

Structural conditions for dynamic innovation networks: a review of eight European Agricultural Knowledge and Innovation Systems

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Keywords: AKIS, System failures, collaborative networks

Abstract

In this paper we investigate the organisation and functioning of the formal AKS and how it can support or inhibit innovative bottom-up approaches to knowledge co-creation and social/joint learning. We have investigated how the main actors interact within their respective innovation systems and how they are influenced by various institutional characteristics. Using an Innovation System matrix the main enablers and barriers with regard to collective action have been categorized. The paper presents a comparative analysis of the different types of Agricultural Knowledge Systems within eight different European countries (England, France, Germany, Hungary, Italy, Latvia, the Netherlands and Switzerland). Results show how the knowledge infrastructure, existing rules and regulations, network structures, innovation capabilities and market structures differ from country to country. And how these institutional determinants can both support or inhibit joint learning and bottom-up innovation projects.

1. Introduction

Government-driven agricultural knowledge systems, or AKS for short, historically have been organised linearly around the transfer of knowledge from scientists to farmers by means of state sponsored extension workers. Research, education, extension, and support systems thus comprised of the most important subsystems of the AKS (Leeuwis & Van den Ban, 2004). Since that time the linear model of innovation has been challenged by a model in which new knowledge and innovations are co-produced by 'a network of organisations, enterprises and individuals focused on bringing new products, processes or new forms of organisation into economic use, together with the institutions and policies that affect the way agents interact, share, access exchange and use knowledge' (Hall, 2006). This definition of an innovation system signifies a transition of the traditional AKS into a more open, inclusive and coordinated system, the Agricultural Knowledge and Innovation System or AKIS that includes rural (micro)entrepreneurs such as farmers and others, as well as consultants, policy makers, supplier and processing industries, retail outlets, customers, NGOs and financial service providers in the innovation process (Knickel et al., 2009).

At the same time, the issues affecting agriculture have grown increasingly complex. Climate change, food security and globalisation are just a few examples of the challenges that are characterised by non-linear processes playing out on multiple scales involving a wide range of stakeholders with different views and interests. To deal with this type of complex problems, flexible and dynamic innovation networks are formed that go under different names in the literature as 'innovation coalitions' (Biggs & Smith, 1998), 'innovation configurations' (Engel, 1995), or 'public private partnerships (PPPs)' (Klerkx, 2008), Communities of Practice (CoPs) and Networks of Practice (NoPs) (Lave & Wenger, 1991; Oreszczyn et al., 2010). In these collaborative networks, joint (or social) learning and negotiation takes place to shape an innovation (Leeuwis and Van den Ban, 2004).

In our contribution to this conference we investigate the current organisation of the Agricultural Knowledge and Innovation Systems in eight European countries and focus specifically on their ability to incorporate these new innovation networks in the innovation process. To enhance 'networking for innovation' the literature emphasises the need to come to shared visions, well-established linkages and information flows amongst different public and private actors, conducive incentives that enhance cooperation, adequate market, legislative and policy environments, and well-developed human capital (Hall et al., 2003). However in reality the establishment of these networks within an existing Agricultural Knowledge and Innovation System (AKIS) is strenuous at best. Creating and fostering effective linkages between heterogeneous sets of actors (i.e. the formation of adequate innovation configurations) is often hindered by different technological, social, economic and cultural divides (Hall, 2006).

The aim of this paper is to compare the organisation of the AKIS in eight European countries (England, France, Germany, Hungary, Italy, Latvia, the Netherlands and Switzerland) and derive some implications of these different types of AKIS for the potential to establish new collaborative learning and innovation networks. As such this paper provides an update and expansion of earlier work done in this field by Garforth et al. (2003), Laurent et al. (2006) the current work carried out by SCAR, the Standing Committee of Agricultural Research (Dockès et al., 2011) and the results of the IN-SIGHT project (Rantanen & Granberg, 2008)

2. Comparing agricultural knowledge and innovation systems

In the last twenty years many European countries have started to reorganise their national Agricultural Knowledge and Innovation Systems. However, in many cases these changes have not occurred under the push of a clear strategy, but rather have been an adaptation to changing regulatory, social and economic environments. Thus, the decreasing economic importance of the agricultural sector in most European countries combined with the changing political landscape in Europe after the fall of the iron curtain, the accession of the new member states and the subsequent reform of the Common Agricultural Policy, and have led to a widely diversifying set of Agricultural Knowledge and Innovation Systems in Europe.

The innovation system framework (Klein Woolthuis et al., 2005; van Mierlo et al., 2010) systemically categorizes some typical institutional failures that might limit the potential of an innovation project or policy to reach its potential. One central pillar of the innovation systems approach is that innovation does not take place in isolation, but requires interaction, cooperation and learning. The other pillar is that institutions, defined as 'the rules of the game', and how they shape and in turn are shaped by the interactions of the actors. The innovation system failure framework, shown in Table 1 makes a distinction between the 'players' and 'the rules' of the innovation game (Edquist et al., 1998). The columns of this matrix contain some of the most important actors that make up the agricultural knowledge and innovation system. Since these actors differ from country to country, we have used a number of common types of organisations to be included in the matrix. However, it is important to note that not all categories are equally important in all countries. The rows of the IS matrix contain the different categories that may hinder (or facilitate) the performance of the innovation system. Below we will briefly describe these categories:

- **Infrastructure** concerns the physical infrastructure, such as roads, railroads and telecommunication. The absence of infrastructure results in constraints that require major investments that cannot be made by the actors of the system independently. With regard to the AKIS, the infrastructure also concerns investments in knowledge infrastructure (R&D facilities) the financial infrastructure and funding of public and private research.
- **Laws and regulations** form the formalised rules of the system. A lack of them may hamper innovation. For example, lack of intellectual property regulation takes away incentives from innovators as they cannot protect their innovation. Absence of environmental regulation on

radically different systems, having an institutional vacuum, may slow down certain developments. However too much regulation and red tape can also be detrimental for the innovative performance.

- The unwritten rules are formed by the **‘norms, values and culture’**, and they refer to ‘the way business is done’ between the actors in the AKIS. They affect how actors interact and the trust between them, but also relate to their (in)ability to change their norms and values to enable innovation to take place, for example, different worldviews of researchers and farmers on what constitutes ‘good farming’ may affect how they cooperate in innovation processes.
- **Interactions and network characteristics** refer to the way actors are connected to each other, or the characteristics of the social networks they are part of. Strong network failure refers to a (small) number of actors ‘locked’ into their relationship with each other without links to outsiders, causing myopia and blocking new ideas from entering. ‘Weak network failure’ refers to a situation where actors are not well connected and fruitful cycles of learning and innovation may be prevented because there is no creative recombination of knowledge and resources (Håkansson & Ford, 2002).
- **Capabilities** points to the technical and organisational capacity of the actors in the system to adapt to and manage new technology and organisational innovations. Examples are a certain level of entrepreneurship, adequately educated persons, time to dedicate to innovation, networking skills, also referred to as ‘absorptive capacity’ (Cohen & Levinthal, 1990).
- Finally, **market structure** refers to the positions of and relations between market parties. In this case we focus on the organisation of the knowledge market and the position supply and demand take of information is arranged. Well known problems are formed by monopolies, or the lack of transparency in complex food supply, but also imperfections in this knowledge market (Klerkx & Leeuwis, 2008).

Table 1: Innovation System Matrix (example)

	Research Institutes and Universities	Extension (public)	Advice and consultancy (private)	Government	Agro-food industry	Unions	Agricultural Chambers	Cooperatives	Farmers and rural population	NGOs
Infrastructure										
Laws, rules and regulations										
Values, norms and culture										
Interactions and networks										
Capabilities										
Market structure										

3. Methodology

3.1 Data collection

The investigation and assessment of the state and functioning of the agricultural innovation systems in each of the eight countries was done by eight different research partners, each located within the country and with close experience and overview of the functioning of the AKIS. Three

different methods have been used by each participating partner to collect the necessary data for these country reports:

- 1) a desk research of existing literature on the country;
- 2) interviews with key stakeholders ;
- 3) an interactive workshop.

The desk research included a description of how the AKIS is set up and operates in the respective countries with particular emphasis on the advisory systems in terms of actors, roles, governance, funding mechanisms and paradigms towards learning and innovation. The desk research was enriched with a number of interviews performed with some of the key actors within each country, see Table 2. Interviewees were selected based on their expertise of a sector or central player within the AKIS: universities, government agencies, innovation subsidising agencies, multinationals, farmers unions, but also advisor groups.

Interviews were done using semi-structured interviews in which the questions were used as a checklist of possible relevant topics being covered in the interview. Not all questions were addressed in every interview as interviews were adapted to the specific position and expertise of the interviewee. The questions themselves and the wording were adapted to local circumstances as the questions were formulated in academic language, and some concepts might not be applicable in all circumstances.

Table 2: Overview of interviews

	Total *	Farmers	Unions	Advice and Consultancy	Extension	Government and policy	Product chains/ agro-industry	Research	Education	Civil society and NGOs
Hungary	11					4		2		5
Italy	12		3	1	2	1	1	3		1
Latvia	11		3	1	2	1		4	2	
The Netherlands	11		1	4		2	1	3	1	
England	13	2	1	1		2	1		2	3
Switzerland	12			2	5	2	2		2	
France	3					1		2		
Germany	7									

**Number of interviews does not necessarily correspond to type of organisations, as some interviewees had double affiliations, or multiple persons from the same organisation were interviewed*

An interactive workshop concluded the investigation. During this workshop the results of the literature study and the interviews were discussed in a broader audience of stakeholders and experts. The organisation and set-up of the workshops differed per country. Some research teams thus did an interactive SWOT analysis (England), while other did other forms of workshop or a seminar (Hungary and Latvia). In Switzerland and the Netherlands, the Collective System Performance Analysis (Van Mierlo et al. 2010) was used to structure the session. The difference in the number of people participating often also depends on the kind of workshop conducted as some methods (seminars) allow for more people to participate in the discussion than other methods, see Table 3.

Table 3: Workshops and attendances

	England	France	Germany	Hungary	Italy	Latvia	Netherlands	Switzerland
Method used	Interactive SWOT	World café	-	Seminar/ Interactive discussion on results	-	Seminar	Collective System Performance Analysis	Collective System Performance Analysis
Persons attending a)	10	42	*)	19	*)	31	11	12

a) Including researchers and facilitators

*) In Germany and Italy no workshops were organised because the researchers felt that the German and Italian situations were characterised by a great diversity in the 20 autonomous regions (in Italy) and the 16 Bundesländer in Germany. A workshop on the nationwide situation with the presence of all the actors interested would therefore be very difficult. Instead, results of the analysis in these two were validated by discussing them with a number of experts by phone, or in person.

3.2 Data handling and processing

The information from the literature review, interviews and workshops combined were used to fill out an Innovation System matrix detailing the main enablers and barriers of the different national agricultural knowledge and innovation systems. As a first step in establishing a comprehensive comparative analysis, the different country reports were reworked into a single IS matrix. Following a grounded theory approach (Glaser & Strauss, 1967) the information in the different country reports was summarised and subsequently labelled, first broadly into the different categories of the ISP matrix (infrastructure, legislation and regulations, values norms and culture, interaction and networks, capabilities and market structure) and later more refined into detailed subcategories. The resulting ISP matrix was checked and adapted where necessary by the different national research teams in order to make sure the summaries and labels properly reflected the existing situation. Finally, the different subcategories of failures and successes within the IS were systematically compared and evaluated.

4. Results

There is such a variety at the country level that it is impossible to discuss all the particularities of the different countries in this short paper. Therefore we will limit ourselves by presenting a rough typology of the most important characteristics that lead to the biggest differences in the organisation of the Agricultural Knowledge and Innovation Systems.

Extension and advisory services: privatised vs. public extension and advice

The most obvious difference pertains to the role and place of the public extension services vis-a-vis privatised advisory and consultancy services. The Netherlands and England have completely privatised their public extension services and almost all advisory systems are operating on a commercial basis. France and Hungary form the other end of the spectrum. Here the extension service is still strongly present although the extension service itself is fragmented over many different organisations. In the case of Hungary these government funded actors provide their services almost free of charge, driving out any commercial consultancy agencies. For the potential of collaborative innovation networks the privatised situation allows for a broader range of partners to work with. The downside is that these partners are 'only in it for the money', which has the downside that network working on fundamental types of research or innovation will have more difficulty in becoming established

Interactions and network characteristics: horizontal and vertical fragmentation

All countries report a fragmented AKIS. However, the reasons for this fragmentation differed from country to country. For some countries the reported fragmentation is the result of a process in which the traditional roles of the AKS actors (research, extension and education) have slowly dissolved and became more entangled. These countries, of which the Netherlands and England are the most extreme examples, have moved towards a diversified landscape of formal and newly emerging informal organisations that each cover an overlapping part of these traditional roles. NGOs, government agencies and research institutes, farmer funded organisations and cooperatives, commercial advisory agencies and consultancy as well as some successful farmers themselves are now new suppliers of information in the agricultural sector and traditional categories between fundamental and applied research or between commercial and non-profit advisory systems are disappearing. In these countries, government intentionally gave away most of its instruments to steer developments of the AKIS directly and the reported fragmentation is therefore an expression of the lack of vertical steering mechanisms. Another example of vertical fragmentation can be found in Hungary and Latvia where the organisation of the AKIS is still aiming at directly improving the productivity of the subsistence farmers. Publicly funded extension services still hold an important position in the AKIS to perform this task. The reported fragmentation in these countries is not so much the lack of steering mechanisms, but it is more the result of a lack of political interest combined with limited funds.

Examples of horizontal fragmentation can be found in Germany and Italy where the reported fragmentation is the direct result of the organisation of the state. Because of their strong federal and regional forms of government, there is also a wide variety of rules, regulations and institutional interactions from region to region. Organisations can have difficulty to reach over regional boundaries. As a result the national AKIS has very high horizontal fragmentation which may be accompanied by a vertical type of fragmentation (depending on the specific region). However, the reported success in Switzerland making a nationwide transition to integrated pest management within a couple of years, shows that this does not necessarily has to be the case. A federal system can still be effectively managed, even at the national level if the country is small enough and actors can still communicate with each other on a regular basis.

Values, norms and culture

The cultural characteristics of a country also determine the potential success of collaborative networks pursuing processes of social learning. Countries like Switzerland and the Netherlands have a culture that values collaboration and strives for consensus. In contrast countries like Hungary and Latvia many farmers do not like anything collective as a result of the years of forced collectivism in agriculture under communist rule. Innovation networks that depend on collaboration therefore can be expected to prosper within the Dutch and Swiss culture, however the downside of the Swiss and Dutch preference of consensus is that risk taking is not well established culturally and changes can only occur at a slow pace as all parties involved have to concur to the changes made.

Market structure: homogeneous vs. non-homogenous farming populations

Here we will look more specifically into the place of the 'demand side' of the information market. In the new member states of Latvia and Hungary, and to a certain extent even in Germany we see a structural difference between the type of farms and farmers, from a small number of very large, technology intensive and international operating farms to a much larger number of small scale, sometimes even subsistence farmers. This structural divide means that there are very large differences between types of farms, with a small number of extremely large farms competing on the international markets and a much larger amount of very small to subsistence farms. This makes the interests of the farmers to diverge widely and also makes it more difficult to come up with policy measures that benefit both these categories. Other countries, like the Netherlands and also France have a more homogenous population of farmers.

Capabilities

Differences in capabilities within the different countries is mainly related to the differences in of their respective farming communities and particularly the education of farmers. Regarding competences, in some countries there is a need to develop at the farmer level the skills necessary for self-organisation and collaboration. Small subsistence farmers in Latvia and Hungary often hardly have any formal agricultural training, while farmers in Switzerland and The Netherlands are among the highest educated of Europe, many of them having followed a form of higher agricultural education. However, this doesn't mean that farmers in the Netherlands and Switzerland have no difficulties in making changes. The shift to more entrepreneurial types of farming styles in Switzerland is for many farmers difficult. Similarly, in the Netherlands and England not all farmers possess the necessary qualifications in information acquisition services or formulate their specific knowledge demands.

But farmers are not the only ones who need some additional set of skills. Advisors and consultants also often see themselves as technical advisors focussing on knowledge transfer and not so much on knowledge co-creation. Similarly researchers often also require a different set of skills to communicate effectively with farmers, but sometimes even with colleagues from other scientific disciplines. Innovation brokers can play an important role establishing the link between different types of organisations, but except for the Netherlands and to some extent England, the category of the innovation brokers does not yet seem to have caught on in other countries. These kinds of support organisations (innovation intermediaries) often perform an invaluable function in arranging the collaborative networks. However, when there are too many agencies, or they start to pursue their own goals, they also can pose a problem, as they create confusion, add to the bureaucratic burden and do not streamline the collaborative process anymore.

4.2 Common trends

With the given differences in the organisation of the national agricultural innovation systems, we have also found a number of common trends that apply for the majority, if not all, of the countries investigated. These trends are currently shaping the different types of systems in the eight countries.

Reduction of (public) research funding

The knowledge infrastructure for fundamental research is threatened by a decrease of research funds. The economic crisis has resulted in reduced research budgets. The competition for scarce financial resources is dealt with differently in different countries however. In some countries (Italy) the national research budgets are being replaced by a stronger dependence on European funding. In other countries (England, France and to a certain extent The Netherlands) research institutes and universities merge in a concentration process.

The increasing competition for contracts and financial sources within the AKIS in turn leads to less collaboration and less sharing of information sources. This competition does not only play out between all the actors involved: both public and private. The traditional roles of some knowledge providers is becoming broader as organisations also move into new fields. This leads to increasing competition between knowledge providers and a decrease of collaboration. This hinders the diffusion of beneficial innovative practices and the formation of collaborative networks.

Agro-food industry moving into research and advisory services

The decrease of public funds leads to a shift to other types of research financed by the agro-food industry. Large agro-food industries have the funds to put into research and they are actively seeking to form alliances with research institutes and universities to do contract research. However, most this this research is concerned with short term near market research in commercially viable products: fertilizers, genomics and seeds. These alliances can go beyond the national borders and

for a country like Hungary this means that contract research of this type is moving outside the country. The results of this type of research is often quickly transferred to farmers. For farmers the free advice given to them by their suppliers is often a major component of how they obtain new information.

Agricultural education is in bad shape

Agricultural education seems to be currently the weakest part of the traditional formal AKS triangle of research, extension and education. Problems facing agricultural education come in two, sometimes interrelated, categories. Some countries report problems with the quality of agricultural schools due to lack of funding (Latvia and Hungary). The Netherlands, on the other hand, suffers from a lack of students. The agricultural sector has a bad image that a lot of potential students, especially at the vocational level, do not find attractive. Agricultural education is especially vulnerable because of its lack of interaction with other parts of the AKS. Switzerland, the Netherlands and Hungary report that the interaction between businesses and schools is difficult to establish.

An exception however are privately financed education and training facilities. Professional (adult) education and training for farmers and other agricultural professionals is thriving. Successful professional education programs for farmers are often established in close cooperation with unions, or cooperatives.

New actors entering the countryside

With the inflow of new actors in the countryside the new perspectives on agricultural production gained increasing importance. This has led to a fragmentation of the common vision on agriculture. Whether or not these actors have access to the agricultural policy making network differs per country. However, it is clear that the idea of 'agricultural exceptionalism' is disappearing all over Europe. This process has been named the 'contested redefinition of the countryside' (Frouws, 1998) and can be observed in many places. This has also led to a variety of discourses on sustainable agriculture to emerge (Hermans et al., 2009). The fragmentation of visions leads to conflicts between various actors within AKIS. Farmers feel undervalued and misunderstood by the general public and politicians, having to deal with what they feel are unrealistic demands of society regarding their ways of production. The decline of trust and social capital is reported to be decreasing among several of the most important partners in the AKIS.

However even within the farming community differences exist with regard to the preferred future. The membership and involvement of farmers in different types of interest groups is in many countries high. Traditional agricultural actors like unions have difficulty adapting to the new situation. Even though many of these organisations are well established and professionally run, they increasingly have difficulty in adapting their roles to changing circumstances. The fragmentation of visions among their members makes it difficult for them to represent their members properly. New unions and cooperatives are being founded, leading to further fragmentation and a dissolution of bargaining power of the traditional players in the AKIS.

Bureaucracy and overregulation of innovation policies

Regulations regarding the support policies for innovation are often considered to be a source of hindrance and not of support. The first common complaint regards the bureaucracy of many innovation programmes, not only among farmers but also among researchers and companies. Innovation policy is often characterised by an overabundance of 'red tape' and overregulation. Sometimes the situation is worsened by bureaucratic infighting and rivalry between ministries. Another set of complaints has to do with funding criteria that are used. Firstly there seems to be a lack of stability in funding criteria and innovation tenders. Shifts in political coalitions will also result in political attention for certain areas to suddenly come up or disappear. As a result there is an increase in discontinuity and a lack of concerted action by the various interested players in the

knowledge system. Finally, rules and regulations are often not very well suited to support collaborative networks. Funding for these types of bottom up networks is hindered by the inability of funding agencies to deal with the unique properties of social learning, where sometimes the social outcomes and improved stakeholder relations are very important. However these types of results are notoriously difficult to monitor and evaluate (Head, 2008).

5. Discussion and conclusions

Networking, knowledge co-creation and collaboration between different partners is becoming very popular across the different countries and also with the concept of the European Innovation Partnership, or EIP it has also become a focal point of EU policy. The application of the innovation system matrix framework shows many examples how some of the national particularities of the AKIS might likely hinder or foster social learning and collaborative innovation networks within a particular country.

The innovation system matrix offers a systematic way to analyse and compare Agricultural Knowledge and Innovation Systems that for historical and structural reasons are very difficult to compare. By focussing on the most important players and the rules that they play the innovation game with it provides insight in how the different components of an AKIS are linked together. However, what it does not do is provide an overview of the performance of the AKIS: there is not a single measure that links the performance of the components to the performance of the AKIS in terms of the quantity and quality of innovations it generates at the systemic level. A second disadvantage is that the different categories are not independent and not mutually exclusive. This makes it difficult sometimes to categorise certain findings.

All in all the matrix was helpful in reducing some of the complexity of comparing the eight European agricultural knowledge and innovation systems. At the same time we acknowledge that also some of the contextual richness has disappeared with this comparison. The analysis and comparison only gives an indication of some of the problems that a new collaborative innovation network might likely face within each country, but more research into the particular mechanisms is still necessary. The question how current organisation of AKIS supports innovation networks is a question of how it can incorporate new actors and their new visions into the existing structures. Results show that the network characteristics of the AKIS play an important role here that links the various categories together. An AKIS where the actors form a more or less closed network enjoy the advantage that their AKIS is more manageable as horizontal and vertical fragmentation are limited. Lines of communication are short and there is a shared discourse and vision on the future of the sector. The downside of this situation is the difficulty a closed AKIS has in incorporating new actors and opposing views. New information does not easily enter such an AKS, and new bottom-up initiatives and innovative practices are not necessarily recognised as such.

The opposite situation, an AKIS that is characterised as an extremely open network, has its own disadvantages. With increasing knowledge supply by brokers, advisors and agricultural consultants, the AKS becomes much more complex and the overview of the different services on offer, not only from commercial actors, but sometimes also from (applied) research institutes, becomes difficult to oversee. End-users get lost in the abundance of possibilities and knowledge providers. Even though bottom-up initiatives have easier access to the more formal research institutions, the steering of the AKS does not necessarily improve. Government has a more difficult job to steer the AKS in a sustainable direction as there is no consensus over the direction of the agricultural sector.

Acknowledgements

This research is part of the SOLINSA project funded under the 7th Framework Programme of the EU (project nr. 266306). We want to thank our fellow researchers: Gustav Nemes, Zoltán Bakucs,

Volker Hoffman, Simone Hemle, Vinzenz Bauer, Gianluca Brunori, Adanella Rossi, Elena Favili, Patrizia Proietti, Julie Ingram, Nigel Curry, James Kirwan, Damian Maye, Talis Tisenkopfs, Sandra Šūmane, Anne-Charlotte Dockès, Christèle Couzy, Anne Guillaumin, Dominique Barjolle, D. Eynaudi, Heidrun Moschitz, Robert Home, Julia Jawtusch, David Bourdin, M. Fischler, Olivier Roque, Erik Thévenod-Mottet and K. Deslandes who work with us in the SOLINSA project and who contributed to this paper by preparing the different country reports the analysis is based on.

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