

Towards a better conceptual framework for innovation processes in agriculture and rural development: from linear models to systemic approaches

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Abstract: The role of farming previously dedicated mainly to food production changed with an increasing recognition of the multifunctionality of agriculture and rural areas. It seems obvious to expect that farmers and rural actors adapt themselves to these new conditions, which are innovative and redefine their job. In many regions farmers can increase their income basis as rural entrepreneurs, developing new services and exploring new markets. Often, however, there is a gap between the need for change and farmers' willingness to adjust, and the insufficient capacities of innovation agencies and advisory services to effectively support changes. In this contribution we discuss the kind of gaps between present societal demands, the related farm-level adjustments, and the capacities of innovation agencies and advisory services. We sketch out ways and institutional arrangements that might effectively improve the capacities of innovation agencies and advisory services.

Innovations are commonly defined as the successful exploitation of creative ideas. They can concern products, processes, markets, institutions; they can be technological, social, and organisational. The related questions addressed include the following: How does innovation support the multifunctionality of rural areas and rural entrepreneurship? Which notion of innovation is being applied and how are processes of innovation seen and supported?

In this paper we discuss a conceptual framework that understands innovation processes as the outcome of collaborative networks where information is exchanged and learning processes happen. We argue that technical and economic factors used to analyse drivers and barriers alone are not sufficient to understand innovation processes. The related social and institutional aspects of cross-sector as well as intra sector processes are explored. Overall, we emphasize that innovation functions as a process where farmers' and rural entrepreneurs' knowledge, motivations and values play an important role. We emphasize that institutions, administrations and extension services, whose mission it is to support changes, can become barriers to innovation if they do not acknowledge that the needs of farmers and of society have changed. The paper builds on the conceptual level work carried out in the on-going EU funded IN-SIGHT research programme with multidisciplinary teams from seven European countries.

Key words: innovation, knowledge systems, agriculture, rural development, systemic approaches

From the modernisation paradigm to a sustainability perspective

Changes in strategic orientations

The role of agriculture previously dedicated mainly to food production changed with an increasing recognition of the multifunctionality of agriculture and rural areas. The reformed Common Agricultural Policy (CAP) and new rural development (RD) policy of the EU is clearly following this trend (CEC, 2006, 2007). Besides agricultural restructuring, it addresses environmental concerns and the wider needs of rural areas (Table 1). Guiding principles of on-going CAP reforms are those of decentralisation of responsibilities – thus strengthening subsidiarity and partnership – and flexibility of programming to be targeted and implemented according to Member States' specific needs.

¹This paper is based on collaborative work of all colleagues involved in the EU-funded IN-SIGHT project. The original work can be found in project reports at www.insightproject.net.

Table 1: Agricultural restructuring, environmental concerns and the wider needs of rural areas

	<i>Rural Development Regulation for the period 2007-2013 (CEC, 2005): three main axes -</i>	<i>Rural Development Report 2007 (CEC, 2007): the CAP has three main objectives -</i>
<i>Agriculture</i>	<ul style="list-style-type: none"> improving the competitiveness of agriculture and forestry 	<ul style="list-style-type: none"> to create a stronger agricultural and forestry sector
<i>RD</i>	<ul style="list-style-type: none"> improving the quality of life in rural areas encouraging diversification of economic activity 	<ul style="list-style-type: none"> to improve the competitiveness of rural areas
<i>Environment</i>	<ul style="list-style-type: none"> improving the environment and the countryside 	<ul style="list-style-type: none"> to maintain the environment and preserve Europe's rural heritage

Source: Own compilation based on CEC (2005, 2007)

In the Rural Development regulation for the period 2007-2013 adopted by the Council of Ministers September 2005 the aims of the CAP have been clarified around three clearly defined economic, environmental and territorial objectives: agricultural restructuring, environmental concerns and the wider needs of rural areas. The reorientation reflects the conclusions of the Salzburg conference on rural development (November 2003) and the strategic orientations of the Lisbon and Göteborg European Councils emphasising the economic, environmental, and social dimensions of sustainability. Already the conclusions of the Göteborg European Council of June 2001 clearly state: *“During recent years, European agricultural policy has given less emphasis to market mechanisms and through targeted support measures become more oriented towards satisfying the general public’s growing demands regarding food safety, food quality, product differentiation, animal welfare, environmental quality and the conservation of nature and the countryside”*.

The reorientation is in correspondence with the situation and trends in rural areas. Over half of the population in the 25 Member States of the European Union (EU) live in rural areas, which cover 90 % of the territory. RD has become a vitally important policy area, while farming and forestry remain crucial for land use and the management of natural resources. Rural areas and rural communities are more and more seen as a platform and starting point for economic diversification and a sustainable development. Farmers still are an important social, cultural and economic actor in rural areas, while the non-agricultural population generally represents the majority of inhabitants. The much broader focus of RD with an integrated and multi-sectoral view characterising the concept of the ‘living countryside’ is accompanied by a transition of contemporary agricultural regimes from a ‘productivist’ to a ‘post-productivist’ era (Wilson and Rigg, 2003; Van der Ploeg *et al.*, 2000; Knickel *et al.*, 2004). An important facet of this development is the emerging ‘turn to quality’ in the agri-food system and the new alternative agro-food networks that are linked with it (Goodman, 2003). Cloke (1997) and Morris and Evans (2004) stress the role that cultural studies have played for the new understanding of rurality and rural policies. Bartunek and Moch (1987) and Brunori *et al.* (2008) argue that the pace and intensity of changes in agriculture and rural areas signal a ‘second order change’ and that this more fundamental change is challenging widely shared assumptions; it is in fact reframing agricultural and rural relations (first order change is, in this regard, change within a system, normally aimed at adapting it).

‘Second order’ innovations needed

Dealing with this type of change requires ‘second order’ innovation, which is innovation based on new goals and new frames. The distinction between ‘first order’ and ‘second order’ is related to the idea of more or less fixed rule-sets that define the needs, objectives, knowledge and heuristics that steer innovation processes. Within a fixed rule-set (or paradigm), innovation is incremental; it builds upon already existing achievements. Once established, therefore, paradigms facilitate first order innovation, based on search and application along given trajectories. Second order innovation, in contrast, implies the adopting of new paradigms and rule-sets. In this case innovators rewrite the grammar of innovation, change the relevant knowledge and even the relevant objectives of innovation. As the consolidation of a paradigm make some groups prevail over others (academic schools, types of knowledge, big/small farms, rural/urban groups, input providers, etc.), it is not surprising that alternative paradigms emerge as a result of a political struggle between coalitions who defend not only ideas and visions of the world, but also interests (Brunori *et al.*, 2008).

In this contribution we examine the changes that are needed in the conceptualisation of innovation processes in agriculture and rural development if agriculture is to be realigned with the demands of post-productivist societies. More specifically we will contrast linear models of innovation processes

with more systemic approaches. The contribution builds on the conceptual level work carried out in an on-going EU funded research programme. The IN-SIGHT project involves seven multidisciplinary research teams from seven European countries. In the discussion of our understanding of innovation processes, we build on concepts deriving from communication theories, innovation studies, education and competence management studies, social network studies as well as institutional economics.

Limitations in present innovation support systems

Farmers and rural actors are part of a continuous process of restructuring that changes their role in rural areas and that is linked with changes in urban-rural relations. The changing conditions redefine the job of farmers and other rural entrepreneurs. In many regions farmers can increase their income basis as rural entrepreneurs, developing new services and exploring markets. Often, however, there is a gap between the need for change and farmers' willingness to adjust, and the insufficient capacities of innovation agencies and advisory services to effectively support changes. In this section we want to first discuss the kind of gaps between present societal demands, institutional orientations and arrangements, and the capacities of innovation agencies and advisory services. In the second part we will identify new practices in rural development and experiences that might contribute to a more up-to-date conceptual understanding of innovation processes.

A gap analysis

The changes described before ought to be reflected in the way rural innovation is perceived as well as in the principles underlying innovation strategies and innovation policies. In the following analysis of the gap(s) between our present understanding and organization of innovation processes, and the demands of post-productivist societies we will examine four different aspects, namely the

- need to realign agricultural and societal goals;
- misunderstanding of innovation as a linear process;
- (related) segmentation of present agricultural knowledge systems;
- outdated orientation of many institutions, administrations and extension services in support of rural innovation.

Realigning agricultural and societal goals

Demand driven approaches rely on the market to prioritise those problems that are to be solved through innovation. As soon as we acknowledge that farmers' interests and societal interests may diverge, we must pose the question whether and how innovation policies ought to respond to both, farmers and societal problems. Clearly there is the need to make a distinction between private interests and public interests (Table 2). Brunori *et al.* (2008) classify them on the basis of two criteria: dominant public/private interest and dominant/alternative paradigm.

Table 2: A classification of policy goals

	Public	Private
<i>Existing paradigm</i>	<ul style="list-style-type: none"> • reduction of negative externalities • non trade-distorting support • efficiency of public spending • food hygiene 	<ul style="list-style-type: none"> • growth and productivity • compliance with public standards • fulfilment of customers' requirements
<i>Alternative paradigms</i>	<ul style="list-style-type: none"> • sustainable use of natural resources • creation of public goods • equity • food quality 	<ul style="list-style-type: none"> • competitiveness through sustainability • looking for new markets • transition to new technologies and farming styles

Source: Brunori *et al.* (2008)

Misconception of innovation as a linear process

Innovation often is still being seen as the result of a linear process from conception to adoption. Innovation strategies tend to follow the simplistic view of a 'linear' model, whereby innovation happens as a result of a flow of new knowledge originating in formalized ways in basic and applied research. This new knowledge is then applied to the production process and, if economically successful, diffused to other firms by imitation or by active knowledge transfer initiatives (for a history of the linear models understanding of innovation see for example Godin, 2005). The importance of the context acting upon individual action, of the existence of much more complex knowledge networks and information flows, and of the importance of learning and social interaction tends to be overlooked in this simplistic view. Conventional approaches have, as a result, concentrated their research efforts on the concept of 'adoption', and tried to understand why, given certain available innovations, adoption rates are much lower than expected on the basis of a neo-classical behavioural model.

A step forward in our understanding of innovation has been the *theory of induced innovation* that has shifted the attention from adoption to the sources of technical change (Hayami and Ruttan, 1970, 1971). What is still completely overlooked is that innovation processes almost always are the outcome of collaborative networks where information is exchanged and learning processes happen. As Ruttan himself in a much more recent paper admits (Ruttan 1997), induced theory of innovation has not taken into consideration the "*inside mechanisms of innovation*", treated as "*black boxes*". In the same paper he recognises the role of the evolutionary theory initiated by Nelson and Winter (1973) and path dependence theories developed by Paul David (David, 1985). Concluding Ruttan advocates for a more general theory bridging insights of the three theories.

In an attempt to get inside the black box, more and more innovation studies have acquired an interdisciplinary openness by developing new theoretical frameworks that focus on learning processes (for an overview see Brunori *et al.*, 2008). The awareness that individuals learn through interaction with their social and physical context has contributed to studies that emphasize the importance of different contexts to learning pace and direction. In the same studies it is emphasized that not only individuals learn, but organizations as well. Innovation studies increasingly underline that innovation has a systemic nature; it is the outcome of collective action and depends on the social structure wherein innovators operate (Hubert *et al.*, 2005).

Segmentation of present agricultural knowledge systems

The concept of agricultural knowledge systems (AKIS) was introduced in the 1990s. As Leeuwis and van den Ban (2004) assert, the concept was originated by an interventionist policy in agriculture based on the idea that, in order to accelerate agricultural modernization, innovation transfer should be strongly coordinated. The model takes into consideration four main actors whose mission is related to agricultural/RD innovation: research, extension services, education and training', and support systems (that is all organisations related to credit, inputs, producers' associations).

All of these domains, according to this model, act upon farmers' and rural actors' knowledge and, in this way, generate innovation (see Figure 1). The two-ways arrows from and to agricultural producers show that this model does not necessarily imply a top-down approach.

Recent debates indicate that the coherence of AKIS and RD has been eroded even in the countries where it was fully implemented (see for example Van der Ploeg, 2003; Van der Ploeg *et al.* 2008; Brunori *et al.* 2008). Van der Ploeg (2003) argues that farming knowledge as accumulated and produced by expert systems such as universities, ministries of agriculture and applied research institutions is increasingly at odds with reality and is not a true representation of the way forward. A critical factor is that more and more knowledge of agriculture is constructed and organized in increasingly segmented agricultural knowledge systems that are largely disconnected from everyday farming practice. The result is that the images generated by expert agricultural systems (described by Van der Ploeg, 2003, as "*the virtual farmer*") diverge seriously from farm level realities.

More recently research, extension and education (the so-called 'knowledge triangle'), and, more specifically, the state-owned or state-funded components of the AKIS, have been strongly restructured following accuses to be inefficient, bureaucratic and not sufficiently responsive to farmers' needs. The subsequent changes have substantially altered expert and innovation systems, leading to privatisation of delivery, multiplication of extension organisations, farmers' participation to the costs, and competitive bids to assign research and extension tasks (Kidd *et al.* 2000).

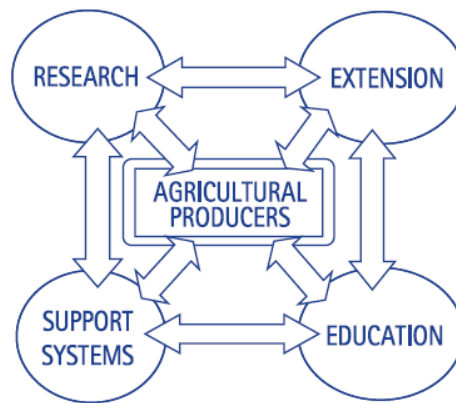


Figure 1. An agricultural knowledge system model (from: Rivera et al., 2005)

Outdated orientation of present innovation systems

The increasing concern with the negative environmental impacts of industrial agriculture, the quality of life of rural population and rural employment and the positive externalities linked to agricultural production and demanded by society, have modified the orientation of agricultural development. More and more emphasis is on rebalancing and integrating agricultural policies with environmental and rural development goals. Simultaneously it is being realized that innovation in agriculture does not automatically have a positive effect on rural areas; that there may be a potential conflict of interests between 'demand driven' innovation and public goals; and that pursuing rural development objectives needs broadening the scope and the targets of intervention. Focus more and more shifted from farmers to rural groups (of which farmers may be an important subgroup), from sector-based measures to territory-based measures, and from private goals to public goals.

A key question is how agricultural knowledge, innovation and support systems have responded to this. To shift the agri-food industries from a volume and output orientation to a more consumer- and society-related, multi-functional strategic direction has major implications for agricultural knowledge and innovation systems. Innovation is now not only needed for raising production and increasing competitiveness in markets. It is also needed for the development of new activities and functions that go beyond production, such as the maintenance of cultural landscapes or the provision of new rural services. Over-arching goals are the creation of more and better jobs in and outside agriculture in rural areas, the multifunctionality of rural areas and an effective support of rural entrepreneurship.

Innovation involves much more than only technology: more and more it regards strategy, marketing, organization, management, design. Farmers looking for alternatives to industrial agriculture don't necessarily apply 'new' technologies. Their novelties emerge as the outcome of '*different ways of thinking and different ways of doing things*', as in the cases illustrated by Ploeg et al. (2004).

Innovation is not only taking place at the level of an individual firm or farm. It may involve a plurality of actors and lead to a reconfiguration of relational patterns. Supermarkets that introduce self-service tools for fruit and vegetables reconfigure the roles between consumers and retailers' personnel, and imply learning processes of all the involved actors. Retailers also play a key role in shaping production systems, as they are able to impose their standards to national production systems (Campbell, 2005). Innovation can attain the shape of new social patterns aimed at improving service provision or at responding to emerging social needs. 'Tandem operation' projects (Moseley 2000), providing separate and distinct services jointly are other examples. They emerge as a most promising change in rural areas (Moseley 2000). Social innovations² respond to social needs by organising goods and services provision in innovative ways.

² "Social innovation refers to new strategies, concepts, ideas and organizations that meet social needs of all kinds – from working conditions and education to community development and health. Over the years, the term has developed several overlapping meanings. It can be used to refer to social processes of innovation, such as open source methods. Alternatively it can be used to innovations which have a social purpose – like microcredit or distance learning. The concept can also be related to social entrepreneurship and it also overlaps with innovation in public policy and governance.

Learning from new approaches and experiences

The EU-funded IMPACT (see <http://www.rural-impact.net>; see also Van der Ploeg *et al.* (2000), SUS-CHAIN (<http://www.sus-chain.org/index.htm>), MULTAGRI (<http://www.multagri.net>) and ETUDE (<http://www.etuderd.eu/>) projects and the case studies carried out in these and other projects show that alternative practices in the agricultural and rural fields, and alternative forms of knowledge have become increasingly important. These practices indicate that there is not only economies of scale, but also economies of scope; specialisation and diversification; measures of productivity of labour and of added value oriented innovations; and a decreasing employment and exclusion of non-agricultural rural residents as well as an empowerment of the rural population.

The 'Regional Action - Rural Areas Shaping the Future' pilot programme initiated by the Federal Ministry of Consumer Protection, Food and Agriculture in Germany in 2001 is an example. The programme acknowledges the need for rural areas to harmonize their various functions in order to be strengthened and create new sources of income. Regional actors, institutions and stakeholders are encouraged to develop visions for the future of their region and to devise integrated development concepts that are geared to the particular regional situation. Through the programme, support is given to the realization of development concepts that aim at quality production and environmental protection in the agricultural sector as well as proximity between producers and consumers, and economic stimuli through regional products and direct marketing. Instead of supporting individual sectors, the programme focuses on the region as a whole, aiming to make it a catalyst for innovation. The programme provides an example of the supplementation of state intervention with less institutionalized mechanisms of co-ordination. Framework steering replaces traditional interventionist policies; territory- and function-oriented measures replace sectoral ones. The mobilization of endogenous regional development potentials allows for counterbalancing the negative effects of globalization, and an effective realization of environmental and social objectives that are neglected at state level (Fürst, 2001). The relevance of the region as level of action is related to the complexity of an integrated sustainable development which is still transparent at the regional level, where the intertwined economic, ecological and social dimensions can be grasped by actors. Knickel and Peter (2005) argue that the partnerships formed have the special capability of working beyond the level of 'being concerned', and therefore create access to innovation. They can function as motors of innovation because they integrate different perspectives and competences better than single institutions.

From linear models to systemic approaches

In this final section we want to sketch out ways and institutional arrangements that effectively improve the capacities of innovation agencies and advisory services.

Recognizing the systemic nature of innovation processes

Which notion of innovation do we apply and how do we define processes of innovation? Innovations are commonly defined as the successful exploitation of creative ideas. They can concern products, processes, markets, institutions; they can be technological, social, and organisational. In a simplistic way, the functioning of innovation can be seen as the result of a linear process from conception to adoption. Innovation processes, however, function – and are increasingly conceptualized – as the outcome of collaborative networks where information is exchanged and learning processes happen.

Any innovation produces a change in socio-technical configurations, which are patterns of relations between human and non human elements. Transfer of innovation, therefore, means that a tool or a method are 'detached' from a socio-technical configuration and 'reattached' to a different one. This is not a simple process, as the conditions of operation of a successful innovation could not be replicated in different environments. Innovation transfer implies learning processes and adaptation to specific socio-technical contexts.

A literature review presented by Brunori *et al.* (2008) reveals an evolution of innovation studies in agriculture, showing the progressive shift from a 'linear' and 'exogenous' conception of innovation to a 'systemic' and 'endogenous' approach, defining innovation as a learning process.

More and more scholars see innovation in the first place as a change in the configuration of hybrid networks. In the conventional view, innovation is mainly embodied into technological *artefacts* (improved seeds, machines, new fertilisers), and its successful application is related to the capacity of the

users to learn to 'adopt' them according to given guidelines/blueprints. In the new hybrid networks view, innovation occurs when the network of production changes its way of *doing* things, so that innovation is mainly related to the resulting pattern of interaction between people, tools, natural resources. This approach gives us a key to understanding the evolutionary trajectories taken by innovation in different temporal, geographical, sectoral contexts. The approach also links conceptually those who produce innovation to those who benefit (or suffer) from innovation, as a problem may emerge at any point of the network. The hybrid networks view sees *learning* at the core of innovation processes, as any change in social or economic organisation improving a certain state of the matters brings to a change in the available knowledge. Moreover, it highlights a specific type of learning – social learning – which affects shared cognitive frames and coordination in a network (Brunori *et al.*, 2008).

The notion of 'novelty production'

"A novelty is a new way of doing and thinking, a new mode that carries the potential to do better, to be superior to existing routines" (Ploeg *et al.*, 2004). From this definition it emerges clearly that innovation is not only technological innovation: any successful change in production, consumption and distribution routines can be considered a novelty. Novelty-production thus refers to the capacity, within the regional society and economy, to continuously improve processes of production, products, patterns of cooperation, etc. Novelties comprise new insights, practices, artefacts and/or combinations (of resources, technological procedures or different bodies of knowledge) that enable a process of production, a network, the integration of two different activities, etc. to function better. Novelties are, at least initially, unelaborated in terms of codified (or scientific) knowledge. "Novelties are located on the borderline that separates the known from the unknown. A novelty is something new [...]. At the same time, [they] are, as yet, not fully understood. They are deviations from the rule. They do not correspond to knowledge accumulated so far – they defy, as it were, conventional understanding. Novelties go beyond existing and explained regularities" (Wiskerke and Van der Ploeg, 2004).

Novelty production is strongly associated with locality (and therefore is unique to a specific region) and contextual knowledge, and at the same time can strengthen the dynamism of rural regions (Van der Ploeg *et al.*, 2008). Novelties can for the same reason not easily be transported from the specific context in which they emerged and germinated, to others contexts. Hence, a novelty is quite different from an innovation. An innovation is an expression of codified knowledge and embodied into an artefact that might travel globally. A novelty, instead, associates with (is part of) tacit knowledge³ and is highly bound to (and rooted in) the *local* (Van der Ploeg and Broekhuizen, 2008).

When sufficiently protected, novelties might contribute significantly to the competitiveness of rural economies. Due to the presence and ongoing unfolding of novelties, regional processes of resource combination, production, distribution, etc., might become more efficient, result in higher quality levels of the produced products and services, and/or contribute to new forms of synergy. Thus, through novelty production competitive advantages are created (Wiskerke and van der Ploeg, 2004). Novelty production might equally translate into the creation of new codified knowledge (it might convert specific regions or localities into 'knowledge exporters').

Van der Ploeg and Broekhuizen (2008) argue that "*rural areas entail, probably far more than urban areas, a balance between tacit knowledge and codified knowledge. Learning processes proceed here very much as and through socialization, internalization and recombination.*" The same authors assume that this applies especially since rural development processes occur very much as 'entering into the unknown'. New experiences are to be translated into new knowledge which on its turn inspires new practices. This applies to the creation of new activities and new networks that add income and employment opportunities; to the construction of new responses that correspond to changing needs and expectations of society at large; and to the reconfiguration of rural resources.

Central to context-related problem-solving cycles are the cognitive frames of the subject: they allow selection and evaluation of all information. Cognitive frames are both resources and constraint for action. They are resources as they reduce the time and the effort necessary to take decisions and to act; when similar situations repeat many times, action becomes routine, and it does not need any effort to decide. Cognitive frames are also constraints for action because they make it much more diffi-

³ Tacit knowledge is also described as *localized knowledge* (Antonelli, 1996). It is about *savoir faire*, about knowing *how* to do things. It resembles very much the concept of *art de la localité* that was introduced into rural sociology by Henri Mendras (1967; 1970). It is knowledge not yet expressed in 'words', i.e. in codified sets of rules that explain the *what* and *why*. Lundvall (1996) stresses that there is a "symbiotic relation" between the two forms of knowledge. Codified knowledge may be utilized only through recourse to tacit knowledge. Etc.

cult to deviate from consolidated patterns of decision and behaviour (Brunori *et al.*, 2008). The notion of 'novelty production' underlines that information-gathering, decision and adjustment in behaviour need to be understood much less as steered by top-down processes. Instead it is processes where farmers' and rural entrepreneurs' knowledge, motivations and values play an important role.

Novelty production typically takes place in *niches*. Niches are governed by paradigms different from those prevailing in the dominant socio-technical systems. Their main characteristic is that they are spaces where norms, rules, routines of production, distribution and consumption are looser and subject to a more rapid evolution. In niches there is a large share of tacit knowledge. Niches are networks wherein learning and societal embedding (capital formation, set up of distribution, dissemination of knowledge, gaining of user acceptance) processes are activated (Kemp *et al.* 2000).

It follows that the further development of novelties is limited by their compatibility with external constraints, which is with actors, rules and artefacts. Development of biofuels, for example, needs refineries, adapted engines, appropriate incentive or taxation systems, appropriate cultivation techniques and logistics, consumers willing to switch from petrol to biofuels. One of the reasons why technologies for the use renewable energies don't spread as fast as hoped, notwithstanding their availability, is that it is necessary to build new energy infrastructures and dismissing old infrastructures, which have been built with huge investments. The example shows that actors, rules/regimes and artefacts are interdependent.

Brunori and Rossi (2000) have illustrated these processes by analysing the development of wine routes in Tuscany as progressive aggregation and reciprocal adjustment of roles and identities between wine producers, local institutions, tourists, agri-tourist farms etc. Once consolidated into systems, wine routes can function as actors in higher level networks, for example by lobbying with regional administrations or creating networks of wine routes. As long as niches develop and consolidate, they modify the networks wherein they operate, and challenge dominant rules, actors, and artefacts by putting pressure on them.

Importance of information flows, learning and social interaction

In this understanding innovation is closely related to information flows, learning and social interaction. Bandura (1977) has been probably the first to introduce the concept of 'social learning' to explain how social structure affects individual learning while, at the same time, learners change their environment. Evolutionary economists look at the knowledge created in firms, which can be perceived as knowledge processing entities (Amin and Condehet, 2000) and look to common frames, routines, lifeworlds as the specific genetic endowment that allows firms' specific evolutionary patterns (Nelson and Winter, 1973). An increasing number of studies and projects have showed how social learning can be mobilised to meet agricultural, environmental and rural development goals.⁴

Different types of knowledge can play an important role in social learning. Tacit knowledge is build through direct experience (learning by doing⁵), so that its transfer requires physical presence and face to face interaction; codified knowledge translates mental frameworks into symbols, and this allows an easier transfer through communication. The reason why innovation concentrates geographically is that codification can't translate all of the cognitive potential embodied in tacit knowledge, especially because it does not take into account the specificities of the context in which knowledge is mobilised. Asheim and Gertler (2006) distinguish between synthetic and analytical knowledge. Synthetic knowledge is mainly created through recombination of different existing knowledge bodies while analytical knowledge has more to do with deductive processes and relies strongly on scientific knowledge and highly formalised models.

Starting from a (social) learning approach to innovation, a number of scholars have tried to establishing links between the 'micro' innovation processes and the 'macro' conditions for change. Actor-network theories (Latour, 1987) and Granovetter's theory of embeddedness of economic action (Granovetter 1985) are increasingly taken into consideration.

⁴ See the EU projects LEARN (<http://www.inra.fr/learning/index.htm>), HarmoniCOP (<http://www.usf.uni-osnabrueck.de/~pahl/projekte/harmonicop/index.en.html>), SLIM (www.slim.open.ac.uk)

⁵ The concept of learning-by-doing has been used by Kenneth Arrow in his design of endogenous growth theory to explain effects of innovation and technical change.

Implications for agricultural knowledge and innovation systems

Innovation systems are to facilitate change and adjustment. When, as discussed in the introductory sections, the role of agriculture changed with societal expectations and the increasing recognition of the multifunctionality of agriculture and rural areas, it is critically important to provide farmers and rural entrepreneurs with the support they need to achieve the related adjustments. Actors directly linked with the market, like farmers, are inclined to develop demand driven innovations. A key challenge for agricultural knowledge and innovation systems is to support improvements in the processing, marketing and value adding capacity of agriculture and forestry as well as the exploration of new opportunities in new rural and environmental services and non-food production. To address the role of farming in the knowledge-based bioeconomy must include addressing the questions related to the establishment of supply chains and a just distribution of value added. Emphasis in production must be on quality, the improvement of environmental protection, occupational safety, hygiene and animal welfare. Practitioners need to be supported in their capacity to valorise the emerging of niches 'from below'. Making rural areas more attractive requires promoting sustainable growth and generating new employment opportunities as well as facilitating the access to up-to-date information and communication technologies. On-farm diversification towards non-agricultural activities, assistance for off-farm activities, and strengthening the links between agriculture and other sectors of the rural economy play an important role in this (CEC, 2006).

Institutions, administrations and extension services, whose mission it is to support changes, are often reacting too slowly to new challenges. Sometimes they continue to provide certain types of support, while the needs of farmers and of society have changed. Institutions, whose mission it is to enable changes, can become a limiting factor. More research is needed on the question of institutional arrangements and factors that support or hinder the diffusion and adoption of innovations, the role of organisations facilitating innovation as well as public innovation policies are critically important research questions that have not been tackled adequately yet. As Winter (1997) stated already ten years ago, "... farmers needed as much, probably more, advice and information to reverse productivity than they did to get it going in the first place".

Agricultural knowledge and innovation systems need to become more effective in making private and public interests converge. Preconditions are that public bodies are able to identify objectives of public interest and to set up research, training and extension programs coherent with them. Innovation agencies and organisations need to be re-embedded in civil society and capable to adapt to changing societal demands. They need to strengthen and mobilise endogenous resources, in particular through improved social learning capacity. Access needs to be provided to knowledge already available elsewhere. At the same time it needs to be recognized that innovation policies for a transition to new socio-technical systems will only be effective if actors' cognitive schemes and motivations are taken into account. Innovation policies must, for the same reason, be accompanied with appropriate incentives, regulation and investment support. The plurality of innovation networks including producers, users, processors and experts need to have access to public and private resources. Rural innovation policies that are coherent with the new agricultural and rural agenda need to address second order innovation. What is at stake is a different approach to steering knowledge and innovation systems.

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