contacts (86%) were perceived to be 'enabling' with respect to sharing information and knowledge. Eighteen individuals in the network were identified as 'not very enabling', including nine government employees, four consultants, three milk company field officers, one agribusiness representative and one farmer. Notably, three of the 'star' nodes (one each from government, a milk company and a consultant) were perceived as 'not very enabling'. Three other core nodes were also perceived as being 'not very enabling' (one farmer, one milk company field officer and one consultant). A perception of 'not very enabling' may indicate that workload and time constraints limit ability to be responsive or that conflict of interest or commitment exists. Importantly, a total of 6 of the 17 core nodes were perceived as 'not very enabling' (35%) which is a concern for this network as the significance of connectivity with RE's suggests that they are influential and have gatekeeping roles with respect to enabling access to critical knowledge resources.

Table 3: REC's perceptions of collaboration with their network contacts

Perception of collaboration	REC R	REC M	REC J	REC G	REC S	Total number of ties
Enabling	27	23	29	23	28	130 (86%)
Not very enabling	3	7	1	7	2	20 (14%)
Ties per REC	30	30	30	30	30	150

Differences in perceptions vary between each REC (REC J only perceives one 'top 30' contact not to be enabling whereas REC M and G each perceive 7 of their 'top 30' contacts to be not very enabling and in combination account for 14 of the 20 'not very enabling' perceptions). Differences in perception may be due to a range of professional and personal factors including personality, relationship history and duration, institutional, epistemological and other differences. Further examination of why particular individuals were perceived to be ‘not very enabling’ was outside the scope of this study. However, all but one individual perceived in this way was identified as belonging to organisational structures based on hierarchical or market principles (i.e. government, processors and consultancies).

Frequency of interactions
Frequency of interaction provides opportunities to develop relationships, trust and rapport. RECs were asked whether they interact with each of their ‘top 30’ contacts weekly, monthly or six monthly. Interaction frequency is summarised in Table 4. The average across all RECs indicates that 60% of their extension contacts occurs monthly, however this varies for each REC. Interaction patterns for REC R, J and G are similar, however REC M has the highest weekly interaction (10) and REC 5 the lowest weekly interact (1). It is likely that each REC develops their contact frequency pattern in relation to their own knowledge needs related to their role and location. The analysis is not intended to imply that there is an ‘ideal’ pattern of interaction common to all RECs but to highlight similarities and differences within the team.

Table 4: Frequency of interaction

Frequency of interaction	REC R	REC M	REC J	REC G	REC S	Total number of ties	Average for the REC team
Weekly	4	10	6	7	1	28	5.6 (20%)
Monthly	21	19	16	19	15	90	18 (60%)
6 monthly	5	1	8	4	14	32	6.4 (10%)
Ties per REC	30	30	30	30	30	150	

Despite implications of social capital theory that more frequent interaction is likely to strengthen relationships (and social capital is created), the RECs reported 27 ‘enabling’ relationships involving 6 monthly interactions. This suggests that some collaborative relationships are likely to be based on linking social capital and do not require highly frequent interactions based on bonding social capital.

Discussion
The study’s findings provide insights about structural and relational opportunities and constraints for the five REC team members and their ‘top 30’ professional contacts with respect to knowledge sharing. Firstly the RECs shared and unique connections identify 98 different individuals and organisations with whom the team share knowledge. Opportunities to develop the relational resources of the team and each individual member can be enabled by explicitly understanding why members access shared connections as well as why each REC maintains relationships with their unique ‘top 30’ connections. For example the SNA model identifies 17 ‘core’ contacts shared by at least three RECs, seven of whom are highly connected ‘stars’ (Cross & Parker, 2004), although some were perceived as being ‘not very enabling’ of collaboration, particularly from government or consultancies. Whether perceived as ‘enabling’ or ‘not very enabling’ of collaboration , network ‘stars’ are typically in high demand and time-poor and their capacity to maintain relationships is affected accordingly. For the REC team it may be possible to connect more effectively with such people through scheduling regular group meetings with them, or by nominating a team member to act as an intermediary on behalf of the team. Another opportunity to tap into the collective relational resources of the team could be for each REC to share their unique contacts with each other, particularly those

who may bring specialised knowledge to the team. For example, REC J has unique contact with agribusiness contacts that may provide access to specialised knowledge held by the commercial sector. In addition only two RECs named researchers and no REC named financial contacts in their 'top 30' contacts, despite both role groups representing critical knowledge resources for extension networks. The knowledge capacity of the REC team and each member could be developed by exploring how to better connect with both these groups. The team can use the SNA as a tool to identify other relational opportunities and constraints based on their knowledge of each other and their sector not necessarily apparent to anyone outside the team. RECs are aware that there are some people within their networks who create relational barriers (gatekeepers) that require time and effort to manage; a solution is sometimes to work around them. They are also aware that developing new relationships as well as maintaining existing relationships is time consuming and it is easier to focus on people they are comfortable with.

> "*There are core contacts who are gatekeepers. They are necessary but challenging people in which bridges are continually in need of repair and strategies are needed to work around them. RECs are also limited in the time they have available to seek new contacts, especially those who work part-time, and each REC's network is flavored by the 'comfortable' relationships – people easy to work with and in areas of familiarity"* (REC).

As well as the relational insights discussed above, SNA offers a way of understanding the structural effects of a pluralised extension network. The framework presented in Table 1 (based on Adler et al., 2008 and Lin, 2001) uses notions of community, hierarchy and market to categorise institutional differences between network actors. Each network member identified by the REC team was allocated to a community, hierarchy or market category according to the dominant structural principle of their activity (see Table 5 and using the 14 different roles groups identified for the SNA). Although farmers operate commercial businesses in Table 5 they are identified as representing community structures based on the willingness to share knowledge with each other (between farmers and in discussion groups) as well as their interdependence for economies of scale in milk production and processing.

The top two rows of Table 5 indicate types of extension resources represented by each actor such as knowledge and information, strategic leadership, databases, practice based knowledge and experience. The lower three rows draw on the REC's perceptions of collaboration and frequency of interaction with their contacts to consider how the different actors may influence access and mobilisation of resources.

Table 5: Summary of knowledge resources and availability in the NSW REC network (numbers in brackets indicate how many organisations and individuals were identified in the network)

Extension network resources	**Network actor**	**Structural principle 1 Community**	**Structural principle 1 Hierarchy**	**Structural principle 1 Market**
Knowledge and information Strategic leadership Research Databases	Organisations	Farmers advocacy groups (2) Farmer discussion groups (7)	Government – DPI LLS (4) Dairy Australia TAFE (3) University (2)	Consultancy – sole practice, group practice (10) Vet practice (3) Milk companies (6) Agribusiness (9)
Knowledge and information Practice knowledge and experience	Individuals	Farmers (26) Industry advocate (1)	Researchers (5) Government employees (21) DA RECs (5) Educators (2)	Vets (3) Technicians (2) Milk company field officers (15) Agribusiness reps (8)
Access and mobilisation of extension resources				
Perceived collaboration	Not very enabling		Government employees 38%	Consultants 45% Milk company field officers 20%
Perceived collaboration (opportunity to mobilise information and knowledge resources	Enabling	Farmers 96%	Government employees 62% Researchers 100% Farmers 4%	Consultants 55% Milk company field officers 80% Agribusiness reps 90%
Frequency of access	Frequency of interaction	3/5 REC's in weekly contact with farmers All RECs in monthly contact with farmers	All RECs in weekly contact with government employees;2 RECs in weekly contact with researchers	3/5 in weekly contact with consultants; 2/5 in weekly contact with consultants; 1/5 in weekly contact with agribusiness

RECs' perceptions of whether their network contacts are 'enabling' or 'not every enabling' of collaboration (as a proxy for knowledge sharing) are based in structures of both hierarchical and market institutions. In contrast 96% of RECs' interactions with farmers aligned with community based principles are perceived to be 'enabling' of collaboration. Structures based on community principles draw on trust and unspecified terms of resource exchange (Lin, 2001) in contrast to those based on market principles and specific exchange of resources (Adler et al., 2008). The distribution of network members of the REC network in Table 5 shows that community structures are represented by 9 farmer groups and 27 farmers; hierarchal structures are represented by 27 organizations and 37 individuals; and market structures are represented by 11 entities and 33 individuals. The implications of this mix and distribution of institutional structures require further longitudinal study to assess changes over time and the impacts on managing and coordinating relationships to facilitate and maintain effective and efficient knowledge sharing. Tracking such changes is important for policy makers as well as extension providers for supporting decisions relating to distribution of resources in the public interest as well as industry goals.

Conclusions

The purpose of this study was to understand the structural and relational implications for knowledge sharing in a recently privatised extension network and what this means for coordination across a wider, pluralised network. Findings show that the composition of each Regional Extension Coordinator's (REC's) network reflects differences in their professional backgrounds, for example whether their previous roles were in government or agribusiness. Knowledge sharing opportunities for the REC team include creating opportunities to access each other's unique contacts, identifying team strategies for working efficiently with contacts they have in common and developing approaches for working more effectively with network contacts considered 'not very enabling'. Community, hierarchy and market based institutions are all represented in the REC team knowledge sharing contacts, however contacts from government (hierarchy) and consulting (market) sectors are most likely to be perceived as 'not very enabling' of collaboration. Further work is needed to understand the basis of these perceptions and what bridging strategies may ensure that these institutions remain open to ongoing shared innovation opportunities.

The SNA offers a benchmark for ongoing longitudinal comparison of the changing balance of roles represented in the RECs' 'top30' network contacts. While it is suggested here that the team's network is currently weak in research and financial knowledge, future changes in farming practice and the need for greater environmental accountability may require different forms of expertise to be available to the network. Further understanding is needed about how to manage and coordinate extension across a changing, pluralised balance of community, hierarchical and market institutions. The geographically dispersed REC team will continue to face ongoing relational and structural challenges as well as coordination challenges. They can use their understanding of the strengths and weakness of knowledge sharing in both their team and individual networks to capture opportunities to access and mobilise knowledge as well as maintain and build social capital and capture opportunities for innovation.

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References

Adler, P., & Heckscher, C. (Eds) (2005). The Firm as a Collaborative Community: Reconstructing Trust in the Knowledge Based Economy. Oxford: Oxford University Press

Adler, P., Kwon, S., & Heckscher, C. (2008). Professional work: the emergence of collaborative community. Organization 19(2): 359-376.

Cristóvão, A., Koutsouris, A., & Kuglar, M. (2012). Extension systems and change facilitation for agricultural and rural development. In Darnhofer, D and Dedieu, B (Eds). Farming Systems Research into the 21st Century: The New Dynamic. Dordrecht: Springer Science+ Business Media.

Cross, R., & Parker, A. (2004). The Hidden Power of Social Networks: Understanding How Work Really Gets Done in Organisations. Boston: Harvard Business School Press.

de Nooy, W., Mrvar, A., & Batageli, V. (2005). Exploratory Social Network Analysis with Pajek. New York: Cambridge University Press.

Faure, G., Desjeux, Y., & Gasselin, P. (2012). New challenges in agricultural advisory services from a research perspective: a literature review, synthesis and research agenda. Journal of Agricultural Education and Extension 18(5): 461-492.

Fisher, R. (2013). A gentleman's handshake: the role of social capital and trust in transforming information into usable knowledge. Journal of Rural Studies 31: 13-22.

Howells, J. (2006). Intermediation and the role of intermediaries in innovation. Research Policy 35: 715-728.

High, C., Pelling, M., & Nemes, G. (2005). Understanding informal institutions: networks and communities in rural development. In: Transition in Agriculture, Agricultural Economics in Transition II, Institute of Economics, Hungarian Academy of Sciences, 28-29 Oct 2005, Budapest, Hungary.

Hunt, W., Birch, C., Vanclay, F., & Coutts, J. (2014). Recommendations arising from an analysis of changes to the Australian agricultural research, development and extension system. Food Policy 44: 129-141.

Kempton, K. (2015). NSW dairy industry overview 2015: Intensive Livestock Production. NSW Department of Primary Industries. Australia.

King, B.J. & Nettle, R. (2013). Private-public advisory networks: an Australian dairy pasture seed case study. Extension Farming Systems Journal 9(1): 1-9.

Klerkx, L., de Grip, K, & Leeuwis, C. (2006). Hands off but strings attached: the contradictions of policy-induced demand-driven agriculture extension. Agriculture and Human Values 23(2): 189-204

Klerkx, L., & Nettle, R. (2013). Achievements and challenges of innovation co-production support initiatives in the Australian and Dutch dairy sectors: a comparative study. Food Policy 40: 74-89.

Knuth, U., & Knierim, A. (2013). Characteristics of and challenges for advisers within a privatised extension system. Journal of Agriculture Education and Extension 19(3): 223-226.

Koutsouris, A. (2012). Facilitation and brokerage: new roles for extension. Journal of Extension Systems 28(1): 18-27.

Lin, N. (1999). Building a network theory of social capital. Connections 22(1): 28-51.

Lin, N. (2001). Social Capital: A Theory of Social Structure and Action. New York: Cambridge University Press.

Prager, K., Labarthe, P., Caggiano, M., & Lorenzo-Arribas, A. (2016). How does commercialisation impact on the provision of farm advisory services? Evidence from Belgium, Italy, Ireland and the UK. Land Use Policy 52: 329-344.

Scott, J. (2013). Social Network Analysis. London: SAGE Publications.

Umali-Deininger, D. (1997). Public and private agricultural extension: partners or rivals? The World Bank Observer 12(8): 203-24.

Wasserman, S., & Faust, K. (1994). Social Network Analysis: Methods and Applications. New York: Cambridge University Press.

Variable collaborative learning spaces in the quest for agricultural sustainability in New Zealand

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Abstract: Participatory research is advocated for fostering multi-stakeholder engagement and learning necessary for advancing sustainability. This work examines how participatory projects develop collaborative learning to advance agricultural sustainability. It presents findings from empirical evidence from six micro-level horticultural innovation projects in New Zealand where farmers and scientists engaged in public / private funded partnerships. Analysis revealed institutions, partner relationships and learning were critical and highly inter-related dynamics of participatory research projects. This paper focuses on the creation of learning spaces in these projects that ideally should support and sustain change to more sustainable practices. The research revealed a 'collaborative learning space' influenced by the strength of partner relationships and institutions that shape how actors engage in participatory research. This paper visualises the variability of the collaborative learning space among the six projects and reveals the importance of this space where innovations can be co-developed and learning is emergent, adaptive and dynamic.

Keywords: Participatory research, learning spaces, agricultural innovation, agricultural sustainability

Introduction

Nearly thirty years after the publication of the Brundtland Report (WECD, 1987), which sought global consensus around sustainability, the implementation of sustainability remains a highly fraught and contested endeavour. Within agriculture there remains an urgent need to effectively address the environmental impacts of agricultural practices. This requires effective responses at all levels, including at the micro-level - the "multi-party collaboration processes in which representatives from different stakeholder groups interact" (Medema et al., 2014, p.27).

Participatory approaches in agriculture are approaches to research that see farmers and scientists collaborate in projects to address a shared problem using both local and scientific knowledge. They are argued to be a suitable platform for facilitating change towards sustainability as they encourage multi-stakeholder engagement, collaboration, learning and collective action (Neef & Neubert, 2011; Pretty, 1995; Reed, 2008). Policy and funding agencies increasingly support the use of participatory approaches to both promote sustainable agriculture and increase adoption of sustainable innovations (Ison, Roling & Watson, 2007; Pahl-Wostl, 2002).

Despite wide support for participatory research there remains limited understanding of how participatory research can stimulate meaningful change towards sustainability in the rural sector. Furthermore the integration of scientific and local knowledge in research projects is often difficult to achieve (Allan et al., 2013; Neef & Neubert, 2011). This raises questions about the effectiveness of participatory research for advancing sustainability. This paper uses empirical data from six micro-level innovation projects in New Zealand, where farmers and scientists engaged in public / private partnerships to explore how participatory research fosters learning environments to advance sustainability.

Participatory research in agriculture

Post Normal Science (Funtowitiz & Ravtez, 1994) demands new approaches to research to address not just the technological requirements of environmental issues but also their socio-ecological complexities. In this environment, science is seen to be more democratic and socially accountable as it embodies multiple perspectives from inside and outside science and technology in decision-making (Gibbons, 1999; Lubchenco, 1998). Within this context, participatory research is put forward as an effective approach for multi-stakeholder engagement to address sustainability and to promote rural change, as it is inherently collaborative and inclusive by seeking to bring a wide base of expertise to both identify problems and co-develop solutions (Leeuwis, 2004; Pretty et al., 2010; Reed, 2008; Vanclay & Lawrence, 1995).

Participatory research challenges traditional ways of undertaking agricultural research and extension that favoured linear top-down approaches that saw agricultural scientists determine priorities, develop technologies and then transfer the knowledge to leading farmers through extension workers (Leeuwis, 2004). Participatory approaches no longer see science as the only legitimate knowledge for to do so denies the socially constructed nature of knowledge production. Participatory scholars call for divergent stakeholders to create shared understanding of problems and co-produce knowledge and solutions (Baars, 2011).

To advance sustainable agriculture, collaborative multi-stakeholder engagement and learning in 'transdisciplinary' participatory partnerships should challenge assumptions and values of both farming and science practice to facilitate new ways of thinking through a process of cumulative and incremental learning (Keen et al., 2005; Roling & Wagemakers, 1998). Success however, must not be solely measured by quantitative indicators as this risks allowing a participation dogma to dominate, where success is solely measured by numbers rather than by the development of meaningful and lasting change (Vanclay, 2011; Ziegler & Ott, 2011).

In participatory research, learning should become an emergent property of the collaboration (Ison, 2005). The knowledge that is obtained from practical experience and collaborative experimentation is then built into solutions (Blackmore, 2007), with decision-making being collectively framed through dialogue (Leeuwis & Aarts, 2011). Leeuwis and Aarts (2011, p.27) call the environment where people interact "a space for change" and highlight how this space is necessary for stimulating innovation in complex systems. They argue that these spaces mobilise divergent "discourses, representations and storylines" that fluctuate between the dominant thinking and new ways of knowing and doing.

The literature is emphatic that participatory projects should focus on the capacity of actors to learn together to enable problems and solutions to be co-constructed. Such 'constructivist' notions of learning are not focused on didactic approaches to teaching or persuading people to simply adopt an innovation. Instead they seek to bring about transformations in people's perceptions and assumptions (Keen et al., 2005; Mezirow, 1994) that ideally leads to a questioning of the underlying assumptions that drive current practice, which can generate new ways of knowing and doing. It is this type of learning that is regarded as essential for addressing the complexity of sustainability (Keen et al., 2005; Lachlan, 2013).

Participatory approaches inherently require traditional power structures, with scientists as experts giving 'top-down' advice to farmers as passive recipients, to be replaced by more equitable partnerships. While power sharing is regarded as a fundamental principle of participatory approaches, processes are often still affected by power structures. Kothari (2001) argues that an unquestioning approach to participatory endeavours can overlook the socially embedded nature of knowledge production and actually reinforce power differentials. Agencies adopting participatory approaches are criticised when superficial approaches to participation ignore the socio-political context of stakeholder interactions (Kothari, 2001; Pretty, 1995).

Redistribution of power structures will require fundamental changes to institutions that have historically afforded western science a privileged position in agricultural research and extension (Fergus & Romney, 2005) and shape how scientists behave and practise science (Klerkx & Leeuwis, 2009; Ziegler & Ott, 2011). Indeed new approaches to research will challenge how scientists view themselves and science's role in research (Roderiguez et al., 2008).

Community, funding and policy actors may however perceive participatory initiatives as vague. Participatory researchers often struggle with the requirements of funding agencies which rely on evaluation measures more suited to the traditional top-down approaches to research and extension (Webber & Ison, 1995). Furthermore, among policy agencies there may be a primary expectation that participatory approaches will increase the acceptance of stakeholder adoption of innovations and government policy. Barr and Carey (2003) contend that the language of contemporary policy remains embedded in the Innovation Diffusion Model (Rogers, 1962), which sees innovation as inherently good for farmers (Ison, 2005), and assumes farmers will eventually adopt. Bruges and Smith (2007) even question the appropriateness of using participatory approaches to achieve policy goals that promote change towards sustainable agriculture.

Investigating participatory projects

New Zealand's farming and science landscape provides a rich context to examine how effectively participatory projects facilitate learning environments to advance agricultural sustainability. While farming remains a dominant force in New Zealand's economy (PCE, 2004), as with other countries its rural communities face increasing pressure to address concerns about the detrimental environmental impacts of farming practices, with growing concern that the agricultural sector is underperforming in improving its environmental performance (PCE, 2004).

New Zealand policy and funding agencies have increasingly challenged scientists to build greater capability for participatory approaches into science research. Since the restructuring of New Zealand's science sector and the dissolution of publicly funded agricultural extension in the 1990s, many micro-level public / private 'participatory' partnerships have emerged to address sustainability.

The six micro-level projects investigated in this research supported engagement between science and farming actors in research partnerships and therefore were all generally consistent with the participatory paradigm. However, with no clear blueprint on how a participatory approach should be applied, implementation is variable. All were situated in the horticultural and arable sectors and located as shown in Figure 1. Five projects were partially funded by the government's Sustainable Farming Fund (SFF) with matching contributions from project farming partners. One project, Crop Science for Maori, was fully funded by the government's public science fund. Table 1 provides a synopsis of each project's objectives, while Table 2 outlines the characteristics of the farming groups and sectors, as revealed from project documentation. While all projects involved scientists and farmers working together to advance sustainability, their distinct differences provide valuable comparisons to assess learning in participatory projects.

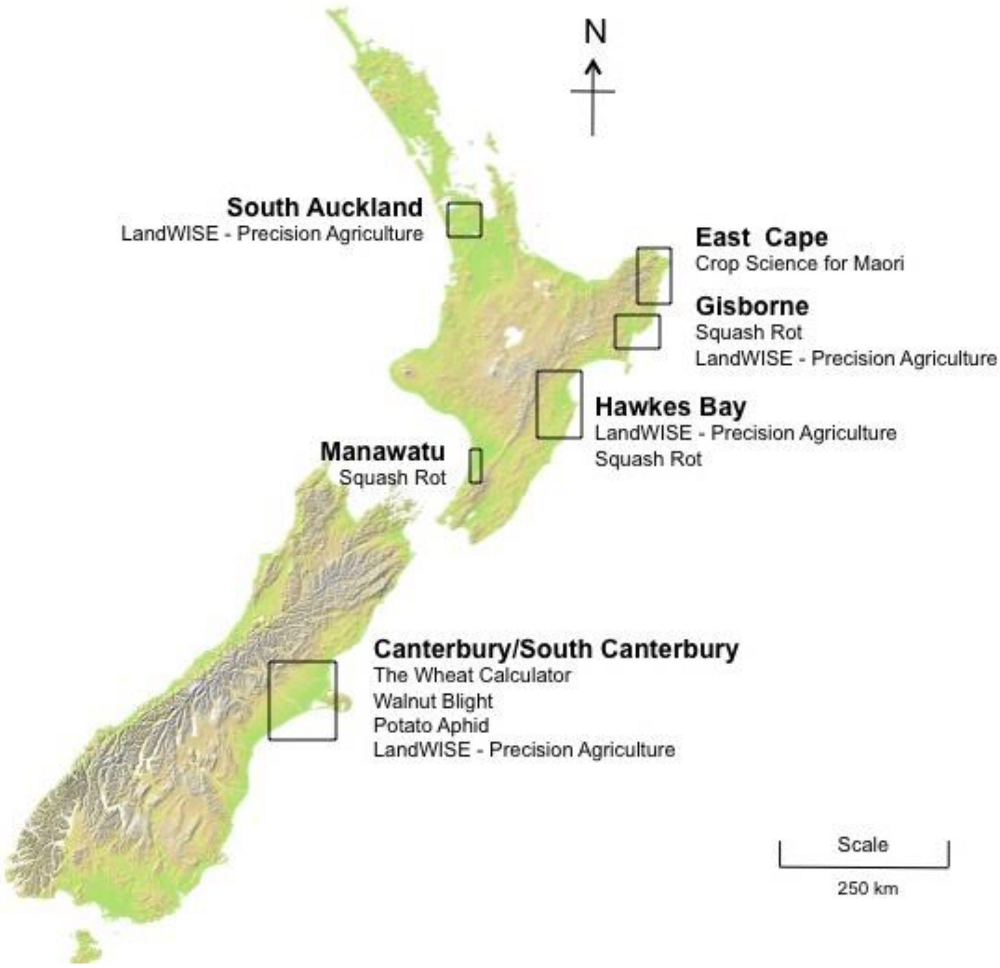

Figure 1. Geographical location of projects

Table 1. Synopsis of project objectives, actors and project initiator

Project / Actors / Initiator	Objectives
Crop Science for Māori (5 year project with 1 year extension) **Actors**: Scientists & the East Coast Organic Producers (ECOP) Trust **Initiator**: jointly initiated by community and scientists	• Identify how Māori communities could transition from extensive agriculture to intensive organic horticulture. • Establish a reciprocal learning network providing scientific, education, and extension services to enable ECOP Trust to develop and implement 'best' organic vegetable farming practices.
Squash Rot (3 year project) **Actors**: Scientists & Squash Industry Group (Horticulture NZ), squash farmers & pack-house owners. **Initiator:** Scientists	• Assess factors that influenced the extent of storage rot in squash (buttercup) fruit lines. • To develop a model of weather influences on squash growth and yield to assist with defining multi-factor influences on fruit yield and maturity.
Potato Aphid Project (3 year project) **Actors**: Scientists & Potatoes New Zealand (Horticulture NZ) & farmers **Initiator:** Scientists	• Develop a pest management strategy to delay or prevent aphid insecticide resistance in potatoes to maintain options for pest control and potato quality. • Determine 'best practice' for the control of aphids and viruses in potato crops, and provide growers up to date information on aphid flights and infestation.
Walnut Blight Project (3 year project) **Actors**: Scientists & Walnut farmers from the Walnut Industry Group (WIG) **Initiator:** Farming Group (WIG)	• Optimise the timing of copper-based sprays and understand and transfer best practice blight management to growers. • Develop an environmentally benign agent for blight control to reduce reliance on copper-based sprays.
The Wheat Calculator (3 year project) **Actors**: Scientists & Foundation for Arable Research (FAR) & farmers **Initiator:** jointly initiated by FAR & scientists	• Examine and quantify the effects of arable and vegetable growing practices on nitrate leaching. • Development of "user-friendly" software - the Wheat Calculator, to provide information on how wheat cultivars respond to nitrogen loadings and irrigation. • Increase farmer profitability by increasing yields & reducing farm inputs & improving environmental outcomes by limiting the effects of nitrate leaching.
Precision Agriculture Projects	• Co-ordinate on-farm research & development.

(3 year project & 1 year project) **Actors**: LandWise working with LandWise farmers, researchers, arable & vegetable industry partners. **Initiator:** Farming group (LandWise)	• *Controlling the Strip* (2003-2006) focused on soil health, minimum tillage & irrigation efficiency. *Advanced Farming Systems* (2008-2009) investigated farmers' engagement with advanced Precision Agriculture technology.

Table 2. Characteristics of farming groups / sectors

Farming Group	Farming group / Sector characteristics
Crop Science for Māori East Coast Organic Producers (ECOP)	• East Cape Region: economically deprived and geographically isolated. • ECOP Trust sought to improve the health, social, cultural, economic and ecological wellbeing on the East Cape by promoting cultural values. • ECOP Trust membership was very small – approximately 6-10 growers. • Community had limited understanding of science as a development tool. • Boundaries of influence limit knowledge sharing between communities. • Communally owned land makes development capital hard to secure.
Squash Rot Squash Industry group	• Group funded by grower levy, supported full time employee. • Product group of grower body (Horticulture NZ) with strong policy focus. • Complex industry value chain. • 5-6 corporate growers largely control the squash value chain. • Competitive industry players; price sensitive market.
Potato Aphid Project Potatoes NZ	• Group funded by grower levy, supported full time employee. • Product group of grower body (Horticulture NZ) with strong policy focus. • Complex, competitive value chain with three sectors: seed, process, table. • In the seed sector (where the project was targeted) profit margins are small. • Seed potatoes are rarely grown as a sole crop. • Most farmers' contract grow for seed potato merchants.
Walnut Blight Project Walnut industry Group (WIG)	• Small emerging industry progressing towards commercial production. • Consists largely of part-time growers, many are scientists and other highly skilled professionals along with older retired couples. • Industry group formed by farmers to represent growers & access funding. • Voluntary membership, so dependent on grant success for group's knowledge generation – no paid staff. • Long association with Lincoln University and access to trial orchard.
The Wheat Calculator	• FAR funded by grower levy, supported several full time employees. • FAR supports research and technology transfer in the arable sector. • Facilities located next to major science institutes.

Foundation for Arable Research (FAR)	• Complex value chain with multiple industry players. • Majority of growers are contract growers & often engaged in mixed cropping. • Farmers' incomes are influenced by the international grain price.
Precision Agriculture LandWISE	• LandWISE is an established and respected farmer extension group focusing on precision agriculture. • Voluntary membership - supported 1-2 part time staff. • Primary income from research grants; vulnerable to funding changes. • Partners with complementary organisations including research institutes. • Scientist sits on the LandWISE Board. • Collegial cooperative membership.

Methodology

The research used a case study approach (Yin, 2009) to gather empirical evidence from the six projects to explore how participatory research in micro-level agricultural projects created learning environments. Multiple sources of evidence were gathered from 84 stakeholder interviews (which were recorded and transcribed), eight participant observations and a review of project documentation and media articles. Interview participants included project actors including farmers, research scientists and farming group employees. In addition interviews were undertaken with actors from the wider agricultural innovation system.

Four of the projects had finished so were examined retrospectively, and two projects were examined while in progress. A large and rich corpus of data was collected and analysed to code, order and structure the data. Two 'cycles' of coding were applied guided by Saldana's (2013) approach to analytical coding. In the first cycle, "holistic coding" (Saldana, 2013, p.142) was undertaken as a 'grand tour' to gain a first impression of the data corpus. This was followed by in-depth second cycle coding which led to 20 coding categories being identified. These grouped into three themes: the institutional context for innovation; partnerships and learning. This paper focuses on the 'learning' theme.

Results

An examination of how knowledge production occurred in each project revealed how projects fostered a discursive learning space for actors to engage, share, collaborate and co-develop. When the six projects were viewed through this knowledge production lens, they could be divided into three groups as discussed in below.

Linear knowledge production (scientist-initiated)

Although all projects employed a participatory methodology, linear processes were evident in two projects - the Potato Aphid and Squash Rot projects. Interestingly, both were scientist-initiated and farming actors were principally observers of the project's research, rather than active research participants. Project steering committees managed both projects and farming actors largely ensured that the field research undertaken by the scientists aligned with farming operations. With minimal farmer engagement in fieldwork and a primary focus on data collection to answer 'science' questions, the development of a collaborative learning space was limited.

The empirical evidence from the Squash Rot and Potato Aphid projects showed that when farmers are largely isolated from the fieldwork, a project is unable to foster a meaningful discursive space where partners can share, communicate, negotiate and build trust, to learn together and co-develop innovations. Project committees allowed partner input, but interactions typically focused on operational matters. While this may be useful for aligning operational and research components, it does not foster active engagement in a 'learning by doing' approach that is integral to effective participatory research (Douthwaite et al., 2003). The linear approach to knowledge production in these projects largely reflects the Transfer of Technology (TOT) approach to research and extension.

Collaborative knowledge production (farming-group initiated)

In the Walnut and Precision Agriculture projects, farmers and scientists collaboratively engaged. Both projects were established on partnerships initiated by the farming groups. Farmers in these groups (some of who were scientists) drew on both explicit codified and tacit knowledge to address issues. They valued science input and sought engagement with particular specialists, however they sought outcomes relevant to their farming business and expected this relevance to be evident in the project design. To maintain relevance field trials were managed by the farming group.

LandWISE and WIG saw themselves as innovators. The groups employed a 'learning by doing' approach and they actively facilitated field gatherings with members, sometimes only involving scientists as advisors or analysts of data collected by farmers. These small self-organised discursive spaces enabled farmers to share and co-produce knowledge. However, they drew on scientific expertise as needed to more deeply understand the complexities of the systems in which they farmed. They saw the science / farmer relationship as a synergy between what Ingram (2008) calls the 'know-*how'* of the farmer and the 'know-*why'* of the scientist.

While WIG and LandWISE maintained positive long-term relationships with scientists, they created a new power dynamic that directly challenged traditional linear approaches to research and extension. Despite positive partner relationships this new power dynamic challenged scientists' desire for a robust and rigorous methodology to agricultural investigations. As a result, research in collaborative spaces led by these farming groups blurred traditional agricultural research boundaries.

Negotiated knowledge production (joint scientist and farming group initiated)

Negotiated learning spaces, where partners jostled for position, occurred where partners needed to become familiar with each other's expectations before they could effectively collaborate. This occurred in the Crop Science for Maori and Wheat Calculator projects, which were jointly initiated by farming and science actors. Partners needed to establish a foundation of trust on which to build a learning space. For effective dialogue to occur, relationships needed to firstly be humanised (Yankelovich, 1999). This was most notable in the Crop Science for Maori project which operated in remote Maori communities. Here scientists needed to respect, learn and understand how to operate in a community with strong cultural values and limited understanding of science as a development tool. This required scientists to temper personal and organisational expectations about project timeframes and create greater flexibility in project delivery.

In the Crop Science for Maori project the positive relationships which developed over time provided the enabling factors for collaborative learning that sought to incorporate both *Mātauranga Māori* (Māori knowledge) and western science knowledge into project learning. The community wanted science knowledge to complement not replace their traditional knowledge. Only when trust was established could learning extend beyond a singular focus on *kumara* (Maori potato) crop production into issues such as market access which led to workshops where chefs provided tastings of specialty *kumara* dishes and scientists worked with the community to organise two food festivals to showcase their organic produce.

In the more conventional partnership of the Wheat Calculator project, science and farming actors were familiar with engaging and farming actors had more understanding of science. Trust building was still required however to overcome an early misalignment of partner priorities that led to a power struggle between partners. This exhibited as a clash between the scientists' requirement for evidence-based findings that valued outputs that were robust and statistically rigorous, and the lived experience of farmers who sought knowledge that was relevant to farming practice. To become an effective learning space, actors needed to understand each other and to collaboratively create a shared vision.

Discussion

The examination of how knowledge was produced in the projects revealed that learning spaces were created most effectively in projects that fostered collaboration and where knowledge was co-produced. This environment created a 'collaborative learning space'. Section 1 explores project characteristics that impeded or fostered a collaborative learning space, while Section 2 visualises how effectively the learning in the projects advanced sustainability.

1. Creating a 'collaborative learning space'

The creation of a collaborative learning space is essential for fostering knowledge co-production that drives innovation and change. Knowledge co-production is created when collaboration, trust-building and negotiation between partners is fostered in this supportive learning space. Without active collaboration in projects, linear knowledge production occurs. Trust building is critical where relationships need to overcome initial power differentials and struggles as collaborative learning challenges institutions that attempt to maintain existing power relationships.

Boundary crossers, who connect actors from different sectors (Veitch et al., 2007) were often used to unlock the learning space. Farming groups who had a strong research focus, (LandWISE, WIG and FAR), took on this critical 'connection' role between science and farming actors and also fostered farmer to farmer learning. Their open and collegial cultures and structural arrangements supported collaborative engagement.

The empirical evidence revealed characteristics that impede and foster a collaborative learning space. Table 3 outlines the characteristics that impede collaborative learning while Table 4 outlines those that fostered the development of a collaborative learning space.

Table 3. Project characteristics that impeded collaborative learning spaces

Characteristic	Examples of empirical support from research
Primary focus on science / crop research not learning processes	Squash project focused on fieldwork for scientists to be able to develop a rot predictor tool. Potato Aphid project focused on gathering field data for scientists to develop a resistance management strategy. Crop Science for Maori project focused on *kumara* production, which under-estimated market requirements and led to a huge quantity of large sized *kumara* that the market did not value.
Scientifically complicated research 'shoe-horned' into participatory projects	Squash Rot project fieldwork was technically complicated and so provided few opportunities for collaboration.
Segmented roles for actors – Scientists responsible for the research while farmers take a passive role in project research	In the Squash and Potato Aphid projects scientists undertook the fieldwork. Farmers' input was confined to project logistics to ensure science fieldwork aligned with farming operation.
Only formal arrangements for collaboration	In the Squash Rot and Potato Aphid projects, steering committees provided the primary site for partner engagement and discussion in the project.
Didactic teaching methods employed	In the Crop Science for Māori project scientists began with classroom-based teaching. The community resisted this 'teaching' approach to engagement.
Project knowledge production does not align with farming practice	The Wheat Calculator software initially did not reflect the way farmers managed their crop.
Organisational infrastructure does not support innovation	Information from field trials assessing aphid numbers was too slowly uploaded to the Potato Aphid project website. Potato Aphid's 'bowl traps' presented problems for farmers' aphid identification. Weather stations in the Crop Science for Māori project were technically cumbersome or inappropriate. Geographical isolation of the East Cape impeded regular collaboration between actors due to distance to field sites.
Institutions are not supportive of collaborative innovation and co-production	Industry / community institutional cultures in Potato Aphid, Squash Rot and Crop Science for Māori projects limited collaboration among community participants, e.g. limited sphere of influence across Maori communities. Scientists' perception of farmers as receivers of science knowledge (challenged by farming group in the Wheat Calculator project)

Table 4. Project characteristics that fostered collaborative learning spaces

Characteristic	Examples of empirical support from research
Learning by doing approach	Farmer experimentation played a significant part in farmers' understanding of their environment e.g LandWISE, and WIG farmers actively engaged in field experimentation; WIG's benchmarking orchard work set protocols for blight management. LandWISE's farmer-led trials allowed farmers to manage soil quality and to adapt and apply the learning to their farm conditions.
Co-development of innovation through learning by interacting and/or learning by using (Hekkert et al., 2007)	Active engagement with scientists to share knowledge: WIG and LandWISE contracted scientists to engage in field activities with farmers or advise on farmers' trials. In the Crop Science for Māori project, growers and scientists co-developed knowledge so science knowledge complemented not replaced their traditional / local knowledge e.g. the production of a *kumara* growing calendar showed how local and science knowledge could be integrated into project learning and outputs.
Trust-building/relationship-building	Trust is essential for collaboration, especially where projects had to overcome power difficulties and differing world views (Wheat Calculator and Crop Science for Māori).
Functioning peer learning networks	LandWISE and WIG created explicit learning networks of farmers actively engaged in the project research, their communities of practice, scientists and relevant industry players.
'Science' is valued by farmers as a development tool and is embodied in project learning.	Research-focused groups (FAR, LandWISE & WIG) understood science as a development tool and science methodology. LandWISE farmers referred to science first principles. WIG's research committee sought 'evidence-based' research to develop orchard best practice of spraying regimes. For these groups farmer / scientist relationships were positive learning relationships where partners developed respect and shared understandings. FAR, LandWISE and WIG all had research committees.
Local knowledge (gained from farming experience or cultural knowledge) is valued by scientists and embodied in project learning.	Collaborative learning challenges linear approaches to research. Many of the difficulties that do arise from challenging how scientists might view themselves professionally and personally are overcome through maintaining positive relationships between science and farming participants
Institutional frameworks that support innovation	FAR had both capacity and capability to support innovation, including staff, secure finances, organisational structure and infrastructure. WIG and LandWISE had capability to support innovation but their dependency on grants made them vulnerable to changes in funding regimes. All these groups fostered innovation through their formal and informal institutions.

2. Visualising collaborative learning for sustainability

To visualise and compare how effectively the six projects fostered learning spaces to address agricultural sustainability, a number of important characteristics with the potential to enable collaborative learning for sustainability were identified from the empirical evidence. These were tabulated to allow each characteristic to be compared across projects and each project to be compared across characteristics.

Each characteristic was qualitatively ranked for each project, as enabling learning (green); disabling learning (red) or being indifferent (orange). Figure 2 visually presents the characteristic ranks for each project. To increase the discrimination for each characteristic, cells of mixed colours indicate a project characteristic that was heterogeneous, to reflect variable actor responses for that characteristic.

Columns have been arranged across the figure in descending order of projects that enable learning. Rows were then similarly ordered in descending order of learning enablement across the six projects. This ordering concentrated those projects and characteristics with the greatest learning enablement in the top left corner of the figure, and those with the greatest learning constraints in the bottom right of the figure.

It can be seen that following the rearrangement of the table as described, the projects have grouped into a 2 x 2 x 2 pattern which coincides both with the groupings of who initiated the project, and also the type of learning space (linear, collaborative or negotiated) that was created. Farming group-initiated projects (which created collaborative knowledge production) had the greatest degree of learning enablement followed by shared partnerships (negotiated knowledge production) where learning enablement was heterogeneous across almost every characteristic and science-initiated projects which largely disabled collaborative learning. Within the science-initiated projects a few characteristics were heterogeneous but none fully enabled collaborative learning.

Comparing these characteristics across the investigated projects provides insight into the effectiveness of individual projects and of projects collectively in realising and most importantly optimising learning for sustainability in the collaborative learning space. Of particular importance in Figure 2 are the learning attributes that contain characteristics that should be evident in innovation projects addressing agricultural sustainability. Co-development and trans-disciplinarity indicate evidence of an enabling learning environment for innovation (Curry et al., 2012; Wieczorek & Hekkert, 2012). Temporal and spatial dimensions recognise the need for innovations to address long-term issues and recognise differing scales. The longevity of project learning has also been explored to see if the outcomes from collaborative learning are sustained in farming communities beyond the funded period of a project, a characteristic argued to be important in sustainability projects and usually indicative of institutional capacity building at the local level (Pretty, 1995). The comparative analysis of the six projects shows the collaborative learning space to be highly variable.

Figure 2. Visualising project realisation of learning for sustainability

Conclusion

This research shows that actor engagement and learning to address sustainability is a complex social process. As a result the creation of a 'collaborative learning space' in micro-level agricultural projects is highly variable. The development of this learning space is critical as the complexities of sustainability will necessarily require integrating different perspectives and knowledges to facilitate questioning of the assumptions and values that drive current practice.

Where changes to agricultural practices are sought as an outcome, actors need to actively engage in a collaborative learning space. In this research this collaboration most effectively occurred in informal peer networks where participants collaboratively engaged in a discursive learning space. Such transdisciplinary environments acknowledge the constructed nature of agricultural knowledge.

When participatory projects create opportunities for multiple stakeholders to collaboratively learn, issues can become apparent, negotiated and resolved. Reframing current understanding of participatory research and conceptualising it as a collaborative learning space provides the opportunity for knowledge to be co-developed where learning can be emergent, adaptive and dynamic.

References

Allan, C., Nguyen, T. P. L., Seddaiu, G., Wilson, B., & Roggero, P. P. (2013). Integrating local knowledge with experimental research: case studies on managing cropping systems in Italy and Australia. Italian Journal of Agronomy, 8(2): 15. doi:10.4081/ija.2013.e15

Baars, T. (2011). Experiential science: towards an integration of implicit and reflected practitioner-expert knowledge in the scientific development of organic farming. Journal of Agriculture and Environmental Ethics 24(6): 601-628.

Barr, N., & Carey, J. (2000). Influencing improved natural resource management on farms: understanding factors influencing the adoption of sustainable resource practices. Australia: Social Sciences Centre, Bureau of Rural studies, Canberra.

Blackmore, C. (2007). What kinds of knowledge, knowing and learning are required for addressing resource dilemmas?: a theoretical overview. Environmental Science & Policy 10: 512-525.

Bruges, M., & Smith, W. (2008). Participatory approaches for sustainable agriculture: a contradiction in terms? Agriculture and Human Values 25: 13-23.

Curry, N., Ingram, J., J, & Maye, D. (2012). Knowledge networks for sustainable agriculture in England. Outlook on Agriculture 41(4): 243-248. doi:10.5367/0a.2012.0106

Douthwaite, B., Kuby, T., van de Fliert, E., & Schulz, S. (2003). Impact pathway evaluation: an approach for achiveing and attributing impact in complex systems. Agricultural Systems 78(2): 243-265.

Fergus, A. H. T., & Rowney, J. I. A. (2005). Sustainable development: lost meaning and opportunity? Journal of Business Ethics 60: 17-27.

Funtowicz, S. O., & Ravetz, J. R. (1994). The worth of a songbird: ecological economics as a post-normal science. Ecological Economics 10: 197-207.

Gibbons, M. (1999). Science's New Social Contract with Society. Nature: 402(Supplement), C81-C84.

Hekkert, M., Suurs, R., Negro, S., Kulhlmann, S., & Smits, R. (2007). Functions of innovation systems: a new approach for analysing technological change. Technological Forecasting and Social Change 74: 413-432.

Ingram, J. (2008). Are farmers in England equipped to meet the knowledge challenge of sustainable soil management? An analysis of farmer and advisor views. Journal of Environmental Management 86(1): 214-228. doi:10.1016/j.jenvman.2006.12.036

Ison, R. (2005). Traditions of understanding: language, dialogue and experience. In M. Keen, V. A. Brown and R. Dyball (Eds.) Social Learning in Environmental Management: Towards a Sustainable Future (pp. 22-40). London: Earthscan.

Ison, R., Roling, N. G., & Watson, D. (2007). Challenges to science and society in the sustainable management and use of water: investigating the role of social learning. Environmental Science & Policy 10: 499-511.

Keen, M., Brown, V. A., & Dyball, R. (2005). Social learning: a new approach to environmental management. In M. Keen, V. A. Brown and R. Dyball (Eds.) Social Learning in Environmental Management: Building a Sustainable Future (pp. 3-21). London: Earthscan.

Klerkx, L., & Leeuwis, C. (2009). Operationalizing demand-driven agricultural research: institutional influences in a public and private system of research planning in The Netherlands. The Journal of Agricultural Education and Extension 15(2): 161-175. doi:10.1080/13892240902909080

Kothari, U. (2001). Participatory development: power, knowledge and social control. In U. Kothari and B. Cooke (Eds.) Participation: the New Tyranny? London: Zed Books.

Lachlan, C.M.A. (2013). Catchment Action Plan 2013. Retrieved from http:/www.lachlan.cma.nsw.gov.au/downloads/Catchment_Action_Plan/Lachlan_CAP2013_-2023_Support_Chapters_web.pdf

Leeuwis, C. (2004). Communication for Rural Innovation: Rethinking Agricultural Extension (3rd Edition). Oxford: Blackwell Science Ltd.

Leeuwis, C., & Aarts, N. (2011). Rethinking communication in innovation processes: creating space for change in complex systems. The Journal of Agricultural Education and Extension 17(1): 21-36. doi:10.1080/1389224x.2011.536344

Lubchenco, J. (1998). Entering the century of the environment: a new social contract for science. Science 279(5350): 491-497.

Medema, W., Wals, A., & Adamowski, J. (2014). Multi-loop social learning for sustainable land and water governance: towards a research agenda on the potential of virtual learning platforms. NJAS - Wageningen Journal of Life Sciences 69: 23-38. doi:10.1016/j.njas.2014.03.003

Mezirow, J. (1994). Understanding transformational theory. Adult Education Quarterly 44(4): 222-232

Neef, A., & Neubert, D. (2011). Stakeholder participation in agricultural research projects: a conceptual framework for reflection and decision-making. Agriculture and Human Values 28(2): 179-194. doi:10.1007/s10460-010-9272-z

Pahl-Wostl, C. (2002). Towards sustainability in the water sector: the importance of human actors and processes of social learning. Aquatic Sciences, 64: 394-411.

PCE. (2004). Growing for good: intensive farming, sustainability and New Zealand's environment. Wellington: Parliamentary Commissioner for the Environment.

Pretty, J. (1995). Participatory learning for sustainable agriculture. World Development 23(8): 1247-1263

Pretty, J., Sutherland, W. J., Ashby, J., Auburn, J., Baulcombe, D., Bell, M., . . . Pilgrim, S. (2010). The top 100 questions of importance to the future of global agriculture. International Journal of Agricultural Sustainability 8(4): 219-236. doi:10.3763/ijas.2010.0534

Reed, M. S. (2008). Stakeholder participation for environmental management: a literature review. Biological Conservation 141: 2417-2431.

Roderiguez, J. M., Molnar, J. J., Fazio, R. A., Sydnor, E., & Lowe, M. J. (2008). Barriers to adoption of sustainable agriculture practices: change agent perspectives. Renewable Agriculture and Food Systems 24(1): 60-71.

Rogers, E. (1962). Diffusion of Innovations. New York: Free Press of Glencoe.

Roling, N., & Wagemakers, M. (1998). A new practice: facilitating sustainable agriculture. In N. Roling and M. Wagemakers (Eds.) Facilitating Sustainable Agriculture: Participatory Learning and Adaptive Management in Times of Environmental Uncertainty (pp. 3-23). Cambridge: Cambridge University Press.

Saldana, J. (2013). The Coding Manual for Qualitative Researchers (2nd Edition). London, UK: Sage.

Tippett, J., Searle, B., Pahl-Wostl, C., & Rees, Y. (2005). Social learning and public participation in river basin management. Environmental Science & Policy 8(3): 287-299.

Vanclay, F. (2011). Social principles for agricultural extension for the promotion of natural resource management. In J. Jennings, R. Packham and D. Woodside (Eds.) Shaping Change: Natural Resource Management, Agriculture and the Role of Extension (pp. 62-71). Australia: APEN.

Vanclay, F., & Lawrence, G. (1995). The Environmental Imperative: Eco-social Concerns for Australian Agriculture. Rockhampton, Australia: Central Queensland University Press.

Veitch, C., Taylor, J., Kilpatrick, S., Farmer, J., & Chesters, J. (2007). Understanding Community Capacity: Community, Professional and Government Perspectives. Paper presented at the Second International Conference on Interdisciplinary Social Sciences, Granada, Spain.

Webber, L., & Ison, R. (1995). Participatory rural appraisal design: conceptual and process issues. Agricultural Systems 47: 107-131.

Wieczorek, A. J., & Hekkert, M. P. (2012). Systemic instruments for systemic innovation problems: a framework for policy makers and innovation scholars. Science and Public Policy 39(1): 74-87. doi:10.1093/scipol/scr008

World Commission on Environment and Development (WCED) (1987). Our Common Future. Oxford: Oxford University Press

Yankelovich, D. (1999). The Magic Of Dialogue: Transforming Conflict into Co-operation. New York: Simon & Schuster.

Yin, R. (2009). Case study research: design and methods (Applied Social Research Methods series; 4th Edition vol 5). Los Angeles, CA: Sage Publications.

Ziegler, R., & Ott, K. (2011). The quality of sustainability science: a philosophical perspective. Sustainability: Science, Practice & Policy 7(1): 31-44

How agroecological farmers develop their own practices: a grid to describe the objects and mechanisms of learning

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Abstract: The agroecological transition - defined here as a transition toward practices based on the management of ecological processes - requires innovations involving a wide range of stakeholders, from farmers to scientists or intermediaries. An extensive literature has shown that agroecological farmers' practices cannot be exclusively based on the application and adaptation of general recipes to the specific context of their farms. For intermediaries, supporting farmers' calls for opening innovation spaces in which they can develop their own practices and generate innovative agroecological knowledge rooted in their peculiar agroecosystem. As a consequence, we argue that it is important to better understand how this knowledge is developed. The ways in which farmers learn, however, remain poorly investigated at the individual level. The major role of experience in learning leads us to build on Kolb's pragmatist theory and to consider the individual learning process as a continuous interplay between a farmer's experience and his or her capacity for action. The purpose of this paper is to propose an analytical grid to describe the mechanisms connecting the farmer's experience and his pragmatic judgements. To do so, we focused on the case of conservation agriculture. We conducted five semi-structured interviews with experienced farmers and analysed them qualitatively. The resulting grid exposes an array of learning mechanisms as well as the objects they may be linked with. This analytical grid may, in the future, be applied to a wider sample of farmers, as a means to better grasp the possible diversity of their learning processes. A deeper understanding of these processes would then help intermediaries to identify which types of support are the most adequate for farmers engaged in the agroecological transition.

Keywords: Agroecology, conservation agriculture, experiential learning, pragmatic judgement

Introduction

Agroecological practices, defined here as production practices based on the management of ecological processes, need to take into account the complexity of these processes as well as their very local characteristics, as minor variations in soil composition, microfauna communities and so on may affect the results of a given practice. Consequently, farmers cannot simply apply general recipes produced by agronomists at a large scale, with only minor adaptations to the ecological specificities of their farm. On the contrary, it has been argued extensively (Altieri, 2002) that agroecological practices need to be developed by farmers in close relationship with their own local context (which includes both the ecological environment and the specificities of the production system). In other words, this questions the system of knowledge transfer, where intermediaries would have the role of expert in charge of educating farmers and giving them the technical solutions ready to be applied.

An agroecological farmer's knowledge must be, at least partly, very specific to his local conditions (Richardson, 2005; Knapp & Fernandez-Gimenez, 2009). However, even though recognising the importance of farmers' knowledge seems crucial in the agroecological transition, this knowledge cannot be directly 'transferred and applied', from one farmer to another. Knowledge exchange between farmers has been shown to provide great benefits to the participants (Millar & Curtis, 1997; Ingram, 2010), but more as a way to promote the circulation of ideas that still have to be tested, adapted and so on. Therefore, understanding not only what agroecological farmers learn, but also how they learn it, seems especially interesting. Such an understanding could indeed help intermediaries (Koutsouris, 2014) in supporting farmers willing to engage in agroecological practices, by highlighting ways to foster the development of adequate solutions by the farmers themselves.

Theoretical background: understanding the learning processes as a way to support farmers in their own transition

Various studies have explored farmers' knowledge in a large range of production systems, from traditional smallholders in poorer countries to larger conventional farms, from fruit and vegetable producers to cattle breeders (Thomas & Twyman, 2004; Richardson, 2005; Knapp & Fernandez-Gimenez, 2009). According to Girard (2014), these works can be classified into four categories, depending on their goal regarding farmers' knowledge: use farmers' knowledge as an inspiration for innovation, evaluate the current state of farmers' knowledge to improve it, promote knowledge exchange between farmers and document farmers' knowledge to support its role in development. In addition to these four types of use of farmers' knowledge, other authors developed ways to describe more precisely this knowledge; Toffolini, et al. (2014), proposed a grid to describe the different forms and characteristics of knowledge used by farmers in their daily activities. Although such works shed light on what farmers' knowledge is and how it can be used, they leave aside the question of how farmers come to develop such knowledge.

Farmers' learning in particular situations

Other works have approached the way farmers learn, but focusing on particular 'learning situations'. Drawing on the pragmatist distinction between a context and a situation, we here consider a learning situation as a "set of conditions taking part in the development of an individual's capacities" (Zask, 2008). Moreover, this 'set of conditions' is taken here in a restricted sense, to indicate a situation fairly limited over time. A learning situation could thus be an interaction with a scientist, a meeting of a knowledge exchange group among peers and so on.

Some studies explored the learning situations involving an 'expert', such as a more experienced farmer or a technician. For instance, Labarthe (2009) investigated the role of agricultural extension services in farmers' learning, and showed how the complex relationships between public and private agricultural extension stakeholders may hamper real support for farmers' learning. In a different setting, Chrétien (2015) examined the transmission of organic farms and described the specificities of the learning processes involved in the interactions between the newcomer and the leaving farmer. Another set of studies concentrated on learning situations involving knowledge exchange groups. Building on two case-studies of Australian breeders, Millar and Curtis (1997) suggested that farmers may undervalue their own knowledge, and that exchange among peers may help them gain awareness of their own knowledge, as well as facilitate the construction of common understanding between farmers and scientists. Along the same lines, McGreevy (2012) examined the synergies and blocking points in the knowledge exchanges between incoming organic farmers and local family farmers in upland Japan.

Finally, some authors have focused on learning situations corresponding to farmers' experiments. Lyon (1996) explores how English farmers "research and learn" and compares this process with scientific methodology, arguing that these two types of experiments are driven by different goals, and should thus be regarded as complementary. More recently, quite a few studies have further documented farmers' experiments in diverse production systems (Milestad et al., 2010; Kummer et al., 2012).

These studies have described and analysed a diversity of learning situations for farmers, but in a somewhat fragmented way in the sense that these varied situations (exchanging with peers, experimenting, etc) are explored independently from one another.

Learning across multiple learning situations

Farmers experiment and exchange with peers and experts on a regular basis. These different learning situations must in some way interact with one another, and their combinations may produce a variety of outcomes. Consequently, we argue that it is especially interesting to understand the learning process as a whole across multiple learning situations.

In the past few years, some authors have started to adopt such an approach. Kilpatrick and Johns (2003), among others, showed that a random sample of Australian farmers display a diversity of 'learning patterns', each including a variety of learning mechanisms such as seeking information from experts, observing a practice chosen by a peer, etc. Ingram (2010) explored the learning processes of farmers practicing reduced tillage, and described them according to two main dimensions, namely "on-farm learning, the technical dimension" and "social learning, the social dimension", thus providing some thoughts on how to combine different learning situations. More recently, Chantre et al. (2014) identified "configurations of learning conditions" for farmers who try to reduce their use of fertilisers and pesticides: in other words, they described how farmers articulate experience and information gathering, and more specifically how they integrate inputs from resource persons along three phases of learning - warning sign, experiencing and evaluating.

In this paper we aim to build on these works to investigate the learning processes of farmers, but in the more specific case of agroecology. As discussed earlier, such practices rely on very local knowledge and require farmers to learn in a context of uncertainty and lack of information. As a consequence, the learning process of farmers who practise agroecology may present specificities that have not yet been analysed.

Conceptual framework and goal of this study

Experience is clearly highlighted in these studies of diverse farming systems as a major aspect of learning. Moreover, in the context of agroecology, practices are deeply rooted in a particular environment, which leads us to consider that an agroecological farmer's continuous experience may play an especially important role in his learning process. We thus chose to mobilise elements of the pragmatist experiential learning theory (Dewey, 1938; Kolb, 1984). Contrary to the view that learning can be seen as a simple transfer of knowledge from a knowledgeable person to a learner (a point of view which has been largely criticised, see Freire, 1970), this theory considers the experience lived by a person as the very basis of this person's learning. As a consequence, we here consider learning as a continuous interplay between a farmer's experience and his or her pragmatic judgement (Pastré, 2005), as presented in the figure below. By 'pragmatic judgements', we here mean the diversity of "concepts that organise actions" (Pastré, 2005), which can include decision rules at a very specific level and more general principles of action.

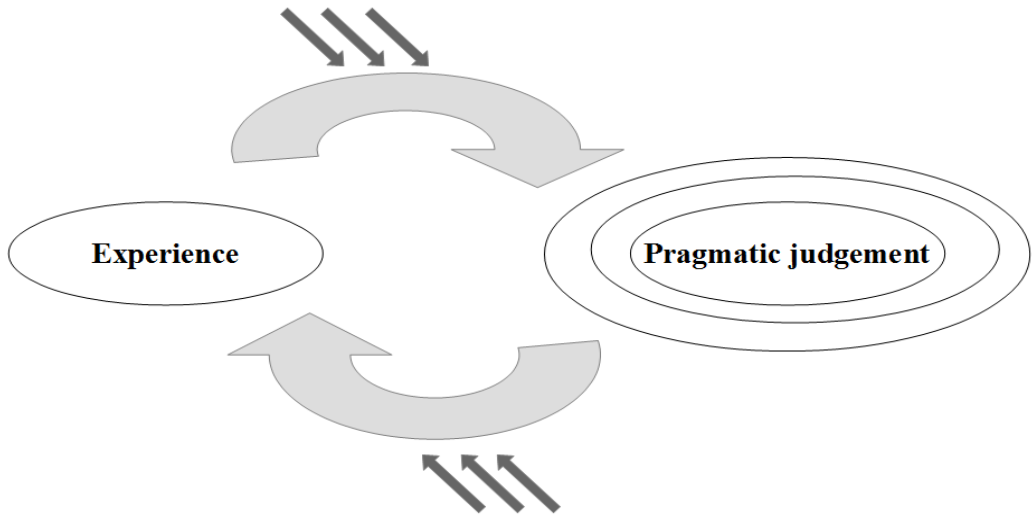

Figure 1. Learning as a continuous interplay between a farmer's experience and his pragmatic judgement. *The concentric circles represent the diversity of pragmatic judgements. The continuous interactions between experience and pragmatic judgements are shown as thicker light grey arrows, while the thinner dark grey arrows represent inputs from peers, scientific sources, etc., which may affect these interactions.*

A farmer's experience is the basis of his elaboration of a pragmatic judgement, which in turn affects what experience is lived. Interactions with peers or experts, and gathering of information from a diversity of documents, also contribute to this process. Consequently, even though we chose to base our study on experiential learning theory, we fully acknowledge that learning does not happen solely in one's field, in a strictly individual way; we only choose to focus on personal experience and the way external sources of knowledge are incorporated in experiential learning, rather than focusing on knowledge dynamics among members of a group for instance.

The succession over time of these interactions between experience and pragmatic judgement is what we here call the *learning process*; meanwhile, we use the term *learning mechanism* to refer to the way in which each of these interactions may happen: the learning process is a sequence of learning mechanisms. Because learning mechanisms may not necessarily be the same depending on what the farmer is learning, we also use the notion of *object of learning* to refer to the object learned about. To understand the learning processes of farmers practising agroecology, we suggest that a first step may be to describe the diversity of learning mechanisms and learning objects –moreover, we will here restrict the learning objects to those directly related to agroecological production practices.

Consequently, the goal of this paper is to propose two grids to describe the mechanisms and objects of learning in the case of farmers experienced in terms of agroecological practices.

Methodology

The case study: conservation agriculture

Conservation agriculture is commonly dated back to the 1930s, when the ecological and human catastrophe of the 'dust bowl' in the American midwest prompted scientists and farmers to develop a set of practices aiming at reducing soil erosion risks, while also improving the agronomic properties of the soil (although similar practices, also linked with soil erosion, were likely happening as early as the late 19^{th} century –Birkas et al., 2004). The term is used mostly for field crops, and it is based on three main principles: reduced tillage; permanent soil cover and more complex cultural successions (De Tourdonnet et al., 2013; Pittelkow et al., 2014). Each of these principles covers a large diversity of possible practices:

- reduced tillage may include a gradient from shallower ploughing to no ploughing at all, use of tools that crack the soil without disturbing its structure, direct seeding...
- permanent soil cover may be accomplished through the use of mulch, ramial chipped wood, diverse cover crops...
- more complex cultural successions can include varied crops with a diversity of nutrient needs, root systems, symbiotic capacity (in the case of legumes especially)...

However, all these practices are directed toward similar goals. For instance, reducing the perturbation of the soil and protecting it through the use of covers globally aims at enabling soil biodiversity to develop and ensure the recycling of organic matter as well as the structuration of the soil itself (Farooq & Siddique, 2015). In other words, conservation agriculture principles aim at fostering ecological processes that provide a benefit for the agricultural system: in this sense it can be considered as an example of agroecological practices as previously defined.

Sample and data collection: semi-structured interviews with 5 south-western French farmers

Conservation agriculture is a particularly promising example of agroecological practices in south-western France, since soil erosion is especially high in that region (GIS Sol., 2011): we consequently chose to base our study in this area. We interviewed 5 farmers (all men), members of a local conservation agriculture association - AOC Sols ("Association Occitane de Conservation des Sols", http://aocsols.free.fr/) who had practised reduced tillage, permanent soil cover and complex cultural successions for at least 6 years. We chose this time frame because of previous studies (Pittelkow et al., 2014) which indicated that the transition towards conservation agriculture usually includes a deterioration of the soil conditions around the third year, and that it takes about 5 years for the benefits of the practices to be effective.

Our qualitative data was gathered through face-to-face semi-structured interviews, always conducted by the same person. Because we had no *a priori* hypothesis to be tested, these interviews were largely exploratory, and were thus conducted in a rather loose way to follow the line of thought of the farmer and enable new topics to emerge (Blanchet & Gotman, 1986). However, even though a certain freedom was given to the interviewee, we made sure that the three main aspects of conservation agriculture (reduced tilling practices, soil cover and crop succession) were discussed at some point, as well as the relationships and knowledge exchange with other farmers, scientists and extension agents.

Data analysis: qualitative structuration of interviews through inductive coding

The interviews were integrally transcribed and a qualitative analysis of content was then performed using the Nvivo® software. We constructed separately the grids of the mechanisms and objects of learning; for the grid of objects of learning, we proceeded as follows.

Taking one interview after the other, in random order, we coded the objects of learning in the inductive way characteristic of "*conventional coding*" (Hsieh & Shannon, 2005). Our strategy was close to grounded theory (Glaser & Strauss, 2009), and consequently there was no previously defined list of nodes to be used.

Each time the interviewee talked about something he learned, we coded this excerpt of the text with a short expression describing 'what the farmer learned about'. We used words that were as close as possible to the farmers, while also trying to choose an expression not too specific to one particular excerpt, so that it could be re-used to code other parts of interviews dealing with the same object. We observed that saturation (or the absence of apparition of any new object) was reached around the end of the fourth interview.

The data thus structured into smaller units through coding was then used for "*gradual construction of a system of categories*" (Langley, 1999), encompassing the various discourses of interviewed farmers. Because the categories of mechanisms and objects of learning had to be sufficiently general to include elements of discourse from different farmers, we could not keep strictly to the words used by each interviewee. Consequently, the labels of the categories of objects and mechanisms of learning are often scientific terms, chosen because they were large enough to encompass the diverse specific expressions used by different farmers.

The same method was then applied again to the 5 interviews to obtain the grid of mechanisms of learning.

Results

Objects of learning of farmers experienced in conservation agriculture

Figure 2 represents in a systemic way the major objects of learning emerging from our interviews. We distinguished three kinds of objects of learning: biological objects (such as pests or cover crops); relationships between biological objects (such as the effect of some crops on weeds) and relationships between a practice and a biological object (such as the effect of tillage on soil micro-fauna). These diverse objects of learning revolve around three large themes which are the three main aspects managed by the farmers, namely soil, cultivated biodiversity and non-cultivated biodiversity.

The farmers interviewed expressed learning about both the physico-chemical and the biological characteristics of the soil. The physico-chemical properties encompass elements regarding the structure and the composition of the soil: soil structure includes the characteristics of the soil layers at a given time as well as the propensity to erosion. Soil composition covers chemical content and micro-geological characteristics. The physico-chemical characteristics of the soil are deeply affected by agricultural practices, and farmers repeatedly talked about the observed effects of different tillage practices on soil structure (e.g. compaction of the soil and reduced water retention). The biological properties of the soil – its micro-fauna and micro-flora - were also frequently evoked, as well as their response to practices such as tillage.

We decided to divide the second theme – non-cultivated biodiversity - according to the roles farmers said it played for them, which led to three categories: harmful biodiversity, helpful biodiversity, and neutral biodiversity:

Harmful biodiversity includes pathogens, pests and weeds, all of which affect, and are affected by, the cultivated biodiversity, i.e. crops. The effects of crops on weeds may happen through a diversity of ecological processes managed by farmers, such as competition (with the planting of a cover crop to make it harder for weeds to start growing) or allelopathy ("Because oat […] hampers weeds a lot. You have barley, oat, but oat is maybe one of the most...It has allelopathic virtues, or I don't know what, that are quite exceptional"). The choice of crops may also affect pathogens and pests by disrupting their life cycles and depriving them of a suitable habitat.

Helpful biodiversity includes species that present an intrinsic advantage for agricultural production (for instance, any bacteria or worms participating in organic matter recycling), and species that are used by the farmer as indicators (e.g. birds used as a way of knowing whether or not insects are present).

We call neutral the biodiversity which does not, according to the farmers, explicitly play a direct role in the production system.

Regarding the third theme, cultivated biodiversity, farmers mentioned learning about seed selection and the effect of climate on crops. The effects of cultivated biodiversity on soil structure often appeared in farmers' discourse, for instance through the use of cover crops to mitigate against soil erosion, or the choice of specific crops such as sorghum to alleviate soil compaction.

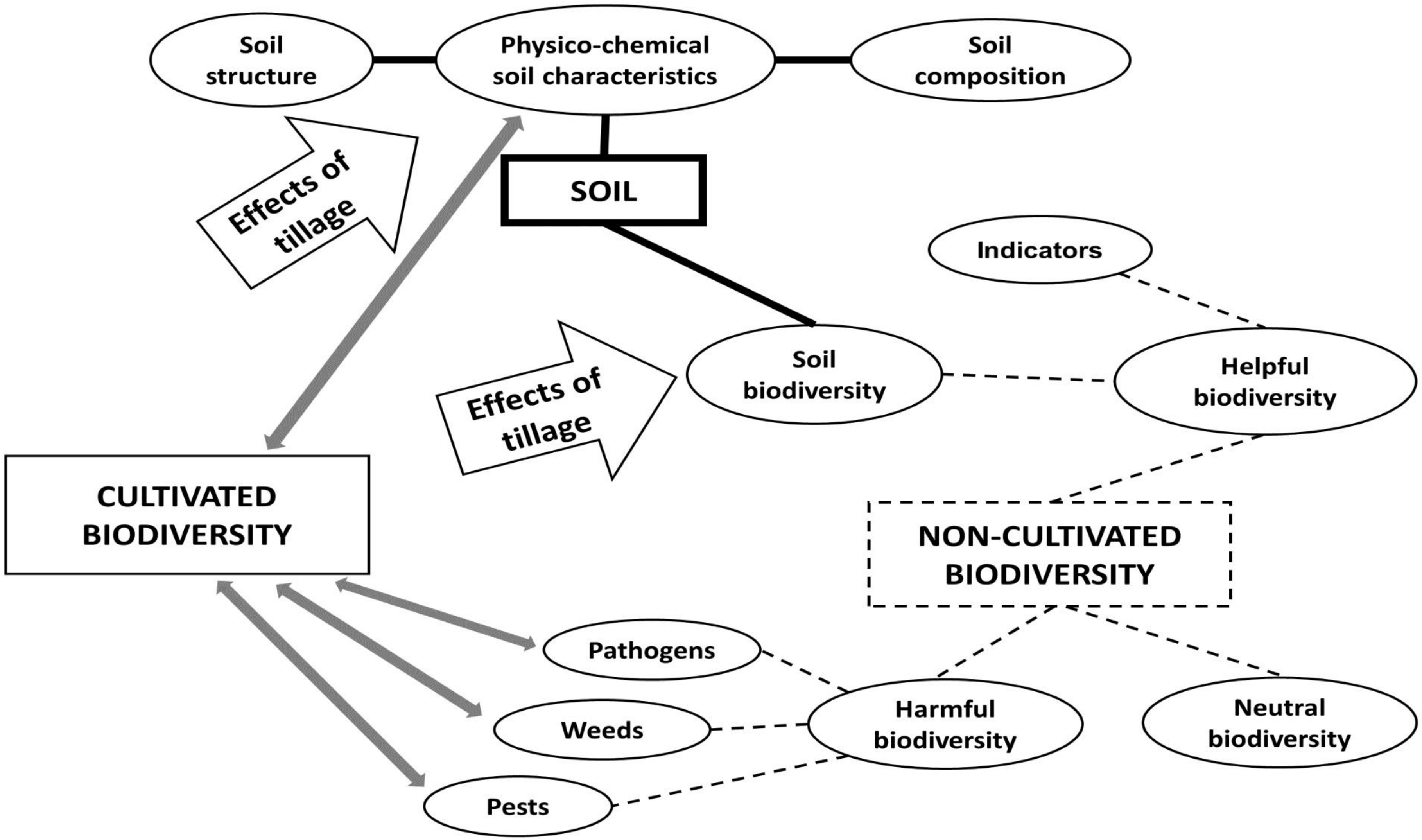

***Figure 2:* Objects of learning of farmers experienced in conservation agriculture.** *The three rectangles indicate the main themes of learning, while the circles represent biological objects included in those themes. The thinner grey arrows represent relationships between biological objects, while the larger arrows represent the effect of a practice on biological object.*

Learning mechanisms of farmers experienced in conservation agriculture

Table 1 presents the mechanisms of learning emerging from our interviews. We organised them into five categories corresponding to different steps in the learning process: these possible steps are not always present for each farmer, nor do they represent a logical sequence which is necessarily followed. They are merely larger categories which we defined to cluster more specific learning mechanisms.

Get an idea for a new practice. This may happen on one's own, or it may result from exchanges with peers, either directly (i.e. getting the idea from another farmer) or indirectly (i.e. on the basis of exchanges with peers, getting inspiration to personally conceive a new practice). It may also come from scientific sources, again, directly or indirectly.

*Implement a new practice***.** Farmers talked about implementing new practices at a variety of spatial scales (e.g., trying a cover crop on a smaller area first, or on a whole field at once) and time scales (e.g. trying direct seeding of corn in just one year, or trying it over several years to see whether or not the specific climatic conditions of the first year made a difference). New practices may also be implemented more or less progressively: some farmers try stopping tillage altogether, whereas others go through gradual change from a 50cm ploughing to 30cm and then15cm and so on, assessing the results as they proceed.

A farmer may implement a new practice in a more or less planned way, and we have identified three types of experiment: *planned experiments*, that are willingly foreseen and conducted by a farmer; *opportunistic experiments*, that happen when some mishap puts a farmer in an unexpected situation, prompting him to try something new which he would not otherwise have tried, and *fortuitous experiments*, that are not decided on by a farmer but happen anyway (e.g. when a mistake leads to interesting results). As this last category is wholly unplanned, it can happen simultaneously to a group of peers, but it cannot include any scientific input, hence the exclusion of the 'scientific inputs' column in the Table 1.

A farmer may implement a new practice on his own, but exchanges with peers may also affect how he decides to go about experimenting. Scientific documents or extension agents may also provide methodological inputs to plan an experimental design.

Monitor the state of the system. Farmers may monitor their system or parts of it in a qualitative or quantitative way, at different frequencies and spatial scales, with a variety of indicators (coming from scientific sources, co-developed with peers and/or personally developed).

The analysis of such monitoring may also be more or less formal (from a very rough guess to a computer-aided statistical analysis including a diversity of independent variables).

Get standards/points of comparison. Farmers form an idea of what their system or parts of it should be like and what its performances should be, either on their own or based on exchanges with peers - leading to the construction of a common ideal, comparison with other farmers' systems and/or scientific standards.

Assign a certain degree of validity to a principle**.** Farmers expressed to different degrees their needs to understand the cause of an observed phenomenon in order to consider it as generally true. Such an explanation may come directly from peers or scientific sources, or be more indirectly inspired by such sources.

Table 1. Learning mechanisms of farmers experienced in conservation agriculture. *The left-side column indicates the main possible steps of the learning process and the upper line presents the different sources that a farmer may mobilise when going through these different steps*

<table>
<tr><th></th><th>Personal experience</th><th>Peers' inputs</th><th>Scientific inputs</th></tr>
<tr><td>Get an idea of a new practice</td><td>Conceive a new possible practice</td><td>Find an idea of a new practice together with peers.
Imagine a new practice, by getting inspiration from peers' practices</td><td>Find an idea of a new practice from a scientific source.
Imagine a new practice, based on a similar phenomenon scientifically understood</td></tr>
<tr><td rowspan="4">Implement a new practice</td><td colspan="3">Choose a time scale
Choose a spatial scale
Choose a degree of intensity of change</td></tr>
<tr><td colspan="3">Experiment in a planned way
Experiment in an opportunistic way</td></tr>
<tr><td colspan="2">Experiment in a fortuitous way</td><td></td></tr>
<tr><td>Implement a new practice individually</td><td>Implement a new practice collectively</td><td>Rely on scientific methods to conceive an experimental design

Be reassured of a decision already taken thanks to a scientific input</td></tr>
<tr><td>Monitor the state of the system</td><td colspan="3">Monitor the system in a quantitative or qualitative way
Monitor a specific experiment, or monitor the system in a more general way
Choose a frequency and spatial scale for monitoring activities
Find indicators for the information desired

Analyse the information obtained through monitoring in a more or less formal, quantitative way
Choose a time and spatial scale for analysing the information obtained through monitoring
Take into account independent variables</td></tr>
<tr><td>Get standards</td><td>Reject peers' standards</td><td>Compare own system with peers' systems
Construct and share common ideals</td><td>Judge the state of the system with respect to scientific standards</td></tr>
<tr><td>Elaborate a principle of action</td><td>Confirm or disprove information coming from a scientific source

Confirm or disprove information coming from peers

Put together different personal experiences</td><td>Confirm or disprove information coming from a personal observation

Confirm or disprove information coming from a scientific source</td><td>Confirm or disprove information coming from a personal observation

Confirm or disprove information coming from peers</td></tr>
</table>

		Find among peers a direct explanation for an observed phenomenon Elaborate an explanation of a phenomenon based on an analogy with an explanation of a similar phenomenon heard from peers Put together different opinions from peers Take a piece of information coming from a peer as true without further inquiry, based on credit given to this peer	Find in a scientific source a direct explanation for an observed phenomenon Elaborate an explanation of a phenomenon based on an analogy with a scientific explanation of a similar phenomenon Put together different scientific sources Take a piece of information coming from a scientific source as true without further inquiry, based on credit given to this source

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Discussion

These results show an extensive diversity of objects and mechanisms of learning for farmers experienced in conservation agriculture practices. However, we do not claim that these grids are exhaustive; quite the contrary, we suggest that they should be taken as a starting point to better qualify the full diversity of objects and mechanisms of learning. Although our sample already presented fairly diverse approaches to learning, it is important to note that because our interviews were conducted with farmers belonging to the same conservation agriculture association and same geographical area, it is possible that part of their discourse is more homogeneous than it would otherwise be. As a result, we are currently interviewing a broader sample of farmers, taken out of this specific context, to complete the grids. In addition, in order to better approach the learning mechanisms and objects which may not be easily verbalised, our further work will include more observation and interviews in the fields.

It will also be interesting to explore the relationships between objects and mechanisms of learning. Indeed, our interviews suggest that a diversity of learning mechanisms may be linked with one same object, but these relationships remain to be clarified. In particular, if some mechanisms are more specifically mobilised by farmers to learn about a given object, then knowing this could help intermediaries to better tailor their actions towards farmers to support them in learning to develop their own practices. These grids may also be used as a first step to investigate the interconnection of the learning mechanisms and their succession over time, or in other words, the learning process as a whole. The learning process may also involve changes in the objects of learning, and further work will help identify the modalities of such changes, i.e., how a succession of learning mechanisms related to one object may result in another sequence of learning mechanisms linked with another object.

We focused here on objects of learning directly related to production practices (biological objects, relationships between biological objects and effect of a practice on a biological object), however learning may also occur for other types of objects. More specifically, we suggest that developing agroecological practices such as conservation agriculture may induce a change in pragmatic judgements about objects such as oneself, one's role in society as a manager of natural resources, one's desired relationship with nature etc. These objects and their role in the learning process as a whole could be envisioned through the theory of double-loop learning (Argyris, 1982): learning about objects directly related to production practices could be considered as first-loop learning, which may in turn induce a second-loop learning dealing with those broader objects. Such a learning process seemed to appear in our interviews, for instance when a farmer explained how learning to change his seeding techniques (from a conventional method to direct seeding) made him reconsider the whole technical orientation of his system and try to develop new methods based on ecological processes through, for example, a diversification of crops.

Understanding in more detail how learning happens for farmers experienced in agroecology is crucial to better tailor extension services and agricultural support generally. If we can identify more clearly which kind of evidence (a scientific explanation of the phenomenon, an observable example at a neighbours…) are required by farmers to consider something as a rule of action, then it may be easier for intermediaries to efficiently search for and expose such evidence. Having a clearer idea of the objects that farmers feel a need to think about, and how they relate these objects to each other, may also help in defining the focus of extension services.

Conclusion

Our study enabled us to present a diversity of objects and mechanisms of learning for farmers experienced in conservation agriculture and to propose organised, although non exhaustive, sets of these objects and mechanisms. This analytical framework may be used as a starting point towards a more comprehensive characterisation of the multiple-loop learning processes of agroecological farmers. The learning processes may well be very varied so any promising research path would need to highlight some steadier aspects, or try to establish a typology of learning styles, based on an understanding of the learning process as a whole, for farmers experienced in agroecological practices. A deeper understanding of the diversity of learning processes may then be mobilised by intermediaries to better tailor their support for farmers engaged in agroecological practices.

References

Altieri, M. (2002). Agroecology: the science of natural resource management for poor farmers in marginal environments. Agriculture, Ecosystems & Environment 93(1–3): 1–24.

Argyris, C. (1982). The executive mind and double-Loop learning. Organizational Dynamics 11(2): 5–22.

Birkás, M., Jolánkai, M., Gyuricza, C., & Percze, A. (2004). Tillage effects on compaction, earthworms and other soil quality indicators in Hungary. Soil and Tillage Research 78(2): 185–196.

Blanchet, A., & Gotman, A. (2010). L'entretien: L'enquête et ses Méthodes. Paris: Armand Colin.

Chantre, E. (2011). Apprentissages des agriculteurs vers la réduction d'intrants en grandes cultures: cas de la champagne berrichonne dans les années 1985-2010. AgroParisTech. Retrieved from https://tel.archives-ouvertes.fr/tel-00675226/

Chrétien, F. (2015). Agriculteurs et apprenants au travail. La transmission professionnelle dans les exploitations agrobiologiques: une approche par les configurations sociales et les situations d'interaction. Université de Bourgogne. Retrieved from https://hal.archives-ouvertes.fr/tel-01218035/

De Tourdonnet, S., Brives, H., Denis, M., Omon, B., & Thomas, F. (2013). Accompagner le changement en agriculture : du non labour à l'agriculture de conservation. Agronomie, Environnement et Société 3(2): 19-27.

Dewey, J. (1938). Experience and Education. New York: Kappa Delta Pi.

Farooq, M., & Siddique, K. H. (2015). Conservation Agriculture. Springer.

Freire, P. (1970). Pedagogy of the Oppressed. New York: Herder and Herder.

Gis Sol. (2011). Synthèse sur l'état des sols de France. Groupement d'intérêt scientifique sur les sols. Retrieved from https://www.gissol.fr/rapports/synthese_HD.pdf

Girard, N. (2014). Etudier et utiliser les connaissances des praticiens pour accompagner le développement des systèmes techniques : une synthèse bibliographique dans le domaine agricole. Conférence Gestion des connaissances dans la Société et les Organisations.

Glaser, B. G., & Strauss, A. L. (2009). The Discovery of Grounded Theory: Strategies for Qualitative Research. New Jersey:Transaction Publishers.

Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. Qualitative Health Research 15(9) : 1277-1288.

Ingram, J. (2010). Technical and social dimensions of farmer learning: an analysis of the emergence of reduced tillage systems in England. Journal of Sustainable Agriculture 34(2): 183-201.

Kilpatrick, S. & Johns, S. (2003). How farmers learn: different approaches to change. The Journal of Agricultural Education and Extension: Competence for Rural Innovation and Transformation 9(4):151-164.

Knapp, C., & Fernandez-Gimenez, M. E. (2009). Knowledge in practice: documenting rancher local knowledge in Northwest Colorado. Rangeland Ecology & Management 62(6): 500–509.

Kolb, D. (1984). Experiential Learning: Experience As The Source Of Knowledge And Development. New Jersey: Prentice Hall PTR

Koutsouris, A. (2014). Exploring the Emerging ‘Intermediation’ (Facilitation and Brokerage) Roles in Agricultural Extension. International Farming Systems Association (IFSA) Europe.

Kummer, S., Milestad, R., Leitgeb, F., & Vogl, C. R. (2012). Building resilience through farmers’ experiments in organic agriculture: examples from Eastern Austria. Sustainable Agriculture Research 1(2): 308-321.

Labarthe, P. (2009). Services immatériels et verrouillage technologique. Economies et Sociétés 11: 173-196.

Langley, A. (1999). Strategies for theorizing from process data. Academy of Management Review 24(4): 691–710.

Lyon, F. (1996). How farmers research and learn: the case of arable farmers of East Anglia, UK. Agriculture and Human Values 13(4): 39–47.

McGreevy, S. R. (2011). Lost in translation: incomer organic farmers, local knowledge, and the revitalization of upland Japanese hamlets. Agriculture and Human Values 29(3): 393–412.

Millar, J., & Curtis, A. (1997). Moving farmer knowledge beyond the farm gate: an Australian study of farmer knowledge in group learning. European Journal of Agricultural Education and Extension 4(2): 133–142.

Pastré, P. (2005). Genèse et identité. In P. Rabardel and P. Pastré (Eds.) Modèle Du Sujet Pour La Conception pp. 231-259. Toulouse: Octarès Editions.

Pittelkow, C. M., Liang, X., Linquist, B. A., van Groenigen, K. J., Lee, J., Lundy, M. E., van Gestel, N., Six, J., Venterea, R. T., & van Kessel, C. (2015). Productivity limits and potentials of the principles of conservation agriculture. Nature 517(7534): 365–368.

Richardson, M. (2005). À la recherche de savoirs perdus? Expérience, innovation et savoirs incorporés chez des agriculteurs biologiques au Québec. VertigO - la revue électronique en sciences de l’environnement 6(1).

Thomas, D. S. G., & Twyman, C. (2004). Good or bad rangeland? Hybrid knowledge, science and local understandings of vegetation dynamics in the Kalahari. Land Degradation & Development 15(3): 215–231.

Toffolini, Q., Jeuffroy, M-H., & Prost L. (2014) Transition towards low-input cropping systems: characterisation of actionable knowledge for technical change. International Farming Systems Association (IFSA) Europe.

Zask, J. (2008). Situation ou contexte ? Revue internationale de philosophie 245: 313–328.

Farming system transformation as transition to sustainability: a Greek quality wines case study

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Abstract: This study aims at analysing the gradual transformation of a low input and bulk wine producing system into a quality system. This transformation is examined in Santorini Island in Greece during the last three decades, in a highly contested natural landscape. The conceptual framework draws from the 'transition to sustainability' approach, in particular the theoretical apparatus of the multi-level perspective (MLP). Spaces for innovations as well as threats for this transformation have been created by a series of 'socio-technical landscape' pressures, along with processes internal to the 'niche', the links between the niche and the 'regime', as well as multi-regime interactions. Public intervention in the form of both regulatory and incentive provision policy measures had a considerable impact on creating space for these reconfigurations and innovative forms of organisation. A series of conflicts have been identified, as well as a polarisation in the power game. Despite significant efforts for co-ordination among local stakeholders, there's a need for more permanent forms of co-operation such as an innovation platform. The interests vested are important hence the necessity of an institution acting as a mediator seems to be apparent.

Key-Words: Transition to sustainability, space for innovation, quality wines, Greece

Introduction

Various challenges and change in agri-food systems have increasingly been analysed from the 'transition to sustainability' perspective over the last 10-15 years (Hinrichs, 2014). In a similar vein, following a systems approach, innovation is considered as a successful combination of new technical devices and practices, new knowledge and new social institutions and forms of organisation (Smits & Kuhlmann, 2004).

Deliberate efforts for the development of a quality wine sector in Greece date back to the early 1960's. An early system of labeling was introduced in 1970's, and after Greece's accession into the EEC/EU in 1981 quality in the wine sector has been promoted within the overall European regulatory framework.

More recently, the Greek wine sector is characterised by both declining production volume and quality upgrading. While the total wine production has decreased by 23%, between the 2004-2009 and 2010-2015 periods (i.e. before and during the current crisis), wines without any quality certification have been reduced by 36.4% while quality wines have increased by 83.2% (MRDF, 2016). Thus, between these periods the share of all quality wines has more than doubled (from 11.3% to 26.8%) whereas in early 1990's quality wines contributed 6% to the total wine produce of the country.

The wines of Santorini island have always been the spearhead in these efforts. Santorini's wines entered a new era after they received their own Appellation of Origin, especially after 1981 (see below). Nowadays, high quality wine production aiming at the global market is an integral part of the local production system. In the course of transforming this system, a series of innovations have been introduced and established, including the use of new technological and biological means, as well as changes in specific farming practices.

It has to be noted that following a complex adaptive system approach, development in tourist areas can be understood as a multilevel, co-evolutionary process, involving diversification in tourist products which requires, inter alia, networking activities among actors and various niche innovations (Hartman, 2016).

This study aims at analysing the gradual transformation of a low input and bulk wine producing system into a quality system. This transformation is examined in Santorini island in Greece during the last three decades, in a highly contested natural landscape. The conceptual framework draws from the 'transition to sustainability' approach, in particular the theoretical apparatus of the multi-level perspective (MLP). Spaces for innovations as well as threats for the transformation examined here are explored in the context of a series of 'socio-technical landscape' pressures along with processes at the 'niche' level. The study is based on material mainly collected in the context of the EU-7th Framework Programme FARMPATH ("Farming Transitions: Pathways towards Regional Sustainability of Agriculture in Europe"), as well as in previous research on the same area.

Data within the FARMPATH project were collected through open-ended interviews with 20 stakeholders, including the local Department of Agriculture, the local co-op representatives, wine makers and representatives of national collective bodies of wine makers. Previous research addressed the topic of the island's landscape and was carried out through discussions with local key informants (wine makers, agronomists, co-op representatives, etc.).

The paper consists of six parts. The second part comprises the conceptual framework, with the third part giving an account of the construction of space for innovation in the framework of the emerging transformation. The key role of policies is examined in the fourth part and a series of conflicts, synergies, open issues and the need for mediation are discussed in the fifth. The paper concludes in the final section.

Conceptual Framework

The substantial transformation of socio-technical systems to more sustainable modes of production and consumption, i.e. their 'transition to sustainability', has taken a prominent place in the academic literature over the last 10-15 years. The multi-level perspective (MLP) has been the main theoretical framework for this research, using the analytical categories of regime, landscape and niche (Geels, 2011). MLP contends that transition comes about as a result of pressures from the broader 'landscape', combined with the propagation of innovations that have been nurtured at 'niches' (Konefal, 2015).

In this context, an agri-food regime can be conceptualised as a configuration of co-evolving technical, social (actors and networks involved) and institutional (prevailing values, knowledge systems and policy measures) elements (Ingram, 2015). On the other hand, the socio-technical landscape is perceived as an exogenous environment that affects both the regime and the niches by exerting pressures, which can create tensions and offer opportunities for change (Geels & Schot, 2007).

Of major importance to any transition are the processes taking place within a niche, i.e. a 'nursery' in which various novelties can be tested and developed (Kemp et al., 1998). With the active contribution of local actors and networks, these niche innovations, after their initial development, could be successfully linked to the regime, thus setting in motion broader transformative changes at the regime level. On the other hand, from a systems perspective, a multitude of stakeholders and networks are involved in an innovation process, while innovations include new social and organisational arrangements (Leeuwis & Aarts, 2011). In exploring the potential of 'space for innovation', the processes of development of a niche are of prime importance, especially the articulation of expectations and visions, as well as the building of social networks and the enrolment of more actors (see also Schot & Geels, 2008).

Moreover, transition is a process with an 'uncertain' outcome, which usually involves frictions, tensions and competing views on the direction of change. As innovations are being introduced in a niche and break through into the agri-food regime, both the internal structure of the regime and inter-regime relations are rearranged. Thus, serious contradictions as well as a series of unresolved issues (e.g. from multi-regime interactions) may emerge, which may hamper the overall momentum of the transition under study.

By using this framework, the actual and/or the potential role of mediation can be identified, which could be beneficial to the innovation process by closing system gaps, facilitating network formation and managing the innovation process (Kilelu et al., 2011).

Space for innovation in an emerging transition

Socio-technical landscape pressures

During the last three decades, the time frame of our paper, there have been two main driving forces conveying various pressures upon the local regime.

Firstly, tourism development (since the early 1980s), which mainly affected space and labour, the most contested dimensions of the local regimes. The emerging tourism industry of the island was in dire need of both of these elements. As land has always been a scarce resource and the ownerships were small and highly fragmented, the increased demand for land, for the construction of hotels and other tourism enterprises, resulted in a considerable increase in land prices, including agricultural land. At the same time, attractive salaries were offered to the local labour force in both tourism and construction, therefore absorbing obscured unemployment and reduced out-migration.

However, within the process of expansion and growth of the tourism industry worldwide, global changes such as improved transport infrastructure and lifestyle changes, as well as saturation of certain market segments, caused the emergence of strong trends within the tourism industry towards the provision of differentiated and diversified tourism services. New forms such as ecotourism, cruises, wine tourism or combinations of these emerged during the 1990s and gained an impetus. Big hotels and mega-installations were not sought after any more, hence the demand for land became more eclectic; smaller pieces of land and the landscape became an asset. In parallel, the transition processes in Eastern European economies and elsewhere during the 1990s created a large pool of available labour. These changes seem to have had an impact on both the local land and labour markets.

An additional sociotechnical landscape pressure has been the development of a worldwide market for quality wines in which globalisation is manifested through a strong tendency towards homogenisation of the taste and the creation of 'international wines' (Nositer, 2010). Based on sales and exports data, the market for quality wines can be seen to have expanded rapidly during the last decades. Thus, various changes have occurred in order to facilitate a new way of co-ordination of the wine production stakeholders so as to deal with the various external threats or opportunities concerning wine production (Barbera & Audifredi, 2012).

The globally widespread perception of 'localness' and provenance as an element of quality, especially for wine, has been a further socio-technical landscape feature that seems to have played an important role in the changes that occurred in Santorini wineries. There are quite a few elements that suggest that geographical indications (GI) provide a considerable added value to wine, e.g. a price differentiation for GI wines (EC, 2012). However, the role of 'terroir' as a decisive factor of quality, is not as incontestable a fact as one might expect (Josling, 2006). Especially in the case of quality wines, the debate is ongoing re issues of grape (variety) vs. terroir or the uniformity of 'international' wines as opposed to the diversity of local wines (Nositer, 2010; Negro et al., 2007; Anderson, 2009; Patchell, 2011; Lugeri et al., 2011).

The regimes under transformation and the new driving forces

In the case of Santorini, the two interconnected regimes - tourism and agriculture (mainly wine production) - can be better described by analysing the synergies and conflicts created during the co-evolution of both regimes in the three last decades.

Santorini has been known for wine production and trade since the 5th millennium BC. Almost 100 years ago (1920) vineyards covered 3,500 hectares., accounting for 84% of the cultivated land (Kourakou-Dragona, 1995). A gradual decline over the years (down to 2,250 hectares in 1970 and 1,492 hectares in 1997) was accelerated by a massive earthquake in 1956 followed by the augmentation of tourism in the 1980's (Drosou, 2005). Since then, the area covered by vineyards seems to have stabilised.

Twenty-five indigenous grape varieties, adapted to the hot, dry climate, harsh winds and volcanic soils, are grown on the island. Santorini also remains one of the few places in Europe with its original un-grafted vines, as the volcanic geology made its grape varieties immune to *Phylloxera* (Kourakou-Dragona, 1995). Two practices, manifestations of the adaption to the local environmental circumstances, constitute a crucial element for the landscape of the island. The first is the self-propagation of the vines, which makes mechanisation and the use of equipment almost impossible. The second concerns two peculiar pruning practices which, in parallel, require skilled pruners and increase costs.

The wine produced was sold, mainly in the form of bulk, to the nearby islands as well as to the mainland, through informal networks of internal immigrants. The local co-operative afforded the only sizeable bottling unit and an elementary marketing mechanism.

As aforementioned, during the early 1980s Santorini started to become an increasingly attractive tourism destination. The process followed a pattern common in Greece: a disorderly establishment of small size tourist installations, starting from the littoral and gradually expanding to other areas. The view, the volcano, sunset, beach and the nightlife were the main (if not the only) features of Santorini's tourism industry. The linkages established with other local agricultural products besides wine (e.g. small tomatoes, fava etc.) were virtually non-existent.

The small size of the numerous tourist activities did not however lessen the pressures towards agricultural land uses. An equally important impact was the increased option-cost of the labour, especially concerning local youth. Adopting a flexible strategy, households divided available labour, with the older members dealing with the vineyards and the younger occupied in construction and tourism. The small size of businesses in both regimes permitted the smooth flow of labour between the two. Nevertheless, the proportion of labour dedicated to agriculture shows a continuous decline during the last three decades. The jobs created in construction also seem to decline after a significant increase during the 1990s, while tourism accounts for an increased proportion of the labour force of the island.

The adaptive strategies followed did not however mean that the pressures on agricultural land use and labour ceased to increase. They resulted in an impressive sprawl of urban uses, with increased land prices having detrimental effects on the rural and the volcanic landscapes as well as on the built environment of the island. Gradually, the flourishing tourism businesses attracted further external investment, as well as real estate. Cheaper external labour also became available on the island creating increased competition for local labour.

Emergence of the niche

During the 1980s, one of the largest wine making companies, based in Northern Greece, started its first attempts towards quality wine production in Santorini in collaboration with local bulk wine producers and the co-operative. At the same time they experimented with traditional techniques used in the area such as the use of *canava*, i.e. human-made grottos used for the aging of the wine.

This decision seemed to have been influenced by four factors: a generational change within the company; the availability of new technological innovations, especially for the processing of the grapes; funding through either national or EU structural subsidies; and, finally, the coincidence with the increase in arrivals of tourists on the island. All factors acting synergistically seem to have triggered the initiation of the niche, starting with the construction, in 1989, of a modern winery and an information centre in which visitors could taste and purchase wine (Boutaris Winery, 2016). Later on (1992) the local co-op, accounting for 2,500 vine cultivators, created an independent facility with considerable success (Santo Wines, 2016). In this respect, two regime actors played a crucial role in the initiation of the niche; they offered it legitimacy and resources as well as considerable momentum (Geels, 2011).

These two efforts, apart from being successful initiatives, paved the way for a new wave of wine makers. They were mainly younger people with origins on the island, who up to the 1980s were migrating for studies or/and work. These returning 'new entrants', came to the island having already established professional, personal and political as well as social network linkages during their previous occupations. Apart from vision and contacts, some of the new wine makers also owned agricultural land and in some cases installations as well as having a family tradition in wine making.

A substantial co-ordination of efforts of individual wine makers can be identified in the efforts for joint presentations to international fares and exhibitions and participation in contests as well as establishing linkages to mainstream and influential specialised press. Another key co-ordination effort is a 'voluntary commitment contract' that all wineries of the island signed with the 'National Inter-Professional Organisation of Vine and Wine', whereby they are bound not to follow unfair competition practices as well as to protect the fame of the product. Apart from the multiplication of involved actors, the niche has therefore set in motion the creation of new networks and a remarkable networking activity.

In the tourism regime, in parallel to the emergence of the niche, the global trend towards alternative forms of tourism highlighted the environment and 'localness' as important elements of diversification; this trend coincided with the 'saturation' of the conventional local tourism market in Santorini, providing local wineries with an opportunity for synergies. Currently, there are more than a dozen wineries offering wine services to tourists as well as direct sales. Wine tours are offered during the whole of the tourist season, some by specialised agencies. The niche thus contributed to the creation of strong links between the two regimes.

The key role of policies

The island of Santorini was one of the first places in which the Greek state tried to design and implement policy measures to promote quality wines. The first 'Appelation of Origin' for Santorini's wines was legislated by the EEC in 1970 as a result of a Greek request, based on the findings of a number of oenological studies (conducted by the Greek Ministry of Agriculture in 1962), concerning the ecosystem of the island and three native vine varietals (Kourakou-Dragona, 1995). The next decisive step was taken in 1981 – when Greece accessed the EEC – with a Santorini wine labeled as 'VQPRD' in the EEC market following requests by the Greek state. This designation triggered the whole formation of the niche in Santorini, along with the above mentioned developments in the 'regime' and 'landscape' levels[1].

A second policy has been the support of investments provided by national and EU funds. Technological innovations in wine making have been available since the late 1970's (Colman, 2008). What this policy made possible was the access of wine makers to these innovative techniques by significantly contributing to investment costs. The small size of the vineyards in Santorini would render the quest for investment capital for novel techniques and equipment in wine making a rather difficult exercise; especially when one refers to small specialised businesses, with limited possibilities for expansion in size.

In addition, within the EU rural development policy framework, two incentive policy measures have been implemented during the last two decades. The older one, in force since the 1990s, concerns the support of the small islands of the Aegean sea. Acknowledging the accessibility problems as well as the increased production and marketing costs of agriculture in the islands, the EU provides financial support to the active islander farmers. Furthermore, farming on islands is considered of great importance for the maintenance of a high level of environmental protection. Hence, within this specific policy measure, a scheme for the maintenance of traditional crops cultivated on the islands of the Aegean archipelago is also included.

[1] Quality criteria linked to provenance have been applied to European wines long before the 1991 launching of the first food quality regulations for Protected Denomination of Origin (PDO), Protected Geographical indication (PGI) and Traditional Speciality Guaranteed (TSG).

Vineyards as well as a number of other traditional crops of Santorini are included in the list of the crops supported. Almost all of the active farmers in Santorini receive this support (Vlahos & Louloudis, 2011).

More targeted is an agri-environmental measure aimed at the maintenance of the traditional agricultural landscape of Santorini, whereby farmers are compensated in order to continue pruning and propagating the vines using the traditional and costly techniques as well as to leave uncultivated parts in each parcel. More than half of the island's area and farmers participate in this measure. Both measures seem to have been a clear success in terms of acceptance. However, the environmental impacts of the measures are not as clear, especially when the pressures to change land use have their origins in driving forces external to agriculture, as is the case of urban expansion (Vlahos & Louloudis, 2011). Neither policy seemed to be very effective, especially in the areas where urban pressures are intense. These areas, due to the spatial expansion of tourism through the creation of urban continua and the dispersion of housing, could be considered as having attributes similar to these of the urban fringe, where the effectiveness of rural development and/or agricultural policies is highly questioned (see also OECD, 2009).

Alliances, conflicts, synergies and the need for mediation

As was expected, changes were not adopted without resistance; innovation not being a neutral notion. The changes that took place affected all the links of the wine value chain (starting from the primary production process), causing rearrangements and new types of co-ordination among actors and stakeholders.

In order to comply with the new cultivation methods required for the production of 'international wines' (since the mid-1990s), two changes occurred:

Firstly, the need for land parcels to be planted with only one variety to facilitate harvesting vs. the traditional way of mixing different grape varieties which made it impossible to co-ordinate harvesting even within one holding. This, however, meant that farmers had to restructure their vineyards investing resources and time (i.e. incurring an entry cost), in order to participate in the quality production project;

Secondly, early harvesting (middle to the end of August) is essential for securing quality. But this created a serious conflict in the intra-household division of labour, since the demand for labour in the vineyards coincided with the peak of the tourism season. Traditionally, late harvesting (early-mid September), meant that the members of the household occupied in tourism could also contribute to the task (Vlahos & Louloudis, 2011). The conflictual relationship of the two regimes, i.e. tourism and agriculture, was thus further aggravated. The possibility of establishing a synergistic effect by using the contested resource, i.e. labour, in different time periods was precluded by the change to the agricultural calendar imposed by the striving for quality.

The high number of grape producers and the relatively limited number of wine makers resulted in a power asymmetry. Farmers, being in a relatively weaker position, had to bear all the burdens of the two changes in order to maintain the access to market for their produce. This caused the partial alienation of the farmers from the "miracle of the Santorini vineyard". Increased prices were not assured due to the intervention of the co-operative, functioning as the last resort buyer for the grapes. This reflected on the farmers' sense of ownership for the GI system.

However, the main conflict among the two regimes has been over land use. As mentioned above, tourism has been a fierce competitor for land use (Vlahos & Louloudis, 2011). The changes to the landscape of the island have been dramatic. The detrimental impacts have not been limited to the agricultural landscape. Urban continua have been formed, in serious detriment to the volcanic as well as the vulnerable small-scale urban landscape. The deceleration in the construction of hotels and recreation facilities has been followed by a second wave of pressures, that of luxury summer holiday homes. Real estate investors have taken advantage of the deficient land planning national regulatory framework and shifted their efforts towards this market.

Additionally, agricultural land is unprotected. Efforts undertaken by the Ministry of Rural Development and Food to protect either highly productive land, or areas characterised as 'High Nature Value' and territories that form important agricultural landscapes, have remained at the stage of statements of principles and noble intentions (MRDF, 2011).

The effects of the financial crisis have also been devastating in terms of policy measures intended to protect the environment through regulation (WWF, 2012). There is only one regulatory tool, that of local land planning, that can be used in order to restrict the expansion of housing. Indeed, there have been two regulatory interventions concerning the agricultural landscape in Santorini, but they are restricted to the most attractive (in real estate terms) areas, hence rather limited. There is, however, a proposal for a complete and structured regulation of land use, through a land use plan for the whole island. Its approval has been pending since 1995, although all stakeholders in the area seem eager for its approval.

The adoption of changes on the part of wine makers on the island relate to technological innovations, especially in the processing part of the value chain. Their primary objective has been access to the market, especially in the increasingly interesting and quality augmenting wine market. When access to the market was achieved, they strived towards maintaining their competitive edge through quality. In this attempt, the changing circumstances of international markets have not been a stabilising factor. Two competing approaches are taking place; one that is pursuing the homogenisation of taste and advocates the prevalence of grape variety as a quality attribute, whilst the other supports the value of diversity of tastes and the importance of terroir, i.e. a unique combination of environmental, agronomic and human factors, particular for each wine producing area.

The adoption of the first approach, calls for the 'correction' of certain characteristics of the wines that are not 'desirable' by the actors that are important in the construction of the 'ideal' wine (Nositer, 2010). Extending the idea of full adaptation to the needs of a globalised market, some of the wine makers decided to change the pruning and propagation system in their owned land and asked their providers to make this change, if they were to buy from them. Thus, the innovations voluntarily adopted by wine makers, called for obligatory changes on the primary production side, since they were deemed necessary in order to comply with this 'ideal' of quality. A new problem was thus created as the changes in the pruning practices and propagation methods affected a landscape much valued, not only by experts or environmentalists but also by tourists, having become an essential part of the "Santorini" experience and hence an asset for the island and the tourism regime.

Despite some co-ordination efforts among wine makers, the lack of co-ordination between vine growers and wine makers seems to have resulted to a further debilitation of their position in the land use regulation policy arena. When they have joined forces however positive outcomes have emerged in the policy field. An indicative example of the potential benefits of co-ordination is the response to a policy measure, potentially detrimental for the island if implemented. As a part of the 2007 reform of the Common Market Organisation for Wine the grubbing up of vines was promoted but the breadth of its implementation was left at the discretion of the Member State. A co-ordinated effort by the co-op, individual wine makers and the local authorities annulled the application of this specific policy provision in Santorini, alleging that vineyards are a scarce economic and environmental resource that have to be protected. However, this effort was on rather an ad-hoc basis, pointing to the need for more permanent forms of co-operation such as an innovation platform (Heemsesrk et al., 2011).

In this respect, the question raised is 'what the role of an intermediary could be'. In a situation where innovation is accepted and implemented but creates conflict and the stakes are significant, the importance a mediator seems to be apparent.

In the case of wine quality, the existence of a quality convention (PDO wine), initiated by the EU but embedded in the local society, implicates local actors in an active protection of a collective good, i.e. fame. Unfortunately, no such convention for the landscape was perceived, much less adopted, by local stakeholders. On the other hand, it can be argued that the active participation in and support of quality schemes, established by public institutions, increases the degree of adherence of local actors to the maintenance of quality regulation within the public sphere and does not subjugate it to a self-regulated market system in the form of either private certification schemes or informal institutions (such as the specialised press), that are of capital importance in the international arena (NYT, 2015).

An analysis of the conflicts that emerged reveals a polarisation in the power game. The first pole comprises the new innovative 'international' wineries. They have as their main objective competitiveness and growth and the need to be adjustable to the changing demands of a very volatile market. They perceive the denomination of origin as merely another element of their marketing strategy which they consequently force their providers, the farmers, to adopt. They are fierce protectors of agricultural land use and supporters of changes deemed necessary in order to comply with standards, even if such changes have a detrimental effect on the landscape and the environment in general.

On the other side lie the co-operative and its allies, the majority of the farmers, whose main preoccupation is the stability of their households. In this respect, pluriactivity is an important element of their survival strategy, while the fame of Santorini wine is considered as a collective, valuable good. Tourism for them is not just an outlet for their wine production but an asset for earning additional income, either through employment in or the establishment of a tourism related business; therefore, the protection of the landscape is essential. But on the other hand, they are not willing to forego the option to exploit their most valuable asset, the land, just because they have not seized the opportunity during the tourism boom.

The two poles have sought allies at national level both in the sector and in public administration cadres. The individual wine makers have formed a professional network (Santorini Wine Producers Association), while participating in the national network of private wineries, i.e. the

Greek Wine Association. On the other hand, the local co-op participates in the third tier wine co-operative organisation (KEOSOE).

In that local ‘power landscape’ the role of institutions has been to a certain degree that of allies to be secured. The aforementioned polarisation has influenced local and regional elections as well as policy implementation.

Conclusions

The aim of this paper has been to analyse the emergence of a quality niche in the Greek wine sector with reference to Santorini island. The analysis reveals that the triggering point for the initiation of the niche has been the activation of two central actors of the wine sector (one external and one local) which, in turn, attracted numerous new wine makers and set in motion some networking (marketing) activities.

Deliberate efforts of both the Greek state and the EU have also played a crucial role through the establishment of a regulatory policy framework for the promotion of quality in the wine sector. Additionally, since the mid-1980’s, investment aids provided through EU Regulations have made a decisive contribution to the establishment of new, modern wineries in Santorini as well as the modernisation of existing wineries.

Changes in the relevant international arenas (i.e. tourism and wine) had direct and almost immediate effects on the local economy and society. Therefore, landscape trends and pressures, processes internal to the niche, the links between the niche and the regime, as well as multi-regime interactions all created a fertile substrate for the germination of innovations. Furthermore, it can be argued that the existence of a quality convention (PDO wine), initiated by the EU but embedded in the local society, indicates an increased degree of social consensus and involves local actors in the active protection of a collective good, i.e. fame. Unfortunately, no such convention for the landscape was perceived, much less adopted, by local stakeholders.

The analysis of the conflicts that emerged revealed a polarisation in the power game, with two poles having different priorities and perceptions about ‘quality’. The first pole comprises the new innovative ‘international’ wineries aiming at extroversion and competitiveness and thus at continuous innovation as relates to growth. This pole supports the protection of the agricultural land but not of the traditional landscape of the island. The second pole comprises the co-operative and the majority of the farmers and aims at stability (household reproduction). This pole supports the protection of the traditional production methods and the landscape since these are crucial aspects for both tourism and their wines. In this sense, it can be argued that the second pole, given its own contradiction and trade-offs, seems more supportive to sustainability.

Finally, the case examined provides significant evidence of the potential benefits of co-ordination among local stakeholders, which has, however, been on rather an ad-hoc basis, thus pointing to the need for more permanent forms of co-operation such as an innovation platform. In a situation where innovation is accepted and implemented but creates conflicts and, on the other hand, the stakes are significant, the importance of an institution acting as a mediator seems apparent. Additionally, in the case of Santorini co-ordinating efforts and network activities have taken place in the absence of ‘professional’ mediators such as brokers or facilitators. This corroborates the claim that the informal everyday communicative interactions among stakeholders are as important as the communicative efforts of professionals (Leeuwis & Aarts, 2011). However, network building and dealing with the dynamics of power and conflict are two of the processes that can be substantially supported by communication/ intermediation professionals.

References

Anderson, K. (2009) Terroir Rising? Varietal and Quality Distinctiveness of Australia's Wine. (Regions Research Paper No. 2009-18). Adelaide, School of Economics, The University of Adelaide.

Barbera, F., & Audifredi, S. (2012) In pursuit of quality. The institutional change of wine production market in Piedmont. Sociologia Ruralis 52(3): 311-331.

Boltanski, L., & Thévenot, L. (2006). On Justification. Economies of Worth. New Jersey: Princeton University Press.

Boutaris Winery (2016, March 29). Wineries. Retrieved from http://www.boutari.gr/en/wineries-states/wineries/11boutari_2011072611.wines.php

EC (2012). Value of production of agricultural products and foodstuffs, wines, aromatised wines and spirits protected by a geographical indication (GI). Brussels: EC.

Geels, F. (2011). The multi-level perspective on sustainability transitions: responses to seven criticisms. Environmental Innovation and Societal Transitions 1: 24–40.

Geels, F., & Schot, J. (2007). Typology of sociotechnical transition pathways. Research Policy 36: 399-417.

Hartman, S. (2016). Towards adaptive tourism areas? A complexity perspective to examine the conditions for adaptive capacity. Journal of Sustainable Tourism 24(2): 299-314.

Hinrichs, C. (2014). Transitions to sustainability: a change in thinking about food systems change? Agriculture and Human Values 31: 143–155.

Ingram, J. (2015). Framing niche-regime linkage as adaptation: an analysis of learning and innovation networks for sustainable agriculture across Europe. Journal of Rural Studies 40: 59-75.

Josling, T. (2006). The war on terroir: geographical indications as a transatlantic trade conflict. Journal of Agricultural Economics 57(3): 337–363.

Kemp, R., Schot, J., & Hoogma, R. (1998). Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management, Technology Analysis and Strategic Management 10(2): 175-195.

Kilelu, K., Klerkx, L., Leeuwis, C., & Hall, A. (2011). Beyond knowledge brokerage: an exploratory study of innovation intermediaries in an evolving smallholder agricultural system in Kenya. RIU Discussion Paper 13. London: DFID.

Konefal, J. (2015). Governing sustainability transitions: multi-stakeholder initiatives and regime change in United States agriculture. Sustainability 7: 612-633.

Kourakou-Dragona, S. (1995). The santorini of Santorini. Athens: Fany Boutari Foundation.

Leeuwis, C., & Aarts, N. (2011). Rethinking communication in innovation processes: creating space for change in complex systems. The Journal of Agricultural Education and Extension 17(1): 21-36.

Lugeri, F.R., Amadio, V., Bagnaia, R., Cardillo, A., & Lugeri, N. (2011) Landscapes and wine production areas: a geomorphological heritage. Geoheritage 3: 221–232

MRDF [Ministry of Rural Development and Food] (2016, March 30). Statistical data for the wine sector. Retrieved from http://www.minagric.gr/images/stories/docs/agrotis/Ampeli

Negro, G., Hannan, M.T., Rao, H., & Leung, M.D. (2007). No barrique, no berlusconi: collective identity, contention, and authenticity in the making of barolo and barbaresco wines. Research Paper. Stanford: Stanford Business School.

Nossiter, J. (2010). Liquid Memory: Why Wine Matters. Paris, Farrar, Straus and Giroux.
OECD (2009). Farmland conversion. The spatial dimension of agricultural and land use policies. Paris: OECD.

Patchell, J. (2011). The Territorial Organisation of Variety: Co-operation and Competition in Bordeaux, Napa and Chianti Classico. Farnham: Ashgate.

Rousou, A. (2006). Conventional and organic farming on Santorini's vineyard (Graduation Thesis). Heraklion, Department of Crop Science, Technological Educational Institute of Crete.

Santo Wines (2016, March 29). History of Santo Wines, Retrieved from http://www.santowines.gr/en/winery/winery.html

Schot, J., & Geels, F. (2008). Strategic niche management and sustainable innovation journeys: theory, findings, research agenda and policy. Technology Analysis & Strategic Management 20(5): 537-554.

Smits, R., & Kuhlmann, S. (2004). The rise of systemic instruments in innovation policy. International Journal of Foresight and Innovation Policy 1: 4-32.

Vlahos, G., & Louloudis, L. (2011). Landscape and agriculture under the reformed Common Agricultural Policy in Greece: constructing a typology of interventions. Geografisk Tidsskrift (Danish Journal of Geography) 111(2):131-147.

WWF (2012). Open letter to heads of States and Government in Europe, the President of the European Council and the President of the European Commission. Athens: WWF GR.

Alternative medicine in dairy breeding: the key role of atypical veterinarians

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Abstract: There is a scientific debate on the impact of the increase in private stakeholders in agricultural extension services. Some social scientists consider that concurrence goes against investment in new techniques. In the past however many agricultural innovations have been promoted by private stakeholders, for example in organic farming and conservation agriculture. The European Union currently encourages the farming sector to reduce antibiotic use in order to avoid antibiotic resistance in human medicines. As a result, farmers show great interest in alternative medicines, such as those promoted by atypical veterinarians: homeopathy, aromatherapy, plant and manual medicines. Our communication focuses on a collective of homeopathic veterinarians, "GIE Zone Verte" (ZV) which is dedicated to farmers' training and advisory services, mainly for organic breeders. Our analysis aims to understand why and how they are committed to the diffusion of alternative approaches in animal health management. Our survey consists of (i) interviews with these professionals and also with dairy farmers, technicians and trainers and (ii) observations made during training sessions on animal health and meetings of farmers' groups. We show that members of ZV are part of a professional segment of atypical veterinarians, who defend an alternative vision of veterinary medicine. Farmer autonomy and animal health equilibrium are the key concepts of their training, but they are still seen as the experts by the farmers. In conclusion, we discuss their interaction with training organisers and their role in breeding innovation processes.

Keywords: Animal health, veterinary profession, alternative medicine, training, organic farming, autonomy

Introduction

Many rural social scientists are dealing with a major transformation of agricultural extension services, i.e. the increase in private stakeholders such as firms or self-employed workers (Kidd et al., 2000; Laurent et al., 2006; Rivera & Zijp, 2002). Yet withdrawal of state support for adapting farms to new health and environmental norms is viewed as a problem by some researchers (Compagnone et al., 2015). They consider that competition between these stakeholders is working against the farmers' interests, as the firms that employ them invest more in marketing than in knowledge. Moreover, they assert that advice given by private stakeholders such as technical salesmen is biased as they have products to sell. Nevertheless, many agricultural innovations have been promoted by private stakeholders in close relationship with atypical farmers, for example in organic farming (Hellec &Blouet, 2012) or in conservation agriculture (Coughenour, 2003). For these two new ways of farming, state extension organisations and state scientific research institutions have overlooked techniques coming from the grass roots. The European Union is currently encouraging the farming sector to reduce antibiotic use, in order to avoid antibiotic resistance in human medicines. As a consequence, breeders are showing great interest in alternative medicines that have long been promoted by atypical veterinarians who are specialised in homeopathy, aromatherapy, herbal or manual medicine.

This article focuses on a French association of homeopathic veterinarians called “Groupement d’Intérêt Économique Zone Verte” (ZV). We will analyse their role in experimenting and spreading alternative animal health management methods in cattle and dairy farms in France. Our approach consisted of (i) interviews with two veterinarians and ten farmers; (ii) observations of three training courses and one meeting organised by ZV, and of five meetings of the Animal Health Commission of the French Organic Farming Technical Institute (ITAB). Interviews with farmers were carried out in tandem by a sociologist and an animal science researcher, in order to analyse animal health, feeding and production management and to assess the influence of social and professional networks on this management. Interviews with other agricultural stakeholders focused on their professional activities and their relationships with farmers and other technicians and advisors, who are either rivals or partners. Here we present the results of the first step of our survey. Further interviews and observations of training courses will be carried out.

Our theoretical framework is based on the interactionist approach to professions (Hughes, 1984), which studies the dynamics of social groups which control a specific domain of human activity, such as medical doctors or lawyers. According to this scientific approach professional groups are in constant movement. They are faced with internal forces such as disagreement amongst profession members as to their mission and the way of achieving it; they are also faced with external forces such as competition with other social groups that have similar activities, or relations with the public, which stabilise or destabilise them (Abbott, 1988). Veterinarians in France form a professional group as they have a monopoly of many activities such as making health diagnoses on animals and prescribing medicines. As for other medical professions, their monopoly is based on professional knowledge and skills. Moreover, in France, veterinarians have a mandate to purchase public health missions like controlling epizootic diseases (Bonnaud & Fortané, 2015).

In this article, we will show that there is a dissident group within the veterinarian profession, which is striving to find another way to cure farm animals. Their curative methods are to a certain extent opposed to current veterinarian knowledge and skills. Moreover, their methods entail a different relationship with farmers that is less focused on emergency interventions and more on advising and training. This goes together with the sharing of activities and expertise domain between veterinarians and farmers regarding animal health management. Farmers working with atypical veterinarians are supposed to be more working more autonomously to cure their herds, but we will demonstrate that they still need the external view of animal health professionals.

In the first part of this article we analyse the place of ZV members within the atypical veterinary collective. In the second part we describe activities carried out by ZV veterinarians, their vision of good animal health and the position they adopt with farmers and other livestock farming advisors.

Alternative veterinarians, a professional segment with blurred lines

At present, ZV consists of ten homeopathic veterinarians (five men and five women) who are spread all over French territory. Some of these veterinarians have additional specialisations e.g. manual medicine, aromatherapy, herbal medicine, bio-geology and cheese making. The ZV headquarters, with its secretariat of two people, is located in the Doubs in eastern France. The constitution of this group is directly linked to the rise of organic farming in France and with the networking carried out by the Organic Farming Technical Institute (ITAB). As we will show, ITAB does indeed participate in structuring the professional segment (Bucher & Strauss, 1961) of veterinarians engaged in promoting and implementing alternative approaches to animal health management on livestock farms.

From Symphytum to the "GIE Zone Verte"

The veterinarians who founded ZV initially met together within the ITAB, during technical days on livestock farming at the end of the 1990s. These days brought together many rural veterinarians who specialised in alternative approaches to health. About ten of these veterinarians chose to found an association, Symphytum, in order to meet together regularly and discuss their practices. During one Symphytum meeting, one of the participants, Doctor Giboudeau, presented the OBSALIM® method which he had developed with ruminant livestock farmers in his region during the 1990s. This method aims at identifying food problems in the cows based on the observation of various signs: condition of the coat, the eyes, the muzzle, the state of the dung, etc. The original aspect of this method is the place given to the observation of the animals, as the observation points selected take their inspiration from homeopathy. It differs from the methods used to calculate the animals' diets, which are based on average needs according to the type of animal.

Within Symphytum several veterinarians were very interested in the OBSALIM® method and collaborated to adapt it to other species of ruminants as well as cattle, such as sheep and goats. Once the principles of the method had been stabilised, they chose to form a group, the economic interest group "Zone Verte", in order to diffuse this method to livestock farmers. The creation of the ZV in 2002 indirectly caused the closure of the Symphytum association.

ITAB is today the principal meeting place of alternative veterinarians. The ITAB livestock committee consists of veterinarians, including a ZV member, researchers, livestock farmers and livestock advisors. Its role is to define the priority actions to be carried out in organic livestock farming. More widely, many alternative rural veterinarians regularly attend a variety of events organised by the ITAB, such as technical days and research and development meetings, or meet within the framework of research and development projects coordinated by the technical organisation.

This participation in various ITAB activities can be explained by the fact that organic farmers are a special audience for alternative veterinarians, who work with conventional livestock farmers too. Organic farming specifications impose limits on antibiotic treatments and require the use of alternative products as a first recourse. These specifications answer the more general principles of organic farming, which aims at a high level of animal health and welfare (Vaarst & Alroe, 2012) and which are shared by these atypical veterinarians.

Atypical veterinarians for alternative animal health techniques

Behind a great diversity of profiles and activities, points of similarity can be observed between the veterinarians working with the ITAB, in particular the fact that they mobilise knowledge of a different kind from that of conventional rural veterinarians. Most of them have a specialisation in homeopathy, aromatherapy or herbal medicine. However these therapeutic approaches are not taught in French veterinary schools. Homeopathy in particular is not taught to veterinary students because its effectiveness has not been proven by medical scientific institutions. So the alternative veterinarians turned towards the human medicine colleges or the homeopathy center in Liège, in Belgium, for training in homeopathy, or towards human pharmaceutical faculties and specialised works to be trained in the therapeutic use of plants. The use of plants is presented as 'natural' and 'traditional' medicine by the professionals who use them, as opposed to medication produced by synthetic chemistry.

The veterinarians within ITAB also show great interest in preventive approaches associated with feeding and grazing management. A large number of them refer to ecopathology, an approach to the health of herds which appeared during the 1970s and which centred on the risk factors related to rearing conditions and called the industrialisation of agriculture into question (Fortané, in press). Most of these professionals work in private practices. Some work within the framework of annual contracts with livestock farmer groups, thus ensuring closer monitoring of the health of herds (Combettes et al., 2012). Finally, most of them regularly run training schemes for farmers, advisors and agricultural technicians.

Their relationship with farmers is different from that of the other rural veterinarians. The rural veterinarians mainly intervene as emergency doctors, to look after seriously ill or injured animals and to date give very little advice (Duval, 2016). In addition, conventional rural veterinarians market the medication used by farmers, combining prescription and delivery. Some alternative veterinarians have developed a considerable business selling therapeutic products, but others refuse to do this. This is the case with ZV members, who do not market medication from synthetic chemistry. They do not sell any homeopathic or plant-based products either, even though they may recommend them.

Collective actions of atypical veterinarians

Atypical veterinarians form a professional segment within the veterinary profession in so far as they advocate another way of looking after animals, based on knowledge of a different kind from that taught in veterinary schools. They also engage in collective actions disputing public political measures involving their profession. Two subjects in particular have been the subject of controversies in which ITAB has taken part: obligatory vaccination against Blue Tongue Virus (BTV) and the use of therapeutic plant-based products.

Obligatory vaccination against BTV was adopted in France in 2008, to stop extension of this epizooty in sheep and cattle farms. This disease does not pose any risks for human health, but it generates economic losses for farmers. Regulations for its prevention aim above all to benefit the international cattle trade. ITAB has committed itself alongside other organisations, such as the ZV or the National Organic Farming Union (FNAB), against the obligation to vaccinate against BTV and for freedom of choice for farmers (Ollivier, 2013). On its website[1], ITAB goes directly to the arguments advanced by the ZV veterinarians: the effectiveness of vaccination is not proven; this technique carries risks, as it weakens some animals; and the dangerous nature of the additives used. Other homeopathic veterinarians also call vaccination as preventive medicine into question. This position goes against the basis of the veterinary profession in France. As shown by Delphine Berdah (2012), for a long time veterinarians had competition from farriers and traditional healers. They acquired expertise by joining the Pasteurian movement and by obtaining the monopoly of livestock vaccination for the control and eradication of zoonoses.

The second subject for collective action of atypical veterinarians is the use of plant-based products in veterinary medicine. Current French regulations, which come directly from European regulations, prohibit the use of many plant-based products for therapeutic purposes. Either these products must be regarded as medication, and therefore obtain marketing authorisation (which is a long and extremely expensive procedure for complex molecules), or they must be assimilated with food supplements and thus not be prescribed for medical care. Today ITAB coordinates the debates and actions to be put in place to obtain legal recognition of care products based on plants, as has been done for crops. But this is coming up against a State requirement concerning proof of the absence of risks to human health. Homeopathy however benefits from a lighter marketing authorisation procedure in human and animal medicine.

So ZV veterinarians are integrated into a wider collective of rural veterinarians using alternative animal care techniques. It is a vaguely defined professional segment for which ITAB is a special meeting place. We will now describe the work of the members of this group to show how their different conception of health is taught to livestock farmers.

Teaching farmers to manage animal health differently

The majority of ZV members no longer work in an independent practice; so their work consists exclusively of training ruminant livestock farmers and of providing individual advice. As we have indicated, they have a positioning with respect to farmers that is very different from that of conventional rural veterinarians. Their intention (Lémery, 1994) with livestock farmers, i.e. the project to transform livestock farming which underlies their training activities, can be summarised in two key concepts: farmer's autonomy and herd equilibrium. These concepts are fundamental to their teaching, both in its content and in its form.

Training and transmitting

From the very beginning ZV has been extremely active. Its training programs have appeared to be in line with the needs of some farmers and in particular farmers who have converted to organic farming. ZV was created at the very time when the number of organic livestock farms was growing rapidly, after public policies began to support their development in France. ZV also met great success with livestock farmers near their head office in the east of France. Most of these farmers produce milk for making cheeses with protected designations of origin, so they have to respect specifications. These specifications are different from organic farming specifications as they do not impose a limit on antibiotic treatments, but a maximum use of pasture.

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[1] The actions carried out by the ITAB for the recognition of plant-based products in veterinary medicine are presented on their website: http://www.itab.asso.fr/itab/sante-animale.php

Whether for organic livestock farmers, or for farmers in the Franche-Comté, training officers (who are in charge of organising training programs) have played a key role in the success of ZV, since they select the educators. In the sub-regions of the Doubs and the Jura in particular, training officers in charge of livestock management chose to develop training on alternatives in animal health, in agreement with their partner farmers.

The technical content of the training given by ZV varies according to what is requested: general training which brings together the principles of OBSALIM®, the principles of homeopathy and recommendations concerning feeding and grazing management, or more specialised training programs in a precise field or method. The training courses always structure the time in the classroom and the time on the farm. Some of them, like training in manual medicine, involve interventions on animals. Educators and ZV members share the same objective, which is to make livestock farmers more autonomous in animal health management to enable them to acquire the knowledge and know-how required to look after their animals themselves. This autonomy also answers a need for organic livestock farmers and all those who want to turn to alternative methods, because conventional rural veterinarians are not trained in these approaches.

In addition, ZV teaching allows farmers to appropriate a dimension of livestock farming work which is not often mentioned: the emotional ties with the animals (Porcher, 2003). Farmers particularly appreciate the emphasis placed on animal observation by OBSALIM® method. As one of them said, these are things that he used to do "unconsciously". However the fact of putting into words a normal, not to say banal activity, enables them to step back and take a new look at their practices. They are able to discuss a whole area of their work which is hardly ever mentioned, as livestock farming work is often primarily discussed via statistical data representing technical and economic performances.

Achieving herd equilibrium

ZV veterinarians are positioned around a particular vision of animal health, considered as a balance to be achieved. According to them, the animal must live in balance with pathogens and with parasites. The aim of herd health management is not to eradicate the disease but to strengthen the animal's immunity to enable it to confront these pathogens and parasites.

This way of considering animal health and disease is different from that of conventional rural veterinarians. Let us take the example of parasite management. When they graze, cattle encounter parasites which infest their digestive system. ZV members consider that by exposing the animals to parasites gradually, from a very young age, they are able to acquire sufficient immunity and thus cohabit with these parasites. This supposes quite specific grazing management from a very early age: reserving fields with low parasite pressure for the young animals; changing the animals' grazing lands sufficiently often and avoiding overgrazing. Conventional rural veterinarians generally recommend systematic treatments, which aim at eradicating the parasites in the animal's stomach. By doing this they do not call herd management methods into question and confine themselves to a medicinal approach.

The same type of argument is used to justify refusal of vaccination against BTV. In the documents published on their website[2], ZV members urge farmers "to learn how to live with BTV" and "to tolerate the natural infection of the animals to allow them to build up lifelong

[2] *Documents online: http://www.giezoneverte.com/dossier-special-fco.php*

natural immunity" (natural immunity which would be different from what they name "vaccine immunity").

ZV training also focuses on animal feeding as they regard it as the main factor to prevent animal health problems. Here their recommendations are not in opposition with current animal science knowledge, but they know more about animal feeding than other rural veterinarians, who have learned to cure sick animals but not so much about prevention and nutrition. So ZV encourage farmers to care at the rumination process and to enhance it. For example, they recommend giving animals roughage first, and feed concentrates after, once roughage has been totally eaten. They also advise farmers to let feeders empty between morning and evening feeds, so that the herd ruminates properly. According to ZV veterinarians, most farmers feed their animals too much to optimise milk and meat production, but this creates rumen malfunction and part of the feed is not digested but just ruined. To achieve a balance between production objectives and a high level of animal health, ZV veterinarians encourage farmers to produce hay with lots of fibre.

Trainers or "gurus"?

We have already pointed out that autonomy is a central concept for ZV members. By following training schemes on animal health questions, farmers are seeking to be less dependent on the different external professionals who come to their farm to advise them about livestock farming. By implementing some simple recommendations from OBSALIM® training programs, such as first distributing roughage, the farmers can quickly see results. However, not all of them systematically implement the veterinarians' recommendations. But they are still greatly influenced by a technical presentation which goes against what they were taught before.

But this autonomy acquired by livestock farmers appears ambiguous: admittedly they keep their distance from the usual advisors and the conventional rural veterinarian, but by doing this they refer almost systematically to what the ZV veterinarians say. Even if the farmers do not implement all their recommendations, they are treated as experts – some organic farming advisors even call them "gurus". In fact, during the training programs that we have observed, some veterinarians structure political and technical discourse. Sometimes they are virulent in saying that the pharmaceutical industry controls the animal health sector, accusing conventional rural veterinarians of being too involved in this industry because they market their products directly. By these criticisms they try to detach the livestock farmers from their usual advisors in order to attach them (Goulet & Vinck, 2012) to their vision of veterinary medicine, opposing conventional and other alternative approaches to animal health management.

Disagreements therefore appeared between certain ZV members concerning training methods. This led to the withdrawal of one of the founder members, the very person who developed OBSALIM® method. He reproached some of his colleagues for not teaching this method correctly and for only giving farmers ready-made recipes, or even excessively dogmatic principles of herd management. For Doctor Giboudeau, OBSALIM® is above all a method of diagnosing the state of the herd, which has to enable problems concerning animal feed and their digestive capacities to be detected precisely. This veterinarian therefore chose to recreate a company devoted to OBSALIM® and to form a network of advisors capable of teaching it. These advisors are invited to create groups of farmers who regularly experiment with the method together, with what they call "hair rally" ("*rallyes poils*" in French). For a whole morning, farmers visit each of their farms and share their observations on the state of the herd. By working together in this way they aim to enhance their observation abilities.

Another point of disagreement has also appeared concerning training in homeopathy. For some homeopathic veterinarians, the farmer cannot make a correct homeopathic diagnosis because he only observes his own animals. The veterinarian sees far more animals on different farms, so he has in mind an important number of clinical cases which helps him to make the right diagnosis for a new sick animal. What is in question here is the work division between veterinarians and farmers. Some veterinarians consider that homeopathic diagnosis can only be made by specialised professionals. During our fieldwork, we have observed that no farmer was able to cure their herd with homeopathic methods alone. They usually used one or two remedies for some specific problems. Some of them systematically refer to a homeopathic veterinarian to choose the best remedy; indeed there is a pay phone service in ZV for such medical consultations. We have noted the same phenomena for manual medicine: farmers prefer to use the services of an osteopath rather than intervening themselves on their herds, even if they have undertaken training courses in that domain. Finally, farmers who participate in ZV trainings become more autonomous in animal observation and early detection of animal health imbalance, but they still depend on specialists to cure sick animals.

Conclusion

Today, alternative veterinarians, and in particular those of the ZV collective studied in this article, play a key role in the field of animal health management innovation. They promote another way to cure animals at the farm level, through training and advisement activities. They also take actions at a national level in order to change state regulation, for example by contesting obligatory vaccination.

ZV veterinarians however do involve other stakeholders to bring about changes in animal health management. Indeed, an innovation process is not the result of a sole stakeholder action, but is supported by a social network whose structure has to be characterised (Coughenor, 2003; Compagnone & Hellec, 2015). Behind atypical - and charismatic - veterinarians, there are discreet but essential stakeholders that we call mediators and who facilitate farmers' access to new methods of animal observation and animal health management. Indeed, ZV training activities depend on training officers' actions, as ZV is not a training centre itself. In Franche-Comté, training officers are employed by agricultural training centres, which are independent of chambers of agriculture and of farming unions; this is a reason why they were able to bring in atypical veterinarians. In other regions, ZV veterinarians are mainly contacted by alternative farming associations, like organic farming associations. So training officers play a major mediation role as they choose trainers and decide what kind of new methods and techniques to disseminate or not to farmers.

Farmers themselves are, of course, major stakeholders in the innovation process as they are final decision takers of innovation adoption. We showed that ZV training success is partly explained by the focus made on an effective tie with animals. Farmers get interested in methods that help them to observe their animals more accurately. Training courses are however only the first step in animal health management changes and it is difficult to say to what extent these changes are implemented on herds. We observe that some farmers form groups that meet regularly to enhance their observation abilities while some farmers turn to homeopathic veterinarians for advice and medical diagnosis, but all breeders keep on working with their close rural veterinarian for emergency intervention or antibiotic prescription when necessary. Whereas atypical veterinarians insist on a division between current and alternative medical methods, farmers utilise both to manage animal health on their farm.

There has still been very little study of the use made by farmers of lessons received during training courses. The question of hybridisation between various forms of knowledge still remains: between knowledge used by conventional veterinary medicine which has been validated by institutional science and other types of knowledge promoted by alternative veterinarians who concentrate more on observation, sensitivity and experience.

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References

Abbott, A. (1988). The System of the Professions. An Essay of the Division of Export Labour. Chicago : University of Chicago Press.

Berdah, D. (2012). Entre scientifisation et travail de frontières : les transformations des savoirs vétérinaires en France. XVIIIe-XIXe siècles. Revue d'Histoire Moderne et Contemporaine 59(4): 51-96.

Bonnaud, L., & Fortané, N. (2015). Les animaux malades de la science politique. L'action publique vétérinaire à l'aune de la littérature sur la santé animale. Paper discussed at RITME Summer School.

Bucher, R., & Strauss, A. (1961). Profession in process. The American Journal of Sociology 66(4): 325-334.

Combette, P., Patout, O., & Robinet, A. (2012). La santé animale sociale et solidaire. Le Sociographe 5: 261-284.

Compagnone, C., Goulet, F., & Labarthe, P. (2015). Acteurs privés et conseil en agriculture. Dijon- Paris: Educagri-QUAE.

Compagnone, C., & Hellec, F. (2015). Farmers' professional dialogue networks and dynamics of change: the case of icp and no-tillage adoption in Burgundy (France). Rural Sociology 80(2): 248-273.

Coughenour, C.M. (2003). Innovating conservation agriculture: the case of no-till cropping. Rural Sociology 68(2): 278-304.

Duval, J., Fourichon, C., Madouasse, A., Sjöström, K., Emanuelson, U., & Bareille, N. (2016). A participatory approach to design monitoring indicators of production diseases in organic dairy farms. Preventive Veterinary Medicine (128): 12-22.

Fortané, N. (in press). Naissance et déclin de l'écopathologie (années 1970-années 1990). L'essor contrarié d'une médecine vétérinaire alternative. Regards Sociologiques.

Goulet, F., & Vinck, D. (2012). Innovation through withdrawal: contribution to a sociology of detachment. Revue Française de Sociologie ENGLISH 53(2): 117-146.

Hellec, F., & Blouet, A. (2012). Technicité versus autonomie. Deux conceptions de l'élevage laitier biologique dans l'est de la France. Terrains et Travaux 20: 157-172.

Hughes, E.C. (1984). The sociological eye. Selected papers. Chicago: Transaction Publisher.

Kidd, A.D., Lamers, J.P.A., Ficarelli, P.P., & Hoffmann, V. (2000). Privatising agricultural extension: caveat emptor. Journal of Rural Studies 16(1): 95-102.

Laurent, C., Cerf, M., & Labarthe, P. (2006). Agricultural extension and market regulation: learning from a comparison of six EU countries. Journal of Agricultural Education and Extension 12(1): 5-16.

Lémery, B. (1994). 1994. Une position d'expert incertaine : les conseillers techniques en agriculture. In JP Darré (Ed). Pairs et Experts en Agriculture. Dialogues et Production de Connaissances pour L'action pp 90-116. Toulouse: Éditions Erès.

Ollivier, B. (2013). The end of the French model for animal health? A sociological analysis of the Bluetongue vaccination campaign (2007-2009). Sociologia Ruralis 53: 496-514.

Porcher, J. (2003). Bien-être et souffrance en élevage : conditions de vie au travail des personnes et des animaux. Sociologie du Travail 45(1): 27-43.

Rivera, W., & Zijp, W. (2002). Contracting for agricultural extension. International case studies and emerging practices. Cambridge: CABI Publishing.

Vaarst, M., & Alroe, H.F. (2012). Concepts of animal health and welfare in organic livestock systems. Journal of Agriculture, Environment and Ethics 25: 333-347.

Social and technical influences that enable and constrain adoption of genetic improvement by commercial lamb producers.

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Abstract: Productivity is important for improving the long term profitability and competitiveness of commercial lamb producers and the Australian lamb industry. Productivity can be achieved in part through improved genetics and as such it is considered a key profit driver for sheep producers. Yet improved genetics, such as breeding value technologies are still not completely accepted or adopted and the uptake of this technology is seen to be slower compared to other animal industries. The value of genetic improvement to productivity and profit has been repeatedly proven and demonstrated in scientific studies and yet the question that is still not well understood or investigated is why some commercial producers do not see and acknowledge the potential benefits. With genetic technology rapidly expanding, becoming more sophisticated and possibly more complex, there is now a greater need to recognise how producers make sense of breeding values and how social influences impact upon behaviour and beliefs or the meaning given to actions. Drawing on qualitative social research methodology and an agricultural innovation systems framework this study will explore the organisational roles and interactions of supply chain actors to address the following question ‘How do social and technical arrangements within the Victorian lamb industry support or hinder adoption of genetic improvement by commercial lamb producers? Data collection and preliminary analysis to inform the research started in 2015. A number of focus groups with commercial lamb producers and semi structured interviews with industry representatives form the basis of early learnings around actor roles, beliefs, confidence, knowledge exchange and interactions.

Keywords: Agricultural innovation systems, breeding values, confidence, interactions, knowledge exchange

Introduction

The intended focus of this paper is to explore the interaction, knowledge exchange and presence of enabling situations between farmers and intermediaries that lead to innovation within the Victorian lamb industry in the state of Victoria Australia.

Research attention and a greater understanding of the roles that innovation brokers and facilitators perform in agricultural innovation is an area that requires further exploration (Klerkx & Leeuwis, 2009). These groups of either individual actors or organisations embedded within networks fulfil vital roles in relation to innovation processes as they facilitate access to knowledge, new technologies, provide interpretation and help overcome information gaps. They are seen to act as a bridge between the science providers who generate and supply knowledge and those actors who convert codified knowledge into practice such as farmers.

In Australia the role and function of advisory services that perform in the intermediary space are of increasing interest as the role is slowly being removed from state funded extension providers into the hands of the private sector. For example the Victorian lamb industry is an extensive and diverse farming system that has traditionally been serviced by a high level of state government funded public advisors. With reduced state investment, there has been a noticeable increase in the engagement of private intermediary roles to facilitate knowledge exchange, form new networks and accelerate innovation. The impacts of this change and the nature of intermediaries with regards to innovation processes has however received limited study and requires further examination, particularly in the Australian context.

Information pertaining to the role and function of intermediaries within this paper is informed from the wider research focus investigating the 'social and technical influences that enable and constrain adoption of genetic improvement by commercial lamb producers, in the state of Victoria Australia'. The Agricultural Innovation Systems (AIS) framework is being used to help guide a comprehensive and systematic approach to explore the organisational roles and interactions of supply chain actors in new, innovative and holistic ways that have not been undertaken in the Australian lamb industry.

The data and discussion presented are based on in-depth interviews carried out with a wide range of actors embedded in the lamb supply chain. The paper is divided into a number of sections. Background outlines the background and industry context that gave rise to the research study and questions. This is followed by the conceptual framework being used to guide the study. The methodology section is followed by one which summarises preliminary findings from the study while the final section considers the key findings emerging from the data around the presence of enabling situations between farmers and intermediaries that lead to innovation within the Victorian lamb industry.

Background

Breeding decisions are important complex management decisions made within a farming enterprise. They influence future flock performance and farm profitability and as Kaine and Niall (2003, p. 2) reported are 'too important to be left to chance or whim'. It is an important complex management decision that should be better understood according to (Rowe, 2010) as the choice of sire made for every joining has a large and permanent impact on production and profitability that compounds over generations.

Research completed in the Australian wool and dairy sectors currently provide the most insights into how Australian livestock producers make breeding decisions and perceive genetic improvement, in particular the value of breeding value technology within their farming systems. The information while valuable cannot be fully extrapolated across the Australian lamb industry however, as different breeding strategies and supply chain systems exist. Furthermore these studies tend to focus on the decision making processes of the end user or farmer. The role and function of intermediaries upon innovation processes within this context has received less attention and yet they play an important role facilitating access to information, technologies and networks that support more efficient, productive and profitable farming practices.

The following sections outline the industry context and conceptual framework in which the research is being undertaken.

Australian lamb industry overview

Victoria is Australia's largest lamb producing state accounting for 42 per cent of national lamb production (VDPI, 2010), making it a significant contributor to Australia's red meat industry which is valued at around $15.7 billion (Kroker, 2013). With new emerging markets, particularly in Asia and others in the developing world (Ridley, 2013), many future opportunities are foreseen for the lamb industry (Kroker, 2013; Sheep CRC; VDEPI, 2014).

Rowe (2010) argues that the future profitability of the lamb industry depends on producers attaining high rates of productivity gain and producing quality products valued by consumers, both of which can be achieved through improved genetic selection and 'best' management practices. Genetic improvement technologies which play a key role in increasing the productivity, profitability and market competitiveness (Islam et al., 2013; Sheep CRC) of the Australian lamb industry have been accessible now for many decades. However the uptake of genetic improvement innovations to assist with selective breeding has been relatively low compared to other animal industries such as the dairy, poultry and pig sectors (Islam et al., 2013). Both research and industry bodies in Australia advocate room for improvement (Rogan et al., 2011; Sheep CRC; Williams, 2010). With industry benefits to be made from the implementation of genetic improvement via the use of quantitative genetics, industry bodies undertook a large collaborative Research, Development and Extension (RD&E) initiative in the late 1980s to make lamb a competitive marketable product both domestically and globally (Banks, 2012). The current industry focus is to identify barriers to the uptake of genetic technologies and overcome these through better communication, training and skills development strategies (Rogan et al., 2011) so as to achieve accelerated rates of genetic gain in those traits of economic importance for Australian sheep producers (AWI, 2013; Rogan et al., 2011).

Animal selection has played a key role in breeding better animals for generations. Today's farmers continue to selectively breed as animals are still capable of rapid improvement or modification due to genetic variation (Hayes et al., 2013). Animal selection traditionally occurs by 'eye', that is a visual inspection of the animal's body, health, pedigree and environment (Holloway et al., 2011; Islam et al., 2013). Over time, continuous selection for desirable traits generally leads to improvements in productivity and performance. Show ring success, that is exhibiting an animal to a judge, can also play a part in the selection process (Banks, 2012). However as Banks (2012, p. 54) points out, in the lamb sector at least 'the characteristics used in judging both live sheep and carcasses bore little or no direct relationship to profitable meat production'.

Scientific advances throughout the past quarter of a century however have provided an alternative way to breed animals for increased productivity, determining genetic merit (the genes responsible for productivity and passed onto progeny) with a calculated figure called estimated breeding values or EBVs. Estimated breeding values (EBVs) are a numerical value that indicates how strong or weak the genes are for various economically important production traits, such as growth rate. The use of EBVs in breeding decisions has been shown to increase animal performance across a range of species (Islam et al., 2013) and has had a positive impact in the Australian sheep industry generally acknowledged by science and industry (Barnett, 2006).

LAMBPLAN, launched in 1989, is the Australian national system for describing genetic merit of animals in the sheep industry (Banks, 1990; Williams, 2010). LAMBPLAN works to genetically improve the 'terminal' and 'maternal' sheep breeds that operate under the sheep meat banner. Terminal breeds produce lambs that go directly to slaughter, while maternal breeds are used to breed the next terminal lamb. Since the introduction of LAMBPLAN there has been significant, albeit variable, genetic progress across the major breeds in the Australian sheep industry (Barnett, 2006; Swan et al.,2009).

Breeding programs that implemented EBV selection produced by LAMBPLAN are credited with increasing the size of slaughter lambs and their carcase[1] weight (EDGE*network*, 2003). Banks (2012) reports that between 1993 and 2006 carcase weight increased sixteen percent from 17.64 kilograms to 20.53 kilograms while fat content decreased.

LAMBPLAN research, information and tools around breeding value technologies, better known as Australian sheep breeding values (ASBVs), has commonly been disseminated over the years through the development of extension programs and delivered through public and private providers. The adoption and utilisation of research however is dependent on the perceived benefits being accepted and adopted by the end-user (Corner-Thomas et al., 2013). Extension programs such as EDGE*network*[2], Making More from Sheep[3] and the recent RamSelect[4] workshops promote and encourage ram breeders and commercial sheep producers to adopt genetic improvement technologies to assist with the selection of rams that will breed the best progeny for them with 'more wool', or 'more meat' or 'more lambs' through buying in the right set of genes for production, quality and disease resistance. Furthermore network programs such as BestWool BestLamb[5] run by Agriculture Victoria (Victoria, Australia) are used by research organisations as conduits to transfer and diffuse knowledge about breeding value technology and the benefits of adoption throughout its farmer and group network.

Genetic improvement technologies, specifically breeding values, are however still not universally accepted or adopted within the sheep industry, a message conveyed and shared by Australian and international research (Kaine et al., 2002; Morris & Holloway, 2014; Swan et al., 2009; Williams, 2010). The science nonetheless has been proven to work and repeatedly demonstrated in scientific studies and practical on-farm demonstrations (Morris & Holloway, 2014; Ramsey, 2012; Williams, 2010).

Other studies contribute insights into how livestock producers perceive genetic improvement. Yet few are in the Australian context and inform enquiry across the whole supply chain in a comprehensive, systematic way such as Agricultural innovation systems. The use of AIS permits a much richer view and diagnosis of enablers, influences and constraints across an innovation system and as such is being used to guide this research.

The conceptual framework: Agricultural innovation system

This research adopts the Agricultural Innovation Systems (AIS) framework as it provides a systematic and comprehensive framework to analyse and categorise technical and

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[1] The body of slaughtered lamb minus the skin, head, hooves and internal organs.
[2] EDGEnetwork is a series of workshops that provides technical and business skills for sheep farmers.
[3] Making More from Sheep is a manual containing 11 sections on 'best practice' technical information for sheep health, pastures, breeding, business management, etc. Information signposting is also provided allowing producers to find further information.
[4] RamSelect is a one day training course offered by the Sheep CRC designed to build sheep producers' confidence around using breeding values for ram selection and purchase.
[5] Bestwool Bestlamb is a Victorian producer network program whereby likeminded sheep producers come together and with the help of a facilitator establish self-directed learning.

institutional constraints to innovation. This permits critical analysis of the broad perspective, encompassing the whole production system and institutional environments in which actors are embedded (Amankwah et al., 2012).

A key concept underpinning AIS is that is stimulates innovative developments. Systems often work imperfectly (Amankwah et al., 2012; Islam et al., 2013; Lamprinopoulou et al., 2014), presenting 'innovation system failures'. Structural and functional elements help identify transformational failures and merits (Klerkx et al., 2012). The failures become analytical focus points (Hekkert et al., 2007) which identify pathways for alignment and coordination (Wieczorek & Hekkert, 2012). Overall functionality of the entire innovation system may therefore be examined to determine if collective innovation priorities are being met, 'and if not, what prevents transformative change towards desirable direction' (Lamprinopoulou et al., 2014, p. 4).

The strength of AIS, recognised as such amongst researchers (Lamprinopoulou et al., 2014) is that it encompasses a holistic diagnostic view of an agricultural innovation that includes the individual adopter (commercial lamb producer), service providers (public and private agribusiness) and formal science stakeholders (Sheep CRC[6], LAMBPLAN) (Amankwah et al., 2012). A whole systems approach to investigating genetic improvement within the lamb industry affords a richer analysis of technology adoption issues whereas analytical tools used in isolation only tell part of the story.

The purpose of AIS in the wider study is firstly to inform the lamb industry about its capacity and potential as a successful innovation system by identifying constraints and enablers across the supply chain and secondly to contribute to the literature on the operational performance of agricultural innovation systems for diagnosing, planning and intervening to improve innovation. Klerkx, Aarts and Leeuwis (2010, p. 391) also suggest that the use of AIS can 'contribute to building blocks for adaptive agricultural innovation policies that can deal with the unpredictability of innovation processes'. The empirical application and analysis of a key Australian agriculture industry as an innovation system will furthermore contribute to AIS literature.

This paper however specifically explores the role, enabling environment and activities between farmers and intermediaries to elicit knowledge and a better understanding of the fit, role and operational performance of the intermediary that leads to innovation.

Methods

This paper provides a preliminary insight into the enabling environments that occur between farmers and intermediaries in the Victorian lamb industry, Australia. The data presented in this study are obtained from interviews with farmers, research and industry organisations who are involved with the use or non-use, diffusion, extension or development of genetic innovations.

The interview questions and analyses used to inform the discussion were structured according to a criteria based upon the agriculture innovation systems framework and social research methodology. This is being used to map and understand the interactions and organisation of the genetic improvement system.

[6] Cooperative Research Centre for Sheep Industry Innovation, Australia

Semi structured interviews were conducted over 2015 with fifteen ram breeders, breed society members and research and industry people involved in the extension, diffusion or development of genetic innovations including private consultants, livestock agents, sheep pregnancy scanners, public extension officers, processors and scientists. The key question which this cohort of the supply chain aims to address is: 'How do value chain actors influence the benefits producers can attain from use of improved genetic animal selection information?

Focus group interviews were conducted with over thirty like-minded commercial farmers that either use or did not use rams with breeding values. The groups were purposely split into separate focus groups so that the questions could be explored in some depth without opposing views being expressed during the interview. The key question under investigation includes 'How do different producer groups differ in their decision processes associated with animal selection and the use of quantitative assessment measures? With a specific focus being placed on attitudes and beliefs about quantitative assessment, the farm system context, market influences and advisory support'.

All interviews were audio recorded and subsequently transcribed. The software program NVIVO 11 was used to facilitate a thematic analysis of farmer and intermediary interviews.

In this paper the analysis was extended to provide further understanding on knowledge exchange, actor interactions, enabling environments and specific activities around the application of genetic technologies. The key question being addressed in this paper is 'to what extent is there a presence of enabling situations between farmers and intermediaries that lead to innovation within the Victorian lamb industry?'

Findings

Findings from the thematic analysis of farmer and intermediary interviews are presented as a set of responses to the key research interest in this paper around the roles of actors embedded within the system, enabling environments and specific activities that generate spaces for innovation.

The role of intermediaries in the Victorian sheep industry

Sheep farming in Australia is in general a pasture fed, extensive system sitting within a mixed farming enterprise. The majority of the farmers interviewed in this study ran up to three different enterprises on their farms: a lamb or red meat enterprise; a wool enterprise as a result of using Merino[7] ewes for lamb mothers and the third was generally a cropping (grain) enterprise.

Given the diverse nature of the enterprises run on these farms there are many actors who potentially act in intermediary roles in the Victorian sheep industry. This includes farmers, agribusiness, public and private extension providers, private sector stakeholders, processors and research organisations. Private sector actors include consultants (who provide financial, general farm advice or specialist advice in disease, nutrition or breeding), agribusinesses (who

[7] *A Merino is a specialist wool producing sheep that is the predominant ewe mother for lamb (red meat) production in Australia.*

provide general farm supplies, chemicals, meat and wool agents, pregnancy scanners and shearers), veterinarians and breed societies.

Within an innovation system actors are those that contribute to the development, diffusion and utilisation of a technology, product or service (Islam et al., 2012). In AIS actors are conceptualised under four broad areas namely, research, enterprise, intermediary and demand according to the actor's activities and roles in the innovation system. The research domain (universities, research institutes) produce basic or applied research and generate knowledge and is considered a supplier of knowledge. Actors on the demand side use innovative products and services (farmers, processors). In between the supply and demand domain are the intermediaries (public and private extension officers) who may not necessarily provide expert advice or be involved in knowledge creation or usage but facilitate knowledge flow and exchange by joining fragmented innovation system actors.

Intermediaries that participated in this research included:

Two public extension officers: state government funded employees who undertake project work and operate in the Bestwool Bestlamb network (state funded project run by Agriculture Victoria) facilitating self-directed farmer groups and delivering knowledge and information with the aim of enhancing the productivity, efficiency and profitability of farmers.

Four private consultants: three are involved in the Bestwool Bestlamb network in addition to operating their own agricultural consultation business. The fourth operates independently and operates more often in the wool industry but was starting to service an increasing number of clients in the lamb industry.

Interviews conducted with the following group of actors, it could be argued, fit in the supply (research) and demand (farmers) sectors of the AIS framework. Yet information obtained from the actors below found that all have performed in an intermediary role when time and situation has created the space for this function. Furthermore it is recognised that an actor can move between roles (Islam et al., 2012; Lamprinopoulou et al., 2014).

Two science researchers who work in industry funded research and development corporations develop knowledge but also pilot and deliver extension knowledge and programs to farmers through existing networks. Both people have been involved in the development and delivery of national projects designed to accelerate genetic improvement by ram breeders and commercial farmers.

Further interviews were undertaken with other highly networked actors embedded within the lamb industry including: two livestock agents, one pregnancy scanner, one red meat processor and two breed society members who are also stud ram breeders.

Early results suggest that there are two or three key relationships influencing farmers' decisions around ram buying criteria and the application of improved genetics such as Australian sheep breeding values.

The majority of participants considered livestock agents and ram breeders to highly influence farmers' use of genetic innovations. Livestock agents are part of a well-connected network of actors within the lamb system. They buy and sell sheep for clients and act as a conduit of information and knowledge on current market place requirements for farmers who employ their services. Livestock agents were used as a source of expertise to select and buy rams by some farmers as they had confidence and trust in their judgement. Interestingly the pregnancy scanner suggested that the livestock agents could also be used as a sounding board by farmers to reassure decision making processes, thus setting the scene for an enabling environment where innovation could occur.

"Agents are used by farmers as a confidence boost, they want a second opinion and they are the boost they need to select" (pregnancy scanner)

Based upon their role and capabilities, livestock agents and other sheep industry service providers such as pregnancy scanners and shearers are similarly aligned to farmers under the AIS conceptual framework whereby knowledge, innovative products and services tend to be demand driven and put into practice. Yet within the context of this research the livestock agents 'fit' was more aligned within the intermediary domain where it was observed that they facilitated knowledge flow between actors in the innovation system. It was noted that a number of the commercial farmers actively sought livestock agents out for advice and guidance about ram selection decisions as they were seen as experienced, knowledgeable and well networked individuals. The livestock agents are therefore not just facilitating information flow but are contributing knowledge that is influencing how farmers use genetic innovations.

Generating spaces for innovation

In this section the presence of enabling situations between farmers and the intermediaries (as described above) that impacted or influenced the use of genetic innovations were explored.

To examine this area further, questions posed to intermediaries, such as; *'Describe how you help farmers to select their ram breeder / individual rams'* and *'Who do you think gives good advice to help farmers make choices about ram selection?'* were used to learn about knowledge exchange and to better understand the relationships between actors. Furthermore thematic coding along the lines of influences, participation in events, information source and selection practices generated findings around enabling environments or constraints seen within the genetic innovation system.

Enablers within the innovation system

Participation in an 'elite' group for one ram breeder provides the motivation and encouragement to undertake innovative processes. The ram breeder is a strong advocate for breeding values and uses them for animal selection within his flock. He is also a member of the national genetic scheme LAMBPLAN. Discussion with the farmer suggest that the environment in which he operates pushes him to be perhaps less risk adverse and more open to innovations and experimentation. Fellow group members collectively share and support the decision making processes especially when it comes to evaluating young sires (rams) that could be viewed as high risk breeding prospects as they tend to have less accurate breeding values. Group members undertake and share similar risks in their progression to accelerate genetic gain within their flock. In addition to his participation in an engaging environment this ram breeder is a firm believer in the uptake of new technology and it was a word that was reiterated throughout the interview, especially in the context of genetic innovations.

"Well it's new technology and it has the potential to increase the value of our livestock" (ram breeder using breeding value technologies)

Genomic technologies to discover the genes for improved meat eating quality are currently being evaluated within his flock.

An interview with a different ram breeder told a similar story. He is embedded within a different breed based group that again share similar interests, goals and risks. This group can be seen to provide engaging environments where innovation processes are shared between people with similar interests in achieving genetic gain.

Both ram breeders are long term members of the national genetic scheme LAMBPLAN that provides a further innovative enabling environment. Findings however suggest that for one ram breeder this group is viewed in a very different light to that of the breed society. Participation in LAMBPLAN, for him, is used more for marketing purposes.

In relation to this work, the supportive breed groups seem to be providing the engaging environment in which both farmers operate and undertake innovations. In addition both farmers are highly networked individuals to many actors across the supply chain that are positive and encouraging of accelerating genetic gain within the industry.

Constraints within the innovation system
The following findings explore some of the likely constraints occurring within the innovation system.

"If you are not using Australian sheep breeding values you're a bloody idiot" (science supplier)

The quote leans towards a source of disengagement and disconnect between the science suppliers and this particular ram breeder. This was found to be a shared experience with some other interviewees.

Livestock agents were frequently referred to as a cohort that inhibited the uptake of genetic innovations by intermediaries (private and public consultants, pregnancy scanner) and farmers whom are advocates of genetic technologies.

"Agents are notoriously low for using ASBVs and that. They need a bomb under them to get them to the right side of the ledger I think" (ram breeder using breeding value technologies)

In this sense livestock agents are viewed as gate keepers to the use of improved genetics by these actors. Livestock agents are highly valued by many of the farmers that participated in this research and for some agents are used to select and purchase rams on their behalf. The farmers trust and have confidence in the decision making processes of the livestock agent.

Agents as a trusted confidant of the farmer can reinforce the perception that breeding values do not provide value as suggested by this farmer and which was recounted similarly by others.

"I think if it could be demonstrated that buying rams with figures improved your bottom line, as opposed to buying rams visually, I think that would be enough to make me want to do it" (commercial lamb producer)

Yet knowledge about the science which has been proven to work and repeatedly demonstrated in scientific and practical on-farm trials (section 2.1) has been disseminated to farmers since the formation of LAMBPLAN, over 20 years ago.

A further view point similarly shared by other intermediaries considered the farmer as the gatekeeper to any changes.

"There are more people using objective assessments, they are tending to move away from that subjective assessment of sheep, they are starting to understand the difference. But the ones that aren't, I think there's 2 things going on there, they're too busy, don't want to know, or I'm too old, I've done it this way forever, I'm making enough money, and I don't care. I think that's reality. There is a definite generational thing but also I'm too busy trying to keep my head above water to look up and see what's going wrong" (private consultant).

The norms about what is or is not a good ram was conveyed strongly by participants from all sectors of the supply chain.

"Size matters. A producer will not a buy a small ram no matter what the Australian sheep breeding values say" (innovation broker)

This idea resonated strongly and was approved of when discussed with different groups of commercial farmers, despite close links with intermediaries or other enabling environments.

Discussion and Conclusion

This paper considers two areas of insight into the presence of enabling situations between farmers and intermediaries that impact on innovation within the Victorian lamb industry. Additional work is still to be undertaken to substantiate and provide further data around the following outcomes.

Ram breeders and livestock agents are key actors within the lamb industry who influence ram selection decisions. Livestock agents play an important role in the dissemination of knowledge, information and technologies to farmers. Their beliefs and knowledge, own life experiences and potential bias becomes a source of powerful messages and influences conveyed to some but not all farmers. Intermediates, both public and private advisors, although engaged and part of the network were not seen to be as well utilised as the livestock agents as a source of knowledge. Yet there are an increasing number of private consultants that are being sought out by science suppliers to support commercial farmers and ram breeders to accelerate genetic progress. This is thought to be achieved by helping farmers to select the right ram and placing them in the right situation for optimum production and economic output while meeting the desired breeding objectives of the farmer. If farmers are actively seeking advice from livestock agents about breeding and ram selection decisions however, then this cohort of actors need to be more actively engaged by the research sector so as a wider network of farmers can be reached and educated about objective genetic innovations.

Livestock agents in this study are viewed mostly as gate keepers to the use of improved genetics. They therefore act as a constraint to the acceleration of genetic gain, particularly to the level being sort by industry bodies to maintain domestic and export market competitiveness. Further research will define if there is a self-reinforcing community of practice emerging in this space. In particular we need to understand if the livestock agents are training the next generation of gate keepers. This in turn will lead to a greater understanding around the relationships formed with farmers and the part they play in enabling or constraining the application of genetic innovations.

Other findings that relate to the wider study but could potentially provide further insight into the nature of relationships between farmers and intermediaries include the presence of norms about what is a good ram or breeder. There is a need to understand how strongly these beliefs are held, to what extent are they being reinforced and by whom. An unexpected finding was the lack of awareness of some farmers that they are purchasing rams from ram breeders who are embedded in the genetic scheme LAMBPLAN. Additional investigation is taking place to understand how this is possible and any potential implications.

With genetic technology rapidly expanding, becoming more sophisticated and possibly more complex, there is now a greater need to recognise how producers make sense of an innovation and how social influences impact upon behaviour and beliefs or the meaning given to actions (Nettle et al., 2010; Sneddon et al., 2009). In addition there is a recognised need to learn more about the intermediaries; the nature of their relationships (Howells, 2006), their specific capabilities (Klerkx & Leeuwis, 2009) and for them to be operationally defined and well-evaluated (Koutsouris, 2014).

This study takes a step towards understanding some of the underlying social dynamics, influences and technical arrangements within the Victorian lamb industry. This includes defining the type of functions or roles, relationships and fit of intermediaries within the Victorian lamb industry to fully appreciate their impact on genetic innovation processes. In identifying constraints and enablers across the lamb supply chain the aim is to inform the industry about its capacity and potential as a successful innovation system.

References

Amankwah, K., Klerkx, L., Oosting, S. J., Sakyi-Dawson, O., van der Zijpp, A. J., & Millar, D. (2012). Diagnosing constraints to market participation of small ruminant producers in northern Ghana: an innovation systems analysis. NJAS - Wageningen Journal of Life Sciences 60-63: 37-47.

AWI. (2013). AWI Industry Consultation Document. Genetic benchmarking: Potential for Further Commercialisation of AWI Funded or Part Funded Projects post June 2015. Retrieved from http://www.wool.com/en/home

Banks, R. G. (1990). LAMBPLAN: An intergrated approach to genetic improvement for the Australian lamb industry. Association for the Advancement of Animal Breeding and Genetics, 237-240.

Banks, R. G. (2012). We Love our Lamb. North Sydney: Focus Publishing, CommStrat.

Barnett, R. (2006). LAMBPLAN Review of adoption by the Australian meat sheep breeding industry. North Sydney: Meat & Livestock Australia.

Corner-Thomas, R.A., Kenyon, P.R., Morris, S.T., Greer, A.W., Logan, C.M., Ridler, A.L., Hickson, R.E., & Blair, H.T. (2013). A survey examining the New Zealand breed composition, management tool use and research needs of commercial sheep farmers and ram breeders. Association for the Advancement of Animal Breeding and Genetics 20: 18-21.

EDGEnetwork. (2003). Effective breeding for lamb [Powerpoint presentation]: Meat & Livestock Australia.

Hayes, B. J., Lewin, H. A., & Goddard, M. E. (2013). The future of livestock breeding: genomic selection for efficiency, reduced emissions intensity, and adaptation. Trends in Genetics, 29(4), 206-214. doi:http://dx.doi.org/10.1016/j.tig.2012.11.009

Hekkert, M. P., Suurs, R. A. A., Negro, S. O., Kuhlmann, S., & Smits, R. E. H. M. (2007). Functions of innovation systems: a new approach for analysing technological change. Technological Forecasting and Social Change 74(4): 413-432. doi:http://dx.doi.org/10.1016/j.techfore.2006.03.002

Holloway, L., Morris, C., Gilna, B., & Gibbs, D. (2011). Choosing and rejecting cattle and sheep: changing discourses and practices of (de)selection in pedigree livestock breeding. Journal of the Agriculture, Food and Human Values Society 28: 533-547.

Howells, J. (2006). Intermediation and the role of intermediaries in innovation. Research Policy 35(5): 715-728. doi:http://dx.doi.org/10.1016/j.respol.2006.03.005

Islam, M. M., Renwick, A., Lamprinopoulou-Kranis, C., & Klerkx, L. (2012). Dynamics of innovation in livestock genetics in Scotland: an agricultural innovation systems perspective. Paper presented at the 131st EAAE Seminar 'Innovation for Agricultural Competitiveness and Sustainability of Rural Areas', Prague, Czech Republic.

Islam, M. M., Renwick, A., Lamprinopoulou, C., & Klerkx, L. (2013). Innovation in livestock genetic improvement. EuroChoices 12(1): 42-47. doi:10.1111/1746-692X.12019

Kaine, G., Court, J., & Niall, E. (2002). Implications of customer perceptions and decision-making for genetic gain in the wool industry. Paper presented at the Proceedings Wool Industry Science & Technology Conference.

Kaine, G., & Niall, E. (2003). Sheep Breeding: Complex Decision Making and Brand Loyalty. Melbourne: The State of Victoria. Department of Primary Industries.

Klerkx, L., Aarts, N., & Leeuwis, C. (2010). Adaptive management in agricultural innovation systems: the interactions between innovation networks and their environment. Agricultural Systems 103(6): 390-400. doi:10.1016/j.agsy.2010.03.012

Klerkx, L., & Leeuwis, C. (2009). Establishment and embedding of innovation brokers at different innovation system levels: insights from the Dutch agricultural sector. Technological Forecasting and Social Change 76: 849-860.

Klerkx, L., Van Mierlo, B., & Leeuwis, C. (2012). Evolution of systems approaches to agricultural innovation: concepts, analysis and interventions. In I. Darnhofer, D. Gibbon and B. Dedieu (Eds.) Farming Systems Research into the 21st Century: The New Dynamic (pp. 457-483): Springer.

Koutsouris, A. (2014). Exploring the emerging intermediation roles (facilitation and brokerage) in agricultural extension education. International Journal of Agricultural Extension 2(International Conference): 21-37.

Kroker, G. (2013). Introduction and Overview [Powerpoint presentation]. Fresh Mint Lamb RD & E Update.

Lamprinopoulou, C., Renwick, A., Klerkx, L., Hermans, F., & Roep, D. (2014). Application of an integrated systemic framework for analysing agricultural innovation systems and informing innovation policies: Comparing the Dutch and Scottish agrifood sectors. Agricultural Systems. Retrieved from http://dx.doi.org/10.1016/j.agsy.2014.05.001

Morris, C., & Holloway, L. (2014). Genetics and livestock breeding in the UK: co-constructing technologies and heterogeneous biosocial collectivities. Journal of Rural Studies 33: 150-160.

Nettle, R., Paine, M., & Penry, J. (2010). Aligning farm decision making and genetic information systems to improve animal production: methodology and findings from the Australian dairy industry. Animal Production Science 50: 429-434.

Ramsey, A. (2012). Using ASBVs – What's in it for me? Armidale: Sheep CRC.

Ridley, L. (2013). Victorian Food and Fibre Export Performance. Retrieved from Melbourne: www.depi.vic.gov.au/export-performance

Rogan, I. M., Williams, S., Sefton, R., Trompf, J., & de Fegely, C. (2011). Genetics training initiative: communication and skills development needs assessment. Armidale: Sheep CRC.

Rowe, J. B. (2010). The Australian sheep industry – undergoing transformation. Animal Production Science 50(12): 991-997. Retrieved from http://dx.doi.org/10.1071/AN10142
Sheep CRC. Retrieved from http://www.sheepcrc.org.au/

Sneddon, J. N., Soutar, G. N., & Mazzarol, T. (2009). On-farm innovation in the Australian wool industry: a sensemaking perspective. Experimental Agriculture 45(3): 295-312.

Swan, A. A., Brown, D. J., & Banks, R. G. (2009). Genetic progress in the Australian sheep industry. Association for the Advancement of Animal Breeding and Genetics 18: 326-329.

VDEPI. (2014). Food to Asia Action Plan: Putting Victorian Food and Beverages on Asian Tables. Melbourne: Victorian Government, Department of Environment and Primary Industries

VDPI. (2010). Victoria's Sheep Meat and Wool Industry. Melbourne: Victorian Government, Department of Primary Industries.

Wieczorek, A. J., & Hekkert, M. P. (2012). Systemic instruments for systemic innovation problems: a framework for policy makers and innovation scholars. Science and Public Policy 39(1): 74-87. doi:10.1093/scipol/scr008

Williams, S. (2010). Discussion paper: adoption of sheep breeding technologies. Armidale: Sheep CRC.

Development of an assessment framework for researcher-farmer knowledge exchange: the case of DAIRYMAN

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Abstract: Knowledge is being recognised as a crucial resource in the search for more sustainable farming practices. We present a literature review discussing i) the types of knowledge at stake, ii) by who and how it can be created or acquired optimally, and the different associated learning processes and iii) the role of networks and communities in supporting processes of knowledge exchange and co-creation. Taking indications from literature we propose an assessment framework to evaluate the potential of an extensive network to provide farmers with support to tackle sustainability challenges. The international network consisted of 10 interconnected, smaller regional networks and was created during the European Interreg IV project 'DAIRYMAN' (2009-2013). Our framework is aimed at assessing individual learning in a social context, combining elements from an individual-centric framework developed by Lankester (2013) with the concept of value-creation designed for networks and communities (Wenger et al., 2011). Follow-up research will use the developed framework to answer two main research questions i.e. i) does the DAIRYMAN network support knowledge exchange and what, how and why have participants learned? and ii) what are the differences in regional networks, and has this influenced participants' learning outcomes?

Keywords: Knowledge, learning, networks, assessment framework, sustainable farming

Introduction

In the challenge for farmers to produce in a sustainable way the concept of knowledge has taken a central position (Wood et al., 2014). Farmers are expected to learn continually to keep up with innovative technologies and farm management practices. At the same time, they also need to stay connected with changing societal and legislative expectations and ways of incorporating these into their day-to-day farming practice (Bergevoet et al., 2004; Darnhofer et al., 2010; Lankester, 2013). The European Commission stated that today's Agricultural Knowledge and Information Systems (AKIS) do not meet the challenge to increase simultaneously agricultural productivity and sustainability. There is a need for more effective innovation processes. Despite the continued generation of knowledge through scientific projects, research results are often insufficiently exploited and taken up in practice and innovative ideas from practice are not captured and spread (EU SCAR, 2012).

So what entails a successful innovation process and what is the role of knowledge in these processes? Questions still remain on the type of knowledge required, by who and how it can be created optimally and how this knowledge can be shared and transferred. This is a concern for farmers, advisors and researchers alike (Curry & Kirwan, 2014; Eshuis & Stuiver, 2005;

Klerkx & Jansen, 2010; Lankester, 2013; Martin, 2015; Novo et al., 2015). These questions have inspired stakeholders from different backgrounds to move away from the traditional model of knowledge dissemination, where new knowledge is generated by scientists and disseminated to possible end-users. Novel ways of cooperation have been introduced recently, with the intention of creating a science-society interaction with a mutual learning process (Moschitz & Home, 2014). In these novel practices the willingness of different actors to share knowledge is important because different actors gather or create different types of knowledge. Hence, these knowledge exchange practices between actors have the potential to produce more knowledge than each can produce individually (van den Ban, 2002).

To support these knowledge exchange processes numerous networks and communities have emerged, either bottom-up or top-down. In the context of sustainable agriculture the Learning and Innovation Networks for Sustainable Agriculture (LINSA) (Moschitz et al., 2015), and Farmer Field Schools, developed by the FAO, are well-known examples. Although existing networks differ greatly in composition, level of stakeholder participation, specific goals and aims, duration, available resources, etc., they all aim to provide access to (practical) knowledge, experiences and innovative developments. The connections in a network can function as learning ties providing access to information flows and exchanges (Wenger et al., 2011). The heightened interest in these processes is also illustrated by the launch of the European Innovation Partnerships (EIP) by the European Commission, which supports and builds numerous networks in the form of Operational Groups and Thematic Networks. These bring together all relevant actors at EU, national and regional levels in order to enable knowledge exchange on research and innovation.

To further our understanding of the types of knowledge at stake, by who and how this can be created optimally, and how this knowledge can be shared and transferred in networks for sustainable agriculture, we present a literature review on knowledge and learning in networks, more specifically in the context of sustainable agriculture. Based on this literature review we propose an assessment framework to evaluate the potential of an extensive network created during the European Interreg IV project 'DAIRYMAN' (2009-2013).

The paper is structured as follows: in the next section we present a literature overview to i) gain an insight into the differences in understanding knowledge and learning in the context of sustainable agriculture and ii) establish the importance of networks and communities in this respect. The literature overview concludes with a brief section on existing evaluation frameworks. The second section presents the DAIRYMAN case and an assessment framework building on insights from literature, followed by future research steps and a brief concluding section.

Knowledge and learning for sustainable agriculture: assessing what and how

What kind of knowledge?

Knowledge encompasses the understanding and skill gained through experience and education. In agriculture different types of knowledge are needed to develop solutions for the variety of challenges associated with sustainable development (van den Ban, 2002). What farmers need to know, and hence what they need to learn, varies from one situation to another (Blackmore, 2007). In literature on knowledge management and organisational learning two types of knowledge can be discerned, i.e. explicit and tacit knowledge (Nonaka & Takeuchi, 1995). Although they are often discussed as two distinct types of knowledge, the original assumption asserts that all knowledge has tacit dimensions (Collins, 2010; Polanyi, 1966 in Leonard & Sensiper, 1998), and that knowledge exists on a spectrum. At one end knowledge can be almost completely tacit, which is semi- or unconsciously held in individuals minds and bodies, while at the other end knowledge is almost completely explicit and as such accessible to different people (Leonard & Sensiper, 1998). Explicit knowledge "can be expressed in words or numbers, and can be easily communicated and shared in the form of hard data, scientific formulae, codified procedures, or universal principles" (Nonaka & Takeuchi, 1995). Tacit knowledge on the other hand is knowledge that is not explicated, residing in the minds and bodies of people. For tacit knowledge two dimensions can be distinguished; i.e. a technical dimension or 'know-how', which encompasses the skills and crafts that a practitioner gains through years of practical experience, and a cognitive dimension, consisting of an individuals' mental models, ideals and values (Nonaka & Takeuchi, 1995; van den Ban, 2002). In previous decades farmers could rely on readily available technical, explicit knowledge, usually supplied by 'experts' in the field, i.e. researchers and advisors. This process has been fueled by an objectivist view on agriculture. In light of such a view, 'scientific' knowledge is believed to be superior, as it is founded on evidence and experimentation and not confounded by errors or biases due to perspectives, history or culture (Curry & Kirwan, 2014; Morgan & Murdoch, 2000). This view has been criticised extensively in the past and Curry and Kirwan (2014) argue that "approaching sustainable agriculture through a constructivist knowledge lens allows a range of these values within 'sustainable' agriculture to be more clearly identified thus improving an understanding of the distinctive nature of sustainable agriculture". In this context access to tacit knowledge is required to adequately address the issue of sustainable farming and associated farming practices (Curry & Kirwan, 2014; van den Ban, 2002).

What kind of learning process?

Various learning theories describe how individuals or collectives acquire and shape knowledge, and if and how this knowledge is turned into action (Blackmore, 2007). De Laat and Simons (2002) plotted learning processes against learning outcomes at both individual and collective levels and distinguished four kinds of learning as a result: i) individual learning; ii) individual learning processes with collective outcomes; iii) learning in social interaction and iv) collective learning. In the context of sustainable development, initiatives and research quite often focus on collective learning, where both the learning processes and outcomes are collective (e.g. Armitage et al., 2008; Blackmore, 2007; De Laat & Simons, 2002; Leeuwis & Pyburn, 2002; Leys & Vanclay, 2011; Marschke & Sinclair, 2009; Sinclair et al., 2008; Sol et al., 2013; Wals & Corcoran, 2012). This can be explained by the fact that sustainability issues are often complex, clouded by uncertainty, contested and surrounded by controversy, competing interests, visions and values (Triste et al., 2016; Wals, 2011). Learning systems for sustainable agriculture are required to embrace often diverging values and principles of a variety of stakeholders. They must continually adapt over time to changing conditions and insights, making them very complex (Curry & Kirwan, 2014).

Given this perspective, different notions of learning come into play. Vare and Scott (2007) make a distinction between education for sustainable development 1 and 2 (ESD1 and ESD2), which is similar to Wals (2011) who distinguishes between an instrumental perspective and an emancipatory perspective. Learning from an instrumental perspective is aimed at changing behavior, including attitudes, beliefs and values, i.e. learning from an instrumental perspective (Wals et al., 2008; Wals, 2011). An instrumental approach assumes that "a desired behavioural outcome is known, agreed on (more or less) and can be influenced by carefully designed interventions". In other words, learning goals and notions of what is 'good' or 'right' are established beforehand, often by experts distinct from the learners. Learners are considered as passive 'receivers' of knowledge (Wals et al., 2008). The theory of planned behavior (Ajzen, 1985) is a well-known model describing this process of behavioural change in which behavior is linked to knowledge and awareness on a particular subject. Although the instrumental perspective or ESD1 is the dominant discourse within education for sustainable development (Van Poeck & Vandenabeele, 2012) such models are criticised for overly simplifying the complexity of an individual's behavior in the context of sustainable development. But providing information, raising awareness and changing attitudes is not enough to change an individual's behaviour (Vare & Scott, 2007).

As a critique on this instrumental perspective, which assumes that the future can be planned rationally from above, a more emancipatory perspective on education for sustainable development has developed over the years. Learning from an emancipatory perspective aims at capacity building and critical thinking, to enable individual and collective action and transformation towards a more sustainable society (Wals et al., 2008; Wals, 2011). It is believed that, to effectively embrace different stakeholders' values, learning processes have to be participatory (Pretty, 1994). Loeber et al. (2007) consider such learning as a way to ensure that any particular elaboration of what is sustainable is meaningful and practical to whom it concerns through i) facilitating determination of sustainability in a given context, ii) inducing processes of value judgment and iii) supporting system innovation through reflection on theories, beliefs and assumptions underlying action. Several new learning approaches fall within this scope e.g. social learning, collaborative, transformative and emancipatory learning (Triste et al., 2016; Wals, 2011). Although they differ in focus these forms of learning have some common characteristics, e.g. the consideration of learning as not merely knowledge-based, or the view of learning as transdisciplinary and cross-boundary in nature (Wals, 2011). Social learning in particular has been widely used in the context of learning for sustainability, but has come to mean very different things over the years built on differing theoretical perspectives and disciplinary backgrounds (De Laat & Simons, 2002; Reed et al., 2010). Perhaps the main difference is that for some social learning refers to individuals learning in social settings, while others define it as learning by social aggregates (Parson & Clark, 1995 in Wals & van der Leij, 2009). Social learning can be regarded as a naturally occurring phenomenon where learning is regarded as ubiquitous and part of human activity as such, i.e. learning cannot be avoided; it is not a choice for or against learning but the result of processes of participation and interaction (Elkjaer, 2003; Nicolini & Meznar, 1995). However, it can also be viewed as a way to organise and structure learning (Wals & van der Leij, 2009), in which the shared learning of interdependent stakeholders is a key mechanism for arriving at more desirable futures (Leeuwis & Pyburn, 2002; Wals, 2011).

Networks to support learning processes

Research on knowledge, learning processes and education for sustainable development has led to the development of various mechanisms, tools, structures and/or educational practices to support the change towards a more sustainable society. Policy makers across the world have developed support measures or subsidy schemes (e.g. Global GAP, CAP), researchers have developed sustainability assessment tools and frameworks (FAO, 2014; Galan et al., 2007; Gerrard et al., 2012; Zahm et al., 2008), networks or communities have been formed to foster innovation (e.g. Hermans et al., 2011; Klerkx et al., 2010; Kroma, 2008; Spielman et al., 2010; O'Kane et al., 2008; Oreszczyn et al., 2010), etc. In this section we would like to focus in particular on networks and communities as a structure to support sustainable (agricultural) development.

Lave and Wenger (1991) were the first to make the idea of communities of practice (CoP) explicit in their work on apprenticeship and situated learning. A CoP can be defined as "a learning partnership among people who find it useful to learn from and with each other about a particular domain. They use each other's experience of practice as a learning resource and they join forces in making sense of and addressing challenges they face individually or collectively" (Wenger et al., 2011). The notion of networks of practice originated in the work of Brown and Duguid (2001) who applied the term to the relations among groups of people with looser connections than expected in a CoP. Individuals in the network use their connections and relationships as a resource to quickly solve problems, share knowledge and make further connections (Wenger et al., 2011). Rather than seeing them as two different types of social structures, Wenger et al. (2011) prefer to think of community and network as two aspects of social structures in which learning takes place. The network aspect refers to the set of relationships, personal interactions and connections, while the community aspect refers to the development of a shared identity around a topic or set of challenges.

These social structures or networks are increasingly recognised for their potential in co-creating knowledge and innovation between academic and non-academic stakeholders. They are also increasingly being employed deliberately as 'tools' for knowledge management (e.g. Klerkx et al., 2012; Oreszczyn et al., 2010; Schneider et al., 2012), opposite to the classical innovation-diffusion model which assumes a clear role for the different parties (i.e. scientists create new knowledge and technologies that are subsequently transferred by extension workers for farmers to adopt). Depending on the nature of the networking activities, they may also provide easier access to tacit knowledge. Unlike explicit knowledge, tacit knowledge is not easily processed or transferred in a systematic manner but is learned rather through practical experience or from observing people in practice. As a result, on-farm demonstration activities and the monitoring of farm businesses have gained an interest as they provide new opportunities for knowledge exchange through observation, interaction and discussion (Bailey et al., 2005; Hall & Pretty, 2008; Klerkx & Proctor, 2013).

The actual realisation of this potential however, i.e. supporting different types of learning processes, knowledge co-creation and tacit knowledge exchange, is not guaranteed merely by engaging in network or community building. It is heavily influenced by issues such as trust, power relations, level of participation, network/community characteristics and individuals' personal characteristics and competencies (De Laat & Simons, 2002; Eshuis & Stuiver, 2005; Oreszczyn et al., 2010; Sligo & Massey, 2007; Wenger et al., 2011; Wood et al., 2014).

Evaluation frameworks for networks and communities

Communities and networks are dynamic structures and this poses challenges for evaluation (McKellar et al., 2014). Evaluating the impact of such activities is also debatable because of difficulties in attribution, linking cause and effect quantitatively (McKellar et al., 2014; Purcell & Anderson, 1997). Nevertheless, several frameworks have been developed over the years to ascertain what is actually realised by investing in networks and communities,. McKellar et al. (2014) present a systematic scoping review of evaluation frameworks for CoP and knowledge networks and found a total of 16 evaluation frameworks. Frameworks varied in purpose; some focused on assessing performance, while others were aimed at determining critical success factors, but based on this review they conclude that more detailed and targeted evaluation frameworks are needed. In particular the intangible or hard-to-measure aspects, such as trust, social capital, tacit knowledge exchange and learning, are seldom addressed, with the exception of the framework by Wenger et al. (2011) which uses member narratives. Furthermore, empirical evidence of the performance and learning outcomes of such networks and communities in the context of sustainable agriculture is relatively scarce. Wood et al. (2014) have examined knowledge-sharing relationships between science and farming based on the study of a pastoral farming experiment collaboratively undertaken by 17 farmers and 5 scientists. The analysis focused on the process of exchange and networking and the value of different contacts for farmers, but did not discuss specific learning outcomes of the networking activity. Bailey et al. (2005) present an evaluation of three separate pilots for on-farm demonstrations to support change at farm level and concluded that such activities can contribute to learning. However, specific information on what kind of learning process is supported is lacking. Eshuis & Stuiver (2005) describe the learning process of a group of 60 farmers in a nutrient management project as 'learning in context', where a (shared) meaning is given to existing knowledge to become valid or useful within a local situation. Learning outcomes are described in terms of the three learning loops developed by Argyris and Schön (1996). Finally, Lankester (2013) developed a framework based on adult learning theories. The framework questions who learns?, what is learned?, why is it learned?, and how?, from an individual-centric perspective, i.e. focusing on individual learning processes but taking social dimensions to individual learning into account. The framework was used to analyse the what, why and how of beef producers' learning to improve land condition.

Knowledge exchange and learning in the DAIRYMAN case

Case description

The DAIRYMAN project (INTERREG NWE, 2009-2013) was largely inspired by the Dutch 'Cows and Opportunities' network, the initiators of which were also involved in DAIRYMAN. 'Cows and Opportunities' started in 1998 as a public-private partnership to deal with nutrient management issues in dairy farming (Oenema et al., 2001). This example was upscaled to the broader north west European region and main activities from the 'Cows and Opportunities' network were copied in the DAIRYMAN project. They included: the construction of a farm development plan by the pilot farmers in collaboration with researchers and/or advisors; monitoring farm performance through a standardised data collection sheet; and the organisation of pilot farmer meetings and farm visits on a regular basis to facilitate knowledge exchange on sustainable farm management practices.

The overall aim of the DAIRYMAN network was to strengthen rural communities in the regions of north west Europe, where dairy farming is a main economic activity and a vital form of land use, through better resource utilisation and stakeholder cooperation. The DAIRYMAN project intended to elaborate an alternative approach of cooperation for knowledge production and transfer. Networks were constructed in 10 European regions, comprising 7 countries,. Networks differed somewhat in composition across regions but common to all regions was a group of pilot farmers and a Knowledge Transfer Centre (KTC). Pilot farmers were commercial dairy farmers who agreed to provide associated researchers with data and participate in specific project activities. KTC's were either experimental farms or agricultural schools. In addition, or in relation to the KTC's, research institutes and/or advisory services were involved, depending on the region. Network participants (farmers, researchers, advisors) were involved in regular, mainly regional, meetings and activities. Other stakeholders were involved on an irregular basis (policy makers, non-involved researchers and farm advisors, etc.). Three main activity areas could be distinguished: i) pilot farm activities (e.g. discussion groups, farm visits); ii) KTC activities (e.g. training courses) and iii) regional activities (e.g. broader stakeholder workshops). Interaction between the 3 areas was possible, e.g. KTC representative attending pilot farm meeting, but was not organised on a structural basis. The focus of DAIRYMAN was not limited to a specific topic or issue within the field of sustainable dairy farming, e.g. greenhouse gas mitigation, water quality, or biodiversity, but participants were free to cover a wide range of economic, ecological and social topics. In addition to regional networking activities, the DAIRYMAN project also undertook steps to connect the different regional networks through exchange visits for farmers and other stakeholders. Inter-regional networking activities stopped at the end of the project period, but some of the regional activities are still ongoing.

Assessment framework

Returning to our research question, our aim is to assess the potential of the DAIRYMAN network to provide farmers with support to tackle sustainability challenges. In the next steps of our research, we will focus on the farmers as key stakeholders in achieving agricultural sustainability. Building on the literature we find several interesting clues to construct our assessment framework (Figure 1). First, we will focus on 'learning in social interaction', i.e. on individual learning outcomes in a collective learning process and not on collective learning outcomes. Although the issue at stake, i.e. sustainable dairy farming, is inarguably complex (with existing competition for land and other resources), the project did not focus on specific conflict situations and did not aim to achieve a collective vision or action for network participants, not even at a regional level. The project did however aim to act as a platform for knowledge exchange by providing access to and information on different types of dairy farming systems. In this respect the framework from Lankester (2013) provides us with a clear outline to assess the different components, i.e. who, what, how and why of the individual farmer's learning process. Second, as we also want to see how the DAIRYMAN context has influenced the different components of individual learning, we have integrated the concept of value creation (Wenger et al., 2011). Wenger et al. (2011) describe 5 cycles of value creation, mirroring the richness of values created by communities and networks, i.e. immediate, potential, applied, realised and reframing value. Firstly, immediate value considers that networking activities and interactions have value of themselves. Potential value refers to 'knowledge capital', whose value lies in its potential to be realised later. Applied value refers to the adoption and application of the knowledge, practices and results learned in one's personal life or professional context. Fourthly, realised value goes further than only application. It looks at the effects and successes of the novel practices, both for farmers and other stakeholders. Finally, reframing value reflects on changed understandings, strategies or goals and changes in the definition of what matters, at individual, collective and organisational level. Although there are causal relationships between the different cycles, no simple causal chain or hierarchy of levels is assumed. Also, success does not necessarily coincide with reaching reframing value (Wenger et al., 2011). Given the DAIRYMAN setting, we expect to achieve immediate, potential and, possibly, applied value.

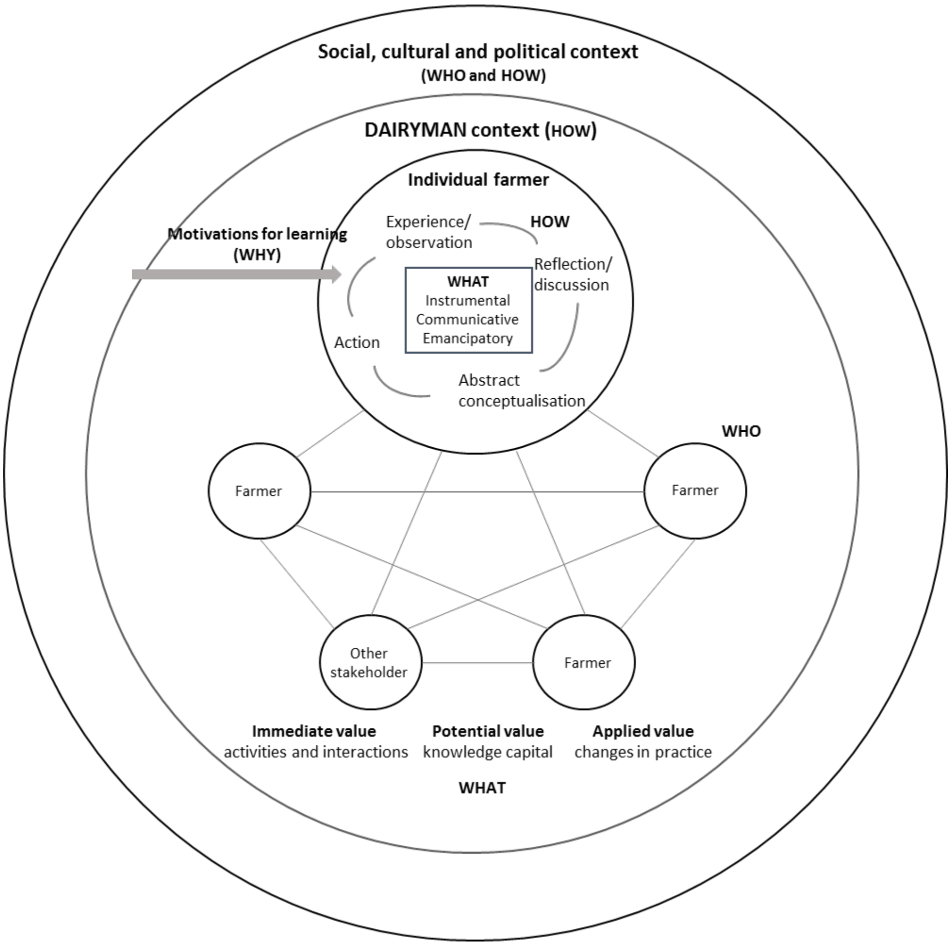

Figure 1. Assessment framework (adapted from Lankester (2013) and Wenger et al. (2011))

Further research steps

We followed a qualitative research approach and have conducted in-depth semi-structured interviews with regional key persons and selected pilot farmers. The assessment framework has been used to structure our interview guide. The regional key persons were researchers or advisors who had a central position in the regional network and who were actively involved in the inter-regional project coordination. We have included 3 DAIRYMAN regions in the current research (the Netherlands, Flanders (Belgium) and Northern Ireland (UK)). The authors of this paper were actively involved in the DAIRYMAN project and we have selected these regions to reflect the diversity of regional networks structures in the overarching DAIRYMAN network. Interviews are currently being transcribed, coded and analysed in NVivo9.

Conclusion

Issues of knowledge and learning in the context of sustainable (agricultural) development are complex. Nevertheless, we believe that the presented literature review has offered us some important indications for analysing the DAIRYMAN case. The importance in distinguishing between individual and collective levels of learning, between tacit and explicit forms of knowledge and between instrumental and emancipatory forms of learning, will enable a more thorough analysis. By doing so, we aim to provide an answer to the two following research questions: i) does the DAIRYMAN network support knowledge exchange and what, how and why have participants learned? and ii) what are the differences in regional networks and has this influenced participants' learning outcomes?

References

Ajzen, I. (1985). From intentions to actions: a theory of planned behavior. Action Control: From Cognition to Behavior 11–39: doi:10.1007/978-3-642-69746-3_2

Argyris, C., & Schön, D. A. (1996). Organizational learning II : theory, method and practice. Addison-Wesley series on Organization Development.

Armitage, D., Marschke, M., & Plummer, R. (2008). Adaptive co-management and the paradox of learning. Global Environmental Change 18(1): 86–98. doi:10.1016/j.gloenvcha.2007.07.002

Bailey, A., Garforth, C., Angell, B., Scott, T., Beedell, J., Beechener, S., & Rana, R. (2005). Helping farmers adjust to policy reforms through demonstration farms: lessons from a project in England. In IFMA 15th Congress - Developing Entrepreneurship Abilities to Feed the World in a Sustainable Way (pp. 59–68). Campinas: SP.

Bergevoet, R. H. M., Ondersteijn, C. J. M., Saatkamp, H. W., Van Woerkum, C. M. J., & Huirne, R. B. M. (2004). Entrepreneurial behaviour of dutch dairy farmers under a milk quota system: goals, objectives and attitudes. Agricultural Systems 80(1): 1–21. doi:10.1016/j.agsy.2003.05.001

Blackmore, C. (2007). What kinds of knowledge, knowing and learning are required for addressing resource dilemmas?: a theoretical overview. Environmental Science and Policy 10(6): 512–525. doi:10.1016/j.envsci.2007.02.007

Brown, J. S., & Duguid, P. (2001). Knowledge and organisation: a social-practice perspective. Organization Science 12(2): 198–213. doi:10.1287/orsc.12.2.198.10116

Collins, H. (2010). Tacit and Explicit Knowledge. Chicago and London: The University of Chicago Press.

Curry, N., & Kirwan, J. (2014). The role of tacit knowledge in developing networks for sustainable agriculture. Sociologia Ruralis 54(3): 341–361. doi:10.1111/soru.12048

Darnhofer, I., Bellon, S., Dedieu, B., & Milestad, R. (2010). Adaptiveness to enhance the sustainability of farming systems. A review. Agronomy for Sustainable Development 30(3): 545–555. doi:10.1051/agro/2009053

De Laat, M., & Simons, R. J. (2002). Collective learning: theoretical perspectives and ways to support networked learning. European Journal of Vocational Training 27: 13–24.

Elkjaer, B. (2003). Social learning theory: learning as participation in social processes. In M. Easterby-Smith and M. A. Lyles (Eds.), The Blackwell Handbook of Organizational Learning and Knowledge Management (pp. 38–53). Blackwell Publishing.

Eshuis, J., & Stuiver, M. (2005). Learning in context through conflict and alignment: farmers and scientists in search of sustainable agriculture. Agriculture and Human Values 22(2): 137–148.

EU SCAR. (2012). Agricultural knowledge and innovation systems in transition - a reflection paper. Brussels.

FAO. (2014). SAFA (sustainability assessment of food and agriculture systems) guidelines - Version 3.0. Retrieved from http://www.fao.org/3/a-i3957e.pdf

Galan, M. B., Peschard, D., & Boizard, H. (2007). ISO 14 001 at the farm level: analysis of five methods for evaluating the environmental impact of agricultural practices. Journal of Environmental Management 82(3): 341–352. doi:10.1016/j.jenvman.2006.06.025

Gerrard, C., Smith, L., Pearce, B., & Padel, S. (2012). Public goods and farming. In E. Lichtfouse (Ed.), Farming for Food and Water Security (p. 278).

Hall, J., & Pretty, J. (2008). Then and now: Norfolk farmers' changing relationships and linkages with government agencies during transformations in land management. Journal of Farm Management 13(6): 393–418.

Hermans, F. L. P., Haarmann, W. M. F., & Dagevos, J. F. L. M. M. (2011). Evaluation of stakeholder participation in monitoring regional sustainable development. Regional Environmental Change 11(4): 805–815. doi:10.1007/s10113-011-0216-y

Klerkx, L., Aarts, N., & Leeuwis, C. (2010). Adaptive management in agricultural innovation systems: the interactions between innovation networks and their environment. Agricultural Systems 103(6): 390–400. doi:10.1016/j.agsy.2010.03.012

Klerkx, L., & Jansen, J. (2010). Building knowledge systems for sustainable agriculture: supporting private advisors to adequately address sustainable farm management in regular service contacts. International Journal of Agricultural Sustainability 8(3): 148–163. doi:10.3763/ijas.2009.0457

Klerkx, L., & Proctor, A. (2013). Beyond fragmentation and disconnect: networks for knowledge exchange in the English land management advisory system. Land Use Policy 30(1): 13–24. doi:10.1016/j.landusepol.2012.02.003

Klerkx, L., Van Mierlo, B., & Leeuwis, C. (2012). Evolution of systems approaches to agricultural innovation: concepts, analysis and interventions. In Farming Systems Research into the 21st Century: The New Dynamic (pp. 457–483). doi:10.1007/978-94-007-4503-2_20

Kroma, M. M. (2006). Organic Farmer Networks: Facilitating Learning and Innovation for Sustainable Agriculture. Journal of Sustainable Agriculture, 28(4), 5–28.

Lankester, A. J. (2013). Conceptual and operational understanding of learning for sustainability: a case study of the beef industry in north-eastern Australia. Journal of Environmental Management 119: 182–93. doi:10.1016/j.jenvman.2013.02.002

Leeuwis, C., & Pyburn, R. (2002). Social learning in rural resource management: Introduction to the book. In C. Leeuwis and R. Pyburn (Eds.), Wheelbarrows Full of Frogs: Social Learning in Rural Resource Management (pp. 11–21). The Netherlands: Royal Van Gorcum.

Leonard, D., & Sensiper, S. (1998). The role of tacit knowledge in group innovation. California Management Review 40(3): 112–132. doi:10.2307/41165946

Leys, A. J., & Vanclay, J. K. (2011). Social learning: a knowledge and capacity building approach for adaptive co-management of contested landscapes. Land Use Policy 28(3): 574–584. doi:10.1016/j.landusepol.2010.11.006

Marschke, M., & Sinclair, A. J. (2009). Learning for sustainability: participatory resource management in Cambodian fishing villages. Journal of Environmental Management 90(1): 206–216. doi:10.1016/j.jenvman.2007.08.012

Martin, L. (2015). Incorporating values into sustainability decision-making. Journal of Cleaner Production 105: 146–156. doi:10.1016/j.jclepro.2015.04.014

McKellar, K. A., Pitzul, K. B., Yi, J. Y., & Cole, D. C. (2014). Evaluating communities of practice and knowledge networks: a systematic scoping review of evaluation frameworks. EcoHealth 11(3): 383–399. doi:10.1007/s10393-014-0958-3

Morgan, K., & Murdoch, J. (2000). Organic vs. conventional agriculture: knowledge, power and innovation in the food chain. Geoforum 31(2): 159–173. doi:10.1016/S0016-7185(99)00029-9

Moschitz, H., & Home, R. (2014). The challenges of innovation for sustainable agriculture and rural development: integrating local actions into European policies with the reflective learning methodology. Action Research 12(4): 392–409. doi:10.1177/1476750314539356

Moschitz, H., Roep, D., Brunori, G., & Tisenkopfs, T. (2015). Learning and innovation networks for sustainable agriculture: processes of co-evolution, joint reflection and facilitation. The Journal of Agricultural Education and Extension 21(1): 1–11.

Nicolini, D., & Meznar, M. B. (1995). The social construction of organisational learning: conceptual and practical issues in the field. Human Relations 48(7): 727–746. doi:10.1177/001872679504800701

Nonaka, I., & Takeuchi, H. (1995). Introduction to knowledge in organizations. In The Knowledge-Creating Company (pp. 3–19). doi:10.1016/B978-0-7506-9718-7.50003-2

Novo, A., Jansen, K., & Slingerland, M. (2015). The novelty of simple and known technologies and the rhythm of farmer-centred innovation in family dairy farming in Brazil. International Journal of Agricultural Sustainability 13(2): 135–149. doi:10.1080/14735903.2014.945320

Oenema, J., Koskamp, G. J., & Galama, P. J. (2001). Guiding commercial pilot farms to bridge the gap between experimental and commercial dairy farms; the project "Cows & Opportunities." NJAS - Wageningen Journal of Life Sciences 49(2-3): 277–296. doi:10.1016/S1573-5214(01)80011-7

Oreszczyn, S., Lane, A., & Carr, S. (2010). The role of networks of practice and webs of influencers on farmers' engagement with and learning about agricultural innovations. Journal of Rural Studies 26(4): 404–417. doi:10.1016/j.jrurstud.2010.03.003

Parson, E. A., & Clark, W. C. (1995). Sustainable development as social learning: theoretical perspectives and practical challenges for the design of a research program. In L. H. Gunderson, C. S. Holling and S. S. Light (Eds.) Barriers and Bridges to the Renewal of Ecosystems and Institutions (pp. 428–460). New York: Columbia University Press

Polanyi, M. (1966). The Tacit Dimension. New York: Doubleday.

Purcell, D., & Anderson, J. (1997). Agricultural extension and research: achievements and problems in national systems. The World Bank, Washington DC, USA.

Reed, M. S., Evely, A. C., Cundill, G., Fazey, I., Glass, J., Laing, A., … Stringer, L. C. (2010). What is social learning? Ecology and Society 15(4): doi:Article

Schneider, F., Steiger, D., Ledermann, T., Fry, P., & Rist, S. (2012). No-tillage farming: co-creation of innovation through network building. Land Degradation and Development 23(3): 242–255.

Sinclair, A. J., Diduck, A., & Fitzpatrick, P. (2008). Conceptualising learning for sustainability through environmental assessment: critical reflections on 15 years of research. Environmental Impact Assessment Review 28(7): 415–428. doi:10.1016/j.eiar.2007.11.001

Sligo, F. X., & Massey, C. (2007). Risk, trust and knowledge networks in farmers' learning. Journal of Rural Studies 23(2): 170–182. doi:10.1016/j.jrurstud.2006.06.001

Sol, J., Beers, P. J., & Wals, A. E. J. (2013). Social learning in regional innovation networks:

trust, commitment and reframing as emergent properties of interaction. Journal of Cleaner Production 49: 35–43. doi:10.1016/j.jclepro.2012.07.041

Spielman, D. J., Davis, K., Negash, M., & Ayele, G. (2011). Rural innovation systems and networks: findings from a study of Ethiopian smallholders. Agriculture and Human Values 28(2): 195–212.

Triste, L., Marchand, F., Vandenabeele, J., Debruyne, L., Coteur, I., & Lauwers, L. (2016). Approaching initiatives stimulating sustainable farming as characteristics of learning practices. In T. Aenis, A. Knierim, M.-C. Riecher, R. Ridder, H. Schobert, and H. Fischer (Eds.) Farming Systems Facing Global Challenges: Capacities and Strategies. Volume 1. Proceedings of the 11th European IFSA Symposium, 1-4 April 2014 in Berlin, Germany (pp. 69–78). IFSA Europe, Leibniz-Centre for Agricultural Landscape Research (ZALF), Humboldt-Universität zu Berlin.

van den Ban, A. (2002). Poverty alleviation among farmers: the role of knowledge. In C. Leeuwis and R. Pyburn (Eds.) Wheelbarrows Full of Frogs: Social Learning in Rural Resource Management (pp. 183–196). The Netherlands: Koninklijke Van Gorcum.

Van Poeck, K., & Vandenabeele, J. (2012). Learning from sustainable development: education in the light of public issues. Environmental Education Research 18(4): 541–552. doi:10.1080/13504622.2011.633162

Vare, P., & Scott, W. (2007). Learning for a change: exploring the relationship between education and sustainable development. Journal of Education for Sustainable Development 1(2): 191–198. doi:10.1177/097340820700100209

Wals, A. E. J. (2011). Learning our way to sustainability. Journal of Education for Sustainable Development 5(2): 177–186. doi:10.1177/097340821100500208

Wals, A. E. J., & Corcoran, P. B. (2012). Re-orienting, re-connecting and re-imagining: learning-based responses to the challenge of (un)sustainability. In A. E. J. Wals and P. B. Corcoran (Eds.) Learning for Sustainability in Times of Accelerating Change (pp. 21–32). Wageningen Academic Publishers, The Netherlands.

Wals, A. E. J., Geerling-Eijff, F., Hubeek, F., van der Kroon, S., & Vader, J. (2008). All Mixed Up? Instrumental and emancipatory learning toward a more sustainable world: considerations for EE policymakers. Applied Environmental Education & Communication 7(3): 55–65. doi:10.1080/15330150802473027

Wals, A. E. J., & van der Leij, T. (2009). Introduction. In A. E. J. Wals (Ed.) Social Learning Towards a Sustainable World (pp. 17–32). The Netherlands: Wageningen Academic Publishers.

Wenger, E., Trayner, B., & De Laat, M. (2011). Promoting and assessing value creation in communities and networks: a conceptual framework. Ruud de Moor Centrum (18): retrieved from http://www.open.ou.nl/rslmlt/Wenger_Trayner_DeLaat_Value_creation.pdf

Wood, B. A., Blair, H. T., Gray, D. I., Kemp, P. D., Kenyon, P. R., Morris, S. T., & Sewell, A. M. (2014). Agricultural science in the wild: a social network analysis of farmer knowledge exchange. PLoS ONE 9(8): doi:10.1371/journal.pone.0105203

Zahm, F., Viaux, P., Vilain, L., Girardin, P., & Mouchet, C. (2008). Assessing farm sustainability with the IDEA method from the concept of agriculture sustainability to case studies on farms. Sustainable Development 16: 271–281. doi:10.1002/sd.380

University research enters practice – and is enhanced by farmers. A precision farming case study

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Abstract: This paper describes the case of a Precision Farming technology, the Yara N-Sensor. This successful university research based innovation is more than 15 years old and has been supplemented by two modules which have been co-developed by farmers. Today the optical crop sensor is used for site-specific nitrogen, growth regulator and fungicide application deriving optimum site-specific application rates which are sent to the spreader or sprayer. The most important impacts of the N-Sensor are efficient use of inputs, higher yields and a better harvesting performance. We trace the innovation's impact pathway from the initial research proposal to the current adoption on an estimated 700,000 hectares (ha) of agricultural land in Germany. Based on a dissertation project running from 1994 to 1996 at the University of Kiel, the innovation was brought into practice by Yara, a mineral fertiliser producer, in 1999. It has since been constantly enhanced, not only by Yara but also by a German SME named AgriCon. The latter company is responsible for sales and marketing in Germany and became a co-developer of the sensor through the development of the two additional modules together with farmers. For the case of the YARA N-sensor, we detect enabling factors and barriers for innovation. Based on these results we draw conclusions on what we can learn from the presented case on how to foster the innovation diffusion and related knowledge co-production and learning processes. Closeness and proximity to farmers seems a key factor in this respect.

Keywords: Impact pathway, precision farming, knowledge co-production, transdisciplinarity, multi-actor networks, learning networks, interactive innovation

Introduction

In recent years the Common Agricultural Policy (CAP) and Horizon 2020 have put renewed emphasis on agricultural research and innovation. At the same time there is a broad variety of Agricultural Knowledge and Innovation Systems across Europe (Knierim et al., 2015). In all these systems research based innovations need to find their way into practice and there will be no one ideal solution on how this works best in different systems. We can however learn from innovations which are today successfully applied by tracing back their impact pathways and detect enabling and disabling factors.

The EU FP7 project 'Impact of Research on EU Agriculture' (IMPRESA) intends to measure, assess and comprehend the impact of all forms of European sustainable research on achieving key agricultural policy goals, including farm level productivity but also environmental enhancement and the efficiency of agri-food supply chains. One activity to rise to this challenge was carrying out studies on a small number of cases of mature research based innovations.

One of these studies was conducted on a precision farming technique in crop production, the Yara N-Sensor. The optical crop sensor for nitrogen application was initially developed at the

German University of Kiel at the end of the 1990s. It was produced and has been constantly enhanced by the company Yara. In Germany, and nowadays a number of other countries, it is supplied by the spin-off company Agricon. Based on self-driven tests and experiments by farmers Agricon co-developed two additional N-Sensor modules for applications to growth regulators and fungicides (Figure 1). In Germany the N-sensor is currently used by around 730 farmers on around 700,000 ha UAA (Utilised Agricultural Area), with a main area of distribution on farms with more than 500 ha.

The paper starts with an outline of the case. We then describe the IMPRESA methodology and in the following section its application to the case. We will describe the impact pathway and show enabling and disabling factors. Based on these results we draw conclusions on what we can learn from the presented case on how to foster the innovation diffusion and related knowledge co-production and learning processes.

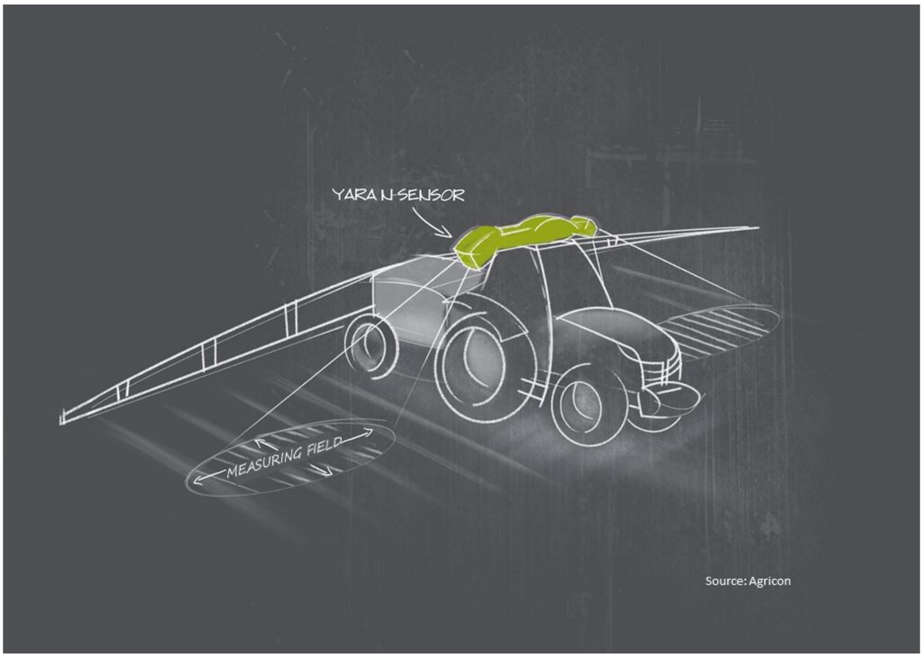

Figure 1. N-Sensor application of the additional module for crop protection.

The case: the Yara N-Sensor

In this section we will present the story line of the N-Sensor from initial research activities, describe its market entry and briefly outline the current situation.

Initial research activities

The optical sensor is based on a dissertation project within the Institute of Agricultural Engineering of the University of Kiel, where it was part of the Collaborative Research Centre (Sonderforschungsbereich) 192 'Optimisation of crop production systems' and thus funded by the DFG, the German Research Foundation (Heege, 1994). The intended research activities were carried out by a doctoral student who had been recruited from the Department of Physics at the same university.

In 1996 project results were presented at different meetings and conferences, raising the interest in Yara, formerly known as Norsk Hydro. At that time, Yara (Norsk Hydro) already had a tool for testing the N-content of a plant on the spot, the N-Tester. Like the sensor it is an optical tool which measures the chlorophyll content of the leaf in order to give fertilising recommendations. The tester can be considered as a proof of principle raising the interest in Yara to develop an easier way for users to receive more specific fertilising recommendations for more than one plant at the same time and apply them on the go. Yara approached the University project team and offered a job to the doctoral student at its R&D Centre in Germany, which he accepted after finishing his thesis in 1997 (Reusch, 1997).

Product development ran from 1997 to 1999 at Yara based on the results of the research project described above.

The innovation enters the market

When the first prototypes were presented a young German start-up, Agricon, approached Yara and acquired the distribution rights. Since then Yara has worked continuously on the adaptation and development of algorithms and control functions, as well as further technical developments, while Agricon cares for sales and marketing activities in Germany. In addition both carry out field trials. Besides these Yara’s direct contact with farmers is rather limited, while Agricon established a close contact with farmers as part of their marketing activities. Together with farmers they continuously work on the development of additional precision farming solutions. The company is located in Saxony and Agricon’s other branch, soil sampling, has led to various contacts with Eastern German crop farmers managing more than 1000 ha of agricultural land. As a marketing strategy the company concentrated on these in the beginning and promoted the pioneers as role models for others.

While the adoption process in Eastern Germany started with the market entry, the number of sensors sold in Western Germany has increased considerably since 2008. In 2008 prices for inputs started to increase which served as an entry point to the N-Sensor on Western German farms (Figure 2).

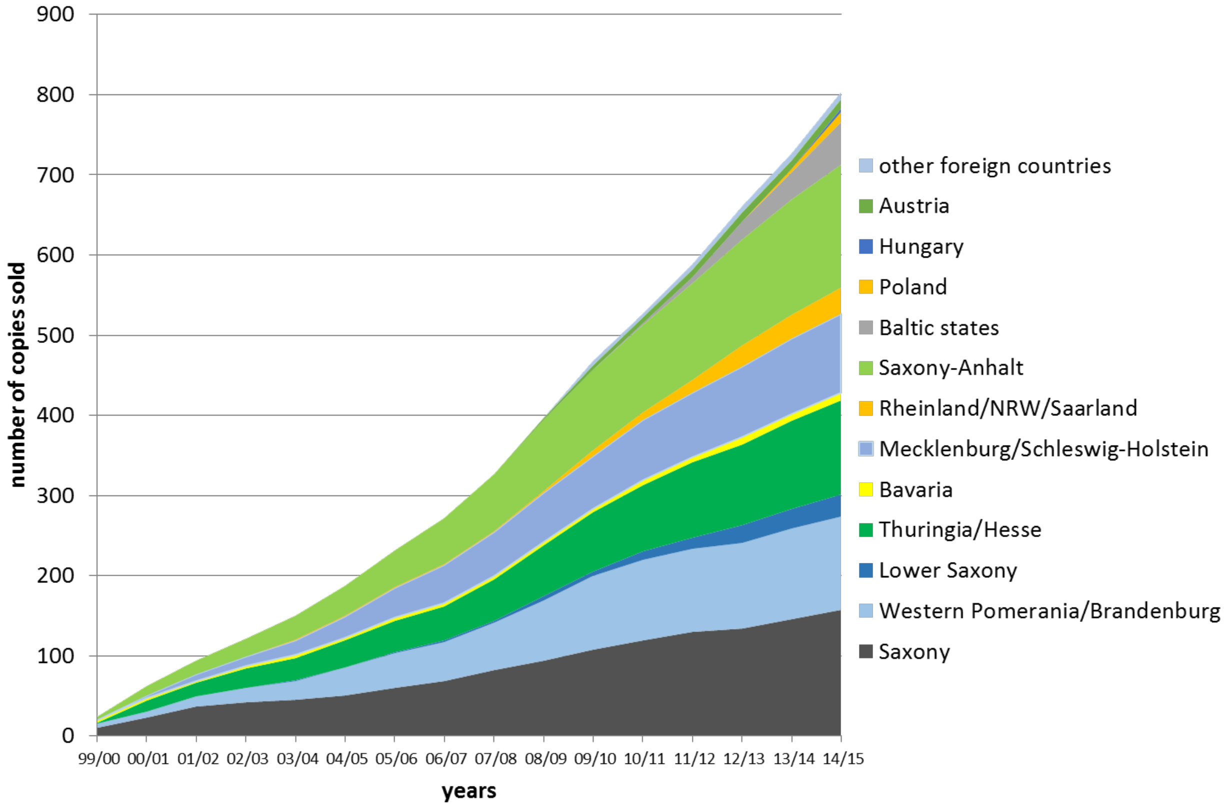

Figure 2. Cumulated sales figures from 1999-2015 for Germany and other countries in which Agricon is distributing the N-Sensor (Authors' illustration)**.**

Today's situation

Currently 1500 copies of the N-Sensor have been sold worldwide (800 by Agricon) - 713 of these are used in Germany, the rest have been purchased by farms in Austria and Eastern European countries where Agricon currently develops a market (Figure 2).

Within our case study we carried out a user survey. On average users are 50 years old (range 16 to 68). Three quarters of them graduated from universities or applied universities. There are farms with a big field plot size, with up to 10,000 ha being cultivated by one farm. The survey shows that the average farm size of N-sensor users is around 1350 ha, with half of the user farms however having less than 1000 ha.

Most advisory services related to the N-Sensor (and other Precision Farming solutions) are provided by the Agricon company consultants. In some countries a small number of other advisors can be found who are trained in Precision Farming solutions.

How to detect impacts of innovation: the application of IMPRESA's stepwise approach

In the early 2000s the impact pathway method was suggested and applied by different authors mainly from the field of agricultural development cooperation e.g. Douthwaite et al. (2003) and Springer-Heintze et al. (2003). The intention was to better capture remote parts of the traditionally applied logical framework. Douthwaite et al. (2003) proposed that the project participants themselves draw an impact pathway at the beginning of the project and carry out monitoring and later ex post impact assessment, with the impact pathway as explicit theory of how the project will achieve impact. This is *"particularly useful in view of the new perspective* *on impact, which conceptualises technical change in agriculture as a complex process involving feedback loops, and interactions between social, cultural and biophysical systems*" (Briones et al., 2004 p. 561). If drawn when setting up the project the pathway will make explicit intended outcomes and impact, which serve as a basis for setting up indicators. These can be measured in the course of the project. During the project's lifetime the impact pathway will evolve and gain complexity, but stakeholders as 'owners' of the impact pathway will be able to follow it easily. Carrying out the ex post impact assessment the evaluator is supposed to establish plausible links between the project's impact pathway and subsequent changes (Douthwaite et al., 2006). Within the IMRESA project we tested the transfer to ex post impact assessment of agricultural research projects and followed a case study approach in order to reconstruct the impact pathway of a research-based innovation. A stepwise approach was elaborated which was applied for all of the six case study regions (Stigler et al., 2014).

In the German case, research work was organised along the steps which were adjusted case-specifically, reflecting the availability of actors, literature and data, etc. An initial screening comprised a review of literature on adoption and impacts of the N-Sensor as well as explorative in-depth interviews with experts in the field of Precision Farming (PF). We then started with the process of impact pathway building based on literature and semi-structured interviews with key stakeholders. The 'Sectoral Study on the Analysis of the Innovation System of the German Agriculture' conducted by Bokelmann et al. between 2010 and 2012, published in 2012, was of special help. With financial support from the Federal Institute for Agriculture and Nutrition the project consortium analysed a broad set of literature, interviewed experts and held Delphi-rounds and expert workshops (Bokelmann et al., 2012). Adding to that, we analysed in our case study a broad set of literature specifically on the effects of the N-Sensor and carried out our own interviews with key stakeholders. In order to evaluate the impacts, we carried out a full user survey and held a workshop with farmers, advisors, product and sales managers. The impact pathway was drafted by the case study team first and then reflected with stakeholder and expert judgement (via interviews, survey and workshops). This deviation from Douthwaite's methodology was necessary as our work collided with the field work peaks of farmers, but was justifiable due to the good set of available literature both on the innovation system and the effects of the N-Sensor, as well as the available project documentation in combination with the in-depth interviews. Each link of the pathway was tested against counterfactual reasoning (if it wasn't for the sensor, would it have occurred) and strong links were made visible graphically by use of more width and colours (Figure 3). The pathway reflection led to crossing out of elements if the attribution to the innovation was not confirmed.

The impact pathway of the Yara N-Sensor and its enabling and disabling factors

The impact pathway was drawn alongside the story of the N-Sensor and was drafted chronologically in earlier versions. In order to allow better readability, it was then rearranged along the traditional linear causal chain from output to impact, the so-called logical framework. It becomes obvious that there are multiple interlinkages between the different pathway elements, underlining the often voiced criticism against the linear chain (Douthwaite et al., 2003).

We present the results of the pathway according to the impacts we were able to confirm. We then give an overview on enabling factors and barriers influencing the impact pathway.

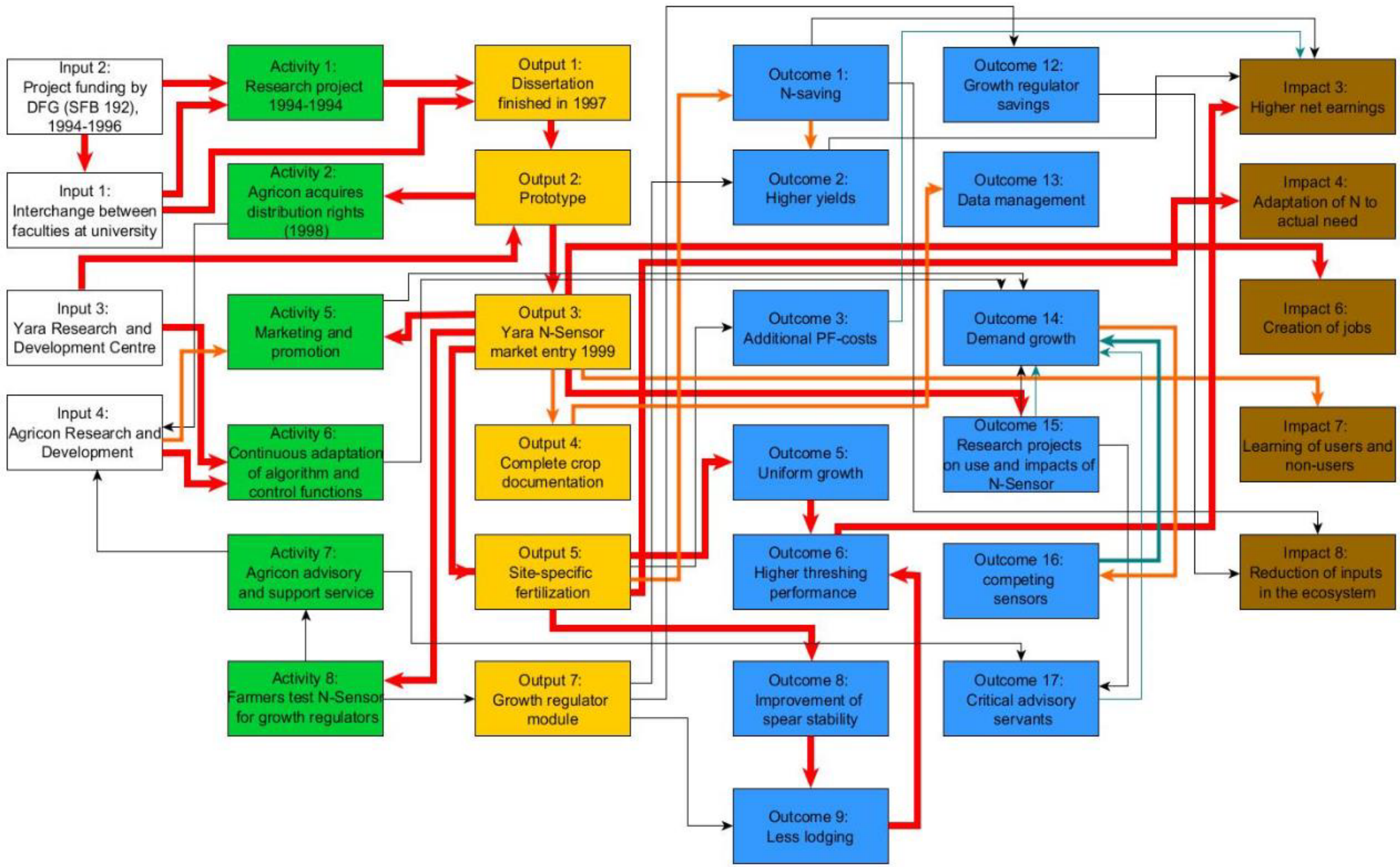

Figure 3. Impact Pathway of the N-Sensor. The strength of the arrows and the colour shows the contribution of the research to the respective link (black is weak, orange is medium, red is strong).

Impacts of the N-Sensor

There is a broad set of literature available on the effects and impacts of the N-Sensor. While Agricon continuously carries out its own field trials in order to gain more insights into the effects of the N-Sensor and thus be able to use them as selling arguments, universities, consulting companies and advisory services also show an increasing interest in finding out if, and in what way, fertilising was improved by the use of the N-Sensor. The minimum design of those studies is an annually repeated testing of N-Sensor fertilising compared with standard fertilising on a number of plots.

Early studies (Wenkel et al., 2002; Lenge, 2003; Rademacher, 2004; Rösch et al., 2005; Feiffer et al., 2005) show impressive effects of the use of the sensor in terms of N-savings in comparison to standard fertilising. For winter wheat for instance, the amount of fertiliser used is reduced by between 2 to 18% (Rösch et al., 2005 p103). Wenkel et al. (2002 p. 258) report 14 kg/ha which equals 7% reduction of N-fertiliser. Rademacher (2004 p. 198f) shows a saving of 14 kg/ha with a small loss of yields between 0.7 and 4 dt/ha. On the other hand Reckleben and Isensee (2005), Rösch et al. (2005) and Feiffer et al. (2005) detect an increase in yields: Feiffer et al. (2005 p.117f) report 7% higher yields with 14% less N-savings. These results are supported by the user survey, which was conducted in the frame of the IMPRESA study. Most of the users report N-savings. Nonetheless, there is a need to differentiate between different crops, because for some crops high N- savings can be observed, while for others these may be negligible (workshop statement).

In general it can be stated that site-specific fertilising leads to the adaptation of N to the actual need of the plants (Pahlmann, 2011). The results however depend very much on land and weather conditions: if there is extreme dry weather or if there are dry areas with low groundwater conditions, there is a threat of over-fertilisation (Kock, 2013; Schliephake, 2007; Schneider & Wagner, 2007; Rösch et al., 2005). The workshop attendees point out that although the N-Sensor is used the farmer still needs to apply his agronomic knowledge and has to calibrate the sensor according to conditions. Agricon tries to provide support, especially on the need to take weather conditions into account, by sending out regular newsletters to all users.

After first harvesting periods, combine harvester drivers reported that harvesting was easier in stocks which had been fertilized with the N-Sensor. Based on these observations the Harvest Pool carried out studies and found that stocks show a more uniform growth (Feiffer et al., 2005). In addition the spear stability is increased leading to less lodging (Feiffer et al., 2005, also reported by Lenge, 2003). Improvement of spear stability, less lodging and uniform growth lead to a higher harvesting performance. A performance increase of 15-20% for different crops was reported. At the same time, a broader harvest window of around 5 days more time for harvesting was observed. In the user survey we conducted, user statements validated the better harvesting performance (82%), whereas the broader harvest window was not observed by users (71% state there was no change, while 8% observe a slightly broader and 8% a slightly smaller harvest window).

In the impact pathway logic, the application of the N-Sensor for site-specific fertilising has led to the outcomes harvesting performance, N-savings and higher yields which contribute positively to the impact ‘higher net earnings’. Investments for the N-Sensor start at about 26,000€ for the N-Sensor and 39,700€, for the ALS. Additional costs may comprise investments in machinery as a prerequisite for the use of the sensor (e.g. a new fertiliser spreader), as well as maintenance and advisory services (Kock, 2013 calculates an additional 5-13€/ha in comparison to standard fertilising for winter rapeseed and winter barley). As with every investment in agricultural machinery, these costs have to be taken into account when calculating the net income. According to Agricon, 100 ha of land for N-Sensor use is the current threshold at which the purchase of the machine is worthwhile.

Research on the effects is being carried out continuously; nowadays the results are more moderate. Agricon officials assume that there has been a learning process for users: the effects are measured in comparison to constant N-fertilising and it is hypothesised that test farmers have adjusted constant fertilising due to experiences with the N-Sensor ; the workshop participants supported this assumption. Due to the fact that the N-Sensor and also other sensors exist, farmers, even if they are not using a sensor, have hinted at the fact that it might be profitable to adjust the N-application to the actual plant and soil conditions. Publications in farmers' magazines but also discussions between farmers have broadened the mind-set and led to a more site-, weather- and soil- specific thinking instead of following fixed fertilising scemes. Besides the fact that there is the impact 'adaptation to the actual need of the plant', we can conclude the impact 'learning of users and non-users', i.e learning of adopters and those who have not (yet) bought a sensor.

Since 2006 several enhancements have been made. Yara launched the N-Sensor ALS (Active Light Source), which worked in a similar way as the classic N-Sensor but has its own built in light source (Xenon flash lamps) enabling sensor operation independent from ambient light conditions. In the late 2000s some farmers tested other uses of the N-Sensor, first on growth regulators then on fungicides. All of these experimenting farmers had a long client relationship with Agricon. Their problem-oriented research was crucial for the development of the module or as one farmer put it: "*we pushed Agricon to take up our own trials with growth regulators and develop a module for it*". Based on farmers' positive results Agricon developed the module for the sensor. The additional application entered the market in 2008. Leithold & Volk (2007), Volk et al. (2012) and Volk (2015) report higher yields and less lodging, both outcomes contributing to a higher net income. In addition, they report a reduction of use of growth regulators, which is supported by the survey we conducted. Together with the N-savings we therefore summarised as an impact 'reduction of inputs in the ecosystem'.

The development of and continuous work on the Yara N-Sensor has led to the creation of jobs. The precise number can only be estimated. Interviewees and workshop attendees estimated that around 50 jobs have been created.

There are two environmental impacts, which we hypothesised resulting from the site-specific fertilising and N-saving: the project proposal (Heege, 1994) intended to contribute to higher groundwater quality due to reduced nitrate leakage; in addition, Pahlmann (2011) found a reduction in greenhouse gas emissions if used for the production of rapeseed biodiesel. Both impacts were ruled out by the workshop as they were hard to detect, not really measurable and attributable to the N-Sensor and depending very much on soil conditions.

Enabling factors within the impact pathway

In our case, the most important factor for the development of innovations and their adoption seems to be knowledge exchange: between disciplines, between science and industry, between the sales company and customers, i.e. farmers, and between farmers themselves.

The intra-university exchange between disciplines, agricultural engineering, crop sciences but also physics laid the foundation for the successful project. After the first prototype had been developed contact opportunities like fairs and exhibitions as well as conferences were crucial in order to spread the idea and bring scientific knowledge into practice. Meanwhile networks between science and industry have established: Agricon for example seeks direct contact to scientists and works together with them in different networks and projects or provides information if there are requests for support or knowledge. It is thus able to keep up with developments in the field and can react to findings.

Exchange with and between farmers seems of special relevance. Agricon has an elaborated marketing and sales plan in which around three quarters of activities focus on direct contact and exchange with a special focus on peer-to-peer contact and information. They organise, for example, regular meetings between users, seminars for drivers, hold webinars etc. The advisory services of Agricon helped to establish contact with both experimental and 'lighthouse' farmers, for whom Agricon sets the scene e.g. as testimonials in farmers' magazines. The IMPRESA survey showed that the buying decision was strongly influenced by exchange with other farmers such as neighbours or other colleagues. Sixty-two percent of the users had recommended the N-Sensor to other farmers, 42% even demonstrated the N-Sensor to others. In addition, experimenting farmers frequently exchanged information informally and thus pushed each other into testing and improving new ways of application leading to the two modules.

Around 750 copies of the N-Sensor have been sold in Germany. Based on interview statements and our own survey we assume that nearly all of the big farms cultivating more than 1000 ha in Germany have at least one sensor. The adoption of the N-Sensor seems to exemplify the hypothesis of Bokelmann et al. (2012) stating the capacity to innovate correlated with the size of the farms: larger farms have the financial resources for the considerable investment; in addition, the return on investment is higher the more hectares are being cultivated; and the education level of farm managers of these large Eastern German farms is generally high. The workshop attendees added that due to higher personnel resources, farm managers, or those responsible for crop cultivation, have more time to inform themselves about innovations and they have personnel which can be trained on the use of the machine – in contrast to most farm managers in Western Germany who often run one-man companies. Smaller farms on which the N-Sensor was adopted are often run by well-trained, prospective thinking farmers who have a technical interest. They are often part of the tinkering or experimenting farmers who bring about incremental innovations (Bokelmann et al., 2012).

While the adoption process in Eastern Germany started with the market entry, the number of sensors sold in Western Germany has increased considerably since 2008. Interviewees and workshop attendees hinted at the fact that prices for inputs started to increase in that time, so there seems to be a direct influence of market prices and margin calculations – making the prospective return on investment more attractive for smaller farms too. This is reflected in our survey, in which half of the farms cultivate less than 1000 ha and 30% less than 500 ha, illustrating that the N-Sensor is increasingly of interest to comparatively smaller farms. On the other hand, experts hint at the fact that the investment behaviour of farmers is volatile and may change from year to year.

The adoption process is also influenced by the respective innovation system. Though criticism has been voiced against Roger's theory (e.g. Robertson et al., 1996) we still borrow his two definitions of heterophilous and homophilous innovation systems (Rogers, 1962 quoted after Stigler et al., 2014), as they are helpful in our context and case. In heterophilous systems, changes from system norms are encouraged. The continuous manifold interactions between people from different backgrounds create a space for new inputs. In these systems change agents can focus on targeting 'the most elite and innovative opinion leaders and the innovation will trickle down to non-elites. If an elite opinion leader is convinced to adopt the innovation, the rest are going to adopt it. The domino effect begins with enthusiasms rather than resistance" (Stigler et al., 2014 p. 47). Examples of heterophilous systems seem to be Saxony and the Rhineland. The opposite are homophilous systems which tend to preserve system norms. Interactions remain mostly between people from similar backgrounds. There is an aversion to innovation as ideas differing from the norm and people thinking outside the box are considered strange and undesirable. Change agents have to focus on a wide group of opinion leaders because in these closed systems it is less likely that innovations or new ideas will find their way to the ground. A homophilous system can be assumed in Schleswig-Holstein. This is also reflected in the research and advisory community: while in Saxony for instance good testing results are achieved and the N-Sensor is advocated by advisors, in Schleswig-Holstein the agricultural chamber, responsible for advisory services there, is involved in research activities showing critical outcomes. Distribution rates in Schleswig-Holstein are accordingly low.

Another enabling factor is the innovation capacity and innovation willingness of farmers, which has increased in the last 20 to 30 years due to the higher education level, the increased market pressure and changing requirements and expectations of society (Bokelmann et al., 2012). Correlating age and year of purchase of the N-Sensor, our survey shows that farms now innovate quicker, i.e. more often than just with a change to the next farmers' generation, as was often the case in the last century.

Barriers

Besides enabling factors in the innovation systems we also found barriers in the impact pathway of the innovation.

One of the most important barriers internally are technical and knowledge-based related problems of farmers with the system. In the IMPRESA survey, 72% of the farmers say that working themselves into the system was moderately laborious and 13% found it very laborious. We even had a small number of farmers answering the survey who had stopped using the sensor and often it was related to the handling of the sensor. In order to use it properly, drivers need additional knowledge on the different application opportunities and the technical features of the sensor. Agricon tries to close the knowledge gap through different dissemination and advisory activities and offers training, but drivers still need the cognitive capacity to be able to operate the machines correctly.

Since its market entry the N-Sensor has been enhanced, and currently more than 100 algorithms, different crops and different forms of application are possible. In addition smart cloud and software solutions have been made available. All of this adds to the complexity for users. In addition farmers need to apply their agronomic knowledge and they have to be able to calibrate the sensor according to (land and weather) conditions. This might be easier for Eastern German farmers who usually have personnel resources and more time to get familiar with a new technique than the typical Western German one-man company or family farm.

If a homophilous innovation system (Rogers, 1962, quoted after Stigler et al., 2014) prevails it may serve as a barrier too. Even if a farmer is located in a heterophiolus innovation system, critical studies and critical advisors may considerably lower interest in adoption. In our survey we found that it took an average of five years from the point of time when a farmer first learned about the N-Sensor until he actually bought a copy of it. During this span of time farmers seek contact with colleagues, they read magazines, some see a presentation, others test it etc. Any critical study, testimonial or remark by an adviser may influence the buying decision, even if these are controversial themselves. In particular, some advisers seem to lag behind in terms of knowledge on new agronomic and Precision Farming developments and prefer to stick to classical pieces of advice.

A future barrier may be the growing share of users which has led to a situation where Agricon has introduced a hotline for farmers who have been dealt with before as preferred customers, being able to contact 'their' Agricon advisor directly whatever question or remark they had. This may lead to the frustrating feeling of being 'downgraded' to a normal customer and may lower the closeness between Agricon and farmers which has proved to be positive for incremental innovations.

Learning from the case

The impact pathway analysis sheds light on impact as (technical) change in agriculture through complex processes and interactions between social, cultural and biophysical systems (Briones et al., 2004 p. 561). The result is a complex impact pathway which has evolved and gained complexity through the project's lifetime, but stakeholders as 'owners' of the impact pathway will be able to follow it easily. We found limitations if applied to ex-post impact assessment of mature innovations. Due to a collision with field work peaks for farmers and other stakeholders we scratched a first version of the impact pathway based on the intended impacts in the proposal, a review of studies on the effects and interviews. Though justifiable from a content perspective (good set of available literature, available project documentation, rich in-depth interviews), it made it difficult for stakeholders to follow the naturally complex pathway of this mature innovation when we finally presented a first version to them. For better readability we rearranged the pathway along the logical framework (which we considered outdated and initially didn't want to have a slightest notion in our pathway). Nevertheless, drawing the impact pathway helped us to take into account a broad range of elements and reflecting, as well as representing in the graph, the manifold links between these.

The analysis of enabling factors and barriers led us to the question of how to create space for innovation and what prerequisites needed to be there in order to foster knowledge co-production processes. One main element might be stimulating the evolvement of heterophilous systems through leveraging continuous manifold interactions between people from different backgrounds. This will create space for new inputs, which in the end encourages changes from system norms. The experiments of the farmers were only taken up by Agricon because of the close personal contact to these farmers. There was so little distance between the two parties that farmers felt able to push Agricon to take up their trials and on the other side Agricon had enough trust in the abilities and knowledge of these farmers to rely on their tests and initiate the development of the two modules. Thus we can conclude in line with Bokelmann et al. (2012), referring to Koschatzky (2001), that close proximity and socio-cultural networks help to reduce uncertainties in the innovation process, which is especially valid for complex technologies. The success and high innovation capacity of SMEs like Agricon is based on the strong integration in rural networks and their closeness to customers.

In addition, the case illustrates the need for independent advisors. They can play a key role in mainstreaming Precision Farming inventions like the N-Sensor and thus helping it to become an innovation, i.e. a new practice which is widely accepted. Our case illustrates the current situation (cp. EIP AGRI FG Precision Farming, 2015) that Precision Farming technology transfer is mostly left to private, often company consultants like Agricon. These pieces of advice, however, will always be conflicting with their own marketing agenda. Advisers need appropriate training and knowledge on Precision Farming solutions in order to be able to perceive the potential to improve advisory services by improving management and the efficient use of resources and help farmers to set up the most appropriate farm management system causing as little frustration as possible (ibid.).

There needs to be continuous exchange and communication at various levels: between disciplines at university level; between science and industry, etc. Of particular relevance is regular and close contact to users with communication as equals. All of these communication processes require time, opportunity and communication skills, but in the end they will broaden the mind-set and foster interactive innovation.

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References

Bokelmann, W., Doernberg, A., Schwerdtner, W., Kuntosch, A., Busse, M., König, B., Siebert, R., Koschatzky, K., & Stahlecker, T. (2012). Sektorstudie zur Untersuchung des Innovationssystems der deutschen Landwirtschaft. Retrieved from: edoc.hu-berlin.de, URN: urn:nbn:de:kobv:11-100202400.

Briones, R., Dey, M.M, Ahmed, M., Stobutzki, I., Prein, M., & Acosta, B.O. (2004). Impact pathway analysis for research planning: the case of aquatic resources research in the WorldFish Center. NAGA, WorldFish Center Quarterly 27(3&4): 51-55

Douthwaite, B., Kuby, T., van de Fliert, E., & Schulz, S. (2003): Impact pathway evaluation: an approach for achieving and attributing impact in complex systems. Agricultural Systems 78(2): 243-265

Douthwaite, B., Schulz, S., Olanrewaju, A. S., & Ellis-Jones, J. (2007): Impact pathway evaluation of an integrated *Striga hermonthica* control project in Northern Nigeria. Agricultural Systems 92: 201-222.

EIP AGRI Focus Group Precision Farming (2015, Nov): Final Report, retrieved from: https://ec.europa.eu/eip/agriculture/en/content/mainstreaming-precision-farming.

Feiffer, A., & Feiffer, P. (2005): Optimierung des Verfahrens Mähdrusch - Maßnahmen vor der Ernte. Homogene Bestände steigern den Gewinn. In A. Feiffer, P. Feiffer, W. Kutschenreiter and T. Rademacher (Eds.) Getreideernte - Sauber, Sicher, Schnell. Ein Ratgeber Rund um den Mähdrusch pp. 116-128. Frankfurt am Main: DLG-Verlag.

Knierim, A., Boenning, K., Caggiano, M., Cristóvão, A., Dirimanova, V., Koehnen, T., Labarthe, P., & Prager, K. (2015). The AKIS concept and its relevance in selected EU member states. Outlook on Agriculture 44(1): 29-36.

Heege, H. J. (1994). Teilprojekt D.6, 1. Folgeantrag zum SFB 192, Universität Kiel (proposal for the second funding period of the Collaborative Research Centre 192).

Kock, C. (2013). Was bringt die teilflächenspezifische N-Düngung wirklich? N-Sensor im praktischen einsatz. Bauernblatt (3): 22-27.

Koschatzky, K. (2001). Networks in innovation research and innovation policy – an introduction. In K. Koschatzky, K.M. Kulicke and A. Zenker (Eds.). Innovation Networks – Concepts and Challenges in the European Perspective pp. 3-23. Heidelberg: Physica-Verlag.

Leithold, P., & Volk, T. (2007). Präziser einsatz von wachstumsreglern. Yara N-sensor bringt wachstumsregler teilflächenspezifisch aus. pflanzenschutz. Getreide Magazin 12 (1): 28–31.

Pahlmann, I., Böttcher, U., & Kage, H. (2011). Teilflächenspezifische N-Düngung im winterraps. In H. Kage and S. Huesmann (Eds.). Acker- und Pflanzenbau. Norddeutsches Marktfruchtforum 2011, 23. und 24. Februa, pp. 39–46, Lübeck, Christian-Albrechts-Universität zu Kiel, (Schriftenreihe des Instituts für Pflanzenbau und Pflanzenzüchtung, 71).

Pößneck, J. (2011): Analysen und Trends. Thema: Precision Farming im Pflanzenbau, Landesamt für Umwelt, Landwirtschaft und Geologie.

Ponitka, J., Pößneck, J. (2009). Precision Farming-Anwendungen. Entwicklung und Erprobung von Algorithmen zur teilflächenspezifischen Düngung (NPK) und des Einsatzes von Fungiziden und Wachstumsreglern, Dresden, Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie (Schriftenreihe des Landesamt für Umwelt, Landwirtschaft und Geologie, 6)

Rademacher, J. (2004). Einflüsse der düngung auf ertrag und mähdrescherleistung. Landtechnik (4): 198-199.

Reckleben, Y. (2003). Ertrags- und proteinunterschiede von weizen bei teilflächenspezifischer bewirtschaftung. Landtechnik (4): 242-243.

Reckleben, Y., & Isensee, E. (2004). Einflüsse auf proteingehalt und ertrag bei getreide. Landtechnik (3):144-145.

Reckleben, Y., & Isensee, E. (2005): Vergleich von sensorsystemen für die n-düngung. landtechnik (3): 138-139.

Reusch, S. (1997). Entwicklung eines reflexionsoptischen Sensors zur Erfassung der Stickstoffversorgung landwirtschaftlicher Kulturpflanzen. Dissertation, Universität Kiel.

Robertson, M., Swan, J., & Newell, S. (1996). The role of networks in the diffusion of technological innovation. Journal of Management Studies 33 (3): 333-359.

Rogers, E. M. (1962). Diffusion of innovations. New York: The Free Press.

Rösch, C., Dusseldorp, M., & Meyer, R. (2005). Precision Agriculture. Moderne Agrartechniken und Produktionsmethoden - ökonomische und ökologische Potenziale. 2. Bericht zum TA-Projekt. Büro für Technikfolgen-Abschätzung beim deutschen Bundestag (Arbeitsbericht, 106), Berlin.

Rösch, C., Dusseldorp, M., & Meyer, R. (2007). Precision Agriculture. Landwirtschaft mit Satellit und Sensor. Frankfurt: Deutscher Fachverlag.

Schneider, M., & Wagner, P. (2007). Wirkungsanalyse der Precision Farming im landwirtschaftlichen Betrieb unter ökonomischen Gesichtspunkten - dargestellt am Beispiel der N-Düngung. In S. Böttinger, L. Theuvsen, S. Rank and M. Morgenstern (Eds) Referate der 27. GIL-Jahrestagung. Gesellschaft für Informatik in der Land-, Forst- und Ernährungswirtschaft e.V. Stuttgart pp. 183-186.

Springer-Heintze, A., Hartwich, F., Henderson, J., Horton, D., & Minde, I. (2003). Impact pathway analysis: an approach to strengthening the impact orientation of agricultural research. Agricultural Systems 78(1): 267-285.

Stigler, M., Quiédevielle, S., & Barjolle, D. (2014). Manual for Case-Studies on Research Impacts' Evaluation. IMPRESA WP3, FIBL Research Institute for Organic Agriculture.

Volk, T. (2015). Lernen, den bedarf zu managen. Wachstumsregler-einsatz. Dossier pflanzenschutz. Agrarmanager (4): 66-68.

Volk, T., Kunick, A., & Leithold, P. (2012). Variabel bleiben. Wachstumsreglereinsatz 2012. Neue Landwirtschaft (2): S. 50–52

Building social capital and promoting participatory development of agricultural innovations through farmer field schools: the Greek experience

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Abstract: More than 25 years after the first implementation of Farmer Field Schools (FFS): there is a rich corpus of evidence that participation in FFS improves farmers' knowledge, skills and competencies. On the other hand several studies converge to show that FFS, by strengthening group action, have the potential to build-up social capital among participants and, thereafter, within local communities. However, it is not yet clear if this social capital is reflected in the levels of knowledge gained by FFS participants and to what extent it promotes farmers' participatory engagement in the process of innovation development. To answer these questions we used between and within-subjects approaches. Data were drawn from facilitators and cotton farmers who participated in an FFS project aimed at the development of competencies in three domains: integrated crop management, farm management and occupational safety. In a first step we developed three measures to assess: the levels of social capital among farmers; the degree to which each participant contributed to the co-production of innovations within the framework of the project and the knowledge gained by farmers. Regression analyses confirmed that the levels of social capital – and especially bonding social capital – do indeed predict both the co-production of innovations by farmers and the levels of knowledge they gain through their participation in FFS. These findings indicate that cultivating social capital among FFS participants is a key element in facilitating the construction of knowledge and the co-evolution of agricultural innovations by farmers, two of the core foci of FFS' approach.

Keywords: Farmer field schools, social capital, innovations, agricultural extension, participatory innovation development, integrated crop management

Introduction

Farmer Field Schools (FFS) were first implemented in Indonesia in 1989 as a way to help rice farmers reduce their reliance on agrochemicals and to promote integrated pest management (Van de Fliert, 1993). In FFS groups of 20-25 farmers meet on a regular basis with an expert (facilitator) to observe, analyse and experiment in real-farm settings. Participants, under the guidance of the facilitator, try to find problems and to solve them using the shared knowledge they construct during the course of FFS. FFS curricula are not strictly mandated thus allowing farmers to self-regulate their learning. The FFS cycle follows the life cycle of the crop (planting to harvesting). Hence participants have the opportunity to deepen their understanding of the wide-ranging and complex factors which affect their crops, as well as to enhance their problem-solving competencies.

As Kenmore (2002) notes, the core aim of FFS is to help farmers increase their analytical skills, improve their decision-making capacities and sharpen their critical thinking skills. FFS philosophy goes beyond traditional models of agricultural knowledge diffusion. The principles of social learning (Pretty & Buck, 2002): transformative learning (Taylor et al, 2012): and experiential learning (Nederlof & Odonkor, 2006) occupy central positions in the FFS approach. Learning in FFS emerges as the output of hands-on experimentation and interactive learning, while farmer-to-farmer learning activities help participants to increase their communication and collaborative skills (Braun & Duveskog, 2008; Van den Berg & Jiggins, 2007; Feder et al., 2004). During the course of FFS, farmers actively participate – both individually and collectively – in the development, implementation and evaluation of time- and context-specific innovations (Charatsari, 2015). This participatory process paves the way for the adoption of innovative technologies, ideas and practices.

Despite the criticism of their ability to reach a wide range of farming communities (Thiele et al., 2001): to attract farmers from all social strata (Simpson & Owens, 2002) and to produce a stable increase in economic gains (Praneetvatakul & Waibel, 2006): FFS remain an effective model in the developing world, where this alternative approach continues to climb in popularity especially among poor farmers (Davis et al., 2012). Research has repeatedly proved that participation in FFS sharpens farmers' specialised knowledge and expertise (Ortiz et al., 2004): strengthens their system thinking skills (Yang et al., 2008): helps them to achieve a more holistic comprehension of the ways farm practices affect crop responses (Dalton et al., 2014) and, consequently, improves their abilities to solve the problems of their crops (Dzeco et al., 2010) and increases their decision-making performance (Yang et al., 2005). As a result FFS participants enjoy higher yields (Cai et al., 2016) and higher incomes (Mutandwa & Mpangwa, 2004).

Interestingly these benefits of FFS extend beyond individual-level frameworks. FFS participants are able not only to apply the knowledge produced and shared within FFS but also to effectively transfer this knowledge to other farmers (Jørs et al., 2016). Moreover participation in FFS is associated with a reduction of agrochemicals use (Tripp et al., 2005) and an increase of social capital within farming communities (Settle & Garba, 2011). In this vein, FFS also have positive environmental and social impacts.

Over time FFS curricula started to incorporate non-farming issues, related to important problems of farming communities in the developing countries such as domestic violence or HIV prevention (Friis-Hansen et al., 2012). In other cases FFS-based approaches like "Farmer Livestock Schools" in Vietnam (Minh et al., 2010) or "Climate Field Schools" in Indonesia (Siregar & Crane, 2011) were designed to address specific needs and/or to target specific population groups. Recently, some successful attempts have also been made in the developed world, like the "East Bay FFS" in San Francisco, U.S.A. (Berman, 2016) and the FFS for cotton and rice producers in Greece (Charatsari, 2015).

Enabling social capital through FFS

Social capital is a concept widely used in many disciplines, from sociology to medicine (Macinko & Starfield, 2001): management sciences (Adler & Kwon, 2002): economy (Knack & Keefer, 1997) and politics (Jackman & Miller, 1998). Hence, literature on social capital is characterised by a broad variety of definitions and a wide range of foci, which complicates any attempt to compare social capital in different contexts. In addition the measurement of social capital is a difficult task since, as Paldam (2000 p. 649) notes, in social capital literature "there is far more theory and speculation than measurement".

Social capital encompasses multiple layers, including social trust (Fukuyama, 2001) and reciprocity (Whiteley, 2000): social bonding (Larsen et al., 2004): social cooperation (Newton, 2001): willingness and/or ability to form social networks (Onyx & Bullen, 2000): social connection (Morrow, 1999) and psychological engagement with a group of people (Brehm & Rahn, 1997): to mention only a few. Nevertheless from the pioneering work of Bourdieu (1980) until today there is a general consensus among researchers that participation in social groups – for example, religious associations (Strømsnes, 2008): ethnic organisations (Brettel, 2005) or groups of volunteers (Peachey et a.l, 2015) – facilitates the development of social capital.

FFS, by definition, have been developed around the idea of creating strong social ties and networks not only among participants but also within farming communities. Participants in FFS form social bonds with their co-learners (Palis, 2006): develop a sense of confidence with their colleagues (Pretty & Buck, 2002): reshape their perceptions toward gender roles (Najjar et al., 2013): build collaboration schemes with other farmers (David, 2007) and develop a logic of collaborative action (Friis-Hansen & Duveskog, 2012) and mutual support (Dzeco et al., 2010); all signs of social capital creation.

The present study

The rich body of literature on FFS offers a variety of findings on the effects of this alternative approach to the creation of social capital. The reverse relationship however has not yet been studied. So two central questions remain open: how does social capital affect the levels of knowledge participants acquire?; and to what extent does the social capital developed in the group of farmers affect the degree to which they participate in the process of co-production of innovative solutions and problem-solving techniques? Hence, unlike much of the abovementioned literature, the present study focused on the ways social capital among trainees influences two key-factors that determine the effectiveness of an FFS project: the levels of knowledge gained by farmers over the course of the programme, and the degree to which farmers participate in the process of the co-development of innovations.

Another point that differentiates our study from previous works which examine the relationship between FFS and social capital is our focus on different dimensions of social capital. Most contemporary efforts to conceptualise social capital within the FFS framework consider just one, or only a few, aspects of this multidimensional concept. Mancini et al (2007) for example and Palis et al (2005) described social capital in terms of access to social assets (e.g. networks, groups): David & Asamoah (2011) used farmers' participation in communities of interest to define social capital, while Mancini & Jiggins (2008) added the dimension of trust. In a meta-analysis, Phillips et al. (2014) refer to social capital as social connections, whereas Settle et al. (2014): in a study based on retrospective data, provide an example of a collective help-giving behaviour as an indication of social capital development after FFS participation.

Although all the above mentioned aspects represent different forms of social capital, grounded in the seminal works of Coleman (1998), Portes (1998) and Pretty (2003), other dimensions of social capital that can emerge within the FFS framework have not been yet operationalised.

In our study, drawing on works from social psychology (e.g. Cook, 2005): work psychology (e.g. Carmeli et al., 2009) and economic sociology (e.g. Nahapiet & Ghoshal, 1997): we tried to take into account some new (emotional and cognitive) components of social capital.

The study used data drawn from cotton farmers and extensionists who participated in an FFS project conducted in Thessaly (Greece) during the growing season of 2015 (thirteen weeks from early June to early September). The aim of the project was threefold: to help farmers understand the principles of integrated crop management; to increase their knowledge on occupational safety issues and to enhance their farm management skills. A variety of learning activities were designed so as to provide the basis for the integration of knowledge, skills and attitude change on these three areas.
It is worth noting that this was the first attempt to implement FFS in Greece. Given that FFS philosophy was built around the developed countries' special contexts and needs, a couple of minor methodological adaptations were made in order to tailor the current project to the specific social, cultural and attitudinal background of Thessalian farmers as well as in order to better fit the project with the competencies of the facilitators. First, a group of three to five extensionists (agronomists) was used to guide and facilitate the learning process of each group of farmers (20-25 persons). The use of groups of extensionists was preferred because it permits the collaboration of scientists with different knowledge bases. This need has to do with the high degree of Greek agronomists' specialisation (one of the major shortcomings of the higher agricultural education system in Greece): which eliminates their ability to engage in a vast range of topics. Secondly, instead of focusing on the 'technology development', the project aimed at the participatory development of innovative solutions – not technological but rather conceptual or managerial.

Method

Participants and procedure

Data for this study were drawn from 36 farmers (34 men, mean age 40.53 years, S.D. 14.72) and 6 trainers/facilitators (5 men, mean age 44.83 years, S.D.14.22) who participated in the FFS project. Farmers came from 27 local communities. Twelve of the participants (33.33%) reported having social relationships with other trainees (mean number of social relationships with other trainees was 0.56, S.D. 0.91) before the starting day of the FFS project. Most of the farmers had secondary education (44.44%): while their average income was €13,680 (S.D. 4,078).
Trainees completed a series of instruments, including the In-Group Social Capital Scale (completed after the end of FFS) and a questionnaire aimed at exploring the levels of knowledge gained through their participation in the project (answered before the start and after the end of the project). Trainers also completed a questionnaire designed to assess multiple facets of the FFS programme, as well as to collect information about the degree to which each farmer contributed to the co-production of innovations over the course of FFS.

Measures

In-group social capital scale

To assess the social capital in the group of trainees we first developed 20 7-point items, pertaining to different dimensions of social capital. Items were selected from a wide range of fields (sociology, social psychology and cognitive science) so as to reflect a wide spectrum of concepts, extending from the pleasure offered by the involvement and participation in a group of people to the identification with the group and the development of a sense of common purpose. Next, items were rated for content relevance and face validity by four researchers on a 3-point scale (from ‘poor’ to ‘fair’ to ‘good’). Items with less than 75% ‘good’ ratings were discarded. After this phase, the final list included 14 items (Table 1).

This final list was administered in the last meeting of FFS. An exploratory factor analysis using alpha factoring and varimax rotation was performed to explore the factorial structure of the scale. The analysis revealed four factors with eigenvalues greater than 1.00, which cumulatively explain 89.28% of the total variance (Table 2). Cronbach’s alpha values exceed 0.8 for all factors. The first factor was labeled “Social bonding” (Mean 4.32, S.D. 0.96) and includes four items that refer to the development of bonding social capital between the participants in the FFS project. The second factor “Social cohesion” (Mean 3.82, S.D. 0.97) reflects the degree to which farmers have social ties with their group mates and feel satisfied with the group membership. The third factor was named “Social identification” (Mean 3.26, S.D. 1.13) because it comprises three items that concern the degree to which farmers identified with the group of trainees. The fourth factor “Social connection” (Mean 4.04, S.D. 1.01) consists of three items that refer to the sense of connectedness with the other group members.

Knowledge gained over the course of FFS

A self-assessment measure was used to assess participants’ levels of knowledge prior and after their participation in the project. The instrument comprises 20 items, measured on a five-point scale (ranging from 1: “very low level” to 5: “very high level”). Items were divided into three a priori specified categories which referred to the three main educational objectives of the programme, namely: integrated crop management (11 items): occupational safety (4 items) and farm management (5 items). Farmers were asked to assess their level of knowledge about these 20 topics pre- and post-participation in the FFS. In this way we calculated a baseline knowledge score (before FFS) and a final score (after participation in FFS). After deducting baseline from final scores we calculated the knowledge gained in each one of the three categories.

Table 1. Items included in the final “in-group social capital scale” and sources from which they were derived

Item	Source
1. I feel connected with the other members of the group, even those who I don’t know well	Putnam (1995)
2. I feel that I belong to a group that shares a common aim	Forrest & Kearns (2001)
3. I feel that with these people we are a homogeneous group	Putnam (1995)
4. I feel that with my co-learners we face the same problems	Jansen et al. (2006)
5. To participate in this group of people is really important for me	Luhtanen & Crocker (1992)
6. I don’t feel that I have any special commitment to this group*	Ellemers et al. (1997)
7. It is really important for me to know that I belong to this group of people	Baumeister & Leary (1995)
8. Sometimes I feel isolated within the group*	Epley et al. (2008)

9. With the other farmers we can understand each other	Kearns & Forrest (2000)
10. I like to offer support to the other participants	Turner (1999)
11. I really feel that I can trust my co-trainees	Adler & Kwon (2002)
12. I really like the sense of being a member of that group	Friedkin (2004)
13. I take part in every joint action in the group	Marsh et al. (2009)
14. To be a member of that group is an integral part of my life	Leach et al. (2008)

*Note: * negatively worded item*

Table 2. In-group social capital scale: factors, loadings, eigenvalues and explained variance

Subscale/item	Loading
Social bonding (Eigenvalue: 4.48; Explained variance: 32.01%)	
I really feel that I can trust my co-trainees	0.92
I like to offer support to the other participants	0.91
I feel that with these people we are a homogeneous group	0.91
It is really important for me to know that I belong to this group of people	0.86
Social cohesion (Eigenvalue: 3.74; Explained variance: 26.74%)	
I feel that I belong to a group that shares a common aim	0.95
With the other farmers we can understand each other	0.88
I feel that with my co-learners we face the same problems	0.85
I really like the sense of being a member of that group	0.84
Social identification (Eigenvalue: 2.48; Explained variance: 17.72%)	
To be member of that group is an integral part of my life	0.94
I don't feel that I have any special commitment to this group*	0.92
To participate in this group of people is really important for me	0.87
Social connection (Eigenvalue: 1.79; Explained variance: 12.81%)	
I take part in every join action in the group	0.95
Sometimes I feel isolated within the group*	0.94
I feel connected with the other members of the group, even those who I don't know well	0.87

*Note: * negatively worded item*

Participatory development of innovations

To assess the degree to which trainees engaged in the process of joint development of innovations we designed and used a three item measure. Trainers/facilitators were asked to rate each farmer who attained the project on the degree to which he/she: i) involved in the joint activities designed to promote the development of innovations (*he/she actively participated in the collective processes of discovering gaps and proposing new ways to overcome them*): ii) shared innovative ideas with the other trainees (*he/she proposed and discussed with the other members of the group innovative ways to solve problems*) and iii) facilitated the integration of his/her co-trainees into the spirit of FFS (*he/she helped other trainees to make sense of the experiences they have encountered during FFS and to generate ideas collaboratively*).

A 5-point scale from 1 (not at all) to 5 (very much) was used. For each farmer a new variable reflecting the degree to which he/she participated in the co-development of innovations during the FFS project was calculated as the mean of ratings across the three items (Cronbach's α=0.69). The mean score of the variable was 3.78 (S.D. 0.95).

Data analysis

To provide a brief overview of our data we used correlations (Pearson's r for normally distributed variables and Spearman's ρ when at least one of the variables did not have a normal distribution): independent sample t-tests, paired sample t-tests and Mann-Whitney U tests. Moreover we used regression analyses to answer the main questions of the study.

Results

Preliminary analyses

In a first step we conducted Pearson's product-moment correlations to examine for possible associations of farmers' age, education and income with the basic variables of the study. Age was significantly correlated with two subscales of in-group social capital – social bonding ($r=-0.37$, $p=0.027$) and social cohesion ($r=-0.35$, $p=0.037$) – while another significant correlation was observed between level of education and social bonding ($r=0.48$, $p=0.008$). On the contrary, income did not show any significant correlation with the basic variables of the study ($r<0.31$, $p>0.05$ in all cases). Moreover, the analysis proved that the number of previous social relationships did not correlate with social bonding, cohesion, identification and connection ($\rho<0.11$, $p>0.05$ in all cases). Mann-Whitney U tests were used to ascertain if participants who had previous social relationships versus those who did not, differed in their scores on the four social capital subscales. In all cases, no significant differences were found ($p>0.05$).

Furthermore, no significant correlations were found between trainees' demographics and their contribution to the development of innovations during the project or their levels of knowledge before and after the attendance at FFS. We also examined all the basic study variables for gender differences. The only gender effect observed was for social cohesion ($t=-1.82$, $p=0.000$): with women reporting higher levels of cohesion with co-trainees than men. Additionally paired sample t-tests were used to assess the levels of knowledge gained by farmers over the course of the FFS project. The tests revealed significant increases in all three pre-specified thematic areas (Table 3).

Table 3. Knowledge levels of farmers before and after their participation in the FFS project

Category	Example item	Cronbach's α	Score		Mean difference
			Before FFS	After FFS	
Integrated crop management	Integrated disease management	0.73	2.58	2.77	0.19 (t=5.02*)
Farmer's safety	Use of protective equipment	0.71	2.63	2.99	0.36 (t=5.50*)
Farm management	Cultivation practices	0.70	2.82	3.14	0.32 (t=5.30*)

*Note: * p<0.01*

Social capital and participatory development of innovations

To examine the influence of the different forms of social capital on the degree to which farmers participate in the process of co-development of innovations within the framework of FFS, we regressed farmers' scores onto the four dimensions of in-group social capital. In a second step we also entered gender, age and level of education as control variables. In the first step ($F=4.98$, $p=0.030$) we found that social bonding ($\beta=0.42$, $p=0.007$) and social connectedness ($\beta=0.42$, $p=0.006$) were significant predictors of the level of the dependent variable. These effects remained significant after controlling for demographic variables in the second step ($\beta=0.40$, $p=0.027$ and $\beta=0.46$, $p=0.008$ respectively) as illustrated in Table 4.

Table 4. **Results of hierarchical regression analysis**

Predictors	Model 1		Model 2	
	R^2	β	R^2	β
Step 1	**0.39**		**0.41**	
Social bonding		**0.42**		**0.40**
Social cohesion		-0.02		-0.01
Social identification		0.06		0.03
Social connection		**0.42**		**0.46**
Step 2				
Gender				0.11
Age				0.05
Education				-0.06

Note: Significant coefficients are presented in bold (p<0.05)

Social capital and knowledge gained

We then examined the associations of the three scores that referred to the knowledge gained by farmers over the course of FFS with the four forms of in-group social capital. To this end, the four subscales of in-group social capital were entered into three regression equations, one for the level of knowledge gained on each one of the three main topics of the FFS project; i.e. integrated crop management ($F=3.01$, $p=0.033$, $R^2=0.19$): farmer's safety ($F=3.31$, $p=0.023$, $R^2=0.21$): and farm management ($F=4.41$, $p=0.006$, $R^2=0.28$). The analysis revealed that the development of social bonding significantly predicted the levels of knowledge in all three equations ($\beta=0.42$, $p=0.011$ for ICM; $\beta=0.33$, $p=0.038$ for occupational safety; $\beta=0.38$, $p=0.015$ for farm management). In addition, as shown in Table 5, the development of a sense of connection to the group of trainees was significantly positively associated with the levels of knowledge gained in the areas of farmer's safety and farm management ($\beta=0.40$, $p=0.013$ and $\beta=0.29$, $p=0.049$ respectively). In-group identification also had significant positive effects upon the levels of trainees' knowledge on issues pertaining to farm management ($\beta=0.42$, $p=0.012$).

Table 5. Coefficients (β) of regressions used to test the association of social capital with knowledge gained over the course of FFS

Predictors	Knowledge score		
	I.C.M.	**Farmer's safety**	**Farm management**
Social bonding	**0.42**	**0.33**	**0.38**
Social cohesion	0.24	-0.09	-0.08
Social identification	0.04	0.09	**0.42**
Social connection	-0.04	**0.40**	**0.29**

Note: Significant coefficients are presented in bold (p<0.05)

Discussion and conclusions

In this study we attempted to establish preliminary evidence that the cultivation of social capital among FFS participants on the one hand promotes the participatory development of innovations within the FFS framework and, on the other, fosters the construction of knowledge by farmers. In doing so the present research goes beyond the existing literature on the association between FFS attendance and social capital in a number of ways. First, despite the value of past research on the relation between FFS participation and social capital, most of the work published on this issue examines the social capital as the output of participation in FFS. In our study we investigated whether social capital among FFS participants triggers knowledge creation and acquisition and facilitates farmers' involvement in the process of innovation development. Second, most past research relies on qualitative methods or on unidimensional assessments of social capital. In the current work, by developing a multidimensional instrument, we tried to capture – and examine – different forms of social capital. Hence, despite the limitations associated with the small sample size, this work offers some new insights and plots a course for future research.

Our results indicate that social capital and in particular its most 'soft aspects' (social bonding and social connection) positively affect farmers' engagement in the process of innovation development, while the dimension of social identification also predicts the levels of knowledge gained by FFS participants. These findings imply that the creation of social capital – and especially bonding social capital – should be a top priority for facilitators. In addition, when considered in conjunction with previous work which concludes that farmers participate in FFS not only to gain knowledge but also to cover their basic psychological need to belong to a group of people (Charatsari et al., 2015): our results suggest that social benefits from participation in FFS deserve more attention by both researchers and FFS designers.

This leads to the question 'what strategies can facilitators use to nurture social capital within the group of participants?' To address this question FFS planners should put more emphasis on social activities targeted at promoting bonding among farmers as well as to integrate concepts and findings from different domains in the FFS blueprint. For example, research on organisational culture argues that the encouragement of cooperation among the members of a group positively influences the in-group social capital (Carmeli et al., 2009): while work on social psychology (Ryan & Deci, 2000) postulates that – in educational settings – the development of a sense of relatedness, not only among learners but also between teachers and students, facilitates students' integration into the educational climate and fosters their motivation to learn. A challenging priority for future research and practice is to identify and compare factors that enhance and maintain FFS participants' (both farmers and facilitators) motivation to engage in and adhere to social capital generating behaviours. When viewed in a more general context the conclusions from this study suggest that, to enlarge spaces for innovation, policy planners and intermediaries must focus not only on the structural conditions that support innovation processes but also on the factors which create social reinforcement contingencies able to foster farmers' capacity to innovate.

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References

Adler, P. S., & Kwon, S. W. (2002). Social capital: prospects for a new concept. Academy of Management Review 27(1): 17-40.

Baumeister, R.F., & Leary, M.R. (1995). The need to belong: desire for interpersonal attachments as a fundamental human motivation. Psychological Bulletin 117(3): 497.

Berman, E. (2016). A fight for food sovereignty: food first. Journal of Agricultural & Food Information 17(1): 3-10.

Bourdieu, P. (1980). Le capital social: notes provisoires. Actes de la Recherche en Sciences Sociales 31(1): 2-3.

Braun, A., & Duveskog, D. (2008). The farmer field school approach: history, global assessment and success stories. Background Paper for the IFAD Rural Poverty Report.

Brehm, J., & Rahn, W. (1997). Individual-level evidence for the causes and consequences of social capital. American Journal of Political Science 41(3): 999-1023.

Brettell, C. (2005). Voluntary organisations, social capital, and the social incorporation of Asian Indian immigrants in the Dallas-Fort worth metroplex. Anthropological Quarterly 78(4): 853-882.

Cai, J., Shi, G., & Hu, R. (2016). An impact analysis of farmer field school in China. Sustainability 8(2): 137.

Carmeli, A., Ben-Hador, B., Waldman, D.A., & Rupp, D.E. (2009). How leaders cultivate social capital and nurture employee vigor: implications for job performance. Journal of Applied Psychology 94(6): 1553-1561.

Charatsari, C. (2015). Farmer Field Schools: A Practitioner's Guide. Report No D4.a., Thessaloniki: ELGO-Dimitra (in Greek). doi: 10.13140/RG.2.1.5142.8881

Charatsari, C., Koutsouris, A., Lioutas, E.D., Kalivas, A., & Tsaliki, E. (2015). Social and psychological dimensions of participation in farmer field schools: lessons from rural Greece. Paper presented at International Conference "Meanings of the Rural". 28-29/9/2015. Aveiro-Portugal.

Coleman, J.S. (1988). Social capital in the creation of human capital. American Journal of Sociology 94: S95-S120.

Cook, K.S. (2005). Networks, norms, and trust: the social psychology of social capital. Social Psychology Quarterly 68(1): 4-14.

Dalton, T.J., Yahaya, I., & Naab, J. (2014). Perceptions and performance of conservation agriculture practices in northwestern Ghana. Agriculture, Ecosystems & Environment 187: 65-71.

David, S. (2007). Learning to think for ourselves: knowledge improvement and social benefits among farmer field school participants in Cameroon. Learning 14(2): 35-49.

David, S., & Asamoah, C. (2011). The impact of farmer field schools on human and social capital: Aacase study from Ghana. The Journal of Agricultural Education and Extension 17(3): 239-252.

Davis, K., Nkonya, E., Kato, E., Mekonnen, D.A., Odendo, M., Miiro, R., & Nkuba, J. (2012). Impact of farmer field schools on agricultural productivity and poverty in East Africa. World Developmen, 40(2): 402-413.

Dzeco, C., Amilai, C., & Cristóvão, A. (2010). Farm field schools and farmers' empowerment in Mozambique: a pilot study. Journal of Extension Systems 26(2): 1-13.

Ellemers, N., Spears, R., & Doosje, B. (1997). Sticking together or falling apart: in-group identification as a psychological determinant of group commitment versus individual mobility. Journal of Personality & Social Psychology 72(3): 617-626.

Epley, N., Akalis, S., Waytz, A., & Cacioppo, J.T. (2008). Creating social connection through inferential reproduction loneliness and perceived agency in gadgets, gods, and greyhounds. Psychological Science 19(2): 114-120.

Feder, G., Murgai, R., & Quizon, J.B. (2004). Sending farmers back to school: the impact of farmer field schools in Indonesia. Applied Economic Perspectives and Policy 26(1): 45-62.

Fliert Van de, E. (1993). Integrated pest management: farmer field schools generate sustainable practices: a case study in Central Java evaluating IPM training. PhD Thesis. Wageningen: Landbouwuniversiteit te Wageningen.

Forrest, R., & Kearns, A. (2001). Social cohesion, social capital and the neighbourhood. Urban Studies 38(12): 2125-2143.

Friedkin, N.E. (2004). Social cohesion. Annual Review of Sociology 30: 409-425.

Friis-Hansen, E., & Duveskog, D. (2012). The empowerment route to well-being: an analysis of farmer field schools in East Africa. World Development 40(2): 414-427.

Friis-Hansen, E., Duveskog, D., & Taylor, E.W. (2012). Less noise in the household: the impact of farmer field schools on gender relations. Journal of Research in Peace, Gender and Development 2(2): 44-55.

Fukuyama, F. (2001). Social capital, civil society and development. Third World Quarterly 22(1): 7-20.

Jackman, R.W., & Miller, R.A. (1998). Social capital and politics. Annual Review of Political Science 1: 47-73.

Jansen, T., Chioncel, N., & Dekkers, H. (2006). Social cohesion and integration: learning active citizenship. British Journal of Sociology of Education 27(2): 189-205.

Jørs, E., Konradsen, F., Huici, O., Morant, R.C., Volk, J., & Lander, F. (2016). Impact of training Bolivian farmers on integrated pest management and diffusion of knowledge to neighbouring farmers. Journal of Agromedicine 21(2): 200-208.

Kearns, A., & Forrest, R. (2000). Social cohesion and multilevel urban governance. Urban Studies 37(5/6): 995.

Kenmore, P.E. (2002). Integrated pest management: introduction. International Journal of Occupational and Environmental Health 8(3): 173-174.

Knack, S., & Keefer, P. (1997). Does social capital have an economic payoff? A cross-country investigation. The Quarterly Journal of Economics 112 (4): 1251-1288.

Larsen, L., Harlan, S.L., Bolin, B., Hackett, E.J., Hope, D., Kirby, A., & Wolf, S. (2004). Bonding and bridging understanding to the relationship between social capital and civic action. Journal of Planning Education and Research 24(1): 64-77.

Leach, C.W., van Zomeren, M., Zebel, S., Vliek, M.L., Pennekamp, S.F., Doosje, B., & Spears, R. (2008). Group-level self-definition and self-investment: a hierarchical (multicomponent) model of in-group identification. Journal of Personality & Social Psychology 95(1): 144-165.

Luhtanen, R., & Crocker, J. (1992). A collective self-esteem scale: self-evaluation of one's social identity. Personality & Social Psychology Bulletin 18(3): 302-318.

Macinko, J., & Starfield, B. (2001). The utility of social capital in research on health determinants. Milbank Quarterl, 79(3): 387-427.

Mancini, F., & Jiggins, J. (2008). Appraisal of methods to evaluate farmer field schools. Development in Practice 18(4-5): 539-550.

Mancini, F., Van Bruggen, A.H., & Jiggins, J.L. (2007). Evaluating cotton integrated pest management (IPM) farmer field school outcomes using the sustainable livelihoods approach in India. Experimental Agriculture 43(01): 97-112.

Marsh, K.L., Richardson, M.J., & Schmidt, R.C. (2009). Social connection through joint action and interpersonal coordination. Topics in Cognitive Science 1(2): 320-339.

Minh, T.T., Larsen, C.E.S., & Neef, A. (2010). Challenges to institutionalising participatory extension: the case of farmer livestock schools in Vietnam. Journal of Agricultural Education & Extensio, 16(2): 179-194.

Morrow, V. (1999). Conceptualising social capital in relation to the well-being of children and young people: a critical review. The Sociological Review 47(4): 744-765.

Mutandwa, E., & Mpangwa, J.F. (2004). An assessment of the impact of farmer field schools on integrated pest management dissemination and use: evidence from smallholder cotton farmers in the lowveld area of Zimbabwe. Journal of Sustainable Development in Africa 6(2): 24-31.

Nahapiet, J., & Ghoshal, S. (1997). Social capital, intellectual capital and the creation of value in firms. Academy of Management Review 23(2): 242-266.

Najjar, D., Spaling, H., & Sinclair, A.J. (2013). Learning about sustainability and gender through farmer field schools in the Taita Hills, Kenya. International Journal of Educational Development 33(5): 466-475.

Nederlof, S.E., & Odonkor, E.N. (2006). Lessons from an experiential learning process: the case of cowpea farmer field schools in Ghana. Journal of Agricultural Education and Extension 12(4): 249-271.

Newton, K. (2001). Trust, social capital, civil society, and democracy. International Political Science Review 22(2): 201-214.

Onyx, J., & Bullen, P. (2000). Measuring social capital in five communities. The Journal of Applied Behavioral Science 36(1): 23-42.

Ortiz, O., Garrett, K.A., Health, J.J., Orrego, R., & Nelson, R.J. (2004). Management of potato late blight in the Peruvian highlands: evaluating the benefits of farmer field schools and farmer participatory research. Plant Disease 88(5): 565-571.

Paldam, M. (2000). Social capital: one or many? Definition and measurement. Journal of Economic Surveys 14(5): 629-653.

Palis, F.G. (2006). The role of culture in farmer learning and technology adoption: a case study of farmer field schools among rice farmers in central Luzon, Philippines. Agriculture & Human Values 23(4): 491-500.

Palis, F.G., Morin, S., & Hossain, M. (2005). Social capital and geography of learning: roles in accelerating the spread of integrated pest management. The Journal of Agricultural Education & Extension 11(1-4): 27-37.

Peachey, J.W., Bruening, J., Lyras, A., Cohen, A., & Cunningham, G.B. (2015). Examining social capital development among volunteers of a multinational sport-for-development event. Journal of Sport Management 29(1): 27-41.

Phillips, D., Waddington, H., & White, H. (2014). Better targeting of farmers as a channel for poverty reduction: a systematic review of farmer field schools targeting. Development Studies Research 1(1): 113-136.

Portes, A. (1998). Social capital: its origins and applications in modern sociology. Annual Review of Sociology 24, 1-24.

Praneetvatakul, S., & Waibel, H. (2006). Impact assessment of farmer field schools using a multi-period panel data model. Paper presented at “Conference of the International Association of Agricultural Economists”, 12-19/8/2006, Gold Coast.

Pretty, J. (2003). Social capital and the collective management of resources. Science 302(5652): 1912-1914.

Pretty, J., & Buck, L. (2002). Social capital and social learning in the process of natural resource management. In C. B. Barret, F. Place and A. A. Aboud (Eds.): Natural Resources Management in African Agriculture pp. 23-33. Walingford: CAB International.

Putnam, R. (1995). Bowling alone: the collapse and revival of American community. Journal of Democracy 6(1): 65-78.

Randel, A.E., & Ranft, A.L. (2007). Motivations to maintain social ties with coworkers the moderating role of turnover intentions on information exchange. Group & Organization Management 32(2): 208-232.

Ryan, R.M., & Deci, E.L. (2000). Intrinsic and extrinsic motivations: classic definitions and new directions. Contemporary Educational Psychology 25(1): 54-67.

Settle, W., & Garba, M.H. (2011). Sustainable crop production intensification in the Senegal and Niger River basins of francophone West Africa. International Journal of Agricultural Sustainability 9(1): 171-185.

Settle, W., Soumaré, M., Sarr, M., Garba, M.H., & Poisot, A.S. (2014). Reducing pesticide risks to farming communities: cotton farmer field schools in Mali. Philosophical Transactions of the Royal Society of London B: Biological Sciences 369(1639): 20120277.

Simpson, B.M., & Owens, M. (2002). Farmer field schools and the future of agricultural extension in Africa. Journal of International Agricultural and Extension Education 9(2): 29-36.

Siregar, P.R., & Crane, T.A. (2011). Climate information and agricultural practice in adaptation to climate variability: the case of climate field schools in Indramayu, Indonesia. Culture, Agriculture, Food and Environment 33(2): 55-69.

Strømsnes, K. (2008). The importance of church attendance and membership of religious voluntary organisations for the formation of social capital. Social Compass 55(4): 478-496.

Taylor, E.W., Duveskog, D., & Friis-Hansen, E. (2012). Fostering transformative learning in non-formal settings: farmer-field schools in East Africa. International Journal of Lifelong Education 31(6): 725-742.

Thiele, G., Nelson, R., Ortiz, O., & Sherwood, S. (2001). Participatory research and training: ten lessons from the farmer field schools (FFS) in the Andes. Currents 27: 4-11.

Tripp, R., Wijeratne, M., & Piyadasa, V.H. (2005). What should we expect from farmer field schools? A Sri Lanka case study. World Development 33(10): 1705-1720.

Turner, R.J. (1999). Social support and coping. In A.V. Horwitz and T.L. Scheid (Eds). A Handbook for the Study of Mental Health: Social Contexts, Theories and Systems pp. 198-210. New York: Cambridge University Press..

Van den Berg, H., & Jiggins, J. (2007). Investing in farmers – the impacts of farmer field schools in relation to integrated pest management. World Development 35(4): 663-686.

Whiteley, P.F. (2000). Economic growth and social capital. Political Studies 48(3): 443-466.

Yang, P., Li, K., Shi, S., Xia, J., Guo, R., Li, S., & Wang, L. (2005). Impacts of transgenic Bt cotton and integrated pest management education on smallholder cotton farmers. International Journal of Pest Management 51(4): 231-244.

Yang, P., Liu, W., Shan, X., Li, P., Zhou, J., Lu, J., & Li, Y. (2008). Effects of training on acquisition of pest management knowledge and skills by small vegetable farmers. Crop Protection 27(12): 1504-1510.