Prospects for Farmers' Support: Advisory Services in European AKIS
WP 4 – AKIS ON THE GROUND: FOCUSING KNOWLEDGE FLOWS SYSTEM | Topic 2
Final Synthesis Report

The capability of extension and advisory services to bridge research and knowledge needs of farmers

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List of acronyms

AAC	Agricultural Advisory Centre
AKIS	Agricultural Knowledge and Information System
AS	Advisory Services
BG	Bulgaria
BSCRA	Bavarian State Centre for Research in Agriculture
DE	Germany
DST	Decision Support Tools
EU	European Union
FR	France
GPS	Global Position System
ICT	Information and Communication Technologies
INRA	National Institute of Agricultural Research
LKV	Erzeugerringe für tierische Veredelung in Bayern e. V
MAF	Ministry pf Agriculture and Food
NAAS	National Agricultural Advisory Service
PL	Poland
PRO AKIS	Prospects for Farmers' Support: Advisory Services in the European Agricultural Knowledge and Information Systems'
R&D	Research and Development
RDP	Rural Development Programme
UHOH	University of Hohenheim
WP	Work Package

Executive Summary

This synthesis report is one deliverable of the European project PRO AKIS (Prospects for Farmer's Support: Advisory Services in European AKIS). The project focus was to investigate the agricultural advisory services across Europe within the context of Agricultural Knowledge and Information Systems (AKIS). One of the project components (Work Package 4) was to explore and describe selected forms of advisory services and agriculture knowledge flows in Europe within the broader context of AKIS by focusing three major themes (Topics 1, 2 and 3) through a case study approach. Topic 1 investigated the effectiveness of advisory services to respond small-scale farmer's needs and demands; Topic 2 the capability of AS to bridge research and knowledge needs of farmers; Topic 3 analysed how rural/agricultural networks enhance farmer's ability to innovate in cooperation with other rural actors. Research in each topic was based on a set of four case studies, and a total of 12 case studies were conducted in different European countries, including both cases with regional and national scope. The selected case studies provide an overview of the diversity of situations across the European Union (EU) respecting the strengths and gaps of AS for each of the research topics covered by the analysis. Each case study was reported by the respective responsible team through a 'country report'. A total of 12 'country reports' were elaborated. The synthesis reports summarise in a comparative way the main findings for each of the three research topics, based on the country reports and including the contributions of stakeholders that have participated in the respective topic seminar. Three synthesis seminars have been organised, each one corresponding to a different research topic, and finally three synthesis reports were elaborated.

The report here presented synthesises the research conducted under the PRO AKIS project for the Topic 2 the capability of advisory services to bridge research and knowledge needs of farmers. It includes a brief description of the four case studies undertook under this research topic, which were: 1) the knowledge transfer system of South-Central region of Bulgaria; 2) the decision support tools (DSTs) supported by ICT, in the French context; 3) the experimental stations in the Bavarian region of Germany; and, 4) the 'Demonstration farms' in Poland.

The case studies selected evidence that the role of the advisory services in bridging research and practice is related with the AKIS infrastructure in each case study. Hence, a conventional mediating role is encountered in the cases of Bulgaria and the 'demonstration farms' (in Poland), with the public advisors exchanging and disseminating operationalised knowledge and information to farmers. However, in the case of the 'demonstration farms' the advisors participate in the process of knowledge generation, together with researchers and the owner of the demonstration farm. In both cases the role of the advisors is a result of a national and regional AKIS infrastructure where the public advisory services are still important and coordinated. On the other hand, the DSTs studied by the French case study highlight the disappearance of the conventional intermediating role of advisors by bridging research with the farmers and, simultaneously, the emergence of new roles for advisors. The DSTs are, apparently, technologies that link directly research and farmers, bypassing advisors conventional mediating role. The Bavarian case, by its turn, underlines the challenges to an effective bridge between research and practice when the advisory services are privatised and how gaps in the AKIS can arise in this respect.

The case studies findings show how innovative models to bridge science and practice, such as the 'Demonstrations farms' in Poland, can in fact improve the effectiveness of knowledge generation for their actual end-users. However, they also show, through the DST case, how technological innovation linked with the ICT sector can revolutionize the traditional formats to link the research with the practice, by passing the knowledge directly to the farmers without the need for mediators, thus bypassing the conventional mediating role of advisors. The Bulgarian case highlights that a strong research sector can bridge directly large farmers but that it shows ineffective (and cost-inefficient) in that respect regarding the small-scale farmers. The Bulgarian and Polish, as well as at same extent

the Bavarian case study (for wellbeing related issues), underline that a strong public research infrastructure appears to be determinant for a well-performing AKIS regarding the generation and the exchange / dissemination of relevant knowledge to farmers. They also show that its performance might be increased by directly involving farmers and advisors into the processes of knowledge co-creation and/or operationalization. Research-practice bridging models such as the 'Demonstration farms' might show quite useful techniques or methods to create and disseminate good practices regarding environmental protection and the sustainable use of the natural resource (public goods provision). This is so because they allow for the creation of practical knowledge that can be used directly on farms. The possibility of farmers to observe the research results on demonstration farms allows them to make a decision to introduce the innovations much faster.

The conclusions of the case studies together with the stakeholder's contributions suggested a number of leading recommendations, from which are stated:

- *Enhance the coordination of the private advisors with the research sector, including the private sector which is client-oriented (such as the FBOs), the independent consultants and also, as much as possible, the selling-oriented advisors from the upstream and downstream farming industry.*
- *Facilitate the communication between farmers and the research sector in order to assure knowledge farmer's needs don't stay unattended.*
- *Differentiate the farmer's knowledge generation and operationalisation needs, according to their size, education and business models.*
- *Reinforce the advisors and other actors (e.g. researchers, specialists or brokers) mediating role, acting as intermediaries, facilitators and/or brokers to bridge farmers and research.*
- *Promote research policy strategies driven by the answer to practical needs of the farmers.*
- *Channel public funding to "good" models to bridge research with practice, such as the 'Demonstration farms', 'Monitor farms', and to research and educational projects that enhance multi-actors cooperation.*
- *Stimulate innovative knowledge exchange and dissemination actions of research sector.*
- *Support the development of DSTs and data bases that provide reliable and robust evidence to farmers and advisors.*

1. Introduction

This final synthesis report is a deliverable of the European project PRO AKIS (Prospects for Farmer's Support: Advisory Services in European AKIS). The project focus is to investigate the agricultural advisory services across Europe within the context of Agricultural Knowledge and Information Systems (AKIS). One of the project components (Work Package 4) aimed to explore and describe selected forms of advisory services and agriculture knowledge flows in Europe within the broader context of AKIS (described previously by the PRO AKIS project at the individual country level), accounting for the diversity and demand conditions across different countries/regions and diverse types of farmers. Within this overall goal, Topic 2 investigated the relationships between the research and the practice by focusing on the specific role of the advisory services in bridging research and knowledge needs of farmers, across heterogeneous AKIS in European regions/countries and accounting for the changing roles of public and private advisors within these systems.

This report presents a comparative synthesis of the findings gathered on this research topic based on four case studies conducted in four countries: Bulgaria (BG), France (FR), Germany (DE) and Poland (PL), which are presented in the respective country reports, elaborated by the teams responsible for each case study, which can be accessed in the PRO AKIS website. The conclusions of this report were enriched by information obtained by the stakeholder's contributions provided at the PRO AKIS Seminar *Advisory services bridging Research and Farmers' Knowledge Needs* held in the University of Hohenheim (UHOH), Stuttgart, on 10th March, 2015.

The case study approach, allowing for in-depth analysis, was the methodology adopted to gather qualitative data and information to answer the overall and specific goals of the PRO AKIS WP4 topic 2. The selected four case studies describe the roles, the opportunities and the limits of advisory services to fulfil the bridge function between farmers and research, especially with regard to farmers' provision of public goods and ecosystem services and to their capacities to respond to global challenges. The four selected case studies comprise: 1) the study of knowledge transfer actors and functions in the agricultural sector in South-Central region of Bulgaria; 2) the case of the experimental Research Stations and their role related with the knowledge transfer in Bavaria (Germany); 3) the role of advisory services in the case of the development and use of Decision Support Tools (DST) in the French context; 4) and, the case of the Demonstration Farms in Poland.

The bridge between research and practice was analysed in each of the selected four case studies. This bridging entails a number of activities, including converting farmers' needs into research questions and reciprocally research results into technical solutions. It encompasses also the more generic functions related with the linkages between research and practice, such as the knowledge transformation and the transmission of the resulting information to the farmers. The AKIS inventory of the 27 European countries, conducted by the PRO AKIS (WP3), highlighted important changes in the infrastructure of these systems with impact on the farm advice related with the knowledge activities and the flows between research and practice (Kania et al., 2014). Hence, that highlights the need for a better understanding of the new relations of farm advice with both, traditional (*e.g.*, experimental stations or applied research institutes) and emerging (*e.g.*, DSTs provided by the private sector or demonstrations farms) actors related with the knowledge generation and transformation within the AKIS.

The terminology respecting the knowledge processes is often confusing due to the use of different concepts to identify the same processes or functions, while the opposite is also common, the use of the same term to refer different knowledge processes. Thus, the vocabulary in this respect used by this report is summarised in table 1. It bases on the typology related to the knowledge transfer, presented by Röling and Engel (1991) and Röling (1990), which comprises the knowledge generation (researcher's function), its transformation (or conversion or operationalisation) in information, and the transmission of the later to the farmers, a function generally assigned to advisors, and finally the use of the operationalised knowledge by the farmers. Other processes in between the transmission and the utilisation of the knowledge include its storage, integration, retrieval and diffusion. While this sequential set of processes suggests a linear mode for the knowledge transfer it is acknowledged by the author (Röling, 1990), that knowledge can be generate by farmers, and this practical knowledge (non-codified also known as tacit knowledge) can be exchanged between farmers, and between them and other actors, namely with advisors. It is now acknowledged the increasingly systemic nature of the knowledge processes and the interchangeable roles of the actors. This has led to the appearance of concepts such as co-generation of knowledge, also known as co-creation, the later term often referring to production of scientific knowledge by involving researchers with farmers; yet, these concepts are also used to refer the production of practical knowledge as a result of the farmer's interaction and the involvement of other actors. In addition these concepts are also envisaged as knowledge co-generation by integrating tacit or implicit with scientific and codified knowledge from research with the aim of producing scientifically-based practical knowledge (Mauser et al., 2013).

Table 1: *Terminology used to describe knowledge processes*

Process	Description
Generation; creation; production	Creation of new knowledge (or information) (e.g., Röling, 1990; Röling & Engel, 1991; Hall et al., 2006)
Transformation ; conversion; operationalisation; Integration	Processing of information; to bring knowledge down from a high-level logical concept into workable information; Farmers situational adaption of scientific knowledge; Farmers site-specific knowledge and experience (implicit tacit knowledge) may require transformation so it can be used by others (e.g., Röling, 1990; Röling and Engel, 1991; Taylor, 2007)
Storage; accumulation; retrieval	Collection and storage of information; accumulated knowledge by its routinely use to solve problems; codify implicit site-specific knowledge (e.g., Röling, 1990; Röling & Engel, 1991; Russell and Ison, 2000)
Transmission; diffusion; dissemination; exchange	The dissemination of the information; the exchange of experiences and information; diffusion is related with the dissemination of technology and other type of science-based knowledge; dissemination is a more general term but also used to designated a generalised way to make information available. (e.g., Röling and Engel, 1991; OECD, 2012)
Utilization; use	Converting knowledge and information into action
Co-generation; co-creation	Co-generation is a process of generating knowledge through actors interaction; co-creation is more often adopt to highlight the interaction between different actors of the knowledge system (e.g. farmers and researchers) (e.g., Mauser et al., 2013)

Following the introduction, this report has been structured within four additional sections. Section 2 introduces briefly the case studies, and it is followed, in Section 3, by a comparative synthesis of the four selected case studies. Section 4 is devoted to present the main findings regarding the actors, processes and knowledge flows involved in bridging of research with practice in each of the four

selected case studies, with a focus on the role of advisory services and on identifying, when possible, best-fit practices of the later (advisory services) in the context of knowledge transfer. A final section comprises the presentation of key insights and policy recommendations based on the main findings of the case studies and the discussions held with the stakeholders at the synthesis seminar.

2. Introduction to cases studies

2.1 The knowledge transfer in the agricultural sector in South-Central region of Bulgaria

In Bulgaria, the case study was carried out in the South-Central region. The region represents 20% of the total population and as well 20% of the total area of Bulgaria. Approximately a third of all farms in the country operate in this region of Bulgaria.

Within the region, the study selected a set of relevant actors that within the regional AKIS enable to illustrate and understand the knowledge transfer mechanisms between research and practice in the region, which are broadly similar to the rest of the country. The selected actors comprise: three scientific institutes (Plant and Genetic Resources, Fruit Growing, and Vegetable Crops); one experimental station (Irrigation); the regional public agricultural university (which is the only one at the national level). These scientific organizations were selected due to their role in the matter under analysis by showing: high scientific achievements, active scientific and consultancy activities with local agricultural growers, and their close relations with shared scientific studies among the institutes and the Agricultural University. It is important to point out that there are several scientific centres related to the agricultural knowledge generation and dissemination with national significance located in the South-Central region of Bulgaria, due to the fact that they are the only ones for the entire country. Each of these institutions is specialized in a particular field and provides advisory services to farmers in thematic areas. Between them, there is no organizational links and they operate as separate units, while they often cooperate through shared projects. However, their main competitors, regarding passing knowledge and information to the farmers, are upstream agro-industries importing seeds, fertilizers and pesticides for crop production, which also offer advisory services to farmers on the production process.

The farmers are the end-users of products and services offered by the scientific centres and only occasionally are involved in the processes of knowledge generation. The case study surveyed both small and large farmers, which are users, or at least addressees, of the scientific achievements and consultancy services of the institutes, experimental stations and the agricultural university.

More detailed information on this case study can be obtained in the respective country report (Dirimanova and Radev, 2014).

2.2 The role of experimental research stations for knowledge exchange and provision to farmers in Bavaria, Germany

The case study for Bavaria (Germany) explored the contribution of experimental research stations in bridging research with the farming practice. The Bavarian AKIS is characterised by a dense infrastructure comprising a high number of public actors and various professional organisations and associations. The important role that agriculture plays for the rural areas in Bavaria explains this

dense AKIS infrastructure. The agricultural advisory services are constituted by several organizational actors who cooperate in the "combined advisory system" – a recent model resulting from a reform on the regional public advisory services. The public agricultural extension service is now confined to the activities related with the "welfare-oriented advice (environmental topics), advice on administrative and investment issues and farm development" (Brechmann et al., 2014). Advice on production-related issues can be co-financed publically, but is provided by private advisors from various professional associations. In addition, farmers' association and other entities offer advice on specific farming topics.

The main actors addressed to get a complete overview of the advising organizations in the case study were the Ministry for Food, Agriculture and Forestry in Bavaria, the Bavarian State Centre for Research in Agriculture (BSCRA), the so called 'education, research and training centres' (LVZ), the public agricultural offices, a number of professional agricultural organisations and the farmers' association.

More detailed information on this case study can be obtained in the respective country report (Brechmann et al., 2014).

2.3 The role of decision support tools (DSTs) in the French context

The French report focused on the role of Decision Support Tools (DSTs) in the new relations between research and farmers. One of the major transformations in the relations between farmers and research in the future is related to the opportunities opened by Information and Communication Technologies (ICTs) (Labarthe and Deville, 2014). These innovations have led to the development of new DSTs for farmers. DSTs are numeric devices, based on ICTs. They provide farmers with new interfaces to access scientific knowledge about the management of agronomic data from their farm. The interfaces could be software, smartphone application, satellite technologies linked to precision farming, among others. Many of these DSTs claim to contribute to a more sustainable use of resources and inputs in farming (e.g., water, nitrogen).

However, the development of these technologies is also associated to new economic models, in a context of moving boundaries in the respective roles of public and private actors in the infrastructures of European AKIS. DST may be developed and sold to farmers by private service firms (sometimes not related to the agricultural sector), or produced by traditional actors of AKIS, or embedded in new public-private partnerships (Labarthe et al., 2013). In such new institutional configurations, traditional farm advisory services can be excluded, associated, or included to the conception and development of the DSTs.

The analysis was based on three DSTs in the French agricultural sector: a smartphone application to identify pest for horticultural production (Di@gnoplant, created by INRA, a public research institute), numeric maps derived from satellite technology to support precision farming for nitrogen fertilisation (Farmstar, created by Airbus Industry and ARVALIS, an applied research institute), and a registered software programme claiming to become 'the Windows' of farm advisors (Phytnes, created by a union of French farmers' cooperatives).

More detailed information on this case study can be obtained in the respective country report (Labarthe and Deville, 2014).

2.4 Demonstration farms for knowledge transfer in Poland

In Poland, the case study comprises the demonstration farms that operate within a cooperation network. The purpose of the study was to present the advisory opportunities in the process of linking education and the needs of farmers, with regard to innovative knowledge. In this process the advisory role was shown through the transfer of knowledge involving environmentally friendly practices implemented and tested by applied research conducted through field experiments in demonstration farms owned and managed by farmers.

The demonstration farms were selected from five Polish provinces — Lesser Poland, Świętokrzyskie Province, Lower Silesian, Lublin and Pomeranian — in order to include agricultural farms from different regions with different production profile and operating in heterogeneous natural and economic contexts.

The demonstration farms implement and test different practices to limit the run-off of nitrogen and phosphorous compounds to groundwater, such as the preparation of fertilizer plans using innovative methods of balancing the fertilizer components, intercropping practices, and pro-environmentally friendly usage of organic fertilizers.

The study involved the representative set of the AKIS actors involved within this innovative model of linking research with the practice. This set comprised a research institute (Institute of Technology and Life Sciences in Falenty), agricultural field advisors from the Provincial Agricultural Advisory Centres (subordinate to provincial self-governments), subject matter specialists from Agricultural Advisory Centre in Brwinów, branch in Radom (subordinate to Ministry of Agriculture and Rural Development), farmers – owners of demonstration farms, and other farmers (potential recipients of innovations)

More detailed information on this case study can be obtained in the respective country report (Kielbasa and Kania, 2014).

3. Cross-country comparison of the cases studies

This section presents a cross-comparison of the four case studies focused on the role, limitations and opportunities of the advisory services regarding the bridging of the research with the farmer's needs. The comparison highlights the differences between the various AKIS and the existent and emergent gaps regarding the liaison between research and the practice. Figure 1 shows a general overview of the regions comprised by the case studies in each country.

Figure 1*: Localization of cases studies geographical areas, by country*

Role of advisory services

The role of the advisory services in bridging research and practice is related with the AKIS infrastructure is each case study. Hence, a conventional mediating role is encountered in the cases of Bulgaria (BG) and the 'demonstration farms' (in Poland), with the public advisors transmitting and disseminating converted knowledge and information to farmers. However, in the case of the 'demonstration farms' the advisors participate in the process of knowledge generation, together with researchers and the owner of the demonstration farm. In both cases the role of the advisors is a result of a national and regional AKIS infrastructure where the public advisory services are still important and coordinated.

In the case study conducted in Bulgaria, representing in detail the situation in North-Central region, the public advisory services play a main role in transferring knowledge from applied research institutions to the farmers. This is particularly important in the case of small and medium farmers which cannot access directly the researchers, due to the transaction costs and also the existence of cognitive distance in many cases. Large farmers often relate directly with researchers and get the needed knowledge and information generated and operationalised by the research sector (e.g. regarding plant protection and animal health-care) without the advisors mediation.

In the Polish case the public advisors maintain a very important role in the system of knowledge and information. Public agricultural advisory services have been very close to farmer for years, promoting and disseminating innovations. This is evident with their inclusion in the demonstration farms model. They participate in the process of co-generation of knowledge regarding agri-environmental good practices and they are responsible for disseminating it to other farmers not directly involved with the 'demonstration farms' activity. In comparison to the BG case, the role of advisors is amplified due to their participation in the process of knowledge generation and operationalisation.

The Bavaria case illustrates a different situation. The role of the public advisory service is confined to the advice related with non-technical matters, as already mentioned the "welfare-oriented and

policy advice". On the other hand, the technical advice is provided by private advisory which is not connected with the public research sector, namely the experimental stations focused by the case study. This situation suggests a gap regarding the bridge between research and practice in the Bavarian AKIS concerning the technical matters, which are, in general, of great relevance to the farmers. This gap appears to be partially mitigated by the dissemination activities organised by the experimental stations and training centres and by the public thematic offices. These include fairs, conferences, workshops and distribution of leaflets and periodic articles in technical magazines. Farmers and advisors (namely private) can attend to these meetings and make use of the operationalised knowledge and information available on the dissemination materials. The experimental stations also link to the advisors through their educational functions, by being involved in teaching within the region vocational educational system.

The Decision Support Tools (DSTs) studied by the French case study highlight the disappearance of the conventional intermediating role of advisors by bridging research with the farmers and, simultaneously, the emergence of new roles for advisors. The DSTs are, apparently, technologies that link directly research and farmers, bypassing advisors conventional mediating role. However, advisors still play a role by disseminating these tools to the farmers and seem to have gained a 'new' important role, which consists on the validation of the knowledge generated by these technologies while being directly usable by farmers still lacks on-farm validation. Thereafter, advisors might be fundamental to validate and retrieve and also to contribute to the storing of the validation results.

Limitations and constraints of advisory services to bridge research and practice

The limitations and constraints of advisory services present similarities and dissimilarities, according to the nature of their role in bridging the research with practice, which is, as shown, quite different between conventional systems and emerging technologies, such as the DSTs, and also variable according to the available public infrastructure of the regional AKIS covered by the case studies.

In the Bulgaria case study the main constraint results from low demand of farmers for public advice, in particular, the small farmers. This situation is due to the difficulties in access of public advice in the case for farms that are located away from the district administrative centres, aggravated by the fact that the research system generates and operationalises knowledge and technology which largely disregards the needs of the small agricultural farms. The asymmetry in the ability to get public advice and directly access researchers as a consequence of smaller size and lower educational level of the farmers is transversal to all case studies. This is a known situation. However, it matters to highlight that new technology, such as the DSTs, which bridge directly scientific knowledge with the farmers, might aggravate this situation along with the disinvestment in the public advisory services. Nevertheless, the Bulgarian case suggest that the effectiveness of the public advisory services might be significantly mitigated by limited access to advisors, due to transaction costs, and as well by the fact farmers prefer to rely on informal and 'free' advise of suppliers from the downstream industry by avoiding to engage in formal relationships with the public research and advisor services (e.g. by dispensing land to field trials).

The main limitations and constraints found in the Bavaria case related to the fact that since the introduction of the combined advisory system in Germany, the public agricultural extension service limits its activities to "welfare-oriented advice, advice concerning administrative performance, investments and the development of the farm", and the private advisory system has a weak connection to experimental stations. Also, the farmers seem to complain that their knowledge needs

are not fully addressed by the system given they have no direct channels to the researchers in the experimental stations.

In the case of the DSTs studied for the French context the main limitations and constraints are of two types: firstly, the DSTs generate asymmetries of knowledge between actors, due to their sophistication and the fact of being often developed outside of the agricultural context; secondly, DSTs address only certain types of farmers, regarding their size (medium to large), education and farming system, and a large diversity of farmers are excluded from the DSTs conception.

In the case of the demonstration farms, in Poland, the main problem reported refers to the poor feedback from advisory services respecting the farmers knowledge needs to the science institutions directly involved in the demonstration farms network.

Opportunities for advisory services in bridging research with practice

Common features regarding the opportunities envisaged in the studied case studies to overcome the observed limitations and constraints of the advisory function in bridging science and practice are: on the one hand, to create or to improve channels for the communication of farmers knowledge needs to the research sector; and, on the other hand, to promote a better and less asymmetrical access of different farmers (e.g. small farmers, lower educated, among others) to the knowledge generated and operationalised by the research sector. Hence, the role of advisory emerges as fundamental, whereas it can be played by different actors, including researchers, innovation brokers and private advisors. A critical aspect seems to be connecting the private advisors with the research sector, including the suppliers linked with the up and downstream farming industries. The DSTs underline, otherwise, new roles for 'conventional' advisors, but which entail them to develop new attitudes and skills.

Highlights in this respect were corroborated from the country reports reporting on each of the four case studies.

The Bulgaria team underline that the weaknesses found on the relationships between farmers and scientific and research activities might be overcome through a better integration of the producers, research institutes, consultancy companies and financial institutions, by involving them in the realisation of practical collaborative projects and the strengthening of the dissemination of the projects results among the farmers.

The DSTs, studied by the French team, highlight in their opinion the opportunity to transform the way advisory services bridges research and practice in the agricultural sector, by providing shared cognitive resources and databases between researchers, farmers and advisors, in the event there are institutions regulating the quality of these resources, and their accessibility.

The German team underline the role of education, research and training centres (LVZ) which compile the generated knowledge and organise education events to make knowledge available to practice. These centres are thus an important bridge between research and practice, a role that might be strengthened, namely in articulation with the recent model of private advice for the agricultural production subjects.

The Polish team stress that agricultural advisory services in Poland are a link between science and agricultural practice. Cooperation between advisors and research institutes has a significant influence on the level and the scope of the provided advisory services, but advisors need to be encouraged to

better interact with farmers and be able to integrate their research needs and next communicate them to the research interface.

4. Main findings

This section presents the main findings of the case studies within a synthetizing and comparative view. The organisation of the section follows the one from the country reports respecting the presentation of the case studies results regarding: the actors generating the knowledge and how they disseminate it (section 4.1), the activities, processes and methods used to exchange and disseminate the knowledge (section 4.2), the main knowledge contents generated and exchanged by the research sector (section 4.3), the roles of advisory services and the identification of the links between AS and farmer's needs 7section 4.4), and finally section 4.5 is devoted to a comparative review of the performance of knowledge flows and best-fit practices for advisory services regarding the bridging of research with practice.

4.1. Actors and sources of knowledge: where the knowledge comes from?

Table 2 shows the actors involved in the generation and co-generation (in the PL case) of scientific knowledge and its operationalisation. The actors involved in the generation and operationalisation of knowledge and information are the 'conventional' entities in the case studies of BG and Bavaria, the agricultural universities, applied research institutes and experimental stations. These actors are fundamental in all the AKIS grounding for the selected case studies. The 'Demonstration farms' case study shows that farmers, and also the advisors, might play a relevant role in the generation and operationalisation of knowledge and information through a direct participating in these processes. On the contrary, the French case study highlights the appearance of new actors on the scene, such as non-agricultural related companies and farmers associations, which develop the DSTs, numeric devices based on ICT which mobilise and generate agricultural scientific knowledge and make it directly accessible to farmers.

The 'Demonstration farms' case study (PL) highlights the role of the farmers as knowledge co-creators, together with the researchers and other AKIS actors. These farms have demonstration plots encompassing cooperation between agricultural advisory services and agricultural research institutes. These plots are spots where scientific research evidence is implemented, tested and demonstrated providing also opportunities for knowledge and information exchange and dissemination. These opportunities are materialised through on-farm discussions and educational meetings, along with training courses and workshops. Demonstration farms are a 'meeting place' for all network participants, farmers, researchers and advisors. However, it was pointed out by the respective country report (Kiełbasa and Kania, 2014), the surveyed advisors and farmers complaint of unsatisfactory coordination by research actors with farmers' needs, where they found insufficient knowledge transfer regarding the farmers needs. These actors also point out a limited role of the universities, which in their view should be improved. These suggestions were also reported in the Bulgarian case study (Dirimanova and Ivanova, 2014), whereas they were less surprising given that in this case the farmers are not directly involved in the generation and operationalisation of knowledge.

The Bavarian case study, and also the Bulgarian one, highlighted the role of crop/thematic specialised R&D institutes or experimental stations as the main actors on the research side, generating and operationalising knowledge and information to be transfer to the farmers.

The DSTs in the French case study underline the role of unconventional actors (public, private or third sector) on the side of AKIS research sector, generating and operationalising sophisticated and highly standardised knowledge. These appear to meet farmer's knowledge needs by solving technical problems, such as precise-dosing fertilisation or using positioning systems (GPS) technologies to combat diseases and pests.

Table 2: *Main actors and activities related with the knowledge generation and dissemination*

	'Region knowledge transfer system (BG)'	DSTs in France	Experimental Stations in Bavaria	'Demonstration farms' (PL)
Actors	• Agricultural University (Plovdiv) • Fruit Growing Institute (Plovdiv) • Institute for plant and genetic resources (Sadovo) • Vegetable crops research institute (Plovdiv) • Experimental station for irrigation (Pazardjik)	• National Institute for Agricultural Research (INRA) • Union of cooperatives (InVivo) • Airbus Defence and Space Industry • ARVALIS (Applied Research Institute)	• Bavarian State Research centre for Agriculture (BSRCA), includes experimental stations • Education, research and training centres (LVZ) • Agricultural offices	• Agricultural Advisory Centre (National unit) • Provincial Agricultural Advisory Centres • Demonstration, educational and experimental stations • R&D and education • Farmers
Activities	• Demonstrations fields • Thematic events • Thematic open days • Training • Seminars • Specialized exhibitions (national and international) • Websites	• Development and utilisation software applications • Formal partnerships/contracts between research institutes and advisory organizations (R&D projects, shared data bases…)	• Fairs • Conferences • Workshops • Communication materials (leaflets, newsletters, reports)	• Periodic meetings (strictly cooperate between farmers and local advisors) • Implementation of the research projects (preparing tools, research methods) • Training and visits on demonstration farms • Professional training, seminar field days, courses (e-learning and b-learning), study visits • Scientific publications • Conferences, scientific seminars

The activities used by the actors involved in the operationalised knowledge dissemination, which include in most cases researchers and advisors, but also specialists and invited experts, comprise a variety of actions. Transversal knowledge exchange and dissemination activities for most of the case studies (excluding the DSTs French case) are training and dissemination events (seminars, workshops, conferences). Also in this category are the thematic open days and the events at the demonstration farms. These activities vary between sporadic and regular and involve a higher or less degree of formality regarding the farmers (and advisors) involvement. Other ways to channel the knowledge and information to the farmers (and to the advisors) are technical publications, leaflets and websites. For example, in Bavarian case study, the farmers indicated that the printed media are their first source of information about new research results and knowledge.

The French case, by opposition, highlighted the importance of new technologies to obtain operationalised knowledge and solve problems in agricultural production activities by direct access to scientific knowledge (to identify pest crops, to map nitrogen needs…) for various end-users

(farmers, advisors). The farmer's access to this highly codified knowledge entails contractual relationships and the payment for the service, pointing out the commoditisation of knowledge.

The case studies indicate that public knowledge generation for farming practices is becoming more alienated. In response, farmers seek contact with private advisors, advisors from the industry and exchange with their colleagues in order to get information. New or adapted institutions seem to be necessary to ensure a bridge between publically funded research and farming practices. The DSTs (FR) highlight the transformation of operationalised knowledge into a commodity to be bought by farmers.

4.2. Activities, processes and methods to exchange knowledge

The four case studies comprise a variety of activities, processes and methods to exchange knowledge between the research sector and the farmers and other end-users. These comprise tangible interactions (based on field experiences in demonstration farms or experimental stations) or more intangible ones (based on ICTs and DSTs).

Table 3 identifies the main activities, processes and methods used to disseminate and exchange knowledge with farmers. In all cases, with the exception of the DSTs case (FR), training actions and on-farm demonstration activities and the involvement of the advisory sector is essential. In Bulgaria expertise advisory and extension services are provided by the research sector, while in Germany and Poland advisory services are needed to mediate research and the farmer's needs (with the exception of owners of demonstration farms).

Table 3: *Activities, processes and methods to exchange knowledge with end-users*

	'Region knowledge transfer system (BG)'	DSTs in France	Experimental Stations in Bavaria	'Demonstration farms' (PL)
Activities, processes and methods	• Practical and applied agriculture research • Advisory and extension services • Conducting demonstrations • Training	• Shared data bases and determination keys to identify pests • Intangible goods such as maps and numeric files to support collective decision • Software to organise advisors' data • Advisory services (and group advice) as a support to integrate DST in broader advice	• Practical and applied agriculture research • Advisory services • Law enforcement function • Conducting demonstrations • Training	• Practical and applied agriculture research (• Advisory services • Conducting demonstrations • Training
End-users	• Farmers • Students • Researches • Experts • Commercial companies • Organisations of the sector	• Up and downstream agro-food industries • Farmers • Advisors	• Farmers • Advisors • Technicians and experts from the agricultural offices • Research and education centres • Students	• Farmers • Local community • Advisors and teachers from agricultural schools and universities

In the Bulgaria case study, the knowledge exchange is promoted through organized events and seminars by the scientific institutes and the university, both independently or cooperatively. Also, the participation in international and national exhibitions and demonstration events are widely used.

In the French case study, as highlighted in the respective country report (Labarthe and Deville, 2014), the development of DST is related to the new opportunities opened by ICTs to hasten the use of scientific knowledge in practice for farmers, and by the growing need for farmers and advisors to keep tracks respectively of their practices and of their recommendation. Although, this is also from the supply side a result of the willingness of different actors to develop new services for farmers, whereas this was not formerly their mission or activity (Labarthe and Deville, 2014). These 'unconventional' actors invest in R&D and have new strategies to generate new knowledge flows within the sector and to earn value and returns from them, by changing not only the procedures for knowledge exchange within AKIS (with more contracting), but also the content of knowledge (with more standardisation).

The following bullets highlight some of the constraints that farmers identified regarding knowledge exchange access in the different case settings:

- Remoteness of the farmer's location regarding the location of knowledge transfer events, which entails high transitional and financial costs, especially to the small scale farmers (BG).
- A growing codification and standardization of the knowledge exchanged between the actors, and a formalisation of the relations between them. There are increasingly formal contractual relationships between actors, where advisory services tend to become 'clients' of the DST supplied by research organisations, either public or private ones (FR).
- Although farmers might formulate research-related questions and communicate them to the public agricultural offices, the lack of involvement of farmers in the generation of research questions create a distance between practice and research (DE).
- Farmers often do not receive the results of the research in which they participated (PL).
- There is lack of funds for implementing the projects to solve the specific problems of farmers (PL).

4.3. Knowledge contents

The main knowledge contents provided by the research sector within the selected case studies are introduced by Table 4. It is noteworthy the variety of subjects presented, whereas there is a predominance of the technical production issues. In both the Polish and the Bulgarian case studies, the research sector appear to be involved also in the transferring of information related to measures within the Rural Development Programme (RDP), probably due to the proximity between the research sector and the farmers (or at least some type of farmers). The Bavarian case study evidence the questions related to environmental and agricultural practices. On the other hand, in the French case the precision farming systems are highlighted and the DST devices are intended to promote and introduce new innovations dynamics with the claim to support a more sustainable use of resources and to decrease the pesticides use (nitrogen, pesticides…).

The diversity and complexity of knowledge content exchanged are closely related to solving practical problems. For example, in the BG case study the demand for knowledge responds to business competitiveness issues and quality of products, but despite this it was also pointed out by farmers a gap regarding the knowledge supply and farmer's knowledge needs. Consequently, in this case it comes without surprise the fact that farmers self-exclude themselves from potential opportunities for co-creation processes. In the Bavarian case, the lack of involvement of farmers in the processes of generation and operationalisation creates distance between practice and research.

Table 4: *Knowledge and information contents supplied*

	'Region knowledge transfer system (BG)'	DSTs in France	Experimental Stations in Bavaria	'Demonstration farms' (PL)
Content	• New technologies and equipment's • New varieties (small-scale farmers) • New ecological methods for disease and pest control (large-scale farmers) • New growing technologies • Plant nutrition systems • RDP measures	• Geographical information systems • Plant nutrition systems and diseases/pest control • Precision farming technologies	• Production Technics • Good agricultural and environmental practices.	• Plant production technology • Animal production technology • Agricultural technology • Environmental protection and ecology • Agro-environmental programs • Economic and farm management (business plan development and measures of the RDP)

The Bulgarian case study of the knowledge transfer system has focused upon the region of Plovdiv that makes clear the knowledge needs (in terms of contents) were different for large or small farmers. For example, large farmers demand specialized knowledge related to combat diseases and pests, implementation of new technologies offered by the scientific institutes, as well as organizational and managerial knowledge (such as methods for management of their farms, preparation of monthly and annual accounting reports etc.); While, on the other hand, the small growers seek knowledge related to the production process itself and methods for reduction of production costs and achievement of higher yields.

The development of the DST, as shown in the French case, might be associated to the new opportunities opened by ICTs to speed up the use of scientific knowledge in practice for farmers. But it is also the expression of strategies for different actors to develop new services for farmers, whereas this was not formerly their mission or activity. These strategies change not only the procedures for knowledge exchange within AKIS, but also the very content of knowledge, with more standardized knowledge. For instance: maps indicating how much nitrogen to spray according to geographical position in fields, pictures libraries and determination keys of horticultural pests, diagnostics to check farm cross-compliance.

In the Polish case study the type of knowledge that is required on farms is mostly determined by the production orientation, the farmer´s experience in management (lower experience tend to relate with the search and use of various sources of information), and farms financial capabilities. Although, the subjects dealt with on demonstration farms network have a close connection with public goods, such as natural environment, biodiversity, surface and groundwater quality, and natural landscape protection.

The Bavarian case study shows a gap in the articulation between research and the private advisory, which is in charge of technical subject's advice. This might explain the farmer's dissatisfaction regarding the account of their needs by the research sector.

4.4. Role of advisory services

As already shown in previous sections the role of advisory services in bridging research and practice varies across the geographical and socioeconomic contexts, depends on the existing AKIS infrastructure, and is somewhat 'threatened' by the novel technologies, such as the DST, that provide

directly to the farmers operationalised scientific knowledge. The role of advisory service in each of the selected case studies is synthesised and briefly discussed in the next paragraphs. Table 5 highlights who are the actors involved in bridging research and practice and how advisory services bridge (or not) these components of the AKIS.

Table 5: *Actors bridging research and farmers and the role of advisory services*

	'Region knowledge transfer system (BG)'	DSTs in France	Experimental Stations in Bavaria	'Demonstration farms' (PL)
Actors bridging research and farmers	• Scientific centres of applied research institutions • Consultants from those institutions	• DST developers, which include: – Public-private partnerships; – Public research institutions – Union of French farmers' cooperatives	• Subject matter centres • Public agricultural offices	• Research centres and universities • Subject matters specialists from Agricultural Advisory Centre • Provincial Agricultural Advisory Centres (field advisors) • Owners of demonstration farmers
Role of advisory services	• Public advisory services play a complementary role • Input suppliers advice often substitutes former actors role (small-scale farmers)	• Ex-post validation of knowledge • Advice to farmers on how to integrate different sources of knowledge	• There is a limited role of public advisors who are confined to non-technical advice	• Public advisory services bridges research and practice, in particular by disseminating the knowledge to other farmers not involved with the demonstration farms

In the Bulgarian case, the research institutions play direct advisory and extension functions, namely by delivering consultancy services to the farmers. These specialized consultancies are mainly in the field of plant production, maintenance of soil in good agricultural and ecologic state and supervision of the approved projects according to the RDP measures. In addition, the consultants of scientific institutions organize a wide range of dissemination events, through their scientific centres, such as seminars, lectures, thematic meetings, workshops, among others. However, due to scarcity of financial resources these functions are performed at a limited extent and benefit mostly the large farmers that can afford the consultancies and that aren't constrained by the transaction costs which hinder small-scale farmers to demand the direct advice of researchers and consultants from the research sector. Hence, the applied research institutions are recognized as institutions that can meet the demands for knowledge in the case of the large farmers, but that fail to respond to the needs for small-scale farmers. The latter resort to advice from suppliers to release farmers from transactional costs and is 'free'.

The DSTs in French context underline 'new' roles for advisors (public and private), which consist in validating the knowledge and/or the integration of information generated by the DST with other sources of knowledge to support farmers in changing their practices or production systems. The validation might not be a relevant function, for instance in the case of where the DST produce evidence of presence of a given pest or disease in a given field. However, advisors can be helpful by supporting farmers on how to integrate information from DST with other knowledge sources as abovementioned. According to the French country report (Labarthe and Deville, 2014) it might be a

bit too early to fully assess the changes induced in by DST in the advisory role, but that nevertheless, it seems that the front-office dimension of advisory services still have an important role to play in the integration of various knowledge flows at farm level. There is still a need for such services in their front-office dimension, for integrating knowledge through interactions between farmers and advisors. But these services may play a less important role in their back-office dimension, e.g. in the validation of the scientific knowledge integrated in the DSTs.

The Bavarian case presents a situation where there is no formalised bridging function of the private advisors who are partners in the combined advisory system, except for voluntary information collection, learning and transmitting, where appropriate. The formal bridging role is occupied by the agricultural offices, the farmers' association and the members of the recently set-up private advisory services. The experimental stations are responsible for the generation and the operationalization of knowledge to their 'clients' within the AKIS (e.g. advisors within the agricultural offices) rather than for direct linkages to farmers.

Agricultural advisory services in the Polish case play a very important role in AKIS. It enables the transfer of knowledge into agricultural practice and provides constant access to advisory services for farmers. The public agricultural advisory service has been very close to the farmer for years. Apart from organizing training courses for farmers (*educational function*), it focuses on the comprehensive assistance to farmers and countryside inhabitants. Recent years show that the main goal is helping farmers in applying for financial aid from the EU funds (*the advisory function* and *the information function*). The *income function* of the agricultural advisory service was partially taken over by private consulting companies or by the companies selling the means of production. The 'Demonstration farms' perform a very important function with regard to disseminating innovations. They are a base for field experiments and tests carried out by researchers and private companies. As a result, the owners of these farms become pioneers in their regions, with regard to the implementation of new technology.

A common gap identified in all case studies by farmers and advisors (not surveyed in the French case) is a limited cooperation between them and the research centres and universities. This affects more the small farmers in the case of Bulgaria, is transversal to all farmers in the Bavarian case, and it is mitigated by models such as the 'Demonstration farms' in Poland.

4.5. Knowledge flows for linking research with the practice

The knowledge generated and operationalised by the applied research institutes, demonstration farms, and experimental stations is transferred more directly or indirectly to farmers through various processes, actors and channels. This section is devoted to synthetize and to discuss the knowledge flows described in the country reports for each case study. The Figure 2 illustrates a comparative view of the knowledge flows observed in the selected case studies.

In Bulgaria, the main topics of the knowledge transfer are related to new technologies, specific productions and different applications in plant growing and livestock breeding sector, as well as to training and participation in the measures of the RDP. Research institutions have scientific centres that use a combination of different communication channels to exchange and to disseminate knowledge and information to farmers. In this case the knowledge transfer benefits from the active role of the agricultural producers, mostly large farmers, who are looking for solutions to their

problems. But, on the other hand, the farmers rarely provide their farms for demonstrations. The lack of long-term contractual relations between the farmers and the research institutions is due to the unwillingness of farmers to be bound to the entity and to have more freedom in choosing advisory providers. Therefore the knowledge flows that link research and practice are rather unidirectional, whereas researchers and subject matters advisors might use feedback from farmers in the design of their research questions.

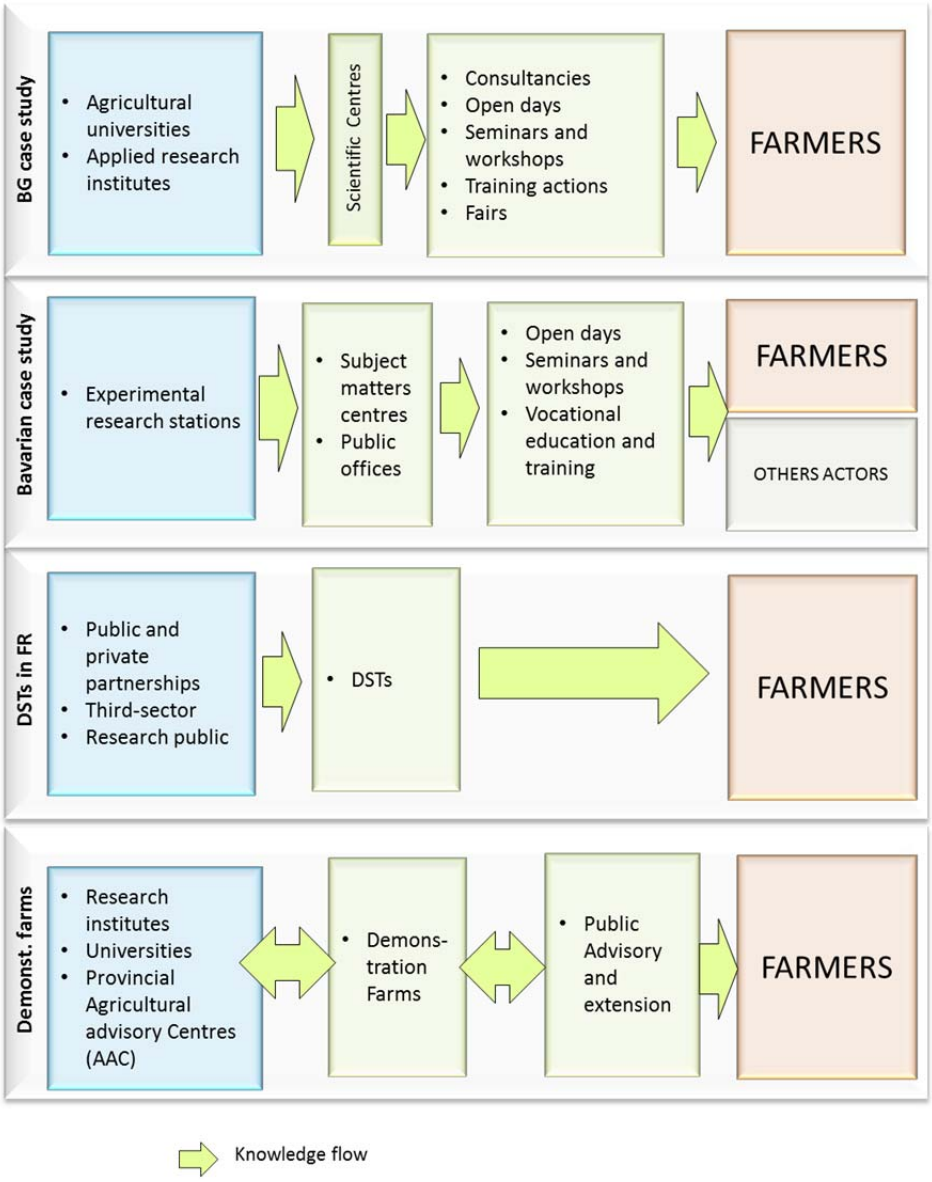

Figure 2*: Knowledge flows between research and practice in selected case studies*

The DSTs, studied in French context, allow for a better understanding on how these tools might change the 'conventional' knowledge flows involved by the scientific knowledge exchange with the farmers. The DSTs studied were developed as an initiative of a research actor, which included outsiders in relation to the agricultural sector (in the studied case, a DSTs has been developed by an aero-spatial company, the Airbus). In terms of changes in knowledge content, it appears that the topic of knowledge embedded in the DST is mainly defined by the agenda of the research organisations launching the DST. The integration of societal concern and public issues depends on

the incentives of these organisations to do so. If the integration of environmental goals is clearly on the agenda of INRA when diffusing *Di@gnoplant*, such goals might be less central for other DSTs developed by industries.

These technologies that allow for the direct transfer of the knowledge from research to the farmers, along with the entrance of non-conventional actors into the AKIS inevitably changes the relations amongst traditional actors of the French AKIS, including applied research institutes and advisory organisations (chambers of agriculture, farmers' cooperatives…). The relations between these actors have been embedded in a very long tradition of interactions within an AKIS supported by public policies, where informal relations were very important. The spread of the DST is one of the elements that leads to a growing formalisation and contracting of the relations between these actors. Different actors (research organisation, private companies…) tend to codify their knowledge into intangible goods that they commercialise to other actors of the French AKIS, and that they want to promote as new standards within AKIS. So, the development of DST comes together with a growing codification of the knowledge exchanged. But, in any case, the question of the empirical validity of the knowledge for practice remains open, and raises the issue of the role that advisory services may play regarding this validation.

In the Bavarian case study, the interviewed advisors indicated that communication between the different advisors does not occur in a structured way but through occasional encounters. They thus argue for a need to install a more structured way of contacting and collaborating with other advisors in the region. Moreover, former advisors of official agricultural extension services fear that through the current reform, that excludes public advisors from the technical advice, may weaken even more the connection between research and the farmer's knowledge needs. They state that even though they still fulfil the role as teachers in vocational agricultural schools, they no longer visit farms themselves. Although the subject matter centres and some experimental stations organise regular knowledge exchange and dissemination actions, farmers aren't involved with the processes of generation and operationalization of knowledge neither in storing knowledge and nor the development of new research topics.

The 'Demonstration farms' in Poland illustrates the only case study where bi-directional knowledge flows are present. This suggests the importance of involving farmers and advisors within the knowledge generation, through testing and demonstration systematic activities. In this case the scientific knowledge created by researchers and specialists from universities and experts from public advisors centres, is operationalised in the demonstration farms by involving farmers and advisors in the process. The demonstration farms themselves, and in particular the advisors participating in these co-creation processes, are key actors in passing the knowledge to other farmers, and as well as to others local actors, such as countryside inhabitants and local authorities. Still the link with these farmers is unidirectional and they also complain of little consideration for their knowledge research needs about the research issues address by the agricultural scientific institutions.

4.6. Performance of knowledge flows and best-fit practices for advisory services

Performance of knowledge flows

The Bulgarian case study establishes a lack of coordination structure for the agricultural research activities that limits the cooperation amongst them and the promotion of the researchers work. The

difficulties that farmers experience in accessing the knowledge exchange and dissemination comprise the following: The main weak points of the knowledge transfer are as follows: 1) low usage and demand for information, consultancy services and training by the agricultural producers; 2) difficult access to agricultural advice for farms that are located away from the district administrative centres; and 3) underdeveloped system for technology and knowledge transfer towards small agricultural farms. These weaknesses translate into a limited demand and usage of new knowledge and information by small-scale farmers, which have a negative impact over the introduction of new technologies, growth of productivity and effective usage of production resources.

The French case study allows for a discussion of whether DSTs and ICTs enable a better access to knowledge for a broader diversity of farmers. The DSTs appears to have some potential for enhancing the quality of the knowledge flows and the relations between partners within AKIS. For instance, the DST Di@gnoPlant makes possible for farmers and advisors to share a diagnosis about which pest is present in a given field. However, the DSTs are initiatives of research organisations and the integration of end-users varies greatly from one case to another, according to the strategies followed by the research organisation at the initiative of the project, but also according to the knowledge content exchanged. In certain cases, such as DSTs associated with precision farming technology, these technologies are not relevant for diverse categories of farms, comprising for instance the small farms or farms not specialised in arable farming.

In the Bavarian case, while the public agricultural offices are an active partner in the role of disseminating knowledge, namely the operationalised knowledge and information generated by the experimental stations, farmers appear detached from the knowledge generation sector. This situation is probably related with the fact of technical advice provided by private advisory system that is not yet properly integrated in the regional AKIS, in particular regarding the linkages with the research sector.

The 'Demonstration farms' in Poland offer a good example of cooperation among researchers, specialists from the Agricultural Advisory Centre, agricultural field advisors and farmers in the knowledge creation process. However, whilst the cooperation of farmers with field advisors is of a permanent nature, the interaction with researchers is not. Hence, the strongest link in the knowledge flows is the cooperation between farmers and advisors from agricultural advisory centres. The implementation of research and educational projects, such as the demonstration farms network, involving the participation of the representatives of science, farmers and advisory services allows for the strengthening of the cooperation between researchers and farmers. This model has a particular importance in the process of transfer of research results to agricultural practice. The direct cooperation between researchers and farmers enables the establishment of contacts, the conversion of theoretical knowledge into practical one and the researchers understanding of the knowledge needs of the farmers.

Best-fit practices for advisory services

The Bulgarian case study evidenced a best-fit practice regarding the interface between the research and its knowledge transfer activities, which is the existence of the scientific centres that rely on multiple channels, including demonstrations on-farm and the supply of quality consultancy services directly to farmers. The demand of large farmers and also from small-scale ones located in the proximity of these centres highlights the benefits of this model. The limitations it presents are

related with the difficulties of small-scale farmers from more distant location to access it, and also to the fact that farmers don't show willingness to receive field trials or other on-farm experiments in their own properties that limits the possibilities for the development of co-creation processes.

The French case study underlined that some DSTs might have potential for enhancing the interaction between AKIS actors, by providing access to reliable sources or empirical evidence. The conditions for success are, according to Labarthe and Deville (2014) the development of DST providing knowledge: 1) perfectly codified; 2) supported by accessible evidence produced with reliable methodology; and, 3) with the perspective of integrating end-users feedbacks.

The Bavarian case study highlights the need to fully integrate the private advisory sector within the multi-actor AKIS which was a feature of the region. There is a gap in linking research sector with the farmers needs in spite of a good coordination between research sector and the non-technical advice performed by the public sector advisory. This gap is probably due to the disconnection of private advisors from the research sector and the fact that farmers don't dispose direct channels with the researchers (e.g. through collaborative projects).

In Poland, the 'Demonstration farms' network is a best-fit case regarding the bridging of research with the practice, by allowing and stimulating knowledge co-creation processes related with environmental good practices, which allow the farmers to supply public goods for the society. Despite the positive features of this multi-actor cooperation involving the advisors, some weaknesses are observed. The main problem seems to be poor feedback from advisory services to research. In this light, agricultural advisory has an important role in connecting practice and science, it should not be only limited to providing knowledge and information to farmers, but it should also transfer feedback problems to the science entities.

5. Discussion and recommendations

The case studies findings show innovative models to bridge science and practice, such as the 'Demonstrations farms' in Poland, that can in fact improve the effectiveness of knowledge generation for their actual end-users. However, they also show, through the DST case, studied within the French context, how technological innovation linked with the ICT sector can revolutionize the traditional formats to link the research with the practice, by passing the knowledge directly to the farmers without the need for mediators, thus bypassing the conventional mediating role of advisors.

The Bavarian case, on the other hand, illustrates that the privatization of advisory services has to improve the articulation and coordination of advisory private sector with other components of the AKIS, in particular with the research sector. This later case study also suggests that farmers actually want to be more directly involved in the AKIS research activities, namely by having a voice regarding the selection and design of the research questions undertaken by the research institutions. This concern by the farmers, regarding the insufficient attendance of their knowledge needs, is transversal to all case studies, with the exception of French case study that didn't interview farmers.

The Bulgarian case highlights that a strong research sector can bridge directly large farmers but that it is ineffective (and cost-inefficient) regarding the small-scale farmers. The Bulgarian and Polish case studies, as well as some extent the Bavarian case study (for wellbeing related issues), underline that a strong public research infrastructure appears to be determinant for a well-performing AKIS

regarding the generation and the exchange/dissemination of relevant knowledge to farmers. They also show that its performance might be increased by directly involving farmers and advisors in the processes of knowledge co-creation and/or operationalization.

The Polish case underlines the importance of a good connection between the research and the advisory services, when the latter are organised and include specialised advisors. The latter are also present in the Bulgarian case, although directly affected to the research sector which delivers consultancy and expertise services directly to the farmers.

The French case demonstrates the emergence of 'new roles' for advisors, such as supporting farmers to integrate heterogeneous knowledge from different sources when they resort to DSTs, and the validation of knowledge within the process of the DSTs development that are created by the conventional AKIS actors, such as farmer's organisations. In the case where DSTs are developed outside the farming sector the validation role of advisors reduces the on-farm validation in the context of supporting farmers to integrate knowledge and to decide upon farming practices and inputs selection to respect regulations and improve yield and/or quality results (e.g. plant protection products). In any case the DST might lead in the future to the reduction of the back-office R&D dimension of advisory services, while it appears to be still needed on the advisory front-office. In addition, the DSTs target only segments of farmers, such as medium to large farmers specialised in arable crops, leaving aside numerous types of farmers. Thus, there is a risk, under certain circumstances (such as the involvement of big private companies), of DSTs to generate growing asymmetries of knowledge within the AKIS, to the detriment of farm advisory services.

Research-practice bridging models such as the 'Demonstration farms' might show quite useful means to create and disseminate good practices regarding environmental protection and the sustainable use of the natural resource (public goods provision). This is so because they allow for the creation of practical knowledge which can be used directly on real farms. The possibility of farmers to observe the research results on demonstration farms allows them to make a decision to introduce the innovations much faster. Hence these models, such as the 'Demonstration farms' appear to be very promising regarding the dissemination of innovations. They are a base for field comparisons and tests carried out by researchers and private companies. As a result, the owners of these farms become farm leaders in their regions which tend to be imitated by other farmers. However, the adoption of these models might be complicated by lack of farmer's adherence to formally engage with the public research sector, as shown by the Bulgarian case study.

Recommendations

Based on the findings of the case studies, from the key message presented in the 'discussion' above, and the insights of the stakeholder guests at the synthesis seminar in Germany, some recommendations are drafted in the following bullets. These recommendations address mainly the stakeholders and politicians committed to the improvement of the AKIS performance in bridging research and practice.

- There is a need to articulate the private advisors with the research sector, including the private sector which is client-oriented (such as the FBOs), the independent consultants and also, as much as possible, the selling-oriented advisors from the upstream and downstream farming industry; The suggestions on how to achieve this goal include: a) advisor education and training; b) advisor involvement in transdisciplinary projects; and, b) their involvement in collaborative projects on-

farm focused on applied research and/or problem-solving (e.g., field trials, co-design of DST, co-design of machinery).

- It is important to facilitate the communication between farmers and the research sector in order to assure knowledge for farmer's needs don't stay unattended; The suggestions on how this recommendation could be implemented include: a) attract farmers to multi-actors knowledge and innovation networks; b) involve farmers in collaborative projects focused on applied research and/or problem-solving (e.g., field trials, co-design of DST, co-design of machinery); c) organise open forums and/or other participatory events which allow farmers and their representatives (e.g., FBOs, Agriculture chambers, farmers associations) to express and communicate their problems and demands which translate into knowledge research needs.
- Differentiate farmer's knowledge generation and operationalisation needs, according to their size, education and business model. The suggestions on how to accomplish this recommendation comprise: a) resorting to the advisors mediating role; b) seeing farmers, advisors and researchers roles as interchangeable function roles; c) change the view of 'excellence' evaluation process by awarding impact on the generation of relevant knowledge, according to different types of farmers and their representatives, including 'alternative' farming models such as organic or 'community supported farming'.
- Reinforce the advisors and other actors (e.g. researchers, specialists or brokers) mediating role, acting as intermediaries, facilitators and/or brokers to bridge farmers and research. This is important to ensure the channelling of different knowledge needs of different farmers to the research sector. How this could be done? The suggestions include: a) advisor training and professional acknowledgement; b) involve advisors with on-farm and/or applied research collaborative projects; c) network advisors with farmers, researchers and other actors of the AKIS; d) use advisory services as a way to better connect DSTs derived from research and conceived by researchers with the diversity of knowledge needs in rural areas (i.e., from diverse social groups).
- Promote research policy strategies driven by the answer to practical needs for the farmers. This recommendation entails development of stimulus for applied research, such as funding opportunities and alternative grids to select projects, based on relevance of expects research results.
- Channel public funding to "good" models to bridge research with practice, such as the 'Demonstration farms', 'Monitor farms', and to research and educational project that enhance multi-actors cooperation around implementing and testing scientific knowledge and its conversion into practical and usable forms of knowledge, and/or the co-creation of practical knowledge addressing farmers problem-solving; these models and projects appear to be particularly important to stimulate the development and the adoption of 'good' environmental and resource-sustainable farming practices.
- Stimulate innovative knowledge exchange and dissemination action of research sector by supporting and (co-)funding activities such as methods for group advisory methods, on-farm demonstrations and experiments and ICT based dissemination actions (e.g. e-learning courses, videos, websites, etc.).
- Related with the development and spreading of the DSTs, support the development of tools and data base that provide reliable and robust evidence to farmers and advisors. This could help

building shared diagnostics between farmers and advisors, and help integrate environmental issues in the co-construction of new technical solutions. In this respect it is also important to design and to implement procedures to guarantee the quality of the evidence produced, and institutions to avoid asymmetries of knowledge (role for public actors or agencies).

The listed recommendations express the concerns of the interviewed actors within the case studies and the reflections that stakeholders made around them in the synthesis seminar. They basically highlight that 'good' models and practices encountered that should be encouraged and that 'new' solutions are needed to deal with the changes in the European AKIS (e.g. advisory services privatisation and public disinvestment), the farmers increasingly awareness that research sector should respond to their needs, and the technological innovations, such as the DSTs, which challenge the conventional ways to bridge research and practice.

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