

Agro-food projects: analysis of procedures within digital revolution

Juan Maria Sagarna Garcia
*Department of Services, Quality and Innovation,
Cooperativas Agroalimentarias de España, Madrid, Spain, and*
David Pereira Jerez
*Department of Agroforestry Engineering,
Universidad Politécnica de Madrid, Madrid, Spain*

Received 14 February 2019
Revised 10 August 2019
13 September 2019
Accepted 30 September 2019

Abstract

Purpose – The purpose of this paper is to provide insights about the approaches and techniques of professionals that nowadays are designing Digital Products and Services (DPS) in the European agriculture. The emphasis is paid on the integration of end-users and participatory approaches such as agile, considering its current influence.

Design/methodology/approach – A survey was conducted to professionals of businesses and entities from 14 European countries. A balanced sample of replies was achieved between private–public background, size of the business or experience of experts. Afterwards, the collection of answers and the opinions of professionals were compared with the state of the art referred in the literature. It allowed checking its soundness and critically discusses the results.

Findings – From the raw analysis of responses, professionals show awareness about the importance of end-user involvement and they are eager to incorporate innovative farmers and early adopters to collect the best requirements for products and services. They also declare knowledge and uptake in their companies of new approaches, such as agile. Confronting results with literature, the discussion highlights some inconsistencies and possibilities for leveraging. Types of end-users considered should be enlarged. Their superficial participation must also be avoided.

Originality/value – There is a lack of research on procedures for projects in agro-food sector. Due to the momentum in the digital transformation of agriculture, there are many project teams working in developing DPS and are relevant to discuss about proper methodologies for improving success.

Keywords Critical success factors, Agile, Stakeholder collaboration, Value co-creation, Diffusion of innovation, Client satisfaction, End-user collaboration, Digital agriculture, Participatory techniques

Paper type Research paper

Introduction

There is a consensus that farming and food is one of the sectors where digital innovations are going to impact deeply (Kaloxylou *et al.*, 2012; Poppe *et al.*, 2013, 2015; Wolfert *et al.*, 2017). These studies were very clear about the relevance of the digital transformation, explaining that economic drivers push for a technological revolution and how those impulses affect different elements of food chain.

In the agricultural sector, information and communication technologies (ICTs) have emerged in the last years and this growth is expected to continue. Investments in tech start-ups oriented to the farming sector grew 63 percent from 2010 to 2015, reaching that year \$4.6bn (Laugerette and Stöckel, 2016). Elements of the so-called smart agriculture market are envisaged to rise from \$ 5.18bn in 2016 to US\$ 11.23bn by 2022, with an annual growth rate of 13.27 percent (MarketsandMarkets, 2017). Other economic forecasts are in the same order of magnitude.

In Europe, political efforts to boost digital markets and specifically the digitalization of farming sector are continuous; Cork 2.0 declaration “A better life in rural areas”; EU



Commission proposal for Common Agricultural Policy beyond 2020; EU Communication “Digitizing Europe Industry”; or Digital Single Market (DSM) initiative are good examples of this strategy.

The digital transformation on agriculture implies different levels and technologies. In a first level, it is possible to make massive captures of data using ground or aerial-based sensors, such as drones or satellites. Second, with the use of algorithms, artificial intelligence and machine learning among others, data become a useful operational information which is presented to farmers and other stakeholders in food chain by Decision Support Systems (DSS). Third, actuators can automatically operate. For instance, handling irrigation systems or controlling heating and ventilation systems on indoor agriculture. Autonomous machines and robots could sow, harvest or apply agrochemicals in a safer way for farmers.

The use of ICT for leveraging agriculture performance is not so new. From the early 1990s the so called “precision farming” also found on technology-based engineering and computers. This precursor was deployed mainly at farm scale, focusing on production efficiency. However, nowadays value creation in Agro-food systems is more linked with other segments of agribusiness further than farm stage (Caiazza, 2012). Electronic Data Interchange between the different businesses of the chain allows for the recording of operations and for managing interactions from input providers to retailers and consumers. That feeds traceability systems for legal or marketing purposes. Machine learning and artificial intelligence also use those data for consumer’s consumption forecasts, market assessments and other issues of great value in the modern food chain.

Considering precision farming as a precursor for the digital transformation of agriculture, there are indeed current interesting examples of their use. For example the adoption of GNSS/GPS technology for agricultural production or the adaptation of management operations and agrochemical applications to weather forecast provided from satellite information. In Europe, the EU Commission states that currently, around 70–80 percent of new farm equipment, is manufactured with some precision farming capability.

However, precision farming has not achieved its main goal to take the place of conventional or “disconnected” agriculture. Successive reports from European Parliament (2014) and EIP Focus Group on Precision Farming (2015), strengthen this qualitative assertion, while official statistical data are expected by early 2020. More references have been found at the country level. In the UK, implementation rate on farms achieved 22 percent on GPS based machinery steering, 20 percent on soil mapping for fertilization management, 16 percent on variable rate application of agrochemicals and only 11 percent on crop yield mapping (DEFRA, 2013). The situation is not significantly different outside of Europe with rates of implementation ranging between 15 and 25 percent in Australia (Bramley and Trengove, 2013; Lamb *et al.*, 2008), USA (Vasisht *et al.*, 2017), Argentina (Melchiori *et al.*, 2013) or Brazil (Borghi *et al.*, 2016). Considering the similar results around the world, the causes of this short penetration of precision farming seem to be global and not local.

Lamb *et al.* (2008), Weltzien (2016), Fountas *et al.* (2015), Kitchen *et al.* (2002) and Meera *et al.* (2004) analyzed some causes of this low rate to identify flaws in design concept and lack of a result-oriented approach.

Considering previous difficulties for the implementation of precision farming, success in the new digital transformation is not guaranteed, despite its strong support by important agribusinesses and governmental institutions. There are, however, clear opportunities such as increasingly lower prices of ICT devices and services linked with data management. The extreme competitiveness in the agro-food system entails a strong fight for efficiency and cost reduction without quality drop (Caiazza, 2012). Those economic incentives push some firms to become bigger, and it fosters the usage of digital tools. New requirements of consumers and citizenship will also push to this change, as a good manner to effectively monitor commitments of products with health, safety and sustainability (Poppe *et al.*, 2013).

Many agents try to play a role in this new and vibrant market of farming technology. In addition to traditional agriculture corporations (e.g. Bayer, Corteva, Cargill, etc.) and technology providers (e.g. John Deere, CNH, Trimble, etc.), some “foreigner” tech companies (e.g. Google, IBM), venture capital (e.g. Anterra, Founders Fund), Universities and Research centers (e.g. INRA, Wageningen) and a plethora of tech start-ups are shaping, together with farmers and cooperatives, a new stakeholder ecosystem (Wolfert *et al.*, 2017). Principal governments around the world are boosting these changes promoting public institutions, universities and renowned technological centers to take part in this movement.

As a consequence, entities offering services and developing digital products and services (DPS) in agriculture are heterogeneous. Some of them have always been linked to the agricultural or food business while others come from the purely digital sector or ICT and some of them are private companies and others are public, like universities or agencies. Logically, their way of managing projects and product development is also diverse. This diversity could be enriching, but the use of inadequate procedures can also add unnecessary complications to the barriers that already affected the uptake of precision agriculture, diminishing chances of success to the digital transformation.

For instance, the significant differences between developing technology-driven projects and others focused on the demands of end-users shape a relevant issue. The use of new participatory procedures in product design and project management is another key example. Some examples of contributions about the importance of participation of stakeholders and multi-actor approach in Europe are Neef and Neubert (2011), Sofka and Distel (2017) or Tinker *et al.* (2017).

Project guidance handbooks from the main international assistance agencies in agriculture (FAO, ADB and USAID) are still based on the Logical Framework Approach (LFA). Baccarini (1999) analyzed the usefulness of LFA for designing projects in agriculture, and Muriithi and Crawford (2003) reported about its usability in projects of development field. It has been adapted several times since its creation and finally derived into Goal Oriented Project Planning (GOPP-ZOPP). In addition to project outcomes and impacts, these agencies must consider aspects as fair and transparent selection processes and they also have to monitor the way that public money is spent. Big development projects in rural areas are complex and include a broad range of subprojects focused on product management, training actions, replicability processes, communication and dissemination strategies, amongst others. Assumptions based on prior knowledge and an estimative allocation of resources and time fit well with manageable rural development projects and plans. However, adaptation to end-user expectations is a weakness in the use of these methods (Sartorius, 1996). Since they are frequently including DPS as a part of bigger projects, the participatory approach is a critical issue.

Meanwhile, in the private sector and specially in big tech corporations (e.g. Google, Apple) agile techniques have an increasing influence on digital developments. Agile techniques and approaches effectively manage technological projects and they have gained a momentum in an environment strongly influenced by exponential advances and high competitiveness. Although these methods were developed by the software industry, their principles have since spread to many other industries and sectors (PMI, Agile Alliance, 2017).

In projects managed by agile principles, initial predictive assumptions are replaced by iterative efforts for obtaining incremental value in product development. Different versions of the product incorporate step by step different features up to the total client satisfaction. In agriculture, some authors have documented frontrunners’ experiences about agile techniques (Dearden and Rizvi, 2008; Khudadad *et al.*, 2014).

Thus, it is important to analyze the opinions, techniques, training and approaches of the professionals who are designing DPS in agriculture. For this purpose, a survey was conducted among a sample of European DPS developers. It pursues the following goals: to

check the attitude of project designers regarding involvement of end-users; to determine the state of the art with respect to methodologies used for management of digital projects and to check the introduction of new participatory techniques, such as the use of agile approaches; to identify pitfalls and to propose corrections for upgrading DPS probability of impact.

Method

The questionnaire used for the survey was designed with three blocks of questions. The first one was focused on expert characterization in order to guarantee the soundness of the sample. The second part inquired about their experience with respect to the participation of farmers and the rest of end-users in digital projects for agriculture. Finally, the last part of the questionnaire asked about knowledge, experience and opinion about some common traditional techniques of project management and those more recent, with a participatory approach.

The composition of the survey panel has sought diversification of professional profiles to obtain proper conclusions. A mandatory condition was to be currently working on the development of DPS for agriculture. The list of people for contacting was provided by the IoF2020 project, which is the greatest project funded so far by the European Commission in the framework of digital farming. Their members fed the largest amount of the sample data set for the survey. Other European developers were surveyed for completing it.

The questionnaire was sent to experts of 82 different bodies from 14 European countries with a balanced weight between private and public sector, and between small companies and big corporations. Experts received access to the questionnaire through e-mail, and during the answer process, an exchange of clarifications took place whenever necessary.

The 35 replies obtained released the following expert's characterization:

- Regarding the size of company/institution of the panelist: 50 percent belongs to entities with more than 250 employees, 32.4 percent between 50 and 250, and 17.6 percent up to 50.
- Regarding their professional background: 48.6 percent worked in the private sector, 40 percent in both public and private sectors and the remaining 11.4 percent, in the public sector.
- Regarding the duration of expertise on agricultural digitization: 34.3 percent worked more than 10 years in agriculture digitization, 11.4 percent worked between 5 and 10 years, 25.7 percent worked between 2 and 5 and the remaining 28.6 percent only for the past two years.
- Experts of the panel were requested to select some terms which they considered linked with their current work. Considering that most of them have not chosen only a single option, the most repeated generic terms were: DSS for farmers (71.4 percent), precision agriculture (65.7 percent), smart farming (65.7 percent), project management (60 percent) or software development (51.4 percent). In addition, some of technologies are clearly identified as frequent subjects for developers, sensors (54.3 percent), big data (51.4 percent), geographical information systems (37.1 percent), machine learning (37.1 percent), satellite (25.7 percent), drones (17.1 percent), GNSS (17.1 percent), remote control (17.1 percent) and robots (8.6 percent) (Figure 1).

Results and discussion

Success, impact and relevance of participatory approach

Traditionally, success in projects has been measured with regards to their achievements of scope, schedule and chronogram (triple constraint). Some authors have proposed more ambitious systems, including success over the entire project and product life cycle

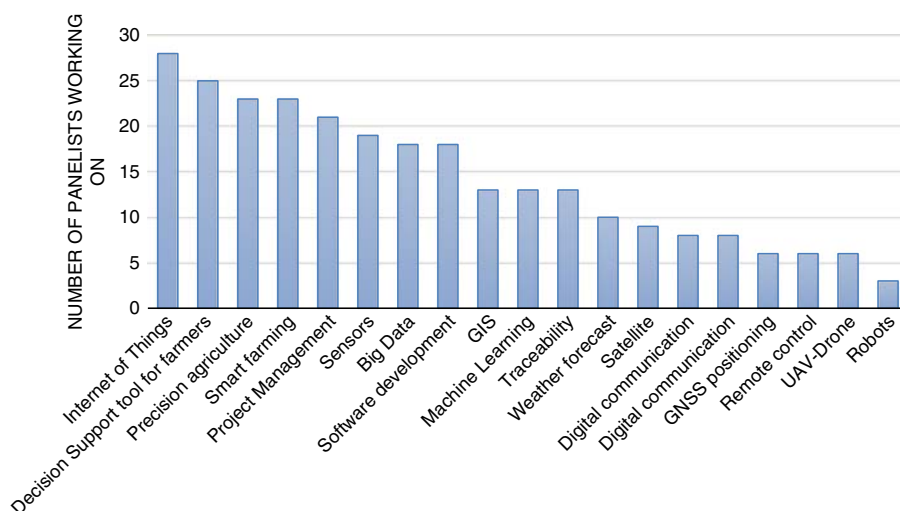


Figure 1.
Responses of DPS
developers about their
current area of work

(Shenhar *et al.*, 1997; Jugdev and Müller, 2005; Cavarec, 2012). In this research, the usage of conventional method allows the comparison of results with the powerful data bases on ICT projects, such as CHAOS Report (The Standish Group, 2015) that has monitored the performance of thousands of software projects against triple constraint, since 1994.

Experts consulted for this paper replied to questions about the success and failure rates of DPS projects in agriculture, estimating it according to its experience. The questionnaire included the same terminology used in the CHAOS Report. The replies were:

- 32.1 percent of the projects were successful. This implies, according to CHAOS Report definitions, that they were completed on time, on budget, with all the elements and functions required and with a satisfactory result.
- 44.9 percent of them were challenged, that means completed and operational but late, with an excess of budget or had less features and functions than specified initially.
- 23.0 percent of them failed, either canceled before completion or never implemented.

The current rate of failures on projects is consistent with other sources and quite significant. Carroll (2006) in his research on critical success factors in e-business projects concluded that only 33 percent were successful. The Standish Group (2015) releases an annual follow-up of software projects. For the period 2011–2015, a 29 percent of successful projects was issued. Around 19 percent were failed and the remaining being considered as challenged.

In projects specifically focused on farming, there is not so much information, but we can learn from some indirect but relevant sources. Agriculture, together with governance and reform, is the most important field in projects funded by the World Bank (Ika *et al.*, 2012). Lai (2001) carried out an assessment for FAO of several monitoring reports of rural projects in Asia of both institutions during the 1990s. It released an average of 25 percent having unsatisfactory outcome ratings. With a similar approach, Asian Development Bank (2008) reported about success in its project portfolio, a big part of it dedicated to Agricultural development and the majority being deployed in rural areas. A total of 30 percent of the projects funded by them did not achieve successful rates in the final evaluation.

Even though they were obtained by different sources and methodologies of evaluation, mentioned figures draft similar ranges from 20 to 30 percent of projects that are not achieving the minimum elements to be considered successful. Considering other equivalent

amount of projects facing difficulties or being questioned, if we analyze the whole life cycle, it turns out that only approximately a third of total projects are developed without management problems, easily carrying out their tasks, and achieving the initial objectives.

This lack of success in many projects is one of the causes that affect the implementation of DPS. Consequently, an improvement of this rate would improve the chance of success of the digital transformation in the agricultural sector.

Considering the mentioned antecedent of precision farming, a review of literature offers good examples of the relationship between the lack of final impact with initial failures establishing end-users' expectations. The conclusion of the Focus Group (2015) on precision farming of European Innovation Partnership stated: "[...] Precision Farming's early promise in the 1990s failed to deliver successful solutions, leaving many farmers skeptical about many aspects of the technologies involved." Lamb *et al.* (2008) studied the weaknesses of precision farming uptake and highlighted gaps between capabilities offered by the techniques available and the expectation of users.

The basic way of participation of stakeholders is collecting their expectations and preferences. This is strongly recommended in most of the standards of project design. For instance, in its guide for agricultural projects, World Bank (2010) states "Involving local communities early in project design and throughout implementation increases the ability of projects to effectively respond to demand, positively impacts the way projects are implemented, and contributes to the sustainability of the outputs and the outcomes of the project." Lessons learned from seventeen projects of the program of the World Bank (Batchelor *et al.*, 2003) using ICT for rural development exposed the utmost importance of end-user participation. It encourages the involvement of target groups both in project design and monitoring and it recommends the identification of every stakeholder and the conduction of a need's assessment with their collaboration.

In the general framework of internet-based projects, through an assessment of 44 projects, Carroll (2006) concluded that end-user participation improves the project's chance of success. In a recent analysis of 50,000 projects, the CHAOS Report (Standish Group, 2015), also concluded that user involvement is a first-order factor of success.

The survey asked to experts about their experience and interest on involvement of end-users. 17.6 percent opted by a moderate importance, while most scored it with high (35.6 percent) or very high importance (47.1 percent). In fact, 94.1 percent out of total replies declare frequent involvement of end-users in their projects. Though the importance is always in a high percentage, slight differences are found regarding the size of the bodies where the experts are working. The smaller the bodies, the more participatory willingness is shown by their experts. The rest of the factors such as experience and public/private environment do not imply significant differences. It can therefore be understood from the data presented that the experts are aware of the relevance of a participatory approach, Table I. Responses to the second block of the questionnaire, considering size, type and experience.

Purpose and restrictions of participatory approaches

When asked about the ways in which this participation can improve their projects, the experts first selected (1) better collection of requirements for the final products (86 percent). This position remains independently of the characteristics considered: size, public/private background or experience, but again the smaller the entities the stronger support this reply receives in the survey. The next favorite options were (2) implication brings the project closer to the real world and (3) improves the future penetration of DPS in the market, both obtaining 57 percent. An element to be highlighted is the preference of public sector for the option about the gaining proximity to the real world when end-users are incorporated. The other options were: 37 percent considered that they (4) would give knowledge of agriculture to the project team, 29.4 percent thought that it helps to (5) better incorporate the changes

Replies	Size of body (workers)			Type of body			Experience of expert in years			
	<50	50–250	>250	Public	Both	Private	<2	2–5	5–10	>10
	6	11	18	4	14	17	10	9	4	12
<i>End-users participation</i>										
From your experience, score importance of real involvement of end user (i.e. farmers) during the project (from 1 very low to 5 very high) average	4.5	4.5	4.2	4.3	4.6	4.4	4.7	4.3	4.8	4.3
Do you usually involve in your projects end-users? (percentage of positive replies)	91%	91%	89%	93%	88%	100%	100%	100%	80%	92%
<i>On which stage do you consider most useful their involvement?</i>										
(Inception/Idea of project)	2.5	3	2.4	2.4	2.4	2.6	2.5	2.6	2.5	2.5
(Planification/project design)	2	1.5	2.3	2.1	2.3	2	2	2.2	1.3	2.1
(Execution of project)	2.1	1.7	2.2	2.1	2	2.2	1.9	2.3	1	2.2
(Testing of product)	2.9	3	2.8	3	3	2.9	3	3	3	2.8
(Panel board along project life)	2.5	2.2	2.6	2.6	2.7	2.4	2.7	2.7	1.8	2.5
<i>What kind of end user do you consider most useful for providing you inputs for your projects</i>										
Innovator farmer (2% of farmers)	63%	100%	64%	75%	57%	65%	0.7	0.67	0.75	0.5
Early adopter of technology (15% of farmers)	89%	100%	73%	75%	93%	88%	0.9	0.67	1	1
Common farmers	29%	0.17	55%	25%	21%	35%	0.4	0.22	0.75	0.08
Multipplier/Aggregator, directly (i.e. cooperative of farmers)	54%	0.5	56%	25%	50%	65%	40%	44%	75%	67%
Advisers of farmers, Chambers of agriculture	40%	67%	45%	25%	43%	41%	60%	33%	25%	33%
Farm equipment suppliers	23%	33%	9%	25%	36%	12%	0%	22%	25%	42%
Food processing companies	31%	50%	27%	25%	21%	41%	40%	44%	0%	25%
<i>From your experiences, select main barrier for effective involvement of end-users</i>										
Communication or understanding problems	24%	0%	30%	50%	17%	23%	20%	22%	0%	40%
Difficulties for accessing to useful end-users	27%	16%	30%	25%	33%	24%	10%	56%	25%	20%
Lack of interest of end-users for collaborating	3%	17%	0%	0%	0%	6%	0%	0%	0%	10%
Need for additional resources (staff, cost, time)	46%	67%	40%	25%	50%	47%	70%	22%	75%	30%

(continued)

Table I.
Main results
of the survey

Table I.

	Size of body (workers)			Type of body			Experience of expert in years			
	<50	50–250	>250	Public	Both	Private	<2	2–5	5–10	>10
Replies	6	11	18	4	14	17	10	9	4	12
General	35									
<i>In which way do you consider involvement of end-users can improve projects?</i>										
Contact with them help to better collect requirements for product	86%	91%	78%	75%	79%	94%	100%	89%	100%	67%
It improves future penetration of Digital Product or Service in the market	57%	55%	50%	75%	50%	59%	50%	56%	75%	58%
It helps to better incorporate changes during life cycle of project	51%	64%	39%	100%	50%	41%	60%	44%	50%	50%
It gives to project team skills on agriculture	37%	27%	44%	50%	36%	35%	40%	56%	0%	33%
It closes project team to real world	57%	45%	67%	75%	64%	47%	40%	78%	50%	58%
It does not improve project in any way	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Ratio cost/benefit of involvement of end-users in project is not positive	3%	17%	0%	0%	7%	0%	0%	0%	0%	8%

during the life cycle of the project. Finally, only 5.9 percent declared that (6) it would not improve the project in any manner.

In their first option, DPS developers opt for integrating, in their requirements, the expectations of end-users. In every project, the initial gathering of requirements for the project itself and the specifications for products to be developed within it are essential for its final success (Dvir *et al.*, 2003). However, the trend is to focus on internal project matters, and the possibility of success decreases if specific work with stakeholders and their environment is not specifically considered (Beers *et al.*, 2014).

In the case of DPS for agriculture and as a comprehensive approach, requirements from end-users must be related to their expectations and should be oriented at delivering the real value for them. As a consequence, projects must be more demand-driven than technology driven. This means that, in the end, technology is a tool, among others. Sometimes, big firms push artificially for technologies on which they have a great experience or have invested in recent years which is known with the expression “technological debt” of companies. Eventually, successful or failure of DPS and projects that develop them must be measured against the real impact on users or clients. Those can be farmers or other stakeholders but always have in common the analysis of satisfaction comparing results with demands, and added value that DPS are able to proportionate. This does not depend on how innovative or cutting-edge technology is but on how it fits in the easiest and most effective way with their expectations.

In agriculture, the simpler a technology is, the greater its impact will be. Analysis of agricultural projects carried out on Information for the World Bank’s Development Program InfoDev. Batchelor *et al.* (2003) point at the simplicity of technology as a matter of success: “simpler technology often produces better results.” When technology is less intuitive the involvement of transference actions is recommended, such as farmer’s advisors with training and experience in both worlds, agriculture and ICT (Meera *et al.*, 2004). It also highlights a need for tailoring technology, considering special constraints in rural areas and paying attention to technical and educational barriers (Batchelor *et al.*, 2003).

Lamb *et al.* (2008) explained the tendency of some big firms to impulse technologies before they are in an advanced level of maturity. Linden and Fenn (2003) outlined the necessary curve of development of ICT technologies, before reaching a plateau of productivity. Their hasty introduction can cause negative effects. In digital projects, Richardson (2005) refers as “technology of the day” to those technologies fostered in rural areas before assessing its real feasibility. In his assessment of ICTs and agriculture, he insists that local people and their needs should be a key driving force behind ICT projects but not the technology. It concludes that participatory extension planning techniques suit better with these approaches.

Therefore, it is advisable to avoid anticipated decisions about technologies. End-users and other stakeholders must provide the basis for a strong definition of project requirements, that must match firstly with clients or user expectations (Project Management Institute, 2017). Afterward, project designers and other experts will determine the technical requirements of products and services to be developed.

However, developers also find restrictions for a participatory approach in practical terms. The consulted experts listed some barriers for an effective involvement of end-users. The main answer was the expenditure in resources (4 – need for additional resources), including time, cost and personnel of project team (42.9 percent), after that, they pointed at 2 difficulties for accessing to useful end-users (25.7 percent) and 1 communication or understanding problems with end-users (22.9 percent). Remarkably, only 2.9 percent answered that the problem is a 3 lack of interest of end-users for collaborating.

Experts consider the costs in terms of money and other resources implied by the involvement of end-users to be very relevant. This would lead to conclude that participatory approach and user involvement are still considered not as a core activity but an auxiliary activity good to be done but not essential.

Timing for end-user's involvement

The moment of participation is relevant. It is not the same to involve the end-users earlier in the first stages, when some crucial decisions are made, instead of using their knowledge only to validate the results in later phases.

Experts were offered four options for consideration about which stages to efficiently involve end-users in: inception, planning, execution and testing. An additional option refers to a horizontal soft-involvement of farmers using an advisory board that frequently validates some outcomes of the project.

Experts highlighted testing of product in the first place almost with maximum score (2.9 out of 3). Involvement on inception/idea of project was also highly scored, the same as participation in a panel board along project life (2.5). Stages of planning and execution were not preferred to involve users, since positive replies were compensated with reluctant ones.

Indeed, involving users for testing products or prototypes developed is a usual practice in ICT or other kinds of projects, even majorly considered as unavoidable. However, following some of the recommendations mentioned before, this kind of interactivity is not enough to be considered as a participatory approach, since users are not part of planning nor decision making. The CHAOS Report (The Standish Group, 2015) defines user involvement as participation on the decision-making and information-gathering process of the project, including user feedback, requirements review, basic research and prototyping.

The name of the mandatory condition for participatory innovation projects in agriculture within H2020 European program is "Multi-actor approach" and it is described as genuine and with enough involvement of various actors (including end-users) all along the project: from the initial planning of work and experiments, to implementation, dissemination of results and a possible demonstration phase.

In the early steps, the design team receives high-level requirements, sometimes an overarching goal or an approximate description of the product. Then, the design team spends the first resources to identify and get in contact with the influential stakeholders, documenting its expectations or restrictions. Some decisions are made in earlier phases of the projects. These can include the methodology of project management, sensibility to changes and preliminary ideas about technologies to be used. Also, the information about final feasibility helps to make decision about project continuity. Mentioned reports about project performance in agriculture carried out by important donors like the World Bank or the Asian Development Bank repeatedly highlights flaws in requirement gathering, due to short participation of targeted groups of farmers in this critical stage of design (Ika *et al.*, 2012). They highlighted the early stages of design and monitoring as prominent critical factors for success.

Considering the responses to the survey, experts were devoted to integrating end-user requirements but they do not give enough value to their incorporation on the stages where those requirements need to be collected.

Selection of end-users for participatory approach

Involving the right sample of farmers in some projects in an effective manner is more interesting, but it presents some difficulties. Sometimes it is not even easy to make decisions about what kind of users could be more useful for contributing to the final success of the projects and products to be developed. Some authors have researched on "diffusion of Innovations theory" (Rogers, 1995), studying its performance in agriculture (Diederer *et al.*, 2003). They explored behaviors of farmers belonging to different groups regarding their attitude toward innovation, using the five roles defined by Rogers (innovators, early adopters, early majority, late majority and laggards). In agriculture, innovators represent 2.5 percent of the total farmers' universe, early adopters 13.5 percent, early majority 34 percent, late majority 34 percent and laggards the remaining 15 percent (Diederer *et al.*, 2003).

Diederer *et al.* (2003) released conclusions on structural contrast between first two categories (innovators plus early adopters) and the other ones. Their research returned that size, age, market position and solvency were factors explaining the different responses to innovation. However, trying to deepen the characteristics and variances amongst innovators and early adopters the same factors were not valid for explaining their behavior, with the clear exception of age. Indeed, other less obvious characteristics such as valuation of external information, the source of innovative ideas and the way they co-operate are at the same level to differentiate innovators and early adopters. This means that a single collaboration with innovator farmers in a project might not be enough to understand the real needs and future impact in the market.

Therefore, it is much better to incorporate elements both from innovators and from early adopters. Even in this case, Lamb *et al.* (2008) evidenced an actual glass ceiling in potential adoption for most mature technologies by farmers. The bulk of precision farming technologies rarely goes beyond the group of early adopters; which is around 15 percent of total farmers. They advise developers to work closely with all kind of end-users for overcoming this current “chasm,” involving not only samples of innovators and early adopters, but including expectations of a larger sort of farmers and users.

When asked, consulted experts expressed their preferences about the types of end-users they consider as most useful for providing inputs for the project. They mostly chose early adopters (88.6 percent) as a better target for obtaining useful inputs. Innovator farmers were selected by 62.9 percent of experts. Multipliers/aggregators (e.g. cooperatives of farmers, organizations) were selected by 54.3 percent and other options obtained poorer results: farmers advisers and chambers of agriculture (42.9 percent), farm equipment suppliers (22.9 percent) or food processing companies (31.4 percent). Remarkably, the inclusion of common farmers is only reliable for 28.6 percent of experts.

Experts working in smaller bodies trust the role of innovator farmers more, decreasing this confidence when size increases. Indirect end-user involvement through cooperatives, chambers of farmers and suppliers is less appreciated than incorporation of early adopters and innovators. However, private companies and more experienced experts are more inclined to ask for their participation.

The following figure compares the curve of diffusion of innovation (Rogers) with the answers obtained from the experts. The curve represents the population of farmers with respect to their sensitivity to innovation with emphasis on the “chasm” existing among innovators plus early adopters and the rest. This group (innovators + early adopter) is also the one preferred by the experts for involving them in the project. Although this shows a coherent pattern, it highlights the difficulties to arrive with satisfactory products toward a majority of farmers without proper gathering of their expectations, or to involve them in some way. Other groups such as cooperatives of farmers or advisers can potentially reach a larger part of the farmer population (Figure 2).

New participatory techniques in agricultural projects

The selection of the methodology for project handling is usually conditioned by the organizational culture of the company or institution. As mentioned in the introduction, main international assistance agencies developing agricultural projects prefer predictive design, frequently based on Logical Framework Methods and/or Goal Oriented Project Planning. In the pure private sector, big Ag-Tech firms have trusted their product development, like brand new machinery, in international standards such as PMP or Prince, between others. In Europe, projects carried out by many SMEs companies are hardly supported by standards or proper methodologies. Even the ones funded by public agencies at a national level were frequently executed with only simple planification tools like Gantt charts, budget proposals and templates of Statement of Work. In this situation, the impact of techniques of agile

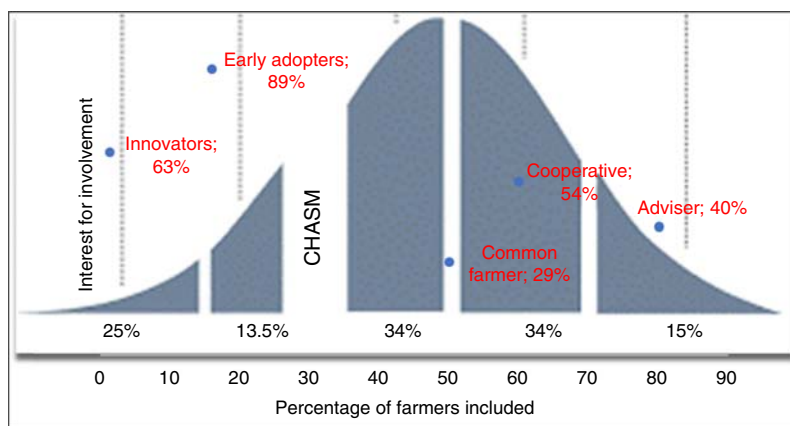


Figure 2. Comparison of Roger's curve with responses on end-user involvement in the survey

approach, pushed by ICT companies, is an interesting topic of research especially due to its ability for end-user involvement.

A new wave of project management procedures proposes specific roles within project teams for representing client/end user desires (Project or Product owner). The best performance is obtained when there is a complete collaboration between this role and the project manager within the project team (Turner *et al.*, 2004). The first principle of agile places end-user satisfaction in the top of the priorities, and thus it is an exponent of participatory decision making in projects. Lean and Design Thinking techniques also share the focus on stakeholder involvement with participatory agile values. Meanwhile, predictive methodologies like LFA or standards such as PMP or PRINCE have tried to be adapted in recent times. An analysis of the different approaches to end-user participation is depicted in Table II.

Experts participating in the panel answered about different methods and project management techniques used by their companies, their knowledge and training about them and about their opinion methods feasibility on DPS projects as well. The inclusion of questions about agile and similar procedures in the survey has as specific purpose to check the status of penetration of these new approaches on DPS projects in agriculture.

Remarkably, a lot of responses from interviewed experts point at agile approach techniques as the favorite ones. There is no significant deviations considering size, experience or public/private framework. Most of the experts outlined them as a principal approach on its entities. Moreover, it obtains very good marks on trustiness for satisfactorily carrying out DPS projects. The responses of the panel have been quite clarifying about it and they show a growing use of new techniques and the current support of the experts to their principles.

According to the responses, most of the organizations uses several procedures at the same time, and most probably a combination of them even within same project. Agile techniques are quite powerful for digital product development and therefore essential in a product-oriented project, meanwhile other classical procedures show better performance for carrying out complex multipurpose, multitask and multiteam projects. Some organizations use waterfall approaches for global management of big projects, allowing at the same time, that some teams involved is specific tasks adopt agile techniques for focusing on product development.

Agile, lean and design thinking are the preferred options, meanwhile classical techniques based on predictive or waterfall project management seem to be less promising for DPS project managers. This change of focus occurs despite these classical techniques still being important in the organizational procedures.

	Approaches to customer/end-user satisfaction	Identification and collection of their initial requirements	– Involvement of end-user + Management of their expectations during development	Periodic feedback and active integration of their suggestions	Integration of end-users in whole decision-making process
Logical framework approach (LFA) Hierarchical definition of project vision through goal, purposes, inputs and outputs	Analysis of previous projects. Goal oriented project workshops (ZOPP)	✓			
Waterfall-PMP Prince ISO 22500 Predictive methods with clear procedures based on similar projects in a framework of certainty	Collection of requirements in initial stages. Monitoring stakeholder's satisfaction	✓	✓		
Lean project management Adaption of lean manufacturing principles for achieving quality, speed and customer alignment	Periodic surveys of satisfaction. Testing of Minimum Viable Products and re-planning	✓	✓	✓	
Agile Method for easy adaptation to change, based on iterations and incremental value	Tools of planning; User Stories. Permanent representant of their interest; Product owner	✓	✓	✓	✓

Table II. Comparison between different procedures for project design and their disposition for end-user involvement

LFA is progressively abandoned by the DPS experts consulted. It clearly contrasts with its remaining use by public agencies in the agriculture and rural development sectors (Figure 3).

Conclusions

Factual conclusions from the survey

- (1) Almost unanimously, consulted experts consider that involvement of end-user is very advantageous, especially because it improves the collection of requirements for DPS in agriculture. They usually involve end-users within their projects in several manners.
- (2) Participation in the testing phase is the most valuable option decided by experts when asked about the best time for interaction with end-users. Contributions in the early stages of the project are ranked in second position but at a great distance from the first one.
- (3) The early adopters are the preferred type of end-user to be involved by most experts. Many of them also chose innovative farmers. The third option places cooperatives of farmers as a collaborator while the participation of common farmers is not well valued.

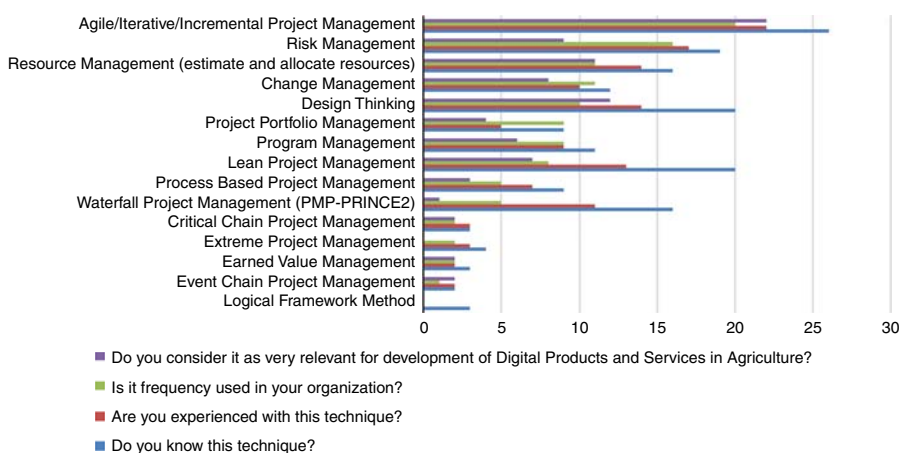


Figure 3. Answers of experts required on its knowledge, experience, expertise and opinion on different project management procedures

- (4) Experts have a promising view of the new methodologies for participatory design and project execution and they foresee that its use will improve the impact of projects. These methodologies already have a relevant grade of penetration in entities developing DPS.
- (5) Results show no relevant differences regarding professional experience, type and size of organizations. Maybe there are slight variations between small companies and the rest, the former being more enthusiastic with involvement of end-users. Also, more experimented experts appreciate the collaboration with end-users using indirect agents like cooperatives, advisors or chambers of farmers better than the others.

Ideas that came out comparing the survey results with the literature

- (1) Designers have a growing awareness of the use of participatory techniques. This process is influenced by its greater introduction by technology companies that do not belong to the food and farming sector. However, a new pattern is not yet reflected in a systematic and full use of this type of techniques. Classic approaches in project management and product design are still common in the design of DPS for agriculture.
- (2) This gap between the theoretical and realistic approach must be considered by companies like a real flaw, since their investments on staff for training on participatory techniques are not providing value on the products so far. Moreover, this missperformance is affecting the rate of success of the projects and it implies economic penalties in the business.
- (3) This transition, however, is taking place and it is expected to have a strong impact and to lead to a growing success of projects related with DPS in the sector. Moreover, a demand-driven approach will profusely replace useless technology-driven approaches.
- (4) Participatory models in project management imply putting clients at the centre of the design process, using specific roles for their strong involvement in the project (product owner or similar). However, in the agricultural sector, pure farmer-centric approach is more complex than in other sectors. Only using innovative or early adopter farmers, the chasm on innovation uptake will not be overcome. It might be advisable to focus on intermediary agents able to reach a more important part of farmer population.

- (1) Some large-scale projects in Europe are going to be frontrunners in the use of a participatory approach. In the food and farming sector, €30m funded IoF2020, is a cluster of 19 case-studies for developing DPS in agriculture. They are guided by Lean approach and it could be an opportunity to make practical insights about the use of this kind of participatory approach in agricultural projects.
- (2) Ensuring demand-driven approach and farmer-centric models could imply deeper involvement of intermediary agents, representing the interests of end-users. The role to be played by this kind of aggregators such as farmer cooperatives deserves a specific study.
- (3) As in other sectors, digital projects in agriculture could improve its success following standardization and better procedures in design and execution stages. The elaboration of tailor-made good practices for this sector will be valuable for businesses.

References

- Asian Development Bank (2008), *Project Performance and the Project Cycle*, Operations Evaluation Department, Mandaluyong.
- Baccarini, D. (1999), "The logical framework method for defining project success", *Project Management Journal*, Vol. 30 No. 4, pp. 25-32.
- Batchelor, S., Evangelista, S., Hearn, S., Peirce, M., Sugden, S. and Webb, M. (2003), *ICT for Development: Contributing to the Millennium Development Goals Lessons Learned from Seventeen infoDev Projects*, World Bank, Washington, DC.
- Beers, P.J., Hermans, F., Veldkamp, T. and Hinssen, J. (2014), "Social learning inside and outside transition projects: playing free jazz for a heavy metal audience", *NJAS – Wageningen Journal of Life Sciences*, Vol. 69, pp. 5-13.
- Borghi, E., Avanzi, J.C., Bortolon, L., Luchiari, A. and Bortolon, E.S.O. (2016), "Adoption and use of precision agriculture in Brazil: perception of growers and service dealership", *Journal of Agricultural Science*, Vol. 8 No. 11, pp. 89-104.
- Bramley, R. and Trengove, S. (2013), "Precision agriculture in Australia: present status and recent developments", *Engenharia Agrícola*, Vol. 33 No. 3, pp. 575-588.
- Caiazza, R. (2012), "The global agro-food system from past to future", *China-USA Business Review*, Vol. 11 No. 7, pp. 919-929.
- Carroll, J. (2006), "Critical success factors in ebusiness projects", paper presented at PMI® Global Congress 2006, Madrid.
- Cavarec, Y. (2012), "Revisiting the definition of project success", *PMI Global Congress-North America Proceedings*, pp. 1-9.
- Dearden, A. and Rizvi, H. (2008), "Adapting participatory and agile software methods to participatory rural development", *Proceedings of the Tenth Anniversary Conference. Experiences and Challenges, Participatory Design Conference, Indiana University, Bloomington, IN, October 1-4*.
- DEFRA (2013), "Farm practices survey autumn 2012 – England", Department for Environment Food & Rural Affairs, London.
- Diederer, P., Meijl, H., Wolters, A. and Bijak, K. (2003), "Innovation adoption in agriculture: innovators, early adopters and laggards", *Cahiers d'économie et sociologie rurales*, Vol. 67, pp. 30-50.
- Dvir, D., Raz, T. and Shenhar, A.J. (2003), "An empirical analysis of the relationship between project planning and project success", *International Journal of Project Management*, Vol. 21 No. 2, pp. 89-95.
- European Parliament (2014), "Directorate-general for Internal Policies Policy Department b: Structural and Cohesion Policies Agriculture and Rural Development Precision Agriculture: An Opportunity for eu Farmers-potential Support with the Cap 2014-2020 Study", European Parliament, Brussels.

-
- FocusGroup (2015), "European innovation partnership", EIP-AGRI Focus Group Precision Farming. European Commission, Brussels.
- Fountas, S., Carli, G., Sørensen, C.G., Tsiropoulos, Z., Cavalaris, C., Vatsanidou, A., Liakos, B., Canavari, M., Wiebensohn, J. and Tisserye, B. (2015), "Farm management information systems: current situation and future perspectives", *Computers and Electronics in Agriculture*, Vol. 115, pp. 40-50, available at: www.sciencedirect.com/science/article/pii/S0168169915001337
- Ika, L.A., Diallo, A. and Thuillier, D. (2012), "Critical success factors for World Bank projects: an empirical investigation", *International Journal of Project Management*, Vol. 30 No. 1, pp. 105-116.
- Jugdev, K. and Müller, R. (2005), "A retrospective look at our evolving understanding of project success", *Project Management Journal*, Vol. 36 No. 4, pp. 19-31.
- Kaloxylou, A., Eigenmann, R., Teye, F., Politopoulou, Z., Wolfert, S., Shrank, C., Dillinger, M., Lampropoulou, I., Antoniou, E., Pesonen, L., Nicole, H., Thomas, F., Alonistioti, N. and Kormentzas, G. (2012), "Farm management systems and the Future Internet era", *Computers and Electronics in Agriculture*, Vol. 89, pp. 130-144, available at: www.sciencedirect.com/science/article/pii/S0168169912002219
- Khudadad, M., Motla, Y.H., Asghar, S., Anwar, S.A. and Iqbal, Z. (2014), "A scrum based framework for e-agriculture system", *17th IEEE International Multi Topic Conference, Karachi, December 8-10*.
- Kitchen, N.R., Snyder, C.J., Franzen, D.W. and Wiebold, W.J. (2002), "Educational needs of precision agriculture", *Precision Agriculture*, Vol. 3 No. 4, pp. 341-351.
- Lai, K.C., The Investment Centre Division (TCD) (2001), *Lessons for Project Design and Implementation from Selected Rural Development Projects in Asia: 1990-1999*, FAO, Rome.
- Lamb, D.W., Frazier, P. and Adams, P. (2008), "Improving pathways to adoption: putting the right P's in precision agriculture", *Computers and Electronics in Agriculture*, Vol. 61 No. 1, pp. 4-9.
- Laugerette, T. and Stöckel, F. (2016), *From Agriculture to AgTech an Industry Transformed Beyond Molecules and Chemicals*, Deloitte, New York, NY.
- Linden, A. and Fenn, J. (2003), "Understanding Gartner's Hype cycles", Strategic Analysis Report, Gartner Research, Stamford.
- MarketsandMarkets (2017), "Smart Agriculture Market by Agriculture Type (Precision Farming, Livestock Monitoring, Fish Farming, Smart Greenhouse), Hardware (GPS, Drones, Sensors, RFID, LED Grow Lights), Software, Services, Application, and Geography – Global Forecast to 2023", MarketsandMarkets.
- Meera, S.N., Jhamtani, A. and Rao, D.U.M. (2004), "Information and communication technology in agricultural development: a comparative analysis of three projects from India", *Agricultural Research & Extension Network*, No. 135, pp. 2-15.
- Melchiori, R.J.M., Albarenque, S.M. and Kemerer, A.C. (2013), "Uso, adopción y limitaciones de la agricultura de precisión en Argentina", *Curso Internacional de Agricultura de Precisión*. 12. 2013 07 17-19, 17 al 19 de julio de 2013. Manfredi, Córdoba. AR.
- Muriithi, N. and Crawford, L. (2003), "Approaches to project management in Africa: implications for international development projects", *International Journal of Project Management*, Vol. 21 No. 5, pp. 309-319.
- Neef, A. and Neubert, D. (2011), "Stakeholder participation in agricultural research projects: a conceptual framework for reflections and decision-making", *Agriculture and Human Values*, Vol. 28 No. 2, pp. 179-194.
- PMI, A. Alliance (2017), *Agile Practice Guide*, Project Management Institute, PA.
- Poppe, K.J., Wolfert, S. and Verdouw, C. (2015), "A European perspective on the economics of big data, in farm policy journal, from little data big data grow", *Farm Policy Journal*, Vol. 12 No. 1, pp. 11-19.
- Poppe, K.J., Wolfert, S., Verdouw, C. and Verwaart, T. (2013), "Information and communication technology as a driver for change in agri-food chains", *EuroChoices*, Vol. 12 No. 1, pp. 60-65.
- Project Management Institute, I. (2017), *PMBOK Guide and Standards*, Project Management Institute, Philadelphia, PA.

- Richardson, D. (2005), "How can agricultural extension best harness ICTs to improve rural livelihoods in developing countries?", *ICT in Agriculture: Perspectives of Technological Innovation*, Hebrew University of Jerusalem, p. 14.
- Rogers, E. (1995), *Diffusion of Innovations*, Free Press, New York, NY.
- Sartorius, R. (1996), "The third generation logical framework approach: dynamic management for agricultural research projects", *European Journal of Agricultural Education and Extension*, Vol. 2 No. 4, pp. 49-62.
- Shenhar, A.J., Levy, O. and Dvir, D. (1997), "Mapping dimensions of projects success", *Project Management Journal*, Vol. 8 No. 22, pp. 5-13.
- Sofka, W. and Distel, A. (2017), *Study on Innovation in Horizon 2020 Projects*, Directorate-General for Research and Innovation. European Commission, Brussels.
- The Standish Group (2015), "Chaos report", Standish Group, MA.
- Tinker, D., Kernecker, M., Knierim, A., Wurbs, A., Wolters, S., Van Evert, F., Bellostas, N., Ait-Amar, S., Balafout, T. and Fountas, S. (2017), "Disseminating and promoting smart farming technologies – the smart AKIS network", *1st AXEMA-EurAgEng Conference, Villepinte*, pp. 1-7.
- Turner, R., Turner, J.R. and Müller, R. (2004), "Communication and co-operation on projects between the project owner as principal and the project manager as agent", *European Management Journal*, Vol. 22 No. 3, pp. 327-336.
- Vasisht, D., Kapetanovic, Z., Won, J., Jin, X., Chandra, R., Sinha, S., Kapoor, A., Sudarshan, M. and Stratman, S. (2017), "FarmBeats: an IoT platform for data-driven agriculture", 14th USENIX Symposium on Networked Systems Design and Implementation, pp. 515-529.
- Weltzien, C. (2016), "Digital agriculture – or why agriculture 4.0 still offers only modest returns", *Landtechnik, Agricultural Engineering*, Vol. 71 No. 2, pp. 66-68.
- Wolfert, S., Ge, L., Verdouw, C. and Bogaardt, M. (2017), "Big data in smart farming – a review", *Agricultural Systems*, Vol. 153, pp. 69-80, available at: www.sciencedirect.com/science/article/pii/S0308521X16303754
- World Bank (2010), *Designing and Implementing Agricultural Innovation Funds: Lessons from Competitive Research and Matching Grant Projects*, World Bank, Washington, DC.

About the authors

Juan Maria Sagarna Garcia holds an MSc on Agricultural Engineering in the Politechnical University of Madrid (UPM) where he is currently making its Doctoral Dissertation about project design on digital agriculture. He obtained a Post Grade Master on Project Management and a certification by PMI. He has developed his career working in food and agriculture sector, currently managing Services, Quality and Innovation Department in Spanish National Association of Farmer Cooperatives. He has coordinated several national and international projects, with specialization on knowledge transference and replicability. He is Vice Chairman of Research in European Association of Farmers and Farmer Cooperatives COPA-COGECA. Juan Maria Sagarna Garcia is the corresponding author and can be contacted at: sagarna@agro-alimentarias.coop

David Pereira Jerez is a PhD Professor in the School of Agricultural, Food and Biosystems Engineering that belongs to the Politechnical University of Madrid. He teaches in Agroforestry Engineering Department and coordinates the third year of Agroenvironmental Engineer Grade. He also coordinates a Trainership Program in Agricultural Engineering. Its background has been based on spatial planning, rural planning and environmental impact assessment.

For instructions on how to order reprints of this article, please visit our website:

www.emeraldgrouppublishing.com/licensing/reprints.htm

Or contact us for further details: permissions@emeraldinsight.com