# AGRI-FOOD LIVING LAB: THE VIRTUAL MEETING PLACE FOR OPEN INNOVATION ON FARM INFORMATION MANAGEMENT AND ICT DEVELOPMENT

*Sjaak Wolfert[1,2], Jan Willem Kruize[2], Cor Verdouw[1] and Adrie Beulens[2]*

[1]*Agricultural Economics Research Institute, Wageningen University and Research Centre*
[2]*Information Technology Group, Wageningen University*

**Abstract**

*Information exchange is a crucial factor in modern farm management, especially when the whole agri-food supply chain network is taken into account. This requires flexible information systems for which a common digital infrastructure is needed. Development of such an infrastructure is, technically and organizationally seen, a huge challenge. In this paper an open innovation approach called Agri-Food Living Lab is presented as an appropriate vehicle to support and conduct this development. In living labs, users and developers are co-operating in an open space to develop innovative ideas. Each player can use innovations, derived from this open space, to develop private or commercial applications. In this way, development of innovations is expected to be accelerated and based on a common investment in a digital infrastructure. The Agri-Food Living Lab is a community of practitioners tightly connected with a web portal functioning as a virtual meeting place and providing a structure and components that support information systems development. Current results show that use cases play a central role, while methodology components such as web services and reference process models are used to create coherence in the gradually developed infrastructure. A key success factor, which is currently not fulfilled, is creation of enough critical mass to boost the development and to create self-enhancement. To improve this, several actions concerning communication and stakeholder involvement are taking place and extensions are planned through connections with similar international platforms.*

*Keywords*: digital infrastructure; software development; business process management; service-oriented architecture; web portal; community of practice

*Subtheme*: Innovation & Leadership

## 1 Introduction: information is a key competitive factor in agri-food business

The business environment of the agri-food sector is very dynamic, driven by different and changing needs of consumers and society. Production is increasingly demand-driven, should be transparent and must meet quality and environmental standards. Several incidents in recent decades (including foot and mouth disease, swine fever, dioxin contamination) have made food safety as one of the main themes. Agricultural markets become more volatile and are constantly under pressure because of high prices of land and labour, combined with increased competition due to globalization.

In Europe, one of the main answers to all these developments is to innovate towards a more demand-driven and knowledge-based production, where high-grade products play a central role. This is generally known as the Lisbon agenda (High Level Group, 2004). It requires application of state-of-the-art knowledge and involvement of research and technology institutes in innovations.

In connection with this development, information exchange between different actors within the agri-food supply chain network (further abbreviated as AFSCN) plays a crucial role (Wolfert *et al.*, 2010a). The farm, as the primary production place, fulfils a central role in this, because much information is generated and combined at that place and this information has to be communicated within the whole AFSCN. From the farmer’s perspective this information also plays an important role in decision-making. In practice, this means that several types of information systems (located at different places in the AFSCN) have to communicate with each other. This calls for flexible information systems that are well coordinated, including good and widely accepted standards for information exchange (Wolfert *et al.*, 2010b). Research in the context of recent agri-food projects showed that the current situation is far away from this ideal picture (Nikkilä *et al.*, 2010; Sorensen *et al.*, 2010; Wolfert *et al.*, 2010b). Wolfert et al. (2010b) recently have coined a methodology to organize information integration in AFSCN in a better way. Technically speaking, this means that developments should be more internet-oriented and based on a service-oriented architecture (SOA). In order to maintain and extend the broad support, a stepwise approach should be used where there is a close interaction between users and developers. By focusing on connecting the actual business processes, through business process management and modelling techniques, these technical and organizational aspects can be linked together.

### 1.1 Research question: how do we reach a good digital infrastructure?

This challenge is large and complex. A common digital infrastructure is needed. Long term benefits are clear for everyone. However, in the short term it is unclear how to get there. Who takes the first steps? It appears that for individual service providers and ICT companies the initial investment are too large and too risky, while the models for return of investment are unclear. Moreover, the trend in ICT development is to build on existing components as much as possible and preferably add only that what is your own core business. The problem for the agri-food sector is that these components are not there yet, or that they are insufficiently accessible. The question is how to establish the required interaction in development between users and developers (McCown *et al.*, 2006). Recent years, several projects in Europe tried to develop these components (Wolfert *et al.*, 2007; Wolfert *et al.*, 2009; Sorensen *et al.*, 2010). So far, no major breakthroughs are provided. It is expected that a project is a too closed environment and therefore reduces the incentive for competition to obtain good solutions.

### 1.2 Objective and outline of this paper

In the referred paper of Wolfert et al (2010b), the open innovation concept of the so-called ‘Living Lab’ approach was considered as an important step in solving this problem. In the meantime, this concept has been further developed and implemented in the Agri-Food Living Lab. The objective of this paper is to present the results of this development. First, we will briefly describe the Living Lab method and how it is applied to the agri-food sector. Then some application results are presented. Next, the pros and cons of this approach are discussed. Finally, conclusions are drawn and a brief outlook on further steps is provided.

## 2 Method

### 2.1 The solution lies in an open innovation and living lab approach

The problem situation that was described calls for an open innovation - or perhaps open source - approach. Well-known examples of such approaches are the Linux operating system, the encyclopaedia Wikipedia and various Google services like Google Maps that everyone can use to make own applications (so-called mash-ups). The Apple iPhone with its ‘app store’ can also be seen as a sort of open innovation environment in which - within certain constraints - everyone can make an own application ("app") and sell it through the store. In this way application developers largely rely on the basic infrastructure of Apple and add only a very specific functionality to it. Especially the latter example shows that open innovation is not a matter of charity but done at a commercial basis. Moreover, parties will only participate in open innovation if, over time, a commercial profit can be obtained. They do participate in open innovation because they recognize that they cannot reach, or not so fast, a certain innovation on their own,. A key competency for open innovation is to be able to decide what you want to share with others and what you don’t want to share (Du Chatenier, 2009).

Living Labs in Europe in recent years have become popular, resulting in the European Network of Living Labs (ENOLL; www.openlivinglabs.eu) (Mirijamdotter *et al.*, 2006). Until now, Living Labs are often closely linked to software development, but when taking a closer look, it is always linked to more general problems. The Living Lab is a specific open innovation approach, in which in fact the laboratory is placed in practice; not in a protected environment to develop and test something first and then roll out into practice. From the very beginning, developers and users are involved in the innovation process. In a Living Lab their specific roles are also blurred: users are sometimes developers and vice versa. In a Living Lab, there is not always a clear goal, but all sorts of questions and problems together with existing solutions can lead to surprising, unexpected results. Think of the many applications that are made with Google Maps that Google never could have imagined in advance, but that have been created through - often anonymous - interaction with many users and developers. One of the important characteristic of open innovations and Living Labs is the potentially large critical mass of people who think along and participate. This contrasts with a traditional proprietary project environment.

### 2.2 The Living Lab concept for Information Management in Agri-Food

Based on the previous problem and solution direction it was decided to setup a Living Lab for information management in the agri-food sector. This concept has already been described in detail in Verloop et al. (2009), but for sake of readability of this paper a brief summary is presented in the following paragraphs.

In Fig. 1, the general process of the Agri-Food Living Lab is schematically represented, where the open innovation process plays a central role. Agri-food business and government are often the parties who bring in practical problems (e.g. in land registration, plant protection, precision fertilizer application, etc.). Research and education bring in knowledge and models that are related to these problems. ICT business and consultants bring in existing business solutions. The open innovation process continuously generates new (partial) solutions and knowledge which is publicly available. These innovations can be constantly reused within the open innovation process. An important side-effect is that these (partial) solutions and knowledge can be picked up by others and be used for a different problem than intended (serendipity). Likewise, all parties are free to share solutions or to keep them for themselves to serve as a base for commercial products or services. In that way, there is always an interaction between the competitive and open space and the players themselves decide in which space they develop. Because the open space is also a place for contacts with (potential) customers, it is expected that this is 'a-place-to-be' for vendors. Hence, it is expected that the open space is potentially a self-enhancing mechanism.

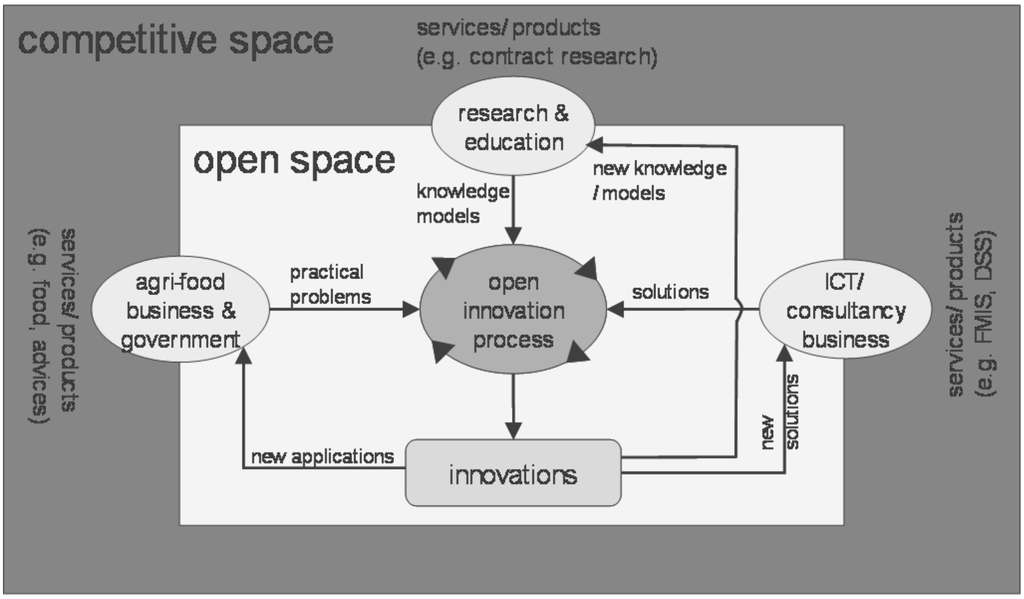


**Fig. 1 Schematic representation of the Agri-Food Living Lab.**

Researchers, developers and users closely operate with each other and their roles have not been pinned down in advance. For example, a farmer can have a good idea about ICT-development and an ICT-expert can sometimes shed new light on the farmer's practice. Unlike a traditional project environment, the participants - both at the requesting and performing side - are not fixed. From the Living Lab view, there is no intended project result defined. Moreover, projects - that aim at a final output - can make use of the Living Lab to obtain better and more supported results.

## 3 Results

Based on the presented method in the previous paragraph, it was decided to build a community of practice with a web platform as a central meeting place. A first version of the Agri-Food Living Lab web portal was realised in July 2010 (see www.agrifoodlivinglab.nl). At the time of writing this paper it is in a phase in which the contents are further being generated and actions to increase the number of users are initiated.

### 3.1 The Agri-Food Living Lab portal: the virtual meeting place

The main components of this web portal are:

- use cases
- discussion forum
- web services catalogue
- reference information models

Besides, other common features are included such as blogs, news, events, interesting links, etc. The components and their relationship are shown in Fig. 2.

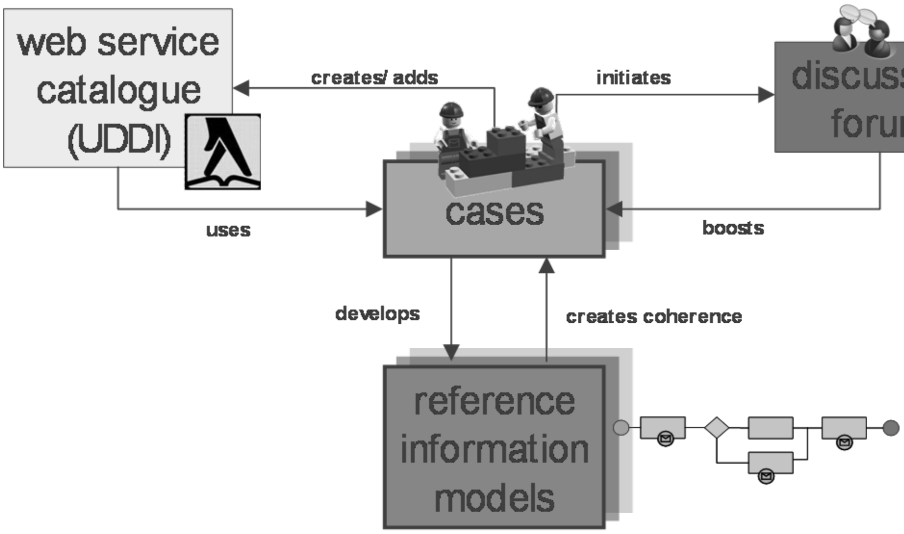


**Fig. 2 Components of the Agri-Food Living Lab portal and their relationship**

The use cases play a central role in developing new applications, where possible, consisting of a combination of existing web services. Examples of use cases are: precision fertilization, land parcel registration, location-based coding and sensor-based data processing. The web services themselves are usually not in the portal, but are located on other servers and accessible via the Internet. Through a catalogue it is made easy to find and link to them. In the background of the website runs a UDDI server. UDDI (Universal Description, Discovery and Integration) is a formal standard to connect to a web-services. It is expected that cases lead to new proposals for functionality in the form of web services or modifies existing web services. The cases are continuously under discussion by users and developers in the discussion forum. In this way, the discussion is a driver for the improvement of the cases. Although each case can stand alone, there will be considerable overlap in use of data, applications and processes. To ensure consistency between them, reference information models are developed, based on business process management (BPM) and modelling and service oriented architecture (SOA) (Verdouw *et al.*, 2010).

The Agri-Food Living Lab portal is open for the public but if people want to interact (e.g. add comments, add discussion topics, etc.), they have to be registered users.

### 3.2 Use cases and projects embedded in the living lab

Currently there are 9 use cases that vary in their degree of activity:

- precision fertilization - generating a variable-rate fertilizer advice
- spraying advice - generating a spaying advice based on a central database
- controlled traffic farming - auto-steering and autonomous vehicles
- sensor-based data processing - handling of data that is generated by various sensors
- sustainability reporting - collecting data to generate a sustainability report at product level
- land parcel identification and registration - coupling of information systems between farm and government
- benchmarking - tools, to be combined with data, with which farmers can benchmark themselves
- Geo-Field-Optimisation-Service - optimizing the arrangement of a field
- QMS online - combining satellite-sensed data with other data to benchmark fields

The latter two cases are examples of more commercial-oriented services. Most of these use cases are connected with the former Dutch project 'From knowledge to practice in arable farming' (Wolfert *et al.*, 2005) and the on-going private-public 'Program on Precision Agriculture'. Therefore, the emphasis is currently on arable farming. Recently, several projects in horticulture have started and it is expected that the following use cases are added to the Living Lab:

- encoding: product/item codes and logistical encodings
- auto-identification in the chain, including RFID
- enterprise management systems (e.g. ERP) at growers, marketing organizations, traders and other parties in the chain and integration of management information systems in the chain
- message standardization

Finally, some interest was shown from animal farming projects, but until now this has only led to a preliminary case on monitoring animal behaviour.

Each case study page in the portal has a fixed format:

- short description of the case
- current status and actions to be done
- demonstration applications
- process modelling
- web services that are involved
- interesting links (other websites, literature, etc.)
- document library in which additional documents can be placed

Each case study has one or more moderators who are responsible for the case. Only they can change the contents of the page. This can be initiated by direct contact with the moderator or indirectly via a corresponding topic in the discussion forum. Besides, there is an option to form a sub-community within the portal that is especially affiliated with one or more cases.

A separate page 'models and standards' is setup for process modelling that underpins the use cases. In cooperation with the Program on Precision Agriculture, a PhD-student is contracted to make a start with this part. Currently, an appropriate modelling tool is being looked for that is able to visualize processes in a simple way so that e.g. farmers still can interpret it, but at the same time is able to make an active connection with software systems (i.e. web services).

### 3.3 Communication and stakeholder involvement

Activities from the use cases are communicated and promoted by news items and articles in the portal itself, but also externally. The latter is enhanced by combinations with social networking media such as RSS feeds and Twitter. Additionally, the Living Lab is presented and demonstrated in meetings, conferences, workshops, etc.

Beside virtual meetings through the portal, physical meetings are frequently organized by so-called 'extreme programming sessions'. Until now, these were mainly attended by software developers. These sessions are meant to speed up certain developments while it helps when more direct interaction and discussion can take place. On purpose, the portal is basically setup in the Dutch language because English was thought to be a barrier for having good discussions, especially at technical level of farm management (e.g. names of machines, processes, etc.). However, the process modelling and web services part is mainly developed in English to link up in the future with international developments. In practice, these parts are mainly 'under the hood' for those that have to use them, so this is hardly a problem.

## 4 Discussion: advantages and disadvantages of the Living Lab

Because the Agri-Food Living Lab portal is still in its initial stage, it is too early to make a thorough analysis of the advantages and disadvantages. Based on the experiences so far and other experiences derived from literature, some preliminary discussion points can be derived:

*Advantages:*

- sharing of initial investment costs and risks. In this way it is ensured that a collective step forward is made. On this basis, individual (commercial) developments and implementations on each other's core business areas are made possible.
- presence of a potentially large critical mass. Basically, anyone can participate so it is more likely that there is always someone who has a solution for a specific problem or who has a good idea.
- much room for creativity. The case studies and discussions are open and the potential building blocks (web services) are readily available to be explored in applications and services.
- higher chance of acceptance. The user is involved from the beginning of the development and components are developed and tested in a real-life situation.

*Possible disadvantages:*

- voluntary participation. This raises the question whether there is sufficient critical mass to make cases successful. This can be overcome by embedding existing projects as much as possible. Additionally, connections can be made with similar portals worldwide, which can increase the numbers of participants dramatically.
- performance and quality are not guaranteed. Contrary to a project, in the Living Lab there are no obligations for results. However, the web services are important end results and once they are commercially interesting enough, the assumption is that quality is guaranteed through common feedback mechanisms (cf. apps in an appstore). The Living Lab can also be seen as independent platform in which the community discusses or rates the quality of the results. For web services and standards in which no direct commercial interest is at stake, but which are crucial for other applications, it could be investigated if standardization authorities can play a role.
- Consistency between cases and related web services is not secured. In practice, this can still lead to poor integration of different applications. Partly, this phenomenon will be prevented because users plays a significant role in the development. Additionally, research institutes will work on a cohesive architecture in the form of reference information models .

## 5 Conclusions and outlook

Information exchange is a crucial factor in modern farm management, especially when the whole agri-food supply chain network is taken into account. This requires flexible information systems for which a common digital infrastructure is needed. Development of such an infrastructure is technically *and* organizationally a huge challenge. The open innovation approach of the Agri-Food Living Lab is considered to be a good vehicle to support and conduct this development. Preliminary results show that use cases play a central role, while methodology components such as web services and reference process models are used to create coherence in the gradually developed infrastructure. A key success factor, which is not fulfilled at the moment, is creation of enough critical mass to boost the development and to create self-enhancement.

Hence, international expansion is one of the planned activities. A concrete starting point for this is the EU-FP7-project 'agriXchange' (see www.agriXchange.eu). agriXchange is a network project to develop a system for common data exchange in the agricultural sector. One of the goals of this project is creating a platform for this, which has many commonalities with the Agri-Food Living Lab. To make a future connection possible, the web services catalogue (UDDI) and reference information models are set up in the English language. It was indicated that most interactive elements (discussion forum, case development) are in Dutch but this can partly be solved by automatic language translation services, which are built-in services in modern web browsers. In 2011, a joint research project is planned between New Zealand and The Netherlands. One of the objectives is also to setup a similar living lab for New Zealand. This could be an extension of the current New Zealand Centre for Precision Agriculture (see www.nzcpa.com). Beside the current extreme programming sessions where people physically meet in a room, it is thought of using web conferences to have a similar, though potentially larger impact. In this way a worldwide network of agri-food living labs can be established in the future.

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