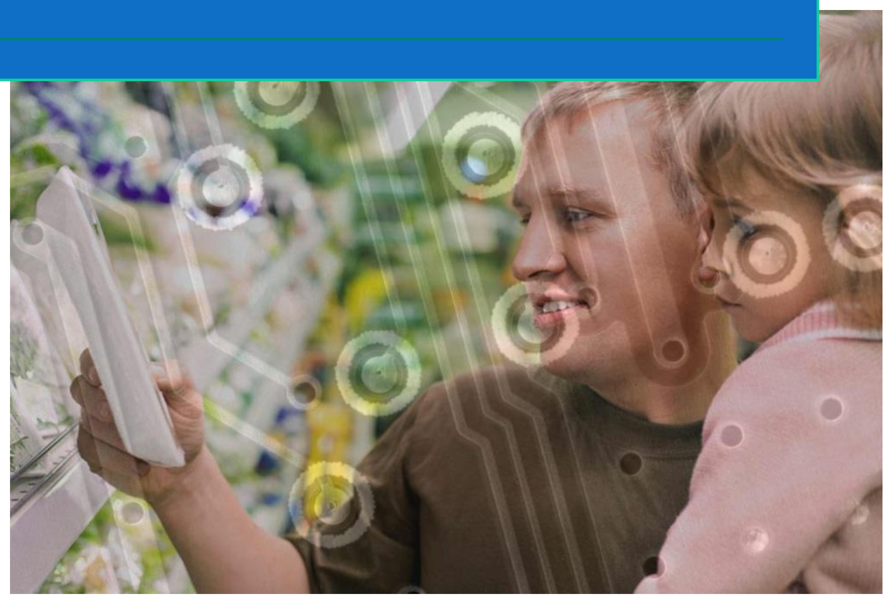
Smart Organic Agriculture and IoT



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Contents

Executive Summary

The 2014 TP Organics Strategic Research and Innovation Agenda describes the priorities for the European organic sector until 2020. TP Organics therefore now looks at 'Internet of Things' as a means to support organic agriculture in increasing its performance. This inventory lists prior research and the available state of the art technology. The inventory was prepared in consultation with many relevant experts.

Needs

From an agriculture perspective, a wide range of needs from across sub sectors (from animal husbandry to viticulture) and across scopes (within farms/companies and/or along the value chain). The needs pertain to:

- Resource efficiency (primarily at company/farm level)
- Risk management
- Compliance
- Weed control (primarily crop sectors)
- Goods monitoring & control
- Product portfolio enrichment
- Communication, coordination and collaboration (mainly along value chain)
- International trading (mainly along value chain)

Considering the technical aspects, three more needs were identified, namely:

- Interoperability and integration of systems and data horizontally and vertically
- Applications that are easy to use and affordable to buy
- Business models that underpin services that make it attractive for software providers

Ideas for smart organic farming

In general, we recommend to focus on building on and strengthening 'existing' ecosystems, e.g. by linking to 'mainstream' agriculture and extending in the specific areas relevant to organic farming. Think of e.g. auditing and compliance, which is more strict in case of organic farming. More specifically the following ideas were suggested:

- Focus on improving technology for matters particularly relevant to organic farming, such as quality sampling, residue finding and storage
- Use the strength of cooperatives to add to the clustered 'power' of organic farming
- Direct improvement of soil quality
- Tailor maintenance more to actual requirements by monitoring equipment

As the European Commission is preparing a call on supporting the implementation of Internet of Things, the experts provided recommendations on the best consortium. Such a consortium would focus on (organic) agriculture as a whole and incorporate the different sub sectors. Together, the parties should represent the European industry, not only specific regions or sub sectors. Parties should also have a wide knowledge base, ranging from technology (hardware, software) to governance and business models.

Introduction

In 2014 TP Organics published its revised Strategic Research and Innovation Agenda. This Agenda describes the research and innovation priorities of the European organic sector until 2020. During the consultations for the development of the agenda, TP Organics stakeholders raised their attention on the topic of smart/precision agriculture. In this regard, the platform took following actions:

- Monitoring a project aimed at analyzing the needs of the organic sector for Internet of Things (IoT) in Italy funded by the Italian Trade Agency and implemented by the IAM-B and Internet of Thing Observatory of Milan 'Polytechnic (IoT-Milan)
- Establishing a cooperation with EPoSS (European Technology Platform on Smart Systems Integration) in order to develop a common topic on "Solutions for resource-efficient primary production, based on the Internet of Things" and provide suggestions for the Horizon 2020 Work Programme 2016-2017
- Monitoring the development of the Work Programme 2016-2017. This Programme will be published in September 2015 and provide for five Internet of Things pilot projects
- Cooperating with EPoSS to identify the demand side of the Large Scale Pilot Project on Smart Agriculture
- Exploratory meeting between EPoSS and TP Organics to discuss involvement of the demand side, in particular from the organic food chain.

In this light, TP Organics now looks at the Internet of Things as a means to supporting organic agriculture in increasing its performance. This document makes an inventory of prior research and available state of the art technology. It is prepared in consultation with many experts in the field of IoT and ICT in the wider agriculture industry.

Note

Concerning ICT and IoT there are more similarities between organic and conventional farming then that there are differences. However organic farming has specific machinery and communication needs and urgencies in e.g. soil management or pest control, as alternatives to non-allowed synthetic pesticides are not satisfactory and lead to high production costs. But even these areas overlap. Although we focused on some examples from organic agriculture above, we strongly support the idea to combine organic and conventional farming in this project, recognizing the need for some work to be carried out especially with the organic sector as a pioneer able to open up spaces and tools for low input and conventional farming.

Needs

Agriculture perspective

ID	Need description	Sector(s)	Scope
1	*Resource efficiency* Reduce employed workforce and use of cultivation-related products (e.g. fertilizers, water, plant protection) while maximizing yield	All sectors	Within individual company
2	*Risk management* Prevention of plant diseases through optimal allocation in quantity and timing for an informed planning of interventions. Other risks include counterfeiting and missing/manipulated transactions	All sectors (including viticulture, horticulture, arables, animal husbandry)	Within individual company or farm/along value chain
3	*Compliance* Adhere to EU-defined agriculture and food norms, obtain conformity certification and respect environmental impacts thresholds	All sectors, (including viticulture, also combining organic and AOC requirements)	Within individual company or farm/along value chain
4	*Goods monitoring & control* Enhance visibility over the whole end-to-end process, from farms to consumers, to track and trace both goods and climate conditions, whether stocked or in motion	All sectors	Along value chain from field to fork or from/orchard to bottle
5	*Product portfolio enrichment* Increase product quality and durability extended shelf life together with a wider product variety range	All sectors (in particular vegetables, wine, fruits, etc.)	Within individual company or farm/along value chain
6	*Communication, coordination and collaboration* Streamline and augment communication effectiveness and flow from farms to consumers. Think of sharing information along the value chain for improved insight in stock availability and production/shipments, inbound coordination of fragmented farmers, and coherent outbound communication across multiple channels. Also	All sectors (though e.g. in ‘wine’ the collaboration with other sectors is already strong)	Along value chain

	marketing targeting consumers was stated to be a key for retailers and farmers		
7	*International trading* Enhance capability to fulfil export demand for local products by opening new markets	High value products (e.g. wine, plant oils, specialty products with AOC, etc.)	Along value chain
8	*Weed control* Enhance the capability of equipment to control weed under different circumstances and to different quality levels depending on the need of the crop grown	All crop sectors	Within individual company or farm

Technological perspective

ID	Need description	Sector(s)	Scope
9	*Interoperability and integration of systems and data*	Technological	Within individual company or farm/along value chain
10	*Applications that are easy to use and affordable to buy*	Technological	Within individual company/along value chain
11	*Business models that underpin services that make it attractive for software providers*	Technological	Within individual company/along value chain

Limitations

(add if anything)

Prior Research

The European Commission has provided substantial support to developing Internet of Things research, e.g. in so-called the Future Internet programme. In the agricultural field, FIspace has been the focal point of this work.

To ensure significant progress in the envisioned Large Scale Pilot, we propose to build on the results of FIspace. It mitigates the needs and limitations discussed previously in various ways.

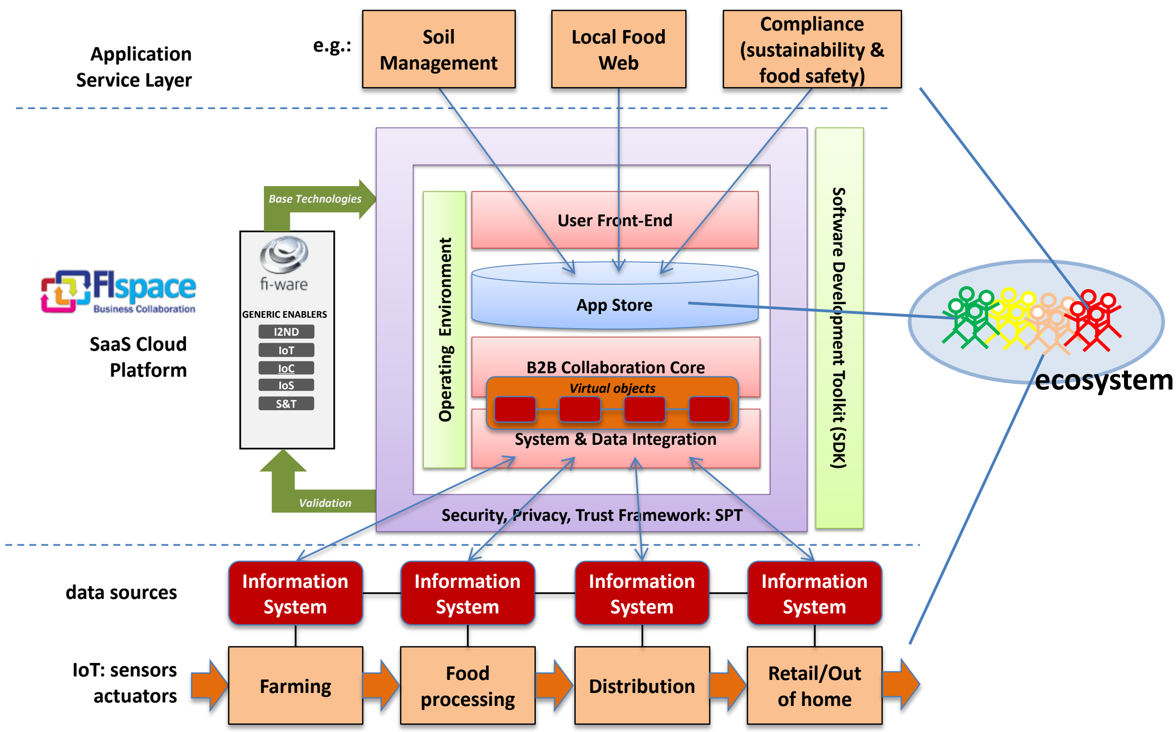

Figure 1 - A three-tiered architecture around the FIspace platform

FIspace[1] provides a multi-domain cloud-based platform, following the Software-as-a-Service (SaaS) delivery model, in which ICT developers can easily develop smart software application services ('Apps') based on FIWARE[2] GEs. These Apps should collaborate seamlessly together to support business control processes. Because FIspace is not intended to replace existing information systems but rather to link them together smoothly, actual data and information systems are placed outside the FIspace platform. This has led to the three-layered architecture that is presented in Figure 1.

1 www.fispace.eu
2 www.fiware.org

The lowest layer – the IoT layer - is where object sensing and actuating takes place, generating data from objects in the food supply chain. The objects are being virtualized and put in the system & data integration module of FIspace. The upper layer is the application service layer where services are offered to the supply chain users to support business process control leveraged by apps from the FIspace App store. The B2B collaboration core enables apps to work together in a seamless and real-time manner. All communication goes through the security, privacy and trust (SPT) framework layer. The Apps are accessed through a User Front-End that consists of a configurable graphical user interface so that Apps can be located at different points (smartphone, machine terminal, bar code reader, etc.). The interaction between all modules is handled by an Operating Environment which ensures the technical interoperability and communication of (distributed) FIspace components and Apps and the consistent behaviour of FIspace as a whole. A Software Development Toolkit (SDK) provides tool-support for the development of Apps.

As visualized at the right in Figure 1, a software ecosystem can be formed consisting of:

- supply chain actors or end users (farmers, technology providers, processors, etc.)
- app developers
- service providers
- infrastructure providers that facilitate the platform

Examples of IoT ecosystems[3] could be 'Organic Farming in Western Europe or 'Organic Wine production in Southern Europe'. Many other examples could be listed as well.

The great benefit of this approach is that supply chain actors are collaborating through the platform and the corresponding apps and services are working seamlessly together. For example if a farmer is supplying a local food web with products he has to comply with certain standards for which he can use a compliance service. He can use the same compliance service probably to deliver his products to another market. The data that are involved in this process are provided by several apps that are connected with through virtual objects with the real production processes on and around the farm. App and service providers can focus on particular services and for a great deal rely on the general infrastructure of the FIspace platform. Apps can come from different independent vendors and also easily be replaced by others. This will lead to lower costs for development and ultimately more affordable services for end users.

(add any major prior research that should be included)

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[3] An ecosystem is defined as a community of users (clients), suppliers and service providers grouped around a particular platform, service or technology. Well-known ecosystems in ICT are Apple and its mobile users or Linux users with their foundations, users, application developers, other programmers, etc.

Cf. trials that we did in SmartAgriFood/FIspace. As specific exampes we could also mention a few example projects from our Accelerators.

- All plant protection systems based on remote sensing and on forecasting software (+ wireless sensors), especially in viticulture and horticulture
- Crop rotation planners a for arable crops taking into account soil fertility and health, carbon balancing as well as changing demands from supply chain
- Sensors (cameras, optic tools) for mechanical weed management for arable and vegetable production, while allowing for the different needs in different sectors
- Flexible soil management and mulching in permanent crops within and between rows – regulated by humidity, growth of crop and by-plants (weeds and companion plants), possibly as further developed agroforestry systems.
- Optimization of health and welfare of animals and product quality in animal production (e.g. milk production) with further developed sensor and actuators.
- Optimization of product nutritional and sensorial quality from field to plate in the supply chain.
- Software for improved traceability of organic products or AOC products (especially wines, but also for other high value products)
- Smart (sustainability) shopping tools linking specific product with information on sustainability aspects of the product and it’s origin linked to personal preferences.

Ideas for Smart Organic Agriculture

Setup and develop an ecosystem around FIspace in organic farming.
From FIspace we have learned that the services mentioned in the upper layer of Figure 1 already suggest some examples of services that could be developed specifically for organic agriculture, but more services could be imagined. The idea would be to setup and develop a particular ecosystem of end users, app and service providers for 'Organic Farming in Europe' around a concrete instance of a FIspace platform. If necessary these could be further split up into particular sub-sectors in arable-, livestock farming and horticulture. In parallel, other ecosystems can be developed e.g. around precision agriculture, agri-logistics, consumers, etc. The great advantage of the FIspace platform would be that these ecosystems will require specific services, but that the underlying apps can be partly overlapping, so that the different ecosystems are intertwined.

Link IoT to control, auditing and inspection services. One aspect could be to use an agricultural business collaboration and data exchange facility to link IoT data with the control, auditing and inspection services in organic (and AOC , conventional) farming. Organic certification and inspection as well as auditing for schemes like GlobalGap could benefit from such an integration: it makes risk-based inspections and auditing more advanced and the possibility to use this IoT data in tracing and tracking up to the consumer level (in apps like Questionmark, Wass ist Drin) would substantiate the credibility of such certification schemes in an era of food fraud. This would be an interesting extension of a current Dutch project Farm Digital in which a service Agriplace[4] is introduced or be a further development of several private systems applied in Italy and France for Geographic indications on wines.

The following aspects can also be incorporated into pilots:

- Improve quality sampling and residue findings, including feedback down the chain (technologies, protocols and balancing of interest)
- Improve utilization procured tools together by a collective farmers initiative
- Improve maintenance of machines (machines that report that they require maintenance)
- Harvest Quality and improve storage
- Direct improvement of soil quality, at tramline systems (no compaction) and place specific repair (aeration etc.)

(add suggestions)

[4] See www.agriplace.com

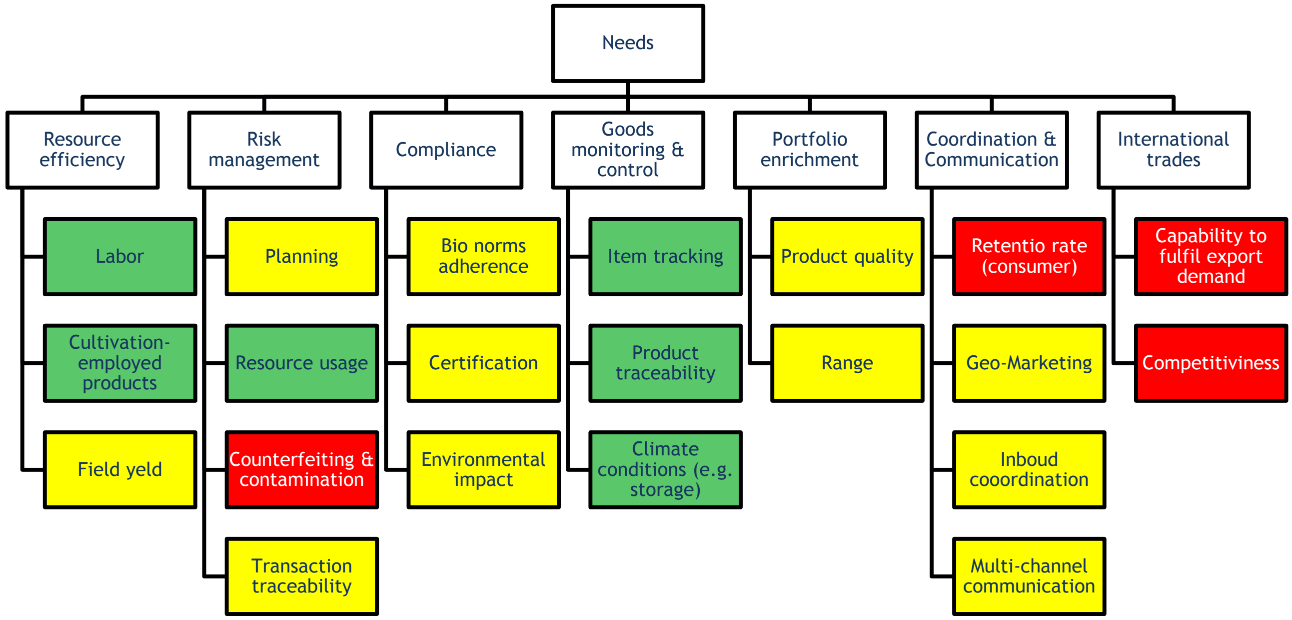

Figure 2 – Areas of potential application for IoT in organic agriculture

Green: areas with solid evidence of the sustainability of IoT applications in terms of costs and benefits
Yellow: areas that represent only qualitative verifications, thus requiring further studies
Red: areas that show no evidence at all