

# Integration of knowledge for sustainable agriculture: why local farmer knowledge matters

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## Abstract

Previous research has revealed that transition to sustainable agriculture requires a new knowledge base – new content and forms of knowledge and learning. In this paper, we explore farmers' knowledge and learning practices with a focus on the role of informal knowledge and learning in strengthening agricultural sustainability and resilience. It is based on 11 case studies from the international RETHINK research programme, which discover diverse pathways of farm modernisation and related knowledge and learning processes. We outline the diversity of knowledge sources and learning forms that farmers use and the particular role of local farmer knowledge. We argue that the potential of farmer knowledge is not being optimally used, and we identify several ways in which different kinds of knowledge can be integrated: by the individual farmer by synthesising knowledge from different sources, through farmer networking – whether or not facilitated by formal agricultural knowledge institutions, through collaboration between farmers and researchers as knowledge co-generators, and through multi-actor knowledge networks that bring together participants from various fields. We conclude that the dynamic contexts, complexity and the local specificity of the current challenges facing agriculture and the many roles it is being asked to fulfil require more inclusive, flexible modes of the generation, integration and sharing of knowledge. All stakeholders and all kinds of knowledge need be brought together on equal base in innovation processes. For these purposes, policy frameworks and initiatives that promote an interactive multi-actor approach to agricultural development, can play a considerable role.

## 1. Introduction

During agricultural industrialization the role of farmer knowledge has been largely deteriorating; a lot of this knowledge has been even lost together with spreading of productivist logic and standardized solutions, and declining farmers' community (Fonte, 2008). However, in the face of the many contemporary challenges – climate change, food security, resource depletion, to name a few, - a growing number of development specialists admit that farmer and local knowledge is a valuable resource to reorient modern agriculture towards more sustainable and resilient paths of development.

In this paper, we explore farmers' knowledge and learning practices with a particular focus on the role of informal knowledge and learning in constructing sustainable and resilient agriculture. We use the distinction between formal and informal knowledge to better illuminate the diverse forms of knowledge which exist outside the formal agricultural knowledge system and are generated by practitioners from their experience, without externally imposed criteria and agenda (Livingston, 1999).

It is recognised that sustainable agriculture, due to its holistic, diverse and distinctive nature - explicitly interlinking environmental, social and economic dimensions - requires also new content and forms of knowledge and learning (Curry and Kirwan, 2014; Kloppenburg, 1991). As formal agricultural knowledge and innovation system (AKIS) is still strongly focused on the production-oriented model of agriculture, farmers who choose more sustainable paths rely often on alternative learning networks and knowledge sources. Therefore better recognition of local farmer knowledge, and the combination of local and scientific knowledge are needed in order to meet sustainability goals in agriculture (IAASTD, 2009; Pretty, 2008). In recent years agricultural sustainability is linked with the concept of resilience, which evokes the capacities of an agricultural system to adapt and transform in order to persist over long term. Learning to live with change and uncertainty, and combining different types of knowledge, including farmer, appear as critical for building resilience (Folke et al., 2003; Darnhofer et al., 2016).

This paper advances the stream of research that points to the potential of informal knowledge, and local farmer knowledge more specifically, in strengthening agricultural sustainability and resilience. The rest of the paper is organised as follows. The next chapter details the concept of informal knowledge, and learning networking for sustainable and resilient agriculture. The chapter 3 presents our multi-case methodological approach. Next, we analyse farmers' knowledge sources and learning practices and how these are related in various networks. We explain why informal knowledge and learning matter for sustainable and resilient agriculture. Finally, we identify several action points to enhance (informal) learning.

## 2. Theoretical framework: knowledge and learning networks for sustainable and resilient agriculture

Research literature brings up several overlapping concepts to delineate informal knowledge (local, practice-based, traditional, lay, farmer, tacit, endogenous, indigenous etc.) and informal learning modes (self-education, learning by doing, experimenting, observing, from own or other's experiences, in social interactions etc.) in agriculture. We focus on two core interrelated kinds of informal knowledge – local and farmer. Local knowledge involves dynamic and complex bodies of know-how, practices and skills, developed and sustained over time on the basis of local people's experiences in their environmental and socio-economic realities (Beckford and Barker, 2007). Farmer knowledge is a subset of local knowledge, enabling to farm in specific local conditions. As agriculture is highly dependent on local environment, local farmer knowledge is of particular importance containing intimate understanding of the particular set of local cultural and natural resources.

The holistic and adaptive character of local knowledge - considering local systems as a whole, integrating their social, environmental and economic aspects, empirical and spiritual dimensions (ICSU, 2002) - makes it especially relevant to agricultural sustainability and resilience. This is illustrated by the development of agriculture within its environmental and social settings through accumulation and application of local knowledge in many regions of the world, over generations

(IAASTD, 2009). For example, traditional farmers integrate their farming methods with natural ecological processes and reproduce biodiversity (Altieri, 1999); local farming practices address local community needs - food security, social activities related to food, local economic conditions and sustainable soil management (Briggs and Moyo, 2012). This points to the links of local farmer knowledge to specific ethical, environmental, and social values. This issue is of particular pertinence when discussing sustainable agriculture which is driven by different from conventional agriculture values and new ways of thinking.

Informal knowledge is often regarded in relation to formal knowledge (see Table 1) and perceived as pushed into a subordinated position. The science driven conventional agriculture with its technological and organisational changes has provoked that farmers are increasingly dependent on external inputs, and loose tacit knowledge due to alienation from production processes, and reduction and standardization of skills (Timmermann and Felix, 2015).

**Table 1**  
Differences and commonalities between informal and formal knowledge

	Informal knowledge	Formal knowledge	
		Academia	Industry
Source	Own experimentations and practical experience	Research stations	Research stations
Ownership and certification	Practitioners, farmers, local community	Scientists	Specialists, scientists
Approach	Holistic	Complexity	Fragmentation, specialisation
Transferability	Locally specific solutions	Standardised and locally specific solutions	Standardised decontextualised solutions
Transmission and access	Exchange with peers, passed through generations	Peer-reviewed articles, conferences	Education in schools, courses, training groups, literature

Source: Authors' compilation

A juxtaposition of informal and formal knowledge is helpful to illuminate their different characteristics. However, it does not reflect well the farming reality where farmers integrate and use all kinds of relevant knowledge they have access to (see Figure 1). Moreover, the domination of formal knowledge is not straightforward - farmers do not accept it uncritically. Rather they negotiate various expert and local information against their own experience-based knowledge (Kaup, 2008). They even tend to value more practice-based knowledge (Wood, et al., 2014; Fonte, 2008) and are able to mobilise their local knowledge to resist the scientific one (Wynne, 1998).

Still, beyond the farm gates, scientific knowledge is more prominent. Together with increasing standardisation and certification of knowledge, farmers' knowledge and skills are devaluated and their application is restricted by legal means of laws and regulations. In other cases farmer knowledge is appropriated and codified by scientists and industry, excluding producers and local communities from the benefits of the valorisation of the product (Fonte, 2008). Poor links and interchanges between scientific and practitioners' life-worlds and knowledge, their asymmetrical powers and interests complicate the applicability and implementation of scientific knowledge in practice and integration of farmer's perspectives in scientific research (Noe et al., 2015).

However, there is an increasing number of research showing the complementarity of informal and formal knowledge, and expansion of multi-stakeholder and participatory approaches where joint trans-disciplinary knowledge production is enabled (Scoones and Thompson, 2009). This research confirms that contemporary sustainable agriculture is advanced by multi-actor knowledge networks where various kinds of knowledge are exchanged, and new meanings and practices of farming are

negotiated and institutionalised (Moschitz et al., 2015; Tisenkopfs, et al., 2015; Wood, et al., 2014; Knickel et al., 2009). It is also noted that knowledge creation and dissemination for sustainable agriculture often happen through informal mechanisms (like networks, personal and local daily relational structures, co-learning, mutual support) rather than formal ones (Curry and Kirwan, 2014; Wood, et al., 2014).

As multi-actor knowledge networks bring together different stakeholders, negotiation of the meanings and practices of sustainable agriculture is a part of their interactions and contestations. Such a “social” process bring more sustainable outcomes than purely rational top-down planning, especially in situations when decisions should be taken on complex issues (Bodin and Crona 2009). In order to reach different stakeholders’ mutual understanding and enhance transition towards sustainable agriculture, knowledge mediators or brokers play a key role through facilitation of interactions, joint reflection, integration of various knowledge cultures (Moschitz et al., 2015; Tisenkopfs et al., 2015).

### **3. Methodology and case studies**

We base our paper on 11 case studies carried out in the international RETHINK research programme. The cases were selected to illustrate diverse pathways of farm modernisation, their connections to rural development and resilience, and the role of knowledge and learning (see Table 2). The case studies utilized common conceptual and analytical frameworks and methodology (Darnhofer, et al., 2013; Darnhofer, et al., 2014). Information was gathered through a range of methods involving semi-structured interviews and group discussions with farmers and other key stakeholders from market, public, administrative and civil society sectors. Also relevant secondary data from surveys, statistics and previous research were integrated into the original research. Empirical material was gathered, analysed and structured according to several predefined themes: farmers’ needs for knowledge, how they source it, learning modes, networks and outcomes. These themes were also used as the base of comparative analysis.

**Table 2**  
Overview of the case studies and key knowledge and learning issues

<b>Case</b>	<b>Key knowledge and learning issues</b>
Organic farming and resilience, Austria	The case demonstrates the role of farmer-led networks, informal knowledge building and knowledge transfer and the way they are supported (or not) by formal institutions such as vocational agricultural schools or institutions of life-long learning.
Landscape strategy making and agriculture, Denmark	The case presents how farmers gain knowledge on local landscape management in Odderbaek watershed, and depicts learning as both individual and collaborative, social capital-building process.
Transitions towards ecological production, France	The case focuses on the types of technical knowledge built during the transition towards ecological production in the French Drôme department fruit and vegetable sector, and the role of on-farm experimentation in the learning processes.
Opportunities for creating an eco-economy: Lessons learned from the Regional Action and Bio-energy Regions schemes, Germany	The case explores links and interactions between key stakeholders who build competence for the bio-energy regions and their cross-sectoral and multidisciplinary exchange of information in a transition towards low-carbon resource-efficient economy.
Farmer adoption of a new nutrient management technology, Ireland	The case highlights farmer learning and the adoption of a new nutrient management method and decision support tool in study groups across the Teagasc Agricultural Catchments Programme. It characterises the role of farmers as intermediaries in innovation dissemination in livestock manure application.
Rural innovation in global fluctuation: The Arava region case study, Israel	The case explores the variety of learning tools available to farmers' cooperative in the Arava desert area, and their gaps regarding new needs for skills and knowledge, such as marketing, self-organisation and product development.
Extensive pig production systems, Italy	The case reveals the role of collaboration / competition and knowledge exchanges between the food-chain actors, research organisations and regional development agencies in the development of a PDO certified supply chain.
Smallholder farm development strategies, Latvia	The case explores small-holder farmers' knowledge and learning practices and networks and highlights the importance of informal knowledge and learning in this farming segment.
Resilient farming systems and market differentiation: Challenges and opportunities in farmers' markets, Lithuania	The case study focuses on the role of the agricultural knowledge system in Lithuania, particularly formal education and advisory, in stimulating farm innovations at local level both in traditional and alternative food chains.
Innovation and social learning in organic vegetable production in the Region of Murcia, Camposeven, Spain	The case study explores how the cooperative's internal governance structure and relational networks promote integration of experiential and expert knowledge, and connecting knowledge and learning to action.
Sub-urban food production systems in a Swiss agglomeration: the example of the milk supply chain in Bern, Switzerland	The case explores knowledge and learning processes across five milk delivery channels with a focus on the role of formal knowledge institutions and informal networks. It points to farmers' strong respect of local farmer knowledge, as well as illuminates learning from consumers in direct sales and CSA systems.

## 4. Analysis: learning for sustainable and resilient agriculture

### 4.1. Farmers' knowledge needs and motivations to learn

We discovered a complex of personal and societal drivers behind farmers' learning decisions and activities. The evolving character of agriculture and new societal demands towards it require new knowledge and skills from farmers. Also farmers' motivations and values guide them in selecting knowledge subjects, sources and learning forms. We group these motivations around two axes: business, and ethical and social.

“Business” is of central importance when farmers learn to improve their market performance, increase income, gain economic stability and growth. In all cases one of the key knowledge needs is marketing, in particular for small-scale farmers and those building new marketing channels (e.g., direct selling, processing or a PDO market chain). Another is technical knowledge that manifested the most in the cases which depended on advanced technologies, like bioenergy production or farming in severe conditions in the desert. Competition, quality demands and opportunities created by scientific advancements push towards constant updating of technical knowledge. To carry out the “business” side successfully, farmers also need bureaucratic, administrative and legal knowledge. The motivation to do better business also involves building certain social and personal skills, like networking, conflict management, creativity, time management.

While a strict division cannot be made between business and non-business, we examine “ethical and social” motivations and corresponding knowledge needs separately. *“I love what I'm doing”* was a common phrase that farmers used describing their work. This passion is also urging them to discover, learn and experiment in fields of their interest. Pride and responsibility to work on the farm belonging to the family for generations was another common learning framework, prioritizing some solutions over others. This can establish a certain path-dependency, an unwillingness to break from family traditions. But the long-term involvement fosters creativity as farmers learn and develop solutions to stay on their farm even in high-pressure situations. Responsibility for the farm involves also care for its natural environments – soil, landscape, old trees, wildlife etc. Farmers tend to preserve these resources and learn ways of doing so, sometimes even at the expense of production efficiency. Another “ethical and social” motivation is consideration for the interests and resources of community: neighbouring farmers, a cooperative, a local village or a broader region. Finally, striving for certain autonomy was guiding knowledge acquisition as farmers are seeking to maintain some independence from market, financial and public forces, and wishing to keep control over their farming decisions and operation.

### 4.2. Knowledge sources

The cases demonstrate that farmers use and integrate knowledge from various sources in order to meet their diverse knowledge needs. In many cases farmer knowledge was the most prominent and trusted knowledge basis due to its local relevance and meaningfulness. In their daily operations farmers rely primarily on their own knowledge accumulated over extended periods of time from practical experience by doing, experimenting and observing.

Traditionally, farm families have been a core platform for learning and knowledge decisions, and in countries like Latvia and Lithuania this is still very common. Another cornerstone source of knowledge featured in the cases is other farmers. Farmers consider their successful colleagues as reputable experts and particularly trustable due to their practical experience in similar conditions. Traditional farmer knowledge serves as a solid production resource and a source of inspiration. For example, production of the reputable ancient Cinta Senese pig meat in the Italian

case (De Roest and Ferrari, 2015) or retro-innovation projects combining traditional knowledge, handcraft and regional resources with new technologies and creative marketing ideas in Austria (Darnhofer and Strauss, 2015).

In all the cases farmers use also knowledge from formal agricultural institutions (provided in form of training courses, advice, field days, etc.), but not on a daily basis. The involvement of formal AKIS institutions in local knowledge and learning processes varies and is higher in the cases of advanced technologies. Sometimes farmers choose formal courses over informal learning due to the high profile of the AKIS, its clear production-oriented knowledge content, higher public appreciation, approved certificates (Darnhofer and Strauss, 2015).

Public administrative and controlling institutions are critical knowledge sources for farmers to receive public support. As food production and distribution are strictly regulated and the agricultural regulative framework and support measures are regularly changing, farmers need to update their knowledge frequently. Farmers often perceived this as a burden that demands financial investments, practical adaptations on farm and considerable bureaucratic work.

Market actors, in particular consumers, are another important source of knowledge and innovation for farmers. In the Austrian and Swiss cases, the direct link to consumers stimulate farmers to rethink their habits of working, and to design new products and services (Darnhofer and Strauss, 2015; Bourdin et al., 2015). For part-time farmers, their off-farm jobs and exposure to other sectors provide additional soft skills, new ideas and experience to integrate in their farms.

The variety of knowledge sources brings us back to the issue of integration, which, happens (or fails) in interactions in networks.

### **4.3. Relations between formal and informal knowledge bases**

#### **4.3.1. Mediating and transmitting knowledge in networks**

In line with previous research, our study demonstrates that farmers operate in multi-actor knowledge networks consisting of overlapping formal and informal sub-networks.

Formal knowledge networks contain various formal institutions: research institutes, advisory services, farmers' organisations, etc. They have a strong historical and institutional 'back-up', have a more structured agenda, operate at a larger scale and receive some public funding. Formal knowledge is often inscribed in printed and digital artefacts circulating in these networks and connecting actors.

Conversely, informal knowledge and learning operate in fuzzier networks, relying on farmers' private interest, community ties, family and personal relations, neighbourhood associations, peer groups, territorial communication structures and tradition. They are often a part of farmers' daily routines and the first channels for exchanging and disseminating ideas and practices. These networks are more local, but not exclusively so, as thanks to mobility and modern ICT tools, the connections may be to more distant partners (Šūmane, et al., 2015).

In several cases a central node in farmers' learning networks are farmers' organisations. As Austrian organic farmers and Latvian niche farmers show, farmer groups are particularly important in the pioneer phase of new agricultural approaches when formal knowledge, advisory or manuals are limited and farmers look for both knowledge and moral support. Farmer organisations retain an essential role also in well-established sectors and businesses as sites of sharing information, knowledge and experiences, and assisting farmers to manage both farming

and non-farming related issues. Farmer organisations also connect farmers to other knowledge sources assuming mediation with wider AKIS.

#### **4.3.2. Complementarity and creative synergy**

Informal and formal knowledge often are complementary. We identify several ways of integrating different kinds of knowledge.

At individual level, farmers use and integrate the many knowledge sources that are available to them, from scientific to their own experiential knowledge. The Irish case demonstrates how a scientifically based support tool (hydrometer) aids farmers' decision making on nutrient management. Its application ameliorated farmers' awareness of the nutrient value of organic manures, improved resource use efficiency and planning, led to savings on chemical fertilisers and reassured farmers for their own estimations (Buckley and Shortle, 2015).

Another level of knowledge integration and dissemination occurs through farmers' networking both in their formal organisations and informal structures. Farmers adopt more easily external ideas and practices which are already accepted and successfully applied by other farmers. An example of the key role of informal knowledge networks in supporting scientific knowledge is the eradication of fruit-fly pest in the Arava region, where the informal social networks and parallel interaction on agricultural and social levels contributed to a region-wide successful eradication, unsuccessful elsewhere (Hurwitz et al., 2015).

Formal AKIS institutions, particularly, advisory services can provide another way of facilitating knowledge transfer and exchange between farmers. They organise knowledge exchange between farmers through site visits, study trips, farmer discussion and training groups, formal forums and the like. In some countries, like Ireland, farmer discussion groups are facilitated by approved agricultural advisors, and monetary incentives are introduced for farmers for participating.

A variation on the previous is co-creation of knowledge between farmers and researchers as equal partners, with mutual benefits. Teagasc, the Irish research, education and extension institution, maintains information feedback loops between researchers and advisors and the farmers, whose experience and opinions are used to evaluate the new technology and its likely success or failure if introduced to the wider farming population (Buckley and Shortle, 2015).

Finally, mixed actor groups, involving participants both from agricultural and non-agricultural fields, can lead to completely new, unforeseen insights and developments. In the Odderbæk river valley (Denmark), the cooperation between farmers, local administration and academics has raised awareness about the diversity of local environmental and cultural resources and resulted in a shared vision and strategy for landscape management in the watershed of the Odderbæk. The initiative integrates agriculture in a broader rural development context and has launched a more complex approach to local development (Pears et al., 2015).

Each site and level of integration of different knowledge sources has its role in farm development and modernisation. Better outcomes in terms of agricultural sustainability and resilience are achieved when various kinds of knowledge – formal and informal, local and external – are put in value in networks, and all actors are reflexive and sensitive to potential synergies.

#### **4.3.3. Conflict and contest**

Diverse knowledge sources may also provide conflicting knowledge. Such knowledge clashes were clearly identified between farmers' practical knowledge rooted in their experience and the



knowledge of agricultural practices presented in regulations of food production and distribution. The increasing standardisation of agricultural knowledge and practice can be restrictive for farmers' diverse knowledge and skills, lack credibility, and demand cognitive, financial and practical efforts to adopt. Latvian small-scale farmers testify that often agricultural knowledge is locked into certified expertise, and they cannot perform some exercises themselves (like, vaccination) they might because of regulations (Šūmane et al., 2015). Austrian farmers complain that the dates to distribute manure on the grassland are fixed by regulations which ignore the regional conditions of weather, soil patterns etc. (Darnhofer and Strauss, 2015). In these cases farmers are not appreciated as experts, and their experience-based knowledge and skills are ignored, undermining also the sustainability of their agricultural practices.

So, formal and informal knowledge and their respective networks may be competing. Where informal knowledge networks are strong, formal advisory services have a weaker role as the informal networks dispense with their technical advice (Lamine et al., 2015). On the other hand, there is a trend of formalisation of knowledge structures and the increasing need for formal knowledge, reducing informal networking and learning (Darnhofer and Strauss, 2015; De Roest and Ferrari, 2015).

The existence of conflicting knowledge can close down or open up the space for innovation and novelties; it demands flexibility from farmers to assume and work it out for their use. For instance, the regulation regarding approved slaughterhouses and processing areas demanding intensive investments prohibit farmers from simple on-farm processing. But these restrictions urge them to look for new market and organisational solutions, like expanding processing, cooperation among farmers, creating a joint commercial enterprise. Nevertheless, this creative energy and efforts of farmers would be more effective if AKIS and other formal agricultural institutions would acknowledge farmers not only as recipients of information, but also knowledge generators. In the context of modernisation their expertise is often neglected, although it holds considerable resources to increase resilience and sustainability.

#### **4.4. Contributions of informal knowledge and learning to sustainable and resilient farming**

Our study confirms that informal knowledge generated in local contexts tends to be holistic - it considers the complexity of the reality in which farms operate integrating the many or at least several of the environmental, economic, social, financial, technical and other dimensions into a single whole. The diverse and dynamic Latvian small-holder farms' strategies illustrate how farmers develop and adapt their farms on the basis of their personal interests, family situation, knowledge of the farm's agro-environmental conditions, regional traditions, market opportunities, available technical and financial resources, labour, public support etc. (Tisenkopfs et al., 2015).

Practical, experiential knowledge adds to farmers' confidence, professional satisfaction and autonomy. Farmers admit difficulties of their profession, but in general they express pride and pleasure in applying their creativity and knowledge and seeing them bring results both for their family and community. Their knowledge accumulated over a long time through personal experience in local settings forms a reliable basis for farming and improves their adaptive capacity – to select solutions that fit their unique conditions best.

Similarly, farmer confidence and capacity to act is increased through informal knowledge networking with other farmers. Informal learning networks ease innovation diffusion as farmers adopt more easily practices accepted by their peers. Importantly, knowledge obtained from family or neighbouring farmers often is the initial motivator and guide into agriculture for young and new

farmers. Local farmer knowledge continues to serve as a valuable support and source of inspiration and innovation also for experienced farmers.

Informal knowledge sources diversify farmers' knowledge and in this way they also strengthen resilience. They compensate for knowledge gaps in the formal knowledge system, in particular with regard to novel, niche, alternative farming practices as well as non-technical knowledge and skills to which formal knowledge institutes pay less attention. Informal knowledge is even more important taking into account the weak or weakening state and accessibility of public formal agricultural knowledge systems in some regions or countries.

Direct knowledge exchange not only helps to develop and disseminate sustainable practices, but also strengthens the social structures through which these practices are disseminated: ties of friendship or solidarity, community and identity building. This is even more pertinent when collective benefits result from joint learning: improved local settings, an eradicated pest, a boosted local economy, an empowered farmers' community.

In addition, we identified also environmental benefits linked to informal local knowledge. For instance, many studied small-scale farmers practice less intensive farming techniques linked to specific local knowledge, rooted in natural processes and creating less environmental pressures. In the Danish case, the experiential local knowledge has been a key to developing a shared integrated vision and projects of agricultural landscape management. The Israeli Arava farmers' unique local knowledge on farming in extreme climatic conditions is relevant when considering climate-smart agriculture.

Thus informal knowledge and the social mechanisms through which it is acquired and disseminated, can compensate for the shortcomings of formal knowledge systems, demonstrating a range of contributions to resilient and sustainable agriculture, including those to farmers' identities, communities, and environments.

## **5. Conclusion**

We have examined the multiplicity of knowledge sources and learning structures in agriculture, the integrative links between informal knowledge and formal knowledge, and demonstrated the prominent role of farmers' informal knowledge for sustainable and resilient agriculture.

Integration of various knowledge sources and learning forms appears as a key aspect in order to survive, adapt and prosper in modern agriculture, in particular, if one innovates and wishes to depart from the well-trodden paths. It requires of individuals and systems both sturdiness and flexibility. Personal curiosity and willingness to learn, together with social networking and supportive formal knowledge and governance structures appeared as central elements for successful learning, knowledge integration and innovation. Both formal and informal knowledge sources have their strengths, yet it is networking and knowledge exchange which make knowledge flexible and sustainability-enhancing. The particular role of informal knowledge lies in the fact that adaptation and transfer of knowledge are mediated by farmers' own and local knowledge.

While joint knowledge activities among various stakeholders are expanding, still additional targeted consideration should be given to farmer knowledge and innovation, other informal knowledge sources and learning forms, and the ways of better integration of this knowledge. Such recognition and use of farmer knowledge would support also the goals of an inclusive knowledge-based society, which builds on the respect of knowledge diversity, broad knowledge

access and everyone's participation with his/her knowledge. The more recent engagement of AKIS in multi-actor knowledge networks and the closer collaboration with farmers point to the development towards more participatory, inclusive and comprehensive knowledge and learning processes.

Our research suggests some areas of engagement for formal knowledge institutes and agricultural policy makers:

- Facilitating connections and knowledge exchange among various stakeholders for joint learning: like, joint events with experts from all the relevant fields, collaboration between farmers and formal research institutes in field tests or developing new products, consulting farmers to integrate their knowledge in regulations.
- Supporting local-level initiatives: networking, cooperation, mentoring, exchange of experiences, young farmers' projects etc. Advisory could involve in such knowledge exchanges acting as a professional knowledge mediator and facilitator.
- Training of the social skills of networking, collaboration and joint learning could help to strengthen both networks by avoiding over-reliance on the few skilful leaders and the outcome of learning.
- Financial support for organisational expenditures (e.g. printing materials, postal delivery, and travel costs) of learning networking together with simple and transparent guidelines to apply for such funds would be helpful, in particularly to reduce financial and time constraints of dedicated and trusted farmers who are often overburdened.

The changing nature of agriculture, its links to other rural sectors, as well as the current challenges facing agriculture and the many roles it is being asked, require development of mixed knowledge and learning networks with a broader inclusion of both agricultural and non-agricultural stakeholders. All stakeholders, including farmers, need to be recognised as equal co-authors of knowledge, and all kinds of knowledge, both formal and informal, need be enhanced and brought together in innovation processes.

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