ICT-AGRI-2
Grant agreement no 618123
Deliverable D1.1

ICT-AGRI 2015 Action Plan

for implementation of the Strategic Research Agenda

with focus on

Precision Agriculture

Jack Verhosel
&
Bert Beck, Christophe Guizard, Jürgen Vangeyte
Kees Lokhorst, Markus Lötscher, Raymond Kelly

17 December 2014

ICT-AGRI
Information and Communication
Technologies and Robotics
for Sustainable Agriculture

Contents

1. Introduction

In the first ICT-AGRI ERA-NET, a strategic research agenda (SRA) has been developed in 2012. It describes the main challenges, goals and solution domains of the application of ICT and robotics in the agricultural sector. One of the objectives of the current ICT-AGRI-2 ERA-NET is to implement the SRA. This means that the SRA is translated into yearly action plans that describe specific actions to be taken in order to stimulate research and innovation in the topics identified by the SRA. This document is the first yearly action plan that describes actions to be taken by the ICT-AGRI-2 ERA-NET in 2015.

1.1. Background

The SRA concluded that Europe and the associated countries have a huge potential to produce high quality and safe food for a continuously growing market due to its leading role in the agricultural engineering sector. The food control along the value added chain is highly developed. On the other hand, the agriculture in Europe and the associated countries is under strong competition, because many other countries in the world are able to produce at lower costs. A cutback of subsidies on both the European and national levels is imminent. The legal and administrative requirements for an environmentally friendly land use and animal friendly livestock production systems increase. Meanwhile new future challenges such as climate change and protecting biodiversity are rising.

According to the European Commission for Agriculture and Rural Development agricultural income per (annual) worker in the EU-27 has grown over the last decade both in nominal and in real terms. On average, however, the increase in real terms has been very modest (0.6 % per year) and the development in recent years has shown, that agricultural income is highly volatile. To strengthen the international competitiveness of European farmers and to reduce the negative impact of agricultural production on the environment are key concerns of the ICT-AGRI ERA-NET. Furthermore, ICT-AGRI aims at facilitating the application of information and communication technologies and implies that farmers use these technologies to meet the challenges agriculture will be faced with in the decades to come.

In the SRA new perspectives in ICT applied in agriculture are proposed. It identifies future challenges for a sustainable European agriculture and deduces goals and solution approaches based on ICT and automation technologies. Further needs for research and innovation (R&I), are determined and prioritized. Finally also a vision for ICT and automation in agriculture together with a road map for SRA implementation is created.

1.2. Main outcome of the SRA

On the background of the future challenges ICT-AGRI has identified goals for a sustainable European agriculture, which are particularly depending on ICT and automation and solutions contributing to these goals (see Figure 1). Precision agriculture and precision livestock farming rely on the use of information and communication technologies including sensors, (global) positioning and decision support systems etc. The collected data enable the farmer to precisely dose fertilizers and pesticides or the application of seeds and other inputs via regulation of agricultural machines. ICT permits the optimized application of inputs and therefore reduce adverse impacts of agriculture on the environment. They can help to enhance the efficiency of food production and to obtain higher outputs, while inputs decrease.

Based on a review of current technologies used in plant and animal production the solutions were designed to cover nearly all contributions of ICT and automation to primary agricultural production and to agriculture related environment. The solution Farm Management and Information System (FMIS) is defined as the backbone system for the other ICT and automation solutions prioritized by ICT-AGRI. The concept of solutions highlights the need of interdisciplinary collaboration and interoperabilty. It is not enough to invent a machine capable of variable rate application; it is also necessary, for example, to include the interaction with farm management or the economic consequences.

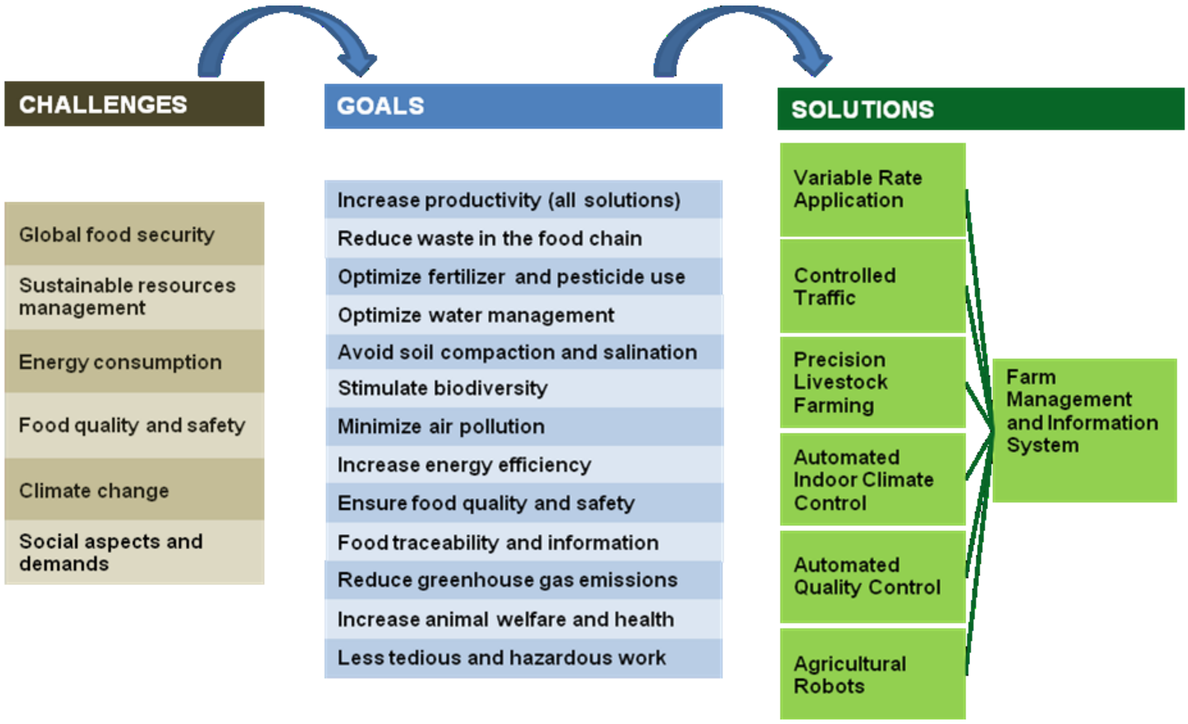

Figure 1: Challenges, goals and solutions for a sustainable European agriculture, identified by ICT-AGRI.

All solutions mentioned above have the potential to increase the production efficiency with regard to production factor (input) and productivity (output). In combination with the reduction of waste in the food chain this is essential to ensure global food supply for future generations.

To produce more food from the same area of land should not be associated with extra negative impacts on the environment. A sustainable management of natural resources aims at optimizing the efficiency of production factors (e.g. fertilizers and pesticides, water, soil) to reduce negative environmental effects. Related goals are also the avoidance of soil compaction and salination, the minimisation of air pollution by reducing emissions and the stimulation of biodiversity. ICT solutions contributing to these goals are Variable Rate Application of fertilizers, pesticides and water as well as Controlled Traffic.

Controlled Traffic Farming can also help to overcome problems related to energy consumption and climate change. The controlling of field operation traffic increases energy efficiency and reduces energy demand (including use of fossil energies) and greenhouse gas emissions from agriculture. The use of energy saving systems for Automated Indoor Climate Control pursues the same goals.

Automated quality control is essential to ensure food quality and safety (e.g. less cells and bacteria, less/no residues of pesticides or pharmaceuticals in plant and animal products). ICT solutions having an impact on product quality and safety are Variable Rate Application, Precision Livestock Farming and Automated Indoor Climate Control. Advanced Farm Management and Information Systems (FMIS) are needed to optimize the information flow between farm software applications and between stakeholders to improve traceability throughout the food chain.

Social aspects and demands will keep on playing an important role in the European agricultural sector. Precision Livestock Farming and Automated Indoor Climate Control contribute to animal welfare and health. Animal specific feeding, milking, monitoring and housing results in a prolonged productivity. The use of Agricultural Robots for animal and plant production processes improves work place ergonomics and labour efficiency by undertaking tedious and hazardous work or by better human-machine interfaces.

Summarizing, there are many points where ICT applications help to pave the way towards more sustainable agricultural production systems and have the potential to change and improve agriculture. Beyond the technological aims the ambitions of the SRA are to integrate these technical solutions in an overall approach to be sure that they are on the sustainability way and that all the conditions are gathered for a realistic dissemination of them to aim a large scale eco-efficiency.

1.3. Goal and structure of the action plan

The goal of the action plan is to define actions on how to stimulate the implementation of the Precision Farming research/innovation topics. Precision Farming encapsulates precision agriculture and precision lifestock farming. The main focus for the action plan is to form the basis for the first ICT-AGRI2 call in 2015 that is focused on precision farming. The challenge for the action plan is thus (1) to first define the main challenges in precision farming based on the SRA topics, (2) to define the specific research & innovation topics in precision farming in more detail, (3) to define actions to be taken for our first joint call that is focused on the precision farming topics, and (4) to define other actions that can be taken to promote precision farming via existing instruments. These parts are described subsequently in the next chapters of this document.

2. Main challenges in precision farming

The implementation of the SRA will be done in 3 yearly action plans. Per yearly action plan, a subset of the 7 solution domains of the SRA is selected to form the specific scope for that year. For the first action plan, targeted to 2015, the scope was chosen to be on Precision Farming. This includes:

1. Variable rate application,
2. Controlled traffic farming,
3. Precision feeding and health management of livestock

One of the main reasons for this selection is that precision farming directly contributes to one of the most important global challenges, namely to secure global food supply to feed an estimated number of 8 billion people in 2024 and 9 billion in 2050. More specifically, the main goal of precision farming is to contribute to sustainable intensification of production and it contributes to solving the following main global challenges:

- Increase resource efficiency
- Reduce waste and emissions
- Increase animal/plant health and welfare
- Increase food safety
- Reduce human labour force

In the sections below, the three subdomains of precision farming are briefly described and the relations with these global challenges are given.

2.1. Challenges in Variable Rate Application

Variable Rate Application (VRA) is the site-specific and therefore reduced application of fertilizers, pesticides, seeds or water. VRA uses sensors to collect empirical data on the current state of crop and/or soil on a suitable spatial resolution. The collected data is then interpreted to generate decisions for optimum variable application rates. Determining the rate of fertilizer, pesticides, seeds or water that should be applied to a certain area in a field, is either based on a specification file generated from earlier sensor measurements or on real-time sensor measurements. This domain include sensors for determining crop/soil variables, decision algorithms for determining variable rates, decision support tools, tools for creating specification files (i.e., files which determine the amount of fertilizer, pesticide, seeds or water that needs to be applied to the different parts of the field) and auto-guidance systems and machines that are capable of variable rate application, i.e., they should be compatible with the specification files or respond to automated decisions made after real-time sensor measurements.

The ongoing technological development of remote sensing techniques by satellites, UAVs and ground-based sensors is making crop management with much greater spatial and temporal resolution possible. Nonetheless, despite the enormous potential of these remote sensing techniques on VRA applications, their use in practice remains rather limited. Therefore, the main challenge in this area is bridging the gap between research and innovation by developing practical applications for remote sensing data in the area of variable rate application. Researchers wishing to tackle this challenge, should aim at collecting high-resolution remote sensing data, preferably at multiple times in the growing season, in order to conduct real-time or near-real-time soil, crop and pest management.

Challenges exist to use VRA for the optimization of water management. In the Mediterranean basin, climate change is exacerbating the reduction of water resources availability for agriculture. In many other parts of Europe, drought sensitive crops, like potatoes grown on sandy soils for example, also require irrigation for optimal growth, even in short dry periods. Drip irrigation systems management is required to optimize water consumption for crops such as olive tree, pepper, cucumber and melon. A challenge is the improvement of soil and agroclimatic data measurement and management (sensing, information management and decision support issues) in order to enable efficient use of water.

2.2. Challenges in Controlled Traffic Farming

Controlled Traffic is the geo-positional control of field operation traffic to optimize yields and input (including fuel and labour) and to reduce negative environmental impacts. This domain includes decision support to minimize traffic and soil compaction, auto guidance, fixed tracks guidance and fleet management. It requires agronomic knowledge relating crop development to field operations and also knowledge on relations between trafficability and workability, soil status and traffic effects. The operation and traffic planning tools as well as real-time monitoring and steering tools call for comprehensive data exchange and interoperability.

Especially for permanent grassland long term experiments are required to gather knowledge about the effects of Controlled Traffic Farming (CTF) on soil compaction, greenhouse gas emissions, harvest and species composition. Knowledge on relations between trafficability and workability, soil status and traffic effects are essential for the site-specific control of machine situations (inflation pressure, dynamic axle load etc.).

2.3. Challenges in Precision Livestock Farming

The main goals of Precision Livestock Farming are the improvement of profitability, resource efficiency, labour and animal health and welfare based on sensor measurements and advanced information and communication technologies. Another goal is the reduction of negative environmental effects from animal husbandry. This domain includes feeding, cleaning and milking systems, the sensor-based detection of animal status regarding breeding, health and welfare and the handling of farm animals. Monitoring and decision support systems allow managing herds efficiently.

Further knowledge and sensors are needed regarding the interaction of animal and pasture and in the context of disease risk management and modelling. A more effective treatment of animals and early detection of problems will also reduce the risk of pharmaceutical residues in meat and manure. Automation technology for precision livestock farming looks to be on the market, but quality and availability is sometimes rather poor. Most biosensors require a higher sensitivity and specificity and the obtained data have to be combined and evaluated in order to provide helpful decision support systems for the farmer. Such systems are only well developed for a few cases and should always consider the variation between individual animals.

Tighter monitoring of individual animals should lead to higher production efficiency and thus a lower environmental footprint per kg of produced product. Rational management of greenhouse gas emissions from animal operations is still a major problem and measures should be taken. Precision livestock management should contribute to an increased profitability in livestock farming. Therefore it is crucial to focus on those technological (and socioeconomic) developments having the highest added value, in particular due to labour savings. Milking and feeding are important, time consuming tasks on dairy farms, but while automated milking systems are sophisticated quite well, feeding systems need further research and innovation. Other weak points in the field of precision livestock farming are the user-friendliness and the compatibility between products from different vendors.

3. Specific research and innovation topics in precision farming

The previous chapter showed the main challenges in precision farming and in its three subdomains: variable rate application, controlled traffic farming and precision livestock farming for feeding and diseases. The SRA described the needed improvements for each of the three subdomains as identified by the end of 2012. In the meantime, the field of precision farming has further developed and during 2014, DG AGRI has set-up a European Innovation Partnership on Agriculture (EIP-AGRI) that has formed a few focus groups on specific topics. One of those topics was 'mainstreaming precision agriculture[1]' and this focus group has worked on a number of specific topics in the area of precision agriculture. The results have been documented in a set of mini-papers that describe the topics, the innovation challenges and how they might be tackled. The specific challenges partly overlap with the challenges and needed improvements from the SRA. When combining all these challenges, the following list of 4 main research and innovation topics for precision farming can be drawn up:

1. Sensing: how to sense the specific animal/plant/soil in an open, interoperable way?
2. Information management: how to collect/store/share/analyse all the information in a semantically interoperable way?
3. Decision support: how to use ICT for better and more precise management of crops and animals?
4. Adoption: how to stimulate/support/involve/train farmers and other stakeholders in the chain?

Each of these 4 main R&I topics are important in various ways for the 3 subdomains of precision farming. The figure below depicts a 3-by-4 matrix that will be used as a vehicle to describe the specific needs per topic per subdomain. Examples of specific needs are given in each cell. Note that these are not complete or totally covering all the needs.

[1] http://ec.europa.eu/eip/agriculture/en/content/mainstreaming-precision-farming

Topic Subdomain	**Sensing**	**Information management**	**Decision support**	**Adoption**
Variable Rate Application	- Smart sensors - Casing of sensors - Remote sensing - Drones	- Analysis techniques for pattern recognition - Information standardization of geo-systems	- Pesticide, fungicide, herbicide spraying - Weather-based decisions	User-friendliness Involvement of farmers, SMEs and other stakeholders Cost-benefit analysis Demonstration
Controlled Traffic Farming	- Remote sensing - Drones	- Information standardization of geo-systems	- Operations and planning	
Precision Livestock Farming	- Biosensors - Smart sensors	- Improve data gathering and interconnectivity	- Early warning models for individual animals - Holistic chain approach	
All subdomains	- Open, connected sensors - Interoperable, compatible sensors - Network of sensors	- Sharing, storage of data - Big, open, semantic interoperable data - Data analysis and pattern detection - Information ownership	- Self-learning algorithms - Data visualization - Multivariate approach	

Figure 2: Research and innovation topics per subdomain of precision farming.

In the sections below the needs for these 4 main R&I topics are worked out in more detail and specific examples are given for each of the subdomains where applicable. It is these needs that the first ICT-AGRI2 call in 2015 will focus on.

3.1. Sensing

Precision Crop Farming and Precision Livestock Farming techniques attempt to determine and control all measures applied to the farmland and the individual animals. These controlled farming techniques require advanced sensors to measure the current state of animals and land for an optimized treatment of crops and livestock at the lowest possible scale, also referred to as Precision Agriculture 2.0[2]. When analyzing the constraints and opportunities for mainstreaming precision farming, one of the main challenges identified was to provide the precision farming community with solutions that apply agricultural knowledge in closed loop control systems. The added value of these solutions should be tested, validated and demonstrated in practice

Smart sensors

The challenge is to make existing sensors smart[3], not develop new sensors. Smart sensors have signal conditioning, embedded algorithms and a digital interface. A lot of interdisciplinary research

[2] Kempenaar C. (2014). Overview of topics and questions to be addressed by the FG Mainstreaming Precision Farming. Starting Paper for Focus Group meeting, June 3-4, 2014, Schiphol.
[3] Defitinion Smart Sensor from the FreeDictionary.com: “A sensor that includes a microprocessor that conditions the signals before transmission to the control network. It filters out unwanted noise and compensates for errors before sending the data. Some sensors can be custom programmed to produce alerts on their own when critical limits are reached.”

and knowledge is necessary to make the provided solutions smarter. Combining different components does not necessarily result in a smart system. A holistic approach is necessary to add intelligence to the system. Several data layers need to be combined to come to better management decisions.

For instance, variable rate application of nitrogen is already quite well managed by commercial systems. However, further development and validation of sensing technology, as indicator of crop nitrogen requirement for yield and quality is needed for crop production. An extra potential area is the use of sensors to detect nitrogen status of plants with a particular reference to grain quality prediction (protein content of the grain). In addition, automation of the irrigation in greenhouses where soil is cultivated can be improved through soil moisture and nutrients monitoring with sensors. Also, identification and development of energy harvesters to supply irrigation monitoring devices are of importance for resource efficiency.

In addition, for VRA increased effort is needed to reduce the costs of high-precision sensors and to improve their durability. The development of in-situ and on-the-go measurement systems using VIS-NIR spectroscopy analysis has to be encouraged. Both proximal sensing using crop reflectance sensors on machines and remote sensing (satellite or small plane) seem to be suitable areas of research. Further development of sensors is needed in the area of soil surveying. Soil surveying is the process of classifying soil types and other soil properties in a given area and mapping such information. Maps can show chemical and fertility features of the soil as well as physical (e.g., water content) and biological features. These maps are very useful for precision farming where recommendations on application of different inputs (e.g. fertilization of N, P, K and lime) can be spatially optimized for maximum yield and minimum input.

Open, connected, interoperable and compatible

An innovation that will speed up the development of technical solutions is the Internet of Things (IoT). The possibility to connect with everything and everyone will enable sensors and farm equipment to communicate autonomously. The potential of the practical implementation of the IoT is already proven in precision agriculture irrigation systems. Precision farming is one of the domains were Internet of Things could help develop initiatives with the help of FI-ware technology.

Recent advances in additive manufacturing (i.e. 3D printing) and low-cost, user-friendly electronics (e.g. open source electronics platforms like Arduino and Raspberry PI) with wireless connection technology now make it possible for small SMEs and even farmers to economically fabricate custom instrumentation. The ability to rapidly prototype sensor designs, literally on your desktop, has many advantages when developing new measurement techniques.

Wireless Local Area Network (WLAN) technology was already identified as a promising solution for affordable research systems and commercial solutions for cow tracking in the future. Combining wireless sensor networks and IoT can provide high-resolution spatiotemporal sensing data to monitor interesting parameters in agricultural applications. The IoT is now starting to shake up the way farmers work. A dairy farm in the United Kingdom is already running a ‘connected’ herd with a view to anticipating the risks of epidemics and spotting random factors in milk production, a use of Big Data that looks set to revolutionize the sector. The combination of wireless sensors and the future Internet in precision agriculture provides a market potential especially for SME’s.

Comprehensive information exchange requires interoperability between products from different vendors. The interoperability of common software components, however, can only be achieved when research institutions, end-users and manufacturers are prepared to work together (to co-create or co-innovate). The involved parties must agree on certain (open) standards (process models, information models and semantics, messages, code lists, etc.) and overcome problems of information privacy and the reluctance to share information, as well as social and cultural barriers.

Biosensors
Recent developments of new biosensors allow to rapidly detect chemical or biological targets ranging from small molecules to microorganism to make point of care monitoring, or even real-time monitoring of any integrated process possible (e.g. remote sensing devices for precision farming). Biosensors are based on combinations of specific recognition structures (e.g. imprints or biological recognition molecules such as aptamers) with transducer technology (e.g. nano-or micro-balances, heat conductivity, impedance spectroscopy), so that the specific detection of the target can be converted into a signal. Biosensors can provide important information not readily available using traditional analytical technologies particularly when continuous or in situ measurements are desired. For example in the dairy industry there is a need for a fast, sensitive and cost effective technology for the detection of foodborne pathogens. Another good example of biosensors being used in agriculture is the measurement of progesterone in milk. This technology has been available since the 1970s in a hand sampled laboratory system. Recently the Herd Navigator system from Lattec/Foss and DeLaval has implemented this as an on-line biosensing system.

Remote sensing & drones
The ongoing technological development of remote sensing techniques by satellites, UAVs/drones and ground-based sensors is making crop management with much greater spatial and temporal resolution possible. Nonetheless, despite the enormous potential of these remote sensing techniques, their implementations in practice remain rather limited. Therefore, the main challenge in this area is bridging the gap between research and innovation by developing practical applications for remote sensing data in precision crop farming, and more specifically in the area of variable rate application. Researchers wishing to tackle this challenge, should aim at collecting high-resolution remote sensing data, preferably at multiple times in the growing season, in order to conduct real-time or near-real-time soil, crop and pest management.

The challenges that will be encountered within this topic are:

- Determining the effects of different management decisions when it comes to Variable Rate Application (e.g., determining the effect of spot spraying against diseases in the field).
- Selecting or developing appropriate spectral indices for sensing the crop/soil variables under study
- Developing the software for making appropriate management decisions and for automatic control of the agricultural machinery (e.g., automatic opening and closing of nozzles).
- At a later stage: combining and analyzing remotely sensed data from different moments in time in order to improve management decisions even further (e.g. determining plant sizes/nitrogen status at several moments in time in order to determine the quantity of fertilizer which should be applied).

A threat to research in this area is the (lack of) legislation about UAV/drone flight and use of cameras for agricultural purposes.

3.2. Information management

Precision Farming is a whole-farm management approach using information technology, satellite positioning (GNSS) data, remote sensing and proximal data gathering to decide about the correct treatment of crops and livestock at the right time and smallest scale possible, up to treatment of individual plants or animals. Clearly, information management in terms of gathering, sharing and processing data is thus a critical step in the PF process.

Sharing and storing of information
Systems are put into the farm environment where they are not designed to share data even with other systems on the farm. It is generally agreed that integrating data will lead to better implementation of PF but there seems to be little activity to ensure this happens. There is no

provisioning to store data from season to season. In experimental situations, researchers combine data with bespoke scripts and manage the process but the power of data integration comes when data exchange is automated and software components have defined interfaces with Application Programming Interfaces (APIs) described so that interrogating software can request data and receive it in an agreed format. The tools and protocols to connect systems have been developed in other sectors and innovation is only required to agree which standards to use protocols like SOAP or REST and to devise a Web Services Description Language (WSDL) for agricultural systems to communicate in. The challenge is how to best apply these existing tools and protocols in the agricultural sector for precision farming.

Data gathering and interconnectivity of data is a main goal to improve the opportunities of precision livestock farming. Data from different systems/sensors need to be made available for farmers and third party software. This will enable development of decision support software independent of hardware vendors and allow combining data from multiple different systems into an integrated farm management system and decision support system. The goals are to create systems for the collection, collation and sharing of relevant data and the creation of protocols for the use of such data in software development for smarter farming systems. Specifically for irrigation and CTF, GIS integration in irrigation systems is needed in order to optimize decision-making on irrigation planning.

Information standardization

Most technology being developed in research laboratories and companies is isolated not only from other research groups but also from standards organisations. Then, companies produce systems and software with proprietary or non-standard interfaces. This leads to compatibility problems when connecting and exchanging data between these systems. Therefore, standardization of the information being exchange at the interfaces of these systems is necessary. Europe does have some agreed data standards such as animal IDs but holding numbers have different formats even within countries. In the field of GNSS, farmers indicate they find it difficult to start working with GNSS, as the investment up front is substantial. One reason for their hesitation is the poor communication and interoperability between different brands of GNSS tools and between GNSS tools and farm management software. This implies that the choice of a brand has implications beyond just the technology and this is difficult to oversee. So, also innovation and action needs to be taken on the development of standards for the interoperability between GNSS systems. The challenge is to find innovations for better compatibility between systems for PF and to stimulate the definition, implementation and usage of information standards for data exchange between these systems.

Big, open data

Today modern farms, both in arable farming and precision livestock farming, are loaded with all kind of sensors. Clients must be able to connect with this data, but also data coming from multiple sources in and outside the farm should be integrated and combined. For instance, satellite data coming from open data sources from government or open weather information sources are very important to be used as a basis for decision-making. The challenge is to define and operationalize a data infrastructure to collect, store, visualize and combine large amounts of data from various different sources for farmers.

Analysis of semantically interoperable data

Based on large amounts of data from different sources that are being combined, it is possible to perform analysis on this data for decision support making. For instance, the detection of anomalies and patterns in the data over place/time with respect to a certain soil concentration or animal behaviour gives insight in possible actions and guidance of the preparation of the soil/crop or the animal with respect to diseases or other treatment. The challenge is to define new analysis techniques and apply them for big data analysis for precision farming. In addition, the challenge is to define mechanisms that enable the semantic mapping of similar but slightly different terms in the various data sources in order to combine them in a semantically correct way.

Information ownership

With respect to data ownership, there is a naïve belief that data belongs to the farmer but this is often not the case if the farmer has signed a typical user agreement. Data collected for supply chain management purposes or for machine evaluation purposes may not belong to the farmer or even reside on his computer system. Innovation may be stifled if data is kept locked up in databases to which there is no access or API agreement. For example, feed companies do not have to declare the exact composition of feeds they supply but that data is essential for some nutritional models to operate successfully. It may be necessary to have data curation agreements whereby the data is held by a third party on behalf of the farmer and made accessible for app developers to develop apps to integrate systems. The IT sector has mechanisms and tools for the development of systems that ensure privacy and ownership of data. These should be used in the agricultural sector to improve innovation on this topic.

Several hurdles in sharing of (open) data have to be taken. Farmers are reluctant to give access to their farm management and sensor data, including data on variation within soil, crop and livestock. They want to control whom can see and use the big data. Only a few farmers see that this big data can be used as a sign of good agricultural practices.

Another challenge is that there is a need for access to good quality public data. New business models for sharing of data and open data sources should be developed to bring Precision Farming to the next level and benefit from Big Data. Recognition of ownership of data is crucial. And portals to facilitate exchange of data are a prerequisite.

3.3. Decision support

In practice and research most of the energy is going to the development of sensors. However the biggest complaint is that it is so difficult to use the growing amount and variety of data. The challenge is to make sense of the data with regard to operational decisions support. Monitoring the production process, having early warning and determining which animal/groups or parcel need acute action are difficult jobs. The reason is that we have to deal with a complex mixture.

Complexity can be found in the:

- Level of the “object of interest” for which a concrete advice is given based on the measured data.
- Multivariate approach. Early warning has its focus on functioning of the production process and on early detection of farm related diseases. In almost all cases detection has to be based on more than one variable. In practice it is not always clear which combinations to use, since also animals are not always susceptible to the same variables. So the challenge is to work on flexible and scalable early warning systems.
- Part of this multivariate challenge is that early warning systems have to deal with incomplete data and sometimes even very low quality of data.
- Time element, not all information is available in (near) real time. Also how far you would like to go back for explanation and how far ahead you would like to predict or set your action for.
- Location: depending on where data and actions have to be performed also another interpretation might be needed. There is limited knowledge yet in the livestock sector on the use and value of location based information
- Choice of reference values is not always clear, but will have great implications on the expectation of the sensitivity and specificity of early warning systems.

- In science there has been much focus on models that explain causal relations. This is sometimes also expected for the early warning models. However, this will be much more data driven and therefore the challenge is to incorporate self-learning and calibration mechanisms in the modelling approach. In this learning also risk and uncertainty can be factors to include.
- Interpretation of models can be done fully automatic. However to build confidence in the outcome it is also a challenge to involve end users in the development and use. Visualisation of data, what-if analysis and incorporation of economic and social aspects in the early warning systems is a challenge.
- There is a challenge on the integration of different scientific fields. On analysis alone there are different approaches: from mathematics, statistics and artificial intelligence. They also have to work together with IT specialists, engineers and agronomists, biologists, etc. In itself, this is already a big challenge.

Based on these challenges the following innovations need to be addressed:

- Multivariate approach. Innovative solutions for flexible and scalable early warning systems that can work with incomplete data and sometimes even very low quality of data.
- Location: There is limited knowledge yet in the livestock sector on the use and value of location based information. Integration of geo-statistics has to be studied.
- Innovative solutions to setup a wiki-style database with reference values for early warning.
- Innovation on incorporation of self-learning and calibration mechanisms in the modelling approach.
- Innovation on visualisation of data
- Challenge on using different approaches from mathematics, statistics and artificial intelligence or making hybrid systems.

Decision management on irrigation

For irrigation purposes in greenhouses and soils, specific decision management systems are required that cover:

- Automation of the irrigation on soil in greenhouses through soil moisture and nutrients monitoring information
- Development of integrated climate and irrigation supervision and control systems
- Development of irrigation strategies based on instantaneous crop water requirements optimizing water use efficiency
- Smart irrigation management system based on matching water demand and resources availability

Decision management on pesticide and fertilizer spraying

For example, in VRA the field of site-specific application of pesticides and fertilizers is still underdeveloped. Computerization of sprayers and further developments in detection of pests, weeds, diseases or stresses are necessary. Furthermore, weather-based decision support systems (DSS) that simulate local pest phenology can provide information on pests and management options and thus increase the efficacy of pest management and reduce the number of sprays and pesticide rates per treatment.

The potential of variable rate application (or spot spraying) in pest, weed and (fungal or bacterial) disease control strategies needs to be determined in the different EU regions by field trials comparing spot and overall control measures against target pest, weed or disease species. This step is necessary before resources are focused on sensing the spatial variation in the distribution of pests, weeds, diseases or disease influencing factors.

Operational planning
For CTF, optimization is needed for operation and traffic planning including scheduling and route planning. Operation and traffic planning tools as well as real-time monitoring and steering tools require input data from a Farm Management Information System (FMIS) and output data to and between vehicles (M2M). Compatibility between products from different vendors will be a desirable advantage for farmers.

Early warning models
For all subdomains of Precision Farming, early warning models on possible diseases or feeding problems are needed. These models should incorporate sensor data coming from various sources around the individual animal. This information should be made available in a compact and comprehensible way and allow the farmer to make decisions on how to deal with the situation at hand. The challenge is to define the decision models from sensor information input to actionable output.

Holistic chain approach
A more holistic approach on systems thinking and chain thinking should be used. Starting point should be that data and information from process level on individual animals, and management units within parcels plays a key role in generating value. This data and information exchange can be simplified and supported by learning from ICT developments in other sectors. A shift is needed from R&D on development and testing of individual sensors towards R&D on real daily management support systems for farmers and other chain partners using innovative ICT tools.

3.4. Adoption
Impact can only be achieved from research and innovation in precision agriculture if farmers adopt the resultant technologies and services. The challenge is to better understand the factors that influence farmer adoption of precision farming and then to address these factors as part of the development of new PF products and services.

Overcome perceived complexity
Precision Farming's early promise in the 1990s failed to deliver, leaving many farmers sceptical of many aspects of the technology. While some aspects (auto-steer etc.) will be successfully marketed by the machinery industry, there is a need for 'independent' farm advise /technology transfer to deal with implementation of PF technologies which impact on the management of crops and livestock. Very often the benefit of using PF is not obvious to the farmer. It is assumed PF may have a positive long-term effect on the farm management because the farmer to adjust his/ her farm management may intuitively use the data from PF tools but it is difficult to define a monetary value for this positive effect. Because a strong motivation of a farmer is being on the field or with livestock, the average farmer is most probably not willing to spend many hours in front of a PC to analyse PF data. The challenge is to overcome the perceived complexity of PF solutions and discover/ define the specific benefit for the individual farmer. Innovation is necessary in the following areas:

- PF should develop farm management solutions, which are focussing on today's farming reality and perceived challenges for a majority of farmers.
- PF should come up with easy to use tools tailored for specific "use cases".
- Provide intuitive PF solutions made for the farmer.
- Provide tools and methods for advisory service to support farmers.

For example, operation of variable rate application is currently difficult for farmers and often claimed as a serious hindrance for use in practise. The development of automated information exchange between different VRA components and the development of user-friendly and efficient ICT tools for farm managers are strongly encouraged. Furthermore, the integration of VRA in Farm

Management Information Systems (FMIS) and Decision Support Systems (DSS), especially in web-based approaches needs the attention of researchers.

Demonstrate benefits to farmers and consumers
In the current situation, farmers have difficulties to see and accept the benefits of implementation of Precision Farming. Rather, they see it as additional costs and complex (a source of technical problems). This is why they are reluctant to invest money in PF. The traditional farm advisors also have problems learning and understanding the potential in the new PF-technologies that reduces the uptake!

The benefit of current systems in Precision Farming is not always clear. And there are many PF tools to consider. In some cases we do not have the necessary information to calculate the economic benefits or don't know how to explain it. The cost of social benefits is difficult to estimate. Many times, farmers rather "feel" their business than calculate it – there must be tools to educate them. The understanding of farmers' decision-making is low and the pedagogy is not adjusted to the farmer's situation.

Innovation is necessary in the following areas:

- Identify new business models based on increased understanding of the decision making in the business situation that farms act in.
- Better quality products to bring true benefits to farmers.
- Clear way to explain benefits and demonstrate them in different form of simulators, i.e. using the Internet and PC but also sophisticated simulators. Simulators aim for agricultural high schools, universities and post-graduate education of farmers and advisors.

Factors influencing adoption
Economic benefit is clearly one of the key factors influencing adoption of new technology by farmers, but there are also many other factors at play. Previous studies in the US have identified farm size, farmer demographics, farmer educational level, level of indebtedness, regional location, perception of net benefit and risk preference as influencing factors. However, research in this area with respect to European farmers is limited and in particular, the recent increase in penetration of smart phones may influence the relative importance of certain factors.

Strategies for improved up-take of the new techniques developed within PLF in the farming community by improved farm management tools and decision support systems needs to be devised. These tools have to make farmers' daily decisions more easy. To have the focus right, it is important to know what these decisions and needs and behavior of the farmers are, and to demonstrate costs and benefits of the tools by "Ambassador Farmers" in operational groups. And consider use of farmer advisors in the dissemination chain. There is also a need to develop training and awareness, which are key factors for success of reaching Small and Medium Farmers. Tailored extension and dissemination activities must be arranged in focused productive areas, having as target farmers groups, cooperatives and local communities. Regional approaches are needed because of differences in farms.

Cost-benefit analysis
It is necessary to develop a system and methodology for calculating the cost-benefit of PF in different farm types, in different geographical locations. This needs to take into account, not just factors which can be easily measured such as efficiency and profitability, but also social benefits, food quality, health of farmers etc. There is also a need to understand the priority that farmers attach to the different types of benefits. Ideally, such a methodology should allow farmers or advisors to easily compare the cost benefit of different PF products and services depending on particular farm characteristics (e.g., Product A Vs Product B for a small, drystock farm in North West Europe; Service A Vs No change for a large arable farm in Eastern Europe etc.).

The cost-benefit assessment of VRA is dependent on multiple interrelating factors. As technology costs decrease and the cost of agricultural input factors increase the economic case for implementation of VRA will improve. The solution domain has potential for labour saving, in particular concerning documentation of actual applications. A global methodology of a virtual case study may allow for the comparison of different kinds of systems on a common base.

The use of Controlled Traffic Farming is a possibility for the farmer to reduce input costs (time, fuel & machinery) and - at the same time - to increase crop yields. But costs and profitability of CTF are not known numerically and therefore feasibility and cost-benefit assessments are strongly needed to thoroughly convince farmers for widespread take-up.

4. First ICT-AGRI2 Joint Call

The research and innovation topics described in the previous chapter form the basis for the first joint call of ICT-AGRI2 in 2015. For this call project proposals will be invited that can focus on a single or multiple topics in the cells of the matrix depicted in Figure 2. Within these proposals it is expected that focus will be on the ICT part of the challenges. This chapter briefly describes the various instruments that can be used in a first joint call.

4.1. Funding instruments for the first Joint Call

One of the instruments is funding of regular projects of different types. With respect to the characteristics of these projects, we distinguish the following ones.

1. **Smaller specific projects** that will study the factors influencing adoption and develop a robust methodology for cost-benefit analysis of PF products and services.
2. **Larger integrating projects** funded by the competitive call should have the following characteristics:
   a. Multi-actor
      It is expected that the adoption of the "multi-actor" approach which has been pioneered by the European Innovation Platform (EIP), with the involvement of end-users such as farmers, advisors, enterprises etc., will help to ensure that the solutions developed will be adopted by end-users due to the cross-fertilization of ideas and continued influence of end-users right along the research and development chain.
   b. Interdisciplinary
      An interdisciplinary approach is vital to ensuring adoption of future innovations. The balancing of agriculture, engineering and ICT with social science and business will help to develop solutions that are user-friendly and have a proven cost-benefit
   c. SME involvement
      The involvement of industry will add a commercial focus to projects, helping to ensure that the project teams remain focused on solutions that can be applied in the real world
   d. A dedicated work package on adoption
      A dedicated WP or collaboration on adoption should at least produce a business case analysis of the proposed innovation. Examples of other activities are demonstration studies; analysis of utility in different farming systems and geographical areas; analysis of compatibility with existing systems; social scientific studies on factors that would influence farmer uptake of the proposed innovation; studies on consumer acceptability etc. This list is neither prescriptive nor exhaustive.
   e. Compatibility and standardization
      In order to enable better adoption projects should come up with solutions that are open and compatible with existing systems and standards. Therefore, solutions should build upon existing standards as much as possible. Relations and links with existing standardization organizations should be used to further promote the solution towards a standardization trajectory. More specific, the following actions can be taken in this respect:
      - Stimulate the use of connectivity standards between PF systems at hardware and protocol level, e.g. the use of Wifi or 4G technologies, plug-and-play protocols for integration of sensors in the PF network, etc. Especially for GNSS systems.
      - Stimulate the development of information standards to be used as a taxonomy or vocabulary by PF systems in order to improve on the semantics and global meaning of shared information. Make sure there are good links with UN/Cefact and OASIS on existing standards for PF.

- Stimulate the implementation and usage of these information standards for data exchange between these systems and the provisioning of APIs on PF systems based on these standards.
- Stimulate projects that incorporate a pilot setting in which new data standards and connectivity technology is being used to show interoperability and to show how to deal with data ownership.

This leads us to the following preliminary proposal for regular project funding instruments including the size of projects. This is input for deliverable D2.1 in WP2 in which the call documents for the first call are being described and prepared.

Funding Instrument	***Characteristics of Project***	***Funding***
Smaller focused project	• Research Oriented • Focused on a single domain or topic	Max €300,000/project for short duration, e.g. 1 year
Larger Integrating Project	• Multi-actor project [1] • Interdisciplinary [2] • SME Involvement [3] • Include dedicated WP on adoption [4] • Facilitate researcher mobility [5] • Facilitate researcher career progression [6] • Leverage additional fellowship funding during the course of the project [7]	Max €1,500,000/project for longer duration, e.g. 3 years

1 The multi-actor approach aims at more demand-driven innovation through the genuine and sufficient involvement of various actors (end-users such as farmers/farmers' groups, advisors, enterprises, etc.) all along the project: from the participation in the planning of work and experiments, their execution up until the dissemination of results and the possible demonstration phase. The adequate choice of key actors with complementary types of knowledge (scientific and practical) should be reflected in the description of the project proposals and result in a broad implementation of project results. The multi-actor approach is more than a strong dissemination requirement or what a broad stakeholders' board can deliver: it should be illustrated with sufficient quantity and quality of knowledge exchange activities and a clear role for the different actors in the work. This should generate innovative solutions that are more likely to be applied thanks to the crossfertilisation of ideas between actors, the co-creation and the generation of co-ownership for eventual results. A multi-actor project needs to take into account how the project proposal's objectives and planning are targeted to needs / problems and opportunities of end-users, and the complementarity with existing research. Facilitation between actors and openness to involve additional actors/groups of actors in the project, for instance relevant groups operating in the EIP context, are strongly recommended.

[2] It is expected that interdisciplinary teams that bring together the necessary skillsets to deliver on the objectives of the project will implement large integrating projects. Consider the possible role of agronomics, engineering, computer science, economics, social sciences and other relevant research and innovation disciplines

[3] It is mandatory to have at least one industry partner in the project. Please also check the national funding rules for country-specific rules on industry-partners. We are willing to accept any industry, but have a preference for a focus SMEs.

[4] A dedicated WP on adoption should at least produce a cost-benefit analysis of the proposed innovation. Examples of other activities are demonstration studies; analysis of utility in different farming systems and geographical areas; analysis of compatibility with existing systems; social scientific studies on factors that would influence farmer uptake of the proposed innovation; studies on consumer acceptability etc. This list is neither prescriptive nor exhaustive. Please note points 1 and 2 above regarding the potential of interdisciplinary teams and a multi-actor approach. Consider the potential added-value of non-traditional research and innovation partners.

[5] Recruitment of staff or students for the project (not including permanent staff of the applicant institutions) should follow the Marie Sklodowska Curie Actions rules on researcher mobility, i.e., the researcher must not have resided or carried out his/her main activity (work, studies, etc.) in the country of the host organisation for more than 12 months in the 3 years immediately prior to the deadline for submission of proposals. Compulsory national service and/or short stays such as holidays are not taken into account. As far as international European interest organisations or international organisations are concerned, this rule does not apply to the hosting of the eligible researcher. However, the appointed researcher must not have spent more than 12 months in the 3 years immediately prior to the deadline for submission of proposals in the same appointing organisation.

[6] Where a project recruits staff or students (not including permanent staff of the applicant institutions), the project description must include a plan for the career development of those staff. Typical training activities include

- Primarily, *training-through-research* under the direct supervision of the supervisor and other members of the scientific staff of the project
- Hands-on training activities for developing scientific (new techniques, instruments etc.) and transferable skills (entrepreneurship, proposal preparation to request funding, patent applications, management of IPR, action management, task coordination, supervising and monitoring, take up and exploitation of research results etc.);
- Inter-sectoral or interdisciplinary transfer of knowledge (e.g. through secondments between project partners);
- Organisation of scientific/training/dissemination events;
- Communication, outreach activities and horizontal skills;
- All applicant institutions wishing to recruit staff or students for the implementation of the project should state whether they have endorsed the European Charter for Researchers and Code of Conduct for the Recruitment of Researchers (http://ec.europa.eu/euraxess/index.cfm/rights/whatIsAResearcher)

[7] For all projects with a total grant of €1,000,000 or greater, a mandatory deliverable (by the end of the first year) will be the submission of an application for a fellowship grant to

complement the activity of the funded project. Examples of funding options include MSCA Individual Fellowships, National post-doctoral fellowships, EMBO fellowships etc. Applicants should take care to avoid any potential double funding of research, therefore the fellowship application should seek funding for research work complementary to the funded project, rather than for activity which has already been funded by the ICT-AGRI ERA-NET.

4.2. Other instruments for the first Joint Call

Besides regular projects of the types identified in the previous section, we also propose to use the following instruments to stimulate research and innovation on the topics described in chapter 3.

Infrastructure

The SRA identified a need for “experiments under various soil, faming and climate conditions in order to gather knowledge on the effects of CTF on soil compaction and regeneration, greenhouse-gas emissions, and plant/animal and yield development”. It is felt that this can best be achieved through access to an integrated European infrastructure on different ecosystems. The ERA-NET consortium will analyse the extent to which this need is already being met through existing European infrastructure. If such a need is not being met, plans will be developed to catalyse the coordination of the relevant actors in order to ensure the availability of such facilities.

Plug Fest

Plugfests can be organized to bring together various suppliers of IT systems and solutions in the PF sector. At such a plugfest they can show that their solutions can be plugged to each other and that they are compatible and interoperable with each other. Users of their solutions are also present at such plugfests in order to present the requirements to the tests that are performed at the plugfest.

5. Other actions using existing instruments

This chapter proposes other actions that can be taken by the ICT-AGRI ERA-NET to further stimulate precision farming besides the ICT-AGRI call instrument. The focus of these actions is on precision farming and not on ICT and agriculture in general. With respect to the types of instruments, we distinguish between 3 types: aligning instruments, exploring instruments and investing instruments.

5.1. Instruments for aligning

The instruments for aligning are meant to be used for actions in which the SRA and the R&I topics on PF are being aligned with other research programmes and initiatives.

Thematic Annual Programming

Means for aligning in the most cost and time-efficient way are being considered for developments that do not involve classic “calls”. In this case, based on the SRA and the identified R&I topics in PF, mapping meetings, bibliometrics and advanced poster analysis, topics would be defined which are shared across many countries. Then, national programme managers would be invited to meet with eachother along with an ICT-AGRI steering group to define topics to be shared by any new national programme in this area. An item text (e.g. one page) can be included in each national programme participating on a voluntary basis. Then, after launching national programmes, a meeting would be organised with all projects working on a given item to discuss objectives, methods and expected outcomes. As part of this coordination, it might be possible to organise a database with project outputs. Following a pilot action of this type, programme managers would be invited to evaluate the effectiveness of this approach.

Teaming-up with other ERA-NETs

ERA-NETs are a means of implementing the alignment of research and innovation in various subdomains of agriculture among countries. There are a number of ERA-NETs that partly cover or are closely related to the topic of precision farming. One of them is the ERA-NET SUSFOOD and a means to align the work and topics with that ERA-NET is to organize a joint workshop. The ICT-AGRI 2 project consortium would like to organize a joint workshop with other related ERA-NETs, to make the concept of ERA-NETs more broadly known, and to generate more interest in upcoming ERA-NET calls. Therefore, the project consortium tends to send out invitations to other ERA-NETs to organize such a joint workshop. The event has to be relevant for all participating ERA-NETs, so it can only be determined after consulting the interested ERA-NET consortia. Possible ERA-NETs to align with are SUSFOOD, ANIMAL WELFARE and CORE Organic.

Partnerships with PPPs

The ICT-AGRI ERANET intends to interact and align with relevant European initiatives and in particular with related ICT-oriented Public Private Partnerships (PPPs). The aim is to avoid overlaps and duplications and when appropriate to work together to form synergies. In 2014, already a joint call has been realized with Future Internet PPP. Another PPP that is about to start is the Big Data PPP and a good alignment with this PPP in 2015 is necessary to get a good overview of the possibilities of Big Data and the current state of the art. This knowledge can be used to guide and assess the project proposals in our first call in 2015. In addition, our ERA-NET can be useful to show good practices and use cases of the application of Big Data in precision farming. When appropriate and agreed by all partners, even a joint call with the Big Data PPP can be put in place with new funding.

5.2. Instruments for exploring emerging subjects

In the domain of precision farming, a number of emerging research areas are considered appropriate for exploratory events, which could develop into new calls and which will provide input into a subsequent version of the SRA.

Exploration and collaboration with EIP-AGRI focus groups

The EU has launched five European Innovation Partnerships (EIPs) in the context of the Innovation Union. European Innovation Partnerships are a new approach to research and innovation. EIPs help to pool expertise and resources by bringing together public and private sectors at EU, national and regional levels, combining supply and demand side measures. All EIPs focus on societal benefits and fast modernisation. They support the cooperation between research and innovation partners so that they are able to achieve better and faster results compared to existing approaches. One of the EIPs is the EIP-AGRI focusing on agricultural topics. The EIP-AGRI has set-up a number of focus groups on various topics, one with a focus on precision farming. The interaction between the ICT-AGRI ERANET and this focus group can be targeted to exchange the SRA and new research & innovation topics. Also the ERANET can be active in providing input to the operational groups that have to continue on the results of the focus group. This latter can be an action in 2015 to further elaborate on.

Joinup and collaborate with EFITA2015 conference

The EFITA/WCCA/CIGR 2015 Conference will take place in Poznan, Poland from June 29 to July 2, 2015. EFITA/WCCA/CIGR 2015 is a joint conference of three associations: European Federation for Information Technology in Agriculture, Food and the Environment (EFITA), International Network for Information Technology in Agriculture – World Congress on Computers in Agriculture (INFITA – WCCA) and International Commission of Agricultural and Biosystems Engineering – Technical Section VII: Information Technology (CIGR VII). All these associations deal with the use of ICT in the agri-food, bioresource and biomass sectors. The ICT-AGRI 2 project consortium tends to send one or more partners to this conference to present the concept, goals and accomplishments of ICT-AGRI and ICT-AGRI 2. In addition, ICT-AGRI can be active at the conference with organising an Interoperability Hack-a-ton in which suppliers of IT systems for precision farming show that their systems can be made interoperable using novel mechanisms for interfacing, such as linked data. In addition, new contacts can be made to explore new and emerging topics in the area of precision farming.

Collect new topics via the MKB stakeholders

As a result of ICT-AGRI, the Meta Knowledge Base is currently being a good instrument to link and connect important stakeholders in the area of ICT and agriculture. This instrument can also be used to collect the current status and potential gaps in a certain subdomain of agriculture, e.g. precision farming. In 2015, the MKB can be further used to organize a survey to collect a broad view on a map for the current use of standards for compatibility, both at connectivity as well as information level and the gaps in there. Based on this survey and its results, new specific topics for research and innovation in precision farming can be derived.

5.3. Instruments for investing

Beside the classic call instrument of ICT-AGRI ERANET, also other instruments exist for further stimulation of the research & innovation topics in ICT in agriculture and more specifically in precision farming.

Knowledge Hub

In order to align national research programming, new ways of working together are required. A new and innovative instrument that enables this is the“Knowledge Hub”. A Knowledge Hub associates 3 complementary dimensions: Research, Networking and Capacity Building. A Knowledge Hub functions through a two-step process in which researchers submit a Letter of Intent (LoI) to their national funder who then decides eligibility on a competitive or non-competitive basis, according to the countries’own rules. Eligible groups are then invited to submit a full proposal as one single consortium, which is then reviewed by an international evaluation committee. Countries may choose to fund new research or to participate only through the funding of coordination costs, which cover networking, additional costs for coordinating and costs for running common activities initiated by the Knowledge Hub. Knowledge Hubs are particularly well suited to research areas with a relatively restricted research community. In addition, a knowledge hub can serve as a strong platform of users of PF systems that require interoperability and the use of standards for that purpose from the PF system suppliers.

Funding on top of H2020

The H2020 program focuses on various societal challenges and challenges towards leadership in industry. Among them is also societal challenge 2 on Food Security and Sustainable Agriculture and Forestry, among others. When looking at the specific topics that can be funded in that challenge, there is very few ICT-related work in. With respect to technology, the focus is more on specific technology to solve e.g. a certain production problem. At the moment, the EC is working on the definition of the Work Programme for 2016-2017. The main challenge and action in 2015 for the ICT-AGRI ERANET is to bring in as best as possible the reasearch and innovation topics on precision farming (and others based on the SRA). Under the assumption that part of these topics will be adopted in the Work Programme, the next action is to investigate the possibilities for providing additional funding for projects on these topics that are accepted in H2020.