ICT and social media as drivers of multi-actor innovation in agriculture – barriers, recommendations and potentials

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Summary

This report presents how innovation is defined, and introduces the three factors, on which innovation should be based: Software, hardware and ‘orgware’. As background information for an evaluation of these factors the conceptual framework of socio-technical networks, innovation and learning processes in relation to ICT is described. Various types of software tools have been evaluated for the survey, and it is shown that already today there is a multitude of ICT and social media tools, which can be used in the agricultural sector for knowledge sharing and innovation. Further, it is described what they offer and how they differ from each other. Some examples of successful use of various types of ICT tools in the agricultural sector have been identified, and also some which are expected to be successful, but which are not widely used today.

The survey has not been able to identify any successful examples of use of software (social networks and ICT tools) for innovation processes in the agricultural sector, but such examples have been identified for other business sectors. These examples have shown that especially the ICT tool, ‘crowdsourcing’ has proved to be a promising tool in innovation processes, but its value depends on the complexity of the subject.

Hardware (PCs, tablets, smart phones and mobile phones plus broadband connection) is a prerequisite for an effective communication. There are considerable differences in the access to and speed of the broadband connections and the price for the use of it in different regions of the EU, with the northern and western countries generally having better access and speed and lower prices for internet connection than the eastern and southern countries. Some of the barriers relating to hardware may be overcome by time, while others will have to be solved by investments in infrastructure.

As regards ‘orgware’, i.e. the capacity building of the different institutional actors involved in the adaptation process of a new technology by networking, the role of the internet in communication and collaboration processes by providing platforms for the development of virtual communities has been described. Furthermore, examples are presented on how the successful/promising examples of use of ICT tools in the agricultural sector fits into the theory. Finally some important barriers for the development and uptake of ICT for knowledge sharing and innovation in the agricultural sector are presented together with recommendations on how to overcome them. The report is based on analyses presented in more detail in 3 appendices on software, hardware and ‘orgware’, respectively.

Content

1. Introduction

Agriculture today is evolving in an environment of rapid changes in technology, markets, policies, demography and natural environment. The challenges these changes pose to the national agricultural sectors and rural communities in Europe are context specific and complex, and therefore putting new demands on all actors in and round the agricultural sector to innovate and develop new ways of collaborating to generate knowledge and put it into use at the required pace (Daane, 2010). In the 'European Commission communication, CAP towards 2020' (COM, 2010) innovation is being highlighted as being indispensable to preparing the agricultural sector in the European Union for the future. The communication from the European Commission on the European Innovation Partnership, "Agricultural Productivity and Sustainability" (COM, 2012) also states that increased and sustainable agricultural output will be achievable only with major research and innovation efforts at all levels.

Innovation is here defined as the implementation of a new or significantly improved product (good or service) or process, marketing method or a new organisational method in business practices, workplace organisation or external relations (OECD http://www.oecd.org/site/innovationstrategy/defininginnovation.htm.) Farmers have a long tradition for sharing of knowledge in cooperatives or farmer learning groups, but there is a gap between the provision of agricultural research results and the application of innovative approaches in practical farming. New knowledge does not or takes too long time to reach the farmers, and the needs of practical farming are not communicated sufficiently to the scientific community. Thus, new collaborative methods and ICT may be important tools to solve some of these gaps by improving access to results, knowledge exchange and communication as well as preservation and education.

Until recently the conventional concept of agricultural knowledge transfer has been the linear "pipeline" model with clearly distinguished roles between creating, transferring and using knowledge and technologies (Daane, 2010). The linear model has progressively been replaced by a participatory or collaborate social network approach in which innovation is coproduced through interactions between all stakeholders in the food chain (especially for 2nd order changes, so called "system innovation" like the introduction of multifunctional agriculture or organic farming (SCAR 2012). In these collaborative networks, "Agricultural Knowledge and Information Systems" (AKIS), researchers, farmers, agricultural advisors, entrepreneurs, food and feed industries, policy makers etc. involve themselves in creation, diffusion, adaptation and use of knowledge as well as in providing other resources for innovation (Klerkx et al., 2009).

ICT has already been used on many types of platforms for dissemination of agricultural research results, e.g. websites, publication archives, newsletters and other channels of output from research institutions and extension services, but increasingly more advanced forms of ICT are being utilized, e.g. decision support systems (DSS), forecast systems, instructive videos, and text – message information by mobile phone between farmer and advisor (Jensen and Thysen 2004), (Jensen et al 2000). ICT and especially also social media play an ever increasing role in society as well as in agriculture. Therefore it is important to identify, how and with which tools ICT may contribute to and speed up innovation processes in agriculture, because innovation is much more than dissemination of research: It occurs as a result of the creativity and interplay between actors combining new and/or existing (tacit) knowledge. This means that it is impossible to classify concrete actions in advance as being “innovative” or not and that what is considered as innovative depends on the state of development, e.g. of farming systems in a given region with huge differences and time lags across the EU (van Oost, 2012).

Innovation is usually based on a successful combination of three factors (Klerkx et al, 2009):

- ‘Hardware” (ability to stay connected – i.e. new technical devices and practices)
- ‘Software’ (tools for social interaction – i.e. new knowledge and modes of thinking)
- ‘Orgware’ (communication models – i.e. new social institutions and forms of organisations)

After setting the conceptual framework (Chapter 2), this report presents an up-to date overview and analysis of these three factors (Chapter 3, 4 and 5) with special emphasis on the role that social media can have in multi-actor innovation processes and sub-processes in agriculture and where possible illustrated by successful examples from agriculture or other domains. Attention is given to easy access, interactivity and long term solutions beyond project periods, which are able to connect, create and exchange knowledge between end-users and other actors. Based on the analysis, barriers are identified and recommendations given in Chapter 6 and the results are set into perspectives and overall conclusions drawn in chapter 7.

2. Conceptual framework

Socio-technical networks are regulated networks, where actors have freedom of choice (for example, establishing new relations and activating new flows), but within the limits established by the rules of the system. For example, supply contracts impose technical standards, specific equipment, selection of suppliers and customers on farmers. Rules governing socio-technical systems are articulated into hierarchies. At the lowest level, rules regulate relations and flows between individual entities. At a higher level rules shape 'regimes' that govern the system as a whole. At each level, rules can be changed, but up to the limit set by higher level rules, which give the system its identity and stability. Regimes may change from within, adapting to the changing environment under external or internal pressures; or from the outside, when regime rules are broken by crises, disruption etc. and new rules are established.

Innovation regards the relationship between knowledge and action. We act on the basis of our knowledge, and at the same time we know on the basis of our experience. It is inherently linked to processes of learning. According to many scholars, learning is a social process before being an individual one. Individuals learn thanks to the instruments – first of all, language - they get from the social networks to which they belong. The quality of social interaction affects efficiency (capacity to solve given problems) and effectiveness (quality of solved problems) of innovation processes. Quality of relations can be assessed in terms of trust and diversity among members plus connectivity (number of members each member can reach) and interactivity (frequency and direction of interactions).

Learning processes affect two levels of knowledge. The first level regards the acquisition of new information within already existing 'frames', which are rules that allow us to classify and store information. An example of a frame is a botanical taxonomy, that allows us to classify a plant, or specialist language, that allows us to give a name to a disease. First order learning is the capacity to store and elaborate information within existing frames. The second level regards the development of new frames. New frames allow us to interpret reality in a different way, and this may lead to a new course of action. Second order learning is the capacity to create new frames. Different network configurations can also provide different quality of social interaction:

- **Closed networks** are characterized by a high intensity of interaction: They generate trust and interactivity which can provide highly efficient knowledge flows, but within given frames.
- **Open networks** are characterized by higher diversity among members (higher rate of exposure to the unknown) and higher connectivity. They can foster more innovative solutions to problems, and are a favourable environment for the development of new frames.

Innovation literature has increasingly posed its attention on the concept of 'communities of practice' (CoP) as a key to improve business performance. CoPs are "groups of people informally bound together by shared expertise and passion for joint enterprise" (Wenger and Snyder, 2000). CoPs magnify the capacity of individuals to learn and innovate, as they provide access to information, frames, memories, validation and legitimization of knowledge. The concept of CoP has been developed before the Internet revolution, but many of its insights are now used to foster virtual communities.

Communities of practice can be seen as knowledge systems wherein components develop specialized functions. The following roles can be identified:

- facilitation: taking care of network relations, enlarging the network and activating interaction

- brokering: procuring relevant information and translating it into appropriate language
- memories: storing information
- retrieval: making information easily available on request
- validation: assessing the relevance of available information to practice
- framing: developing criteria to turn information into knowledge.

Also other types of virtual networks, e.g. social communities of interest and individual communities of interest may have similar functions.

ICT can improve these functions in many ways:
- It can dramatically improve the access and storage of information, which potentially makes huge amounts of data available to everybody.
- It can dramatically increase the capacity to gain access to information. Imaging tools, sensors, satellites, handsets, provide an unprecedented wealth of information. By providing increasing amounts of machine-readable 'information on information', ICTs allow to scale up integration of data of any kind.
- Software, often free, can relieve people from the burden of elaborating information and turn information into ready-to-use knowledge. Instrumental operations, once carried out only by experts, for example measuring blood pressure, can be done by virtually everyone.
- Data-mining technologies allow identification of 'patterns' by processing huge amounts of data, opening the way to better understanding of behaviour, and to improve search strategies to accelerate selection of information relevant to one's problems.
- By reducing the cost of interaction to nearly zero, the Internet has multiplied connectivity and interactivity of people, creating the conditions for intense flows of information.
- ICTs also provide trust creation mechanisms, fostering the consolidation of 'virtual communities'.
- Basic principles of virtual communities are 'sharing' and 'co-creation'. Collaborative tools distribute the possibility to contribute to the creation of a common pool of knowledge among people, removing in principle – or shifting ahead - barriers between 'knowledge producers' and 'knowledge users'.
- Interactivity on a mass basis allows processes of continuous review, improving continuously the quality of knowledge produced.
- Automatic translation tools challenge one of the most powerful barriers to knowledge circulation, language barriers.
- Used in integration with physical interaction, virtual interaction amplifies the outcome of physical interaction, as it can be used to disseminate, to replicate, to store and to follow up physical encounters.

3. Software

In recent years a lot of social media and other ICT tools have been developed. The SCAR CWG AKIS mention in the tender document, Lot 2 the following types of ICT tools/Networks (adapted from Omona et al., 2010), which may enable creation, sharing and preservation of knowledge:

Knowledge portals:	are ICT tools for searching and access to web based knowledge. Knowledge portals enable a common platform for delivery of information from diverse sources.
E-document management systems	are pieces or collections of software that can digitize and store documents in a digital format. This ICT tool is used as a database, allowing for searching and sorting of the documents collected.
Data warehouses	are databases used for reporting and data analysis. It is a central repository of data which is created by integrating data from one or more disparate sources.
Groupware or collaborate software	is software, which helps facilitation of action-oriented teams working together over geographic distances by providing tools that aid communication, collaboration and the process of problem solving. Additionally, groupware may support project management functions, such as task assignments, time-managing deadlines, and shared calendars.
Community of practice (CoP)	is a group of people who share a craft and/or a profession. The group can evolve naturally because of the members' common interest in a particular domain or area, or it can be created specifically with the goal of gaining knowledge related to their field.
Social communities of interest	is a community of people who share a common interest or passion. These people exchange ideas and thoughts about the given interest, but may know (or care) little about each other outside of this area.
Individual communities of interest	are ICT tools for individuals to manage personal knowledge and networks.

Table 1 shows examples of these 7 types of ICT tools. 15 of the tool examples (with names in bold text in table 1) have been selected and evaluated systematically according to a standardized method in Appendix 1. In addition table 1 lists a number of successful examples of various ICT tools from agriculture and other domains. These are also described further in Appendix 1.

Table 1: Software types, evaluated tools (in bold text) and other examples of tools of the different types and successful examples of application of the tools, mainly in agriculture.

Software type	**Tools evaluated**	**Successful examples :** (see Appendix 1)
Knowledge portals (KP)	*Search engines:* Google, Yahoo *Slide and document sharing:* **Slideshare** *Video and photo sharing:* **YouTube**, Flickr	VOA^{3}R, eXtension, Chil
E-document management systems(E-MS)	*Digital libraries:* Groen Kennisnetin NL, **Organic E-prints**	Organic Eprints, Agriwebinar
Data Warehouse (DW)	Eurostat, **FADN**	FADN
Groupware (GW)	**Wikipedia**, **Yammer, Crowdsourcing**	British Farming Forum, Lego Cuusoo, Climate CoLab, P&G Connect+Develop, Betacup Challenge
Community of practice (CoP)	**ResearchGate, Erfaland**	Disease surveillance and warning systems, IDRAMAP
Social communities of interest (SCI)	**Facebook, LinkedIn**, **Google+, Ning**, Quora	AgTalk+,. E-Agriculture, Jeunes-agriculteurs, E-agriculture, Rede Inovar
Individual communities of interest (ICI)	**Wordpress, Twitter**, blogs	AG Chat

Below is presented a short description of the evaluated tools and a link to mainly agricultural examples of the tool. The tool descriptions include their characteristics, their audience and use as well as their strengths in relation to the evaluation criteria used in Appendix 1: 'Networking', 'branding', 'promotion', 'engagement', 'discussion', 'crowdsourcing', 'co-production', 'cooperation' and 'dissemination'.

Slideshare: http://www.slideshare.net/eagriculture
Knowledge portal tool for upload and sharing of slides, PDFs, videos, webinars and support documents. The website gets an estimated 58 million unique visitors a month and has about 16 million registered users. This tool is particularly relevant for dissemination and branding.

YouTube: http://www.youtube.com/user/FarmersUnions
Knowledge portal tool for sharing of videos up to 15 minutes. It has 4 billion video views a day with users uploading an hour of video each second. This tool is particularly relevant for branding, promotion and dissemination.

Organic Eprints: http://www.orgprints.org
E-document management system tool for papers and research projects related to organic food and farming. At present it contains almost 13,000 publications

from all around the world. In 2012 the archive had an average of 5,760 daily visits. This tool is only relevant for dissemination and branding.

FADN: http://ec.europa.eu/agriculture/rica/index.cfm?new_language=en
This data warehouse tool, the Farm Accountancy Data Network is an instrument for evaluating the income of agricultural holdings and the impacts of the Common Agricultural Policy. The annual sample covers about 80,000 holdings representing and represents about 6.200,000 farms in the EU-27 member states. This tool is only relevant for dissemination and to some degree for engagement.

Wikipedia: http://en.wikipedia.org/wiki/ICT_in_agriculture
This Groupware tool is a multilingual, web-based, free-content encyclopaedia project, written collaboratively by largely anonymous Internet volunteers. This tool is relevant for co-production, co-operation and dissemination.

Crowdsourcing: http://myfarmnt.com/
This open access Groupware tool is used for obtaining needed services, ideas, or content by soliciting contributions from a large group of people, and especially from an online community, rather than from traditional employees or suppliers. This tool is particularly relevant for discussion and engagement and to a lesser degree for dissemination, cooperation and branding.

Yammer: http://sustainability.psu.edu/instructions-connecting-terracycle-group-yammer
This closed groupware tool provides secure enterprise social networks within organizations or between organizational members and pre-designated groups, where employees can easily communicate, collaborate and view co-workers' projects. This tool is particularly relevant for discussion, engagement, co-production, co-operation, dissemination, crowdsourcing and networking in closed networks.

ResearchGate: http://www.researchgate.net/journal/0167-8809_Agriculture_Ecosystems_Environment
This community of practice tool is a social networking site for scientists to share papers, ask and answer questions, and find collaborators. It includes profile pages, comments, groups, job listings, and ‘like’ and ‘follow’ buttons. Currently it has 2.7 million members of which 120,000 are categorized in agricultural science. This tool is particularly relevant for crowdsourcing, co-production, co-operation, dissemination, networking and discussion and to a lesser extent for engagement, promotion and branding.

Erfaland: https://erfaland.dk
This community of practice tool is the gathering point for everybody involved in the Danish agricultural sector. The mission of Erfaland is to give future farmers a dynamic platform for knowledge sharing, collaboration and continuous development of both the individual and the farm business. This tool is particularly relevant for discussion and engagement and to a lesser extent for networking, promotion, branding and dissemination.

Facebook: https://www.facebook.com/dairyfarmingtoday
This social community of interest tool had as of primo 2013 more than one billion active users, of whom more than half use Facebook on a mobile device. Users may create a personal profile, add other users as friends and exchange messages, including automatic notifications when they update their profile. Additionally, users may join common-interest user groups, organized by workplace, college, or other characteristics. This tool is particularly relevant for discussion, networking and dissemination and to a lesser extent for branding promotion and engagement.

LinkedIn: http://www.linkedin.com/groups/Precision-Agriculture-1561757
This social community of interest tool is mainly used for professional networking. As of January 2013 it had more than 200 million acquired users in more than 200

countries and territories. This tool is particular relevant for networking, discussion and branding and to a lesser extent for promotion.

Google+: https://plus.google.com/communities/112192611231489743370
This social community of interest tool is Google's response to Facebook. Google+ is not a "social layer" consisting of just a single site, but rather an overarching "layer" which covers many of its online properties. This may make it more complicated to use. As of December 2012, it has a total of 500 million registered users of whom 235 million are active in a given month. This tool is particularly relevant for branding, discussion and networking and to a lesser extent for dissemination, cooperation and engagement.

Ning: Http://apf-down2earth.ning.com
This social community of interest tool is an online platform for people and organizations to create custom social networks It features sets such as photos, videos, forums and blogs; and support for "Like", plus integration with Facebook, Twitter, Google and Yahoo. There were over 90,000 (as of June 2011) social websites, known as Ning Networks, running on the Ning Platform. This tool is particularly relevant for discussion, networking, dissemination and engagement and to a lesser extent for branding and co-production.

Wordpress: http://technology4agri.wordpress.com
This individual community of interest tool started as a blogging system but has evolved to be used as full content management system with possibilities for using more than 24,000 plugins, enabling users to tailor their site to their specific needs. WordPress is currently the most popular blogging system in use on the Web, powering over 60 million websites worldwide. This tool is particularly relevant for dissemination and co-production and to a lesser extent for branding.

Twitter: https://twitter.com/AgBlogFeed
Twitter is a micro-blogging site via which users share updates in "tweets" that are limited to 140 characters. Users build audiences of "followers" and also choose to follow other users, read their content and then share some of it with their own followers through what are called retweets. Twitter has over 500 million registered users as of 2012, generating over 340 million tweets daily and handling over 1.6 billion search queries per day. This tool is particularly relevant for dissemination, networking and branding.

Figure 1 shows a honeycomb presentation of the functionalities of the 15 selected tools in relation to their subjectively judged functionalities for the 6 social network functions, which are considered to be most important for innovation networks:

- **Networking** - ways for one person to meet up with other people on the net.
- **Cooperating** - working or acting together towards a common end or purpose.
- **Co-producing** - using each other's assets, resources and contributions to achieve better outcomes.
- **Crowdsourcing** - obtaining needed services, ideas, or content by soliciting contributions from a large group of people.
- **Discussing** – exchanging viewpoints about topics in open and informal debate.
- **Engaging** – making users share, connect and contribute.

The honeycomb presentation uses10 colour grades from white (not supported) to dark green (strong functionality of the tool) to describe each of the social network functions in the diagrams in Figure 1.

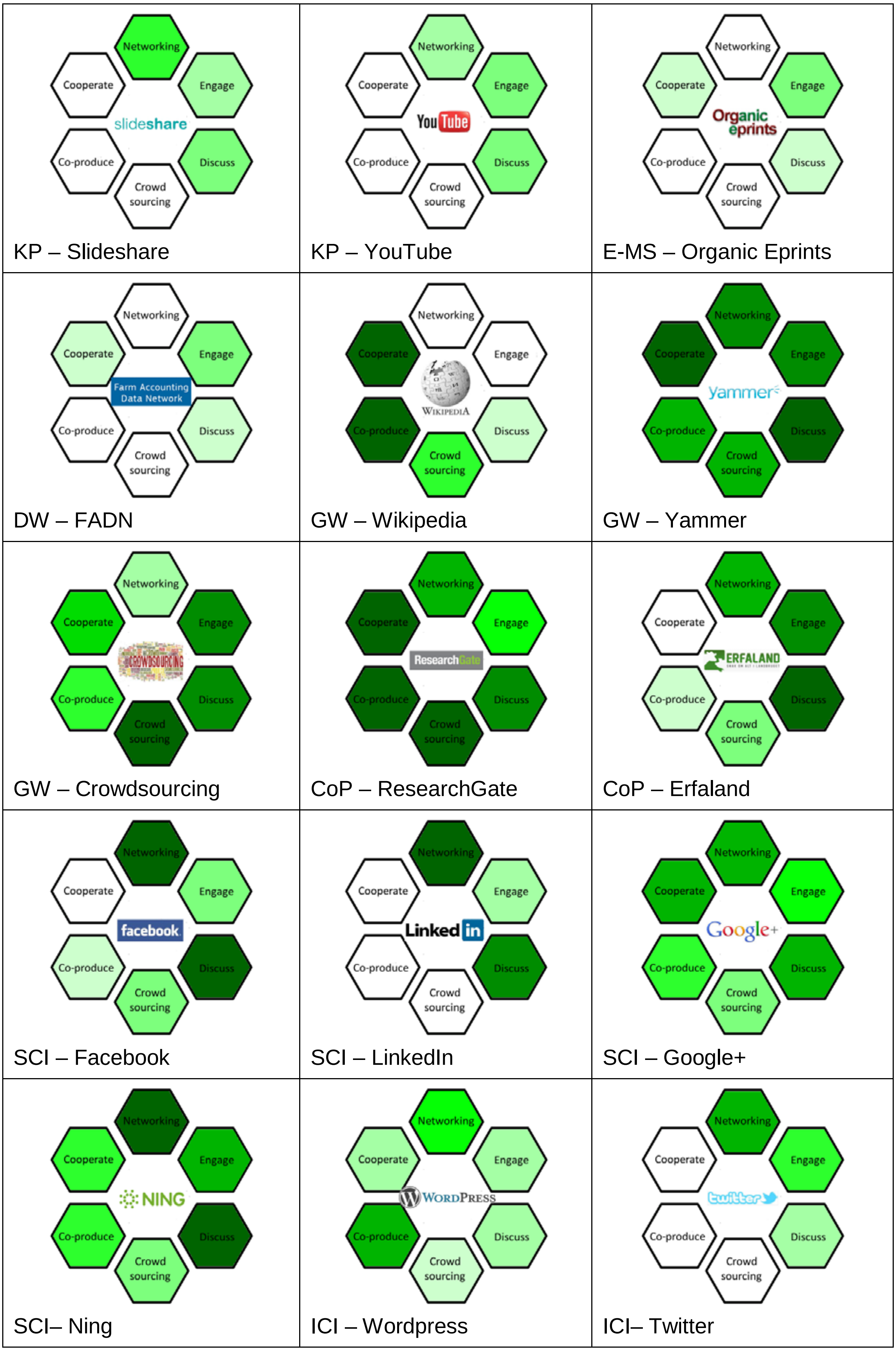

Figure 1: Honeycomb evaluation of selected tools in relation to 6 social media functions (see table 1 for explanation of type abbreviations, KP, E-MS, DW, GW, CoP, SCI and ICI).

The honeycomb evaluation of Figure 1 mainly demonstrates that there exists a large variety of social media with different strengths, capabilities and focuses. It is not evident which tools or platforms to choose to ensure a successful, i.e. active and vibrating community.

For example, if looking at the tools with the highest user potential for all 6 network functions, then the groupware tools,Yammer and Crowdsourcing, the communities of practice tool, ResearchGate and the social community of interest tools, Ning and Google+ perform best, but the individual community of interest tool and blogging system, Wordpress is also reasonably well rated for all 6 networking characteristics. However, these tools also have disadvantages, since Yammer can be used in closed networks only; ResearchGate is an open network, but with strong focus upon academia and with Ning, one has to start from scratch building the platform and gathering users.

Searching of the net revealed the following successful examples of use of the various ICT tool types in the agricultural sector plus a few very promising examples of crowdsourcing from other sectors (A more detailed description of the examples can be found in Appendix 1):

Knowledge portals:

VOA^{3}R: http://voa3r.cc.uah.es/.
VOA^{3}R is a 3 year EU FP7 project under the ICT Policy Support Program started in 2010. It is a social platform for researchers, practitioners and students in agriculture and aquaculture integrating open access institutional research repositories. It combines the archive function with the social online communities of interest known from a.o. LinkedIn. The VOA^{3}R consortium consists of 14 partners from 10 different countries and 3 collaborators from external organisations. The platform gathers 500,000 + open access resources from 14 repositories that cover agriculture, forestry, animal husbandry, aquatic sciences, fisheries and nutrition. The platform is planned to run after the end of the project.

eXtension: http://www.extension.org/
EXtension, which was launched in 2007, provides access to the land-grant university system with rules of operation, governing committee, staff and long-term implementation plan. EXtension was launched to meet the public's expectations of a relevant and accessible Cooperative Extension Service (CES). The goal of eXtension was to become a centrally managed, but locally delivered state-of-the-art, full-service program that uses technology and new organizational processes such as Communities of Practice (CoPs), Frequently Asked Questions (FAQ), Ask An Expert and various Wikis.

Chil: http://chil.org/
CHIL was launched by the Spanish government and Polytechnic University of Madrid in 2011. It is a portal that integrates network and free webhosting of companies, cooperatives and related organisations within the agricultural sector. It also features tools for knowledge management such as wikis, blogs, publication of documents, forums and services such as list of accommodation and agrifood suppliers, promotion of courses etc. It also includes geo-referencing information.

E-document management systems:

Organic Eprints: http://orgprints.org/.
Organic Eprints is an international open access archive for papers and projects related to research in organic food and farming. It is the largest existing repository specialized in organic food and agriculture and contains at present more than 13,000 publications from all around the

world and has more than 23,500 registered users and 150,000-210,000 visits per months. The main objectives of Organic E-prints are to facilitate the communication of research papers and proposals, to improve the dissemination and impact of research findings, and to document the research effort. The archive accepts many kinds of papers. It has been rated as number 38 out of more than 1500 archives in the world, and ranges as the highest with agronomic related content (http://repositories.webometrics.info/en/world). In 2011, Organic Eprints was nominated for the Oberly Award for Bibliography in the Natural or Agricultural Sciences, and received 'Honorable mention'.

AgriWebinars: http://www.agriwebinar.com
AgriWebinar is a web-based conference developed by Farm Management Canada, which runs webinar sessions from November to March every Monday at Noon EST. Speakers and topics are selected from the results of a client survey conducted previous to each new season of Agriwebinar®, so content is 100% client-driven. All live presentations are archived and available by podcast for access by any one at any time.

Groupware:

British farming forum: http://farmingforum.co.uk
British farming forum is an online peer to peer advice platform according to the same principle as AgTalk+. It has different fora focusing on different agricultural matters such as livestock, cropping machinery etc., where the users can pose a question and get input or advice from other online users.
Some subfora have more than 200,000 views and 1200 responses/comments within a short period of time.

Lego Cuusoo: http://lego.cuusoo.com
Lego Cuusoo is an example of crowdsourcing. It was launched worldwide by LEGO and it's Japanese partner CUUSOO in 2011. Lego Cuusoo invites you to submit your ideas to be considered as future LEGO products, and let you vote on and discuss ideas to help the LEGO Group decide what to release next. When a posted idea reaches 10,000 supporters, it is reviewed by LEGOs Cuusoo team who then decide on whether to produce it. So far four Lego sets have been developed/accepted based on users' ideas, and more are under review.

Climate CoLab: http://climatecolab.org
Climate CoLab, developed by MIT Center for Collective Intelligences, has the goal to harness the collective intelligence of thousands of people from all around the world to address global climate change. As of late 2012, more than 40,000 people from all over the world have visited the Climate CoLab, and over 4,000 have registered as members.

P&G Connect+Develop: http://www.pgconnectdevelop.com/.
Procter &Gamble launched its Connect+Develop program more than 10 years ago and has developed more than 2,000 global partnerships, delivered dozens of global game-changer products to consumers, accelerated innovation development and increased productivity, both for P&G and its partners. The website has served as P&G's "open front door to the world," allowing any innovator anywhere to share their innovations with the company. The site receives about 20 submissions every weekday – or more than 4,000 a year – from all over the world.

Betacup Challenge: http://www.thebetacup.com/
In the Betacup Challenge in 2010, the goal was to find ways to reduce the use of cups that cannot be recycled. There were more than 430 entries in the challenge. First place, with a

$10,000 prize, went to a group from Boston, which proposed what it calls the 'Karma Cup', not a new design, but a new way to encourage customers to bring reusable cups to their local Starbucks shop.

Community of practice:

Disease surveillance and warning systems. http://agcommons.files.wo
Agricultural warning and surveillance systems based on ICT is a whole separate category and numerous solutions could be mentioned. An example on control of banana diseases in Uganda is presented here: The system consists of a Community Level Crop Disease Surveillance system (CLCDS), a number of locals who disseminate and collect information in their communities using mobile phone applications and a team of professionals in relevant research fields, who have developed a technological system to identify, map, monitor and control banana diseases. Over the course of two months, 38 locals using mobile phones, MTN Mobile Internet, and GPS devices collected more than 3,000 surveys documenting the presence of three banana diseases in two districts in Uganda.

IDRAMAP http://www.bonificavalleserchio.it/manutenzioni/ is an on-line information system based on Google maps, created by a group of mountain municipalities in Tuscany. The system allows local people to signal hydrogeological problems (obstruction of water lines, landslides, state of roads and of infrastructures), to indicate them on an online map, and to provide photos illustrating the problem. Local authorities collect this information, analyse and use it, intervene in case of urgency and feed the information into the maintenance plan. [Strengths: the system increases local awareness about problems of the territory and stimulates participation. Weaknesses: the system is not endowed with a social network utility that may foster the creation of a community of practice]

Social communities of interest

AgTalk+ http://agtalkplus.com/
AgTalk+ is an American platform, purely run on voluntary basis and on donations. It has forums, blog, wikis and (sharing innovations) workshop creations and very active forums - e.g. on machinery and equipment, stock, crops, IT, market and precision tools.

Jeune agriculteurs http://www.jeunes-agriculteurs.fr/.
The French Jeunes Agriculteurs Syndicat is an organisation for young people (under the age of 35) working in agriculture. It counts more than 50,000 members and has an active Facebookpage with more than 5,000 followers. JA is organized on the basis of a geographical grouping of members, representing all regions and all agricultural production sectors in France.

E-Agriculture http://www.e-agriculture.org/
E-Agriculture is a global platform, launched in 2007 by FAO, UN and the World Bank. Here people from all over the world exchange information, ideas, and resources related to the use of information and communication technologies (ICT) for sustainable agriculture and rural development. It has over 9,000 members from 160 countries and territories.

REDE INOVAR http://www.redeinovar.pt
Rede Inovar is a Portuguese network, which aims at providing a technology- and knowledge transfer environment between the academia and the business community in the agro, food and forest sectors. The platform is supported by the EU and the Portuguese Ministry of Agriculture. It offers sector-selected search, personal profiles, event calendars, sharing of

articles, images, links and videos. It also has a brokerage area which aims to strengthen cooperation between academia and business environment and to speed up the process of technology transfer.

Individual communities of interest

AgChat https://twitter.com/agchat
AgChat Foundation, which was founded by a group of American farmers, started AgChat in 2009**,** using Twitter. It has more than 30,000 followers, and its mission is to "Empower farmers and ranchers to connect communities through social media platforms." It was launched through volunteer activities but is now funded by donations and sponsorships. It now launches four programs all focusing on how the agricultural sector can get the message cross via ICT. AgChat Foundation also has an active Facebook page https://www.facebook.com/AgChatFoundation - and a not so active YouTube page http://www.youtube.com/agchat and Pinterest - http://pinterest.com/agchatfound/. They also have quite passive LinkedIn and Google+ profiles.

When looking at the success stories described above, it is not possible to point at one type of software tool as being more successful than another in relation to networking, knowledge exchange and innovation in the agricultural sector – nor as regards the number of users, the activity in the network or the longevity of the network. Actually It has not been easy to find agricultural networks and platforms representing all 7 types of social media, and most of those found have been within the software types, 'community of practice' and 'social communities of interest'. One of the most successful examples of ICT use in agriculture measured in number of active users, is the Twitter based AgChat, which has more than 30,000 followers although Twitter's honeycomb (figure 1) scores zero in half of the communication functions evaluated. This shows that the success of a software tool as regards communication, knowledge sharing and innovation depends on many other factors than the ICT tool itself.

Despite the lack of formal metrics to determine whether social software has succeeded or not, the number of users and their level of activities offer significant evidences for a success. Without users there will be no information or other kind of knowledge to fuel the innovation processes. General social software systems such as Facebook, Twitter and similar tools are indeed successful measured by this 'number of users' metric, whereas specific agricultural targeting systems such as VOA^{3}R still need to prove their potential. However, the number of participants in a virtual social network is not necessary a sign of success. There are many other factors, which should be evaluated.

Apart from a few exceptions, our review of social software systems reveals, that agriculture as a sector to some extent has adopted the general social software programmes as tools for networking and knowledge sharing, but the potential to use it for crowdsourcing and cooperation or as a supplement to face-to-face interactions has not yet been exploited. Crowdsourcing has proven to be a huge success in other business areas, e.g. for the multi-national company, Proctor and Gamble, which, via its connect+develop website http://www.pgconnectdevelop.com receives more than 4000 submissions per year from all over the world.

Kärkkäinen et al. (2012) have investigated the use of crowdsourcing, especially from business-to-business companies' innovation perspective, with the aim to create a more comprehensive picture of the possibilities of crowdsourcing for companies operating in business-to-business markets. They performed a systematic literature review and found 19 cases, in which evidence of innovation as a result of crowdsourcing activities were found in 12 cases. Use of crowdsourcing was identified in three innovation process phases: front-end, product development, and commercialization. Furthermore, evidence was found for crowdsourcing to be used in innovation mainly in the manner of crowd creation, crowd wisdom and crowd funding. It is concluded, that the role of social media was quite essential in all the analysed B2B crowdsourcing examples.

Boudreau and Lakhani (2013) have also studied dozens of company interactions with crowds in innovation projects over the last decade in areas as diverse as genomics, engineering, operations research, predictive analytics, enterprise software development, video games, mobile apps, and marketing. On the basis of that work, they have identified when crowds tend to outperform the internal organization and, equally important, when they don't. Crowds make sense only when a great number and variety of complements is important; otherwise a few partners or even an internal organization will better serve the goal.

Despite the lack of identification of innovation in any of the successful agricultural examples, it is evident, when judged by the variety in capabilities of the reviewed tools and successful examples in the agricultural sector and in other sectors as well, that there is a potential for using existing social software tools and platforms much more to communicate, interact, create, share and organize information and as such stimulate multi-actor innovation in agriculture. Furthermore, instead of inventing new tools it is recommended to analyze which of the ICT tools already developed, are best suited for the purpose and the cooperation of the stakeholders to be involved.

4. Hardware

A prerequisite for an effective communication via electronic networks are reliable hardware tools (wired and wireless broadband, PCs, tablet computers, smart phones and cell phones) to support the various software tools for communication and search of information. In a recent survey. Holster et al (2012) made an overview of the relative distribution of various hardware tools (farm PCs, internet access, Farm Management Information Systems (FMIS), handheld phones/devices), (see Table 2).

Table 2: Relative access level to Farm PCs, internet access, FMIS and handheld phones/devices (Excerpt from Holster et al., 2012)

Country	Farm PC	Internet access	FMIS Farm Mgt Info System	Phones/ Handheld
Belgium	High	High	Average	High
Bulgaria	Low	Low	Low	-
Czech Rep.	High	High	High	Low
Denmark	High	High	Average	High
Estonia	High	High	Average	-
Finland	High	High	High	High
France	High	Average	Average	High
Germany	High	High	Average	High
Greece	Low	Low	Low	Average
Hungary	Average	Average	Low	Low
Ireland	Average	Average	Average	Average
Italy	Average	Average	Average	High
Latvia	Low	High	Low	-
Netherlands	High	High	High	High
Poland	Average	Average	Average	-
Portugal	Low	Average	Low	Average
Romania	Low	Low	Low	Low
Slovakia	High	Average	Low	Low
Slovenia	Low	Low	Low	Low
Spain	High	Average	Average	High
Sweden	High	High	Average	High
United K.	High	Average	Average	Low
Switzerland	High	Average	Average	Low

In another recent survey, OECD (2012) studied the access to various types of wired and wireless broadband in 34 countries of which 21 EU member states (See Appendix 2). Of the 21 EU member states examined, 9 (NL, DK, FR, DE, UK, BE, SE LU and FI) in falling order) had a similar or higher number of wired broadband subscriptions than the OECD average of 30 subscriptions/100 inhabitants, while the other 12 EU member states were below the OECD average. As regards wireless broadband access SE had the highest number of wireless broadband subscriptions out of the 21 EU countries with slightly more than 100 subscriptions per 100 inhabitants followed by 6 countries with 60 or more wireless broadband subscriptions/100 inhabitants (FI, DK, LU, EE, EI and UK). The rest of the EU countries had less than 60 wireless broadband subscriptions/100 inhabitants.

The two surveys show that the northern and western EU countries generally have the highest level of access to ICT hardware.

Another important factor for the use of communication software tools is the speed of the broadband connections. This was studied by ITU(2011) in a survey, covering among others, 15 EU countries. There were large differences in the advertised speed of the available fixed broadband connections in the different countries (Figure 2).

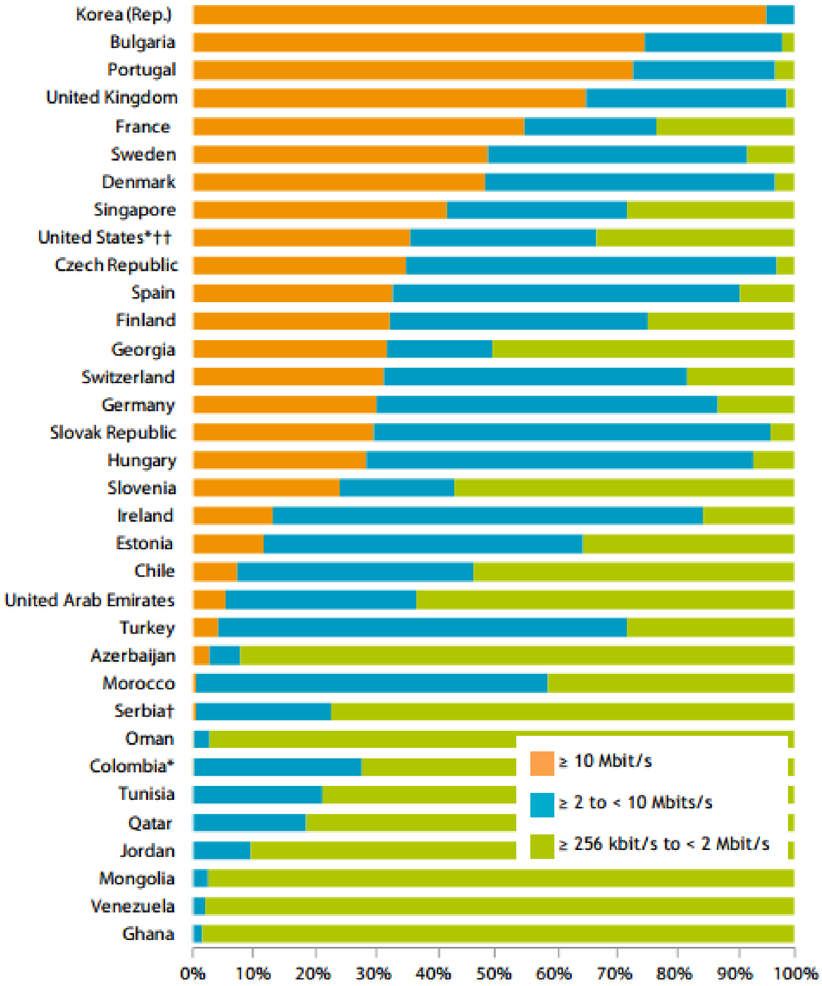

Figure 2: Advertised speed of broadband connections in various countries (ITU, 2011)

Of the 15 EU countries, 6 countries had a speed of 10 Mbits/s or more for 50 % or more of the advertised broadband connections, while the rest had less. Bulgaria and Portugal were the highest scoring with more than 70% of the advertised broadband connections being 10 MBits/s or more, while a country like Germany scored surprisingly low with only about 30 %.

The price for the use of broadband connections has also been studied in the survey of OECD (2012). It showed a large variation in the price per broadband megabits/per second, both within and between countries (see Appendix 2). This may be due to price differences between broadband providers, lack of competition and differences in the speed of the broadband advertised.

Lack of investment in high speed broadband and low competition between broadband providers in rural areas is a well-known problem for farmers in most EU-countries. This causes reduced access to internet connections, unreliable connections and low speed as well as high prices on broadband subscriptions (OECD, 2012). The problem is probably not going to be solved in the near future due to severe reductions in the EU Budget for 2014-2020 as regards investments in high speed broadband in rural areas. According to The Guardian, 11 February 2013 *"Broadband campaigners say EU budget cuts hammered out last week will kill high-speed connections needed by rural homes and businesses, after it emerged the budget for rural broadband – seen as vital to creating new businesses – has been cut by €8.2bn (£7bn) to just €1bn…"* (http://www.guardian.co.uk/technology/2013/feb/11/broadband-budget-cut-rural-connection-billion-euro*).* However, as of 31 May 2013 the EU budget has not yet been approved by the European Parliament and the Council, so it is uncertain if the budget for ICT infrastructure in rural areas will be cut or how much it may be cut.

The lack of high speed broadband connections in rural areas is a major barrier for establishment of an efficient ICT platform for communication and free exchange of knowledge in the agricultural sector (i.e. farmers, extension services, food and feed processing enterprises, agricultural scientists etc.), especially in the eastern and southern countries with poor economies and high prices on the use of the broadband connections. Therefore care should be taken to choose the right hardware tools in different countries.

There may also be a mental barrier to some (mainly older) farmers and other actors in the food chain to acquire and use ICT hardware and software tools. In 2007, 31% of holders of agricultural holdings in the EU-15 (the "old" EU member states) were 65 years or older and the number has been steadily growing since 1990 (Matthews, 2012).

Some barriers will be overcome without actions taken by public regional or national authorities. The price of ICT hardware is continuously decreasing while the capacity, portability and user friendliness is increasing. The change from monolithic to networked computers also reduces the demand for processing power and storage on the client side, because the storage and processing is done on internet servers/in the cloud. The communication platform most used among European farmers and extension workers is the mobile phone. With the technological development of more and more advanced smartphones and other portable devices the phone will also become the internet portal for the farmer. However, there is a need for investments in reliable and high speed broadband structures in rural areas where broadband suppliers cannot see a business opportunity, and there is a need for educating older farmers in the use of ICT.

5. 'Orgware'

'Orgware' refers to the capacity building of the different institutional actors involved in the adaptation process of a new technology by networking. (Wikipedia, 2013)

Network models of innovation existed long before the recent developments of the Internet. The first communities of practice were face-to-face communities, of which informal social relations were the most important media. The internet makes possible to expand in time and space the model of informal social interaction. Face-to-face communication (characterised by co-presence) is indeed complemented by remote interaction, both synchronous (for example, Skype conversations, chat functions on Facebook and other platforms) and delayed (for example, e-mail). Progressively, the Internet expands the possibilities to broadcast information (one to many) while receiving feedback from many contrary to traditional media. Moreover, they progressively expand the amount and type of information exchanged (sounds, texts and images). The Internet also allows the storage of growing amounts of information in remote repositories, such as Organic Eprints (http://www.orgprints.org/), making shared repertoires available without direct social interaction.

When we look at the role of the Internet in communication and collaboration processes, we can say that:

- The Internet adds human-to-machine interaction to human-to-human interaction. A lot of information can now be accessed without any human mediation.
- The Internet makes operations possible that once were possible only in co-presence.
- The Internet reduce the time necessary to perform activities that, when done in a face-to-face setting, can be slow and complicated, though somethimes necessary.

Social media have made a step further. They provide platforms for the development of virtual communities, giving users tools to develop 'social' skills (profile description, asking connection, exploring other members' connections, publishing posts, commenting on others' posts, 'like' buttons, reputation generators - as in the case of amazon book reviews - , social bookmarking, etc.). Social media provide platforms for collaborative working, such as collaborative text writing (e.g. in Google Docs) and collaborative maps (e.g. IDRAMAP, www.bonificavalleser-chio.it/manutenxioni), not to speak of the 'open source' software projects.

Internet forces us to reconsider the respective roles of offline and online, face-to-face and remote, and to redesign processes accordingly. As the cost of physical interaction increases, its relative cost to remote interaction decreases – due to scarcity of time and energy costs for transportation. It is important to identify the features that still give physical interaction an advantage compared to remote interaction, thus mobilizing it when it really adds value. The following could be criteria to identify future roles of different types of interaction:

- Human-to-machine interaction will replace all standardized knowledge transactions, as in the case of search for information stored into databases. This type of interaction is expanding constantly, as the progress in automatic translation, automatic text summarization and the so called 'semantic web' – where data are accompanied with metadata which make the data machine readable - develops.
- Remote human interaction will replace face-to-face interaction whenever unproblematic communication is involved: for example, agreeing on dates for a meeting, responding to specific questions, writing collaboratively short reports, polling on alternative options,

discussing routine issues among people, who already know each other. Possibility of exchanging images and voice, together with experience concerning the use of these media, shifts progressively the range of issues that can be addressed through remote interaction.

- Physical interaction is still not replaceable when information is too complex to be codified in a digital way (for example, involving taste, touch, smell, body language as well as co-production of new knowledge). Thus, in situations where it is essential to foster motivation, to mobilize emotions, to capture background information and tacit knowledge and, to interpret complex natural phenomena. Rather than mere replacement of physical interaction with remote or machine interaction, innovation systems will enjoy an integration of online-offline interaction.

However, the successful formation of networks and virtual communication platforms may not be enough to obtain innovation. The World Bank (2006) found that even when there were strong market incentives for players to collaborate for innovation, linkage formation was still extremely limited. An important role of public policy should therefore be to promote these linkages. This may be done by means of innovation brokers, i.e. a type of intermediary that is neither involved in the creation of knowledge nor in its use in innovation, but one that binds together the various elements of an innovation system and ensures that demands are arcitulate to suppliers, that partners conect and that information flows and learning occurs (Klerkx, 2009).

All the above mentioned aspects will have implications on the future activities carried out in the Agricultural Knowledge and Information Systems (AKIS).

The social media are changing dramatically the way agricultural research and development is organized. Social media allow the creation of communities of practice among researchers and students to exchange ideas, expertise, bibliographies, as in e.g. ResearchGate, http://www.researchgate.net/, and which is also the ambition of the EU FP7 project, VOA3R, http://voa3r.eu/). Some specialist software media that can help you organize your research, collaborate with others online, or discover the latest research, such as Mendeley (www.mendeley.com), Academia.edu (http://academia.edu/), ResearchGate (http://www.researchgate.net/) and LinkedIn (http://www.linkedin.com/) have grown rapidly over the the last years. Possibilities of exchanging and sharing large amounts of data and processing capacity allows the connection of laboratories/research institutions in places distant from each other. Possibilities of collaboration fosters interdisciplinarity. Open access journals and repositories are making scientific outputs availbale for free to everybody (e.g. Organic Eprints).

Social media will provide a much faster and effective dissemination of research output and the feedback to the researchers will be much more consistent. Peer review, that at present is the key of scientific quality of research output, will be possible at a much larger scale and will become a continuous process. Civil society may have the possibility to feedback on the relevance of research output, on the possible impact and on potential risks (e.g. VOA3R).

According to Ballantyne et al. (2010), research in agriculture can benefit from the possibility of sourcing data from farmers through mobile digital devices. This will cut down the costs of data collection and will allow the development of locally specific solutions. This is the idea behind IDRAMAP in Tuscany, an on-line community of practice information system based on

GoogleMaps. The system allows local people to signal hydrogeological problems (obstruction of water lines, landslides, state of roads and of infrastructures), to indicate them on an online map, and to provide photos illustrating the problem. Local authorities collect this information, analyze it and use it, intervene in case of urgency and use the information in the maintenance plan. Appliction of such a community of practice system in agriculture may generate a progressive involvement of farmers in research, provided that social media allow them to give not only data but also inputs on research problems, feedback on research output and direct access to the use of the results. An example of this could be the social communities of interests network, E-agriculture (http://www.e-agriculture.org)

When access to information is no longer a problem, teachers will lose their role as 'content providers', and will have to concentrate on methods: thinking, finding relevant information, synthetize, contextualize, critically evaluate (Williams and Tapscott, 2010), and ICTs will transform e-learning tools from 'medium' to 'platforms', in which content is created, shared, remixed, repurposed, and passed along (Downes, 2005). As Downes stated, '*the control of learning will be placed in the hands of the learner'*, and learning will be linked to specific goals. The teacher, in this context, will become a facilitator, a resource person, and the class will be transformed into an environment where to develop creative discussion and to stimulate collaborative work. In the new context, students will view learning as the process of joining a community of practice. An example of this type of virtual space is Erfaland (https://erfaland.dk/), a Danish platform for agricultural actors, which aims to be a dynamic platform for knowledge sharing, collaboration and continuous development of both the individual and the farm businesses).

When it comes to farmers, training will concentrate face-to-face activities on problem-solving activities and may also be used to increase group building, knowledge sharing and collective problem definition. Brokerage methods such as transect walks, focus groups, Venn diagrams, world cafés, card games, could make the meetings more effective as they will stimulate participation, discipline of interaction, curiosity, group identity. Offline (face-to-face) encounters will be followed up by post-event social interaction, which will strengthen and disseminate learning output, such as in the portugese initiative, Rede Inovar.

Repeated interaction among multiple actors allows a reduction of the distance between expert advice and lay knowledge. Social media also allow to integrate expert advice with lay knowledge through peer-to-peer interaction. This might be the case in foras such as British Farming Forum (http://farmingforum.co.uk/forums/forum.php), provided that the researchers and extension sector are willing to interact on these kind of platforms and also "put the ear to the ground" in order to get inspired to develop new research projects and advicing products. As in the case of research and education, also with technical advice, all the tasks that can be standardized and digitalized will be progressively performed through human-to-machine relationships; remote advice will have a much more relevant role as seen e.g. on Agriwebinar (http://www.agriwebinar.com/), especially for frequently asked questions, and peer-to-peer interaction will complement the expert advice.Physical interaction will be concentrated on the discussion of complex issues or on problems that require direct observation of the object of knowledge. Imaging and recording will allow to share the information gained with physical interaction and to contribute to shared repertoires.

Peer-to-peer interaction will increasingly integrate technical advice, and extension services will have to design their activity in a way to foster and monitor social learning, e.g. by participating in discussions at the virtual platforms used by farmers, like the Danish Erfaland. All actors in the system will dedicate a higher share of resources to online instruments to increase their productivity. Mailing lists, content management systems, collaborative working tools will become tools of daily usage. Social Media have the potential of turning any project into a community of practice. Development projects – such as those funded by Rural Development policies - will increasingly mix different activities (research+training+extension) and diverse actors, including consumers, linked together by flows of information across the Internet and finalized to specific innovation objectives (see IDRAMAP example in Annex 1).

Extension services will increasingly dedicate themselves to the creation of communities of practice, specializing in bridging worlds characterized by different languages, bodies of knowledge, goals, to align actors around specific innovation objectives and to facilitate the access to financial resources (innovation brokerage). Brokering skills, both online and offline, rather than technical specialization, will become key elements in the new extension services. As far as face-to-face interaction is concerned, brokerage tools will increasily be employed to increase their effectiveness. (Some examples of this may be found in Annex 5: Orgware).

6. Barriers and recommendations

Based on the analysis of software, hardware and 'orgware' in Chapter 3, 4 and 5 for improvement of information, communication, knowledge sharing and innovation in the agricultural sector, the following barriers and recommendations on how to overcome these barriers are proposed:

Barrier 1 – Limited use of social media for innovation in the agricultural sector
The agricultural sector has far from used the full potential of ICT software tools for innovation, though some virtual networking and knowledge sharing between farmers, agricultural advisors, researchers and other actors in the agricultural sector is taking place on various types of social media platforms. However, only one example of the use of crowdsourcing in the agricultural sector has been identified (British Farming Forum) although this software tool seems to have been rather efficient to create innovation for private companies like Procter and Gamble and Lego, among others (see Appendix 1).

Recommendations

- As a first step utilization of general social software systems should be promoted, while alignment of the various software systems and their strengths in relation to well-defined purposes and types of network groups and actors should be investigated.
- As a second step application of crowdsourcing and innovation brokers in the agricultural sector should be tested in relation to creation of innovation in Horizon 2020 or in Operational groups or networks under the European Innovation Network (EiP).
- Invention of new systems should not be promoted. Even if they may be superior from a technical viewpoint, it will be difficult and a steep climb to attract a critical mass of users and especially attracting peripheral users to new social platforms– these are important for spurring innovation.

Barrier 2 – Insufficient internet connections
A stable, reliant and relatively fast internet connection is crucial for the innovation and collaboration in agriculture. The quality of both mobile and wired internet connections varies across Europe, with North and West European countries generally offering higher quality and speed at lower prices than south and east European countries. Within each country the possibilities for high-speed, stable internet connection is highest in urban areas and lowest in rural areas. This is clearly a barrier for the development of ICT usage in the agricultural sector.

Recommendations
Promote the development of internet connections in the rural areas, perhaps supplemented by national, regional or EU funding of rural broadband infrastructure. Fast connections are better than slow, and slow connections are better than no connections.

Barrier 3 – Lack of access to hardware tools
The price of ICT hardware (PC, tablets and smart phones) is continuously decreasing while the capacity, portability and user friendliness is increasing. Today the majority of European farmers have a mobile phone and more and more of them are smartphones. The availability of rugged computers that can resist the tough environment of a farm is also increasing.

Recommendations
No actions are necessary in the northern and western EU countries because the market forces develop in the desired direction, but in the eastern and southern EU countries public support measures for ICT hardware (robust smartphones and tablets) may help speeding up the use of ICT by farmers.

Barrier 4 – Cultural barriers and lack of engagement in the use of social media
Several cultural barriers for optimal use of the social media and networking have been identified:

- The age of farmers. The average age of farmers in the EU is increasing and so is the percentage of farmers above 65 years, who are often not familiar with ICT tools and networking via internet applications.
- Lack of engagement of researchers in open access social media, which are used by farmers.

Recommendations

- Introduce education of farmers in the opportunities and use of ICT tools, promote easy access ICT solutions, advertise and demonstrate the good examples.
- Change the rewarding system for scientist so that engagement in the application of research results / innovation activities is also rewarded, in parallel to publishing in peer reviewed journals.
- Highlight successful examples of implementation of research results in practical farming, food and/or feed processing etc.

Barrier 5 – Overload of farmers with information and misinformation
There is a risk of information overload of farmers and other users of social media and risk of misinformation due to lack of quality control of the information available.

Recommendations
De facto peer review via social media already exist to a wide extent in the sense that users often tend to read, visit or use the articles, websites and tools recommended by someone in their network. This adds authenticity and credibility and serves as a filter of the vast amount of online information available. This is one of the main principles of Twitter, where you follow someone you regard as an authority or pioneer within a given field, and then tend to read or connect to whatever this person recommends rather than visiting a generic platform on a given topic.

This pattern of individualization on news and information usage is a megatrend in western society and can be found in a broad range of media use, from personalized play lists of music on Spotify to tailor made “menus” of TV channels. Filtering can thus happen on the receiving end of the information stream, but it is also important as a broadcaster or disseminator of knowledge to filter your output. This can be built into the software, as seen on Amazon (http://www.amazon.com/) or the Danish agricultural platform Landbrugsinfo (https://www.landbrugsinfo.dk/), where your start page is personalized based on your previous behaviour on the site.

Barrier 6 - Lack of long-term solutions beyond the research project period
ICT systems created within a project (e.g. webpage with chat forum for presentation and discussion of deliverables, meetings etc.) rarely gain a lot of users and are usually not intended to stay 'alive' after the project has ended, because there is no funding for further development and activities.

Recommendations
By using social media and ICT tools that are already available, and which have a well-established network with active communication and cooperation, the costs for maintenance can be minimized and the results of the research project may continue to be discussed and new ideas generated after the end of the project lifetime for the benefit of the researchers as well as the potential users of the results. Popular systems like the individual community of interest tool, AgChat (http://agchat.org/) started using Twitter and volunteer activities but it now has a forum of more than 30.000 followers and is funded by donations and sponsorships.

7. Perspectives and conclusion

Perspectives

The interest from farmers in using ICT and social media to exchange knowledge, experiences and ideas presents a potential for a targeted support and development of such tools for dissemination and support of innovation. Currently these tools are used to some extent as part of extension efforts such as the Danish advisory services ERFALAND, and the Portuguese Rede Inovar (more examples in the preceding chapters). There is a large unused potential for implementing this in combination with the different types of farm related groups and networks established within the general social network media (e.g. the Facebook group of the French organisation Jeunes agriculteurs).

It is a hypothesis that a combination of face-to-face interactions and social network media could not only strengthen classical linear dissemination but also encourage new forms of interaction between different actors, which could facilitate innovation processes. However, this study has not identified actual innovations being the result of the use of such tools within agriculture so far. Thus, there is a need to further explore how the social networking potential can be directed towards actually supporting innovations, for example by linking these with innovation brokers. Our analysis suggests that the challenge is to improve the cohesion behind the 3 conditions for ICT supported innovation: software, hardware and' orgware'. This could be one of the challenges and roles of the coming European Innovation Partnership (EIP) 'Agricultural Productivity and Sustainability'.

The applications of social media have perspectives for the functioning of the modalities under the EIP. It is expected that so called Operational Groups (OG) of the EIP at local level will be the core units of this tool aimed at innovation and knowledge exchange. The idea is that EIP should go beyond the linear dissemination model and 'adhere to the interactive innovation model' which focuses on forming demand-driven partnerships - using bottom-up approaches and linking farmers, advisors, researchers, businesses, and other actors in Operational Groups. " (COM, 2012). An OG will consist of members from different actor groups joined in an action- and result-oriented "hands-on" activity, where interaction between group members is maximised for co-creation and cross-fertilisation. They will need means of communication besides meeting face-to-face, and as shown in the analysis above, a number of tools for social networking would be useful for this purpose. Moreover, it is important to communicate with other stakeholders outside the specific OG and between OGs in order to secure the wide uptake of the innovations developed. Here, social media will be very useful to allow for continuous exchange of ideas and knowledge within and as part of networking between OGs. This is foreseen to be supported by Thematic Networks, which should assist in connecting OGs across regions and countries and facilitate wider knowledge exchange.

As discussed in Chapter 2 about the conceptual framework, the quality of social interaction affects capacity and effectiveness in innovation processes. These qualities again depend on diversity, connectivity and interactivity among members of networks and especially the capacity to create "new frames" through second order learning, which often is fundamental for radical innovation. Therefore, it seems important that an efficient use of social media by OGs and Thematic Networks may facilitate "crowd sourcing" processes, where members of an OG could seek assistance and ideas for a particular challenge from a wider knowledge pool and thus speed up the innovation process. As mentioned in Chapter 3 about software, crowd sourcing has been used successfully in other sectors. Building up such facilities (preferably using existing infrastructures as described above) would be a valuable support for the ambitions that Thematic Networks can act as think tanks, knowledge hubs and innovation brokers.

As mentioned initially, there seems to be a significant time lag and geographical difference in the implementation of new knowledge and innovation across the EU member states. It is a hypothesis worth testing that facilitating improved communication using social media might improve "long-distance cross-fertilisation" in the fields of agriculture. Language differences and skills will be a challenge, but might be partly overcome by new semi-automated translation tools and the assistance of knowledge brokers and Thematic Networks within a social network infrastructure.

Conclusion

This analysis of the use of social media and other ICT tools in the agricultural sector and other sectors shows that there is a great potential for using existing social software tools and platforms for communication, interaction, knowledge sharing, preservation of information and as such stimulate multi-actor innovation. However it is not possible to predict which ICT tools that will be best to use in a given situation, but focus should be on the end user and the purpose of the network, taking into account the target groups' pattern of ICT usage. Maintaining the platform, selecting first movers, ambassadors etc. may also play an important role for the success. Moreover, a redesign of the organizational model from top-down to network models will also improve the knowledge sharing and mutual learning, which are prerequisites for innovation.

The analysis has identified some important barriers, which need to be overcome to obtain the full potential of the use of social media and other ICT tools in the agricultural sector: The present lack of use of social media for innovation in the agricultural sector may be overcome by stepwise promotion and tailoring of social software systems and testing of crowdsourcing and innovation brokers in Horizon 2020 or in OGs under the EIP. Lack of reliable and fast internet connections are crucial barriers for virtual collaboration and innovation in the agricultural sector. This barrier may be reduced by rural development funding of broadband infrastructure in regions with no or slow access to the internet. The price of hardware and broadband subscription may also be an obstacle in poor regions, but rural funding programmes may also assist here.

Cultural aspects may be a serious barrier – almost one third of the EU farmers are above 65 years and probably not familiar with PCs, smartphones and ICT tools. Promotion of easy access ICT tools, courses and demonstration of good examples may reduce the problem. Another cultural barrier is the lack of engagement of researchers in social media for farmers. Change of the rewarding system for researchers may solve this problem. Risk of overload and misinformation of farmers, participating in multi-actor social media platforms may also be a barrier. Use of Twitter for following reliable experts may be used as a filter for overload and misinformation or it may be built into the software tools used for the virtual networking. Lack of maintenance of networks beyond research project periods is also a serious barrier for establishment of stable and lasting collaborative networks within different fields of the agricultural sector. Increased use of already established ICT tools and well-established virtual social networks like AgChat may change that.

Definitions:

2G (GSM): Second-generation wireless telephone technology (Global System for Mobile Communications). 2nd generation (2G) digital cellular networks used by mobile phones. It is the global standard for mobile communications with over 80 % market share. (Wikipedia)

3G (UMTS): Third generation wireless telephone technology, (Universal Mobile Telecommunications System). 3G provides an information transfer rate of at least 200 kbits/s.

FADN: Farm Accountancy Data Network**:** http://ec.europa.eu/agriculture/rica/

FMIS: Farm Management Information Systems

ICT: Information and Communications Technology

PC: Personal computer

RSS: Rich Site Summary (originally RDF Site Summary) is a family of web feed formats used to publish frequently updated works—such as blog entries, news headlines, audio, and video—in a standardized format.

Venn diagram: or **set diagram** is a diagram that shows all possible logical relations between a finite collection of sets (aggregation of things).

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Appendices:

Appendix 1: Software and successful examples
Appendix 2: Hardware
Appendix 3: Orgware