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PROJECT PERIODIC REPORT

Grant Agreement number: 311989

Project acronym: ALL-SMART-PIGS

Project title: Practical implementation of precision livestock technologies and services at European pig farms using the living lab methodology

Funding Scheme: Collaborative Project

Date of latest version of Annex I against which the assessment will be made:

Periodic report: **2nd**

Period covered: **from 01/11/2013** **to 31/10/2014**

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[1] Usually the contact person of the coordinator as specified in Art. 8.1. of the Grant Agreement.

[2] The home page of the website should contain the generic European flag and the FP7 logo which are available in electronic format at the Europa website (logo of the European flag: http://europa.eu/abc/symbols/emblem/index_en.htm logo of the 7th FP: http://ec.europa.eu/research/fp7/index_en.cfm?pg=logos). The area of activity of the project should also be mentioned.

Declaration by the scientific representative of the project coordinator

I, as scientific representative of the coordinator of this project and in line with the obligations as stated in Article II.2.3 of the Grant Agreement declare that:

- The attached periodic report represents an accurate description of the work carried out in this project for this reporting period;
- The project

  has achieved most of its objectives and technical goals for the period with relatively minor deviations.

- The public website

  is up to date

3 To my best knowledge, the financial statements which are being submitted as part of this report are in line with the actual work carried out and are consistent with the report on the resources used for the project (section 3.4) and if applicable with the certificate on financial statement.

- All beneficiaries, in particular non-profit public bodies, secondary and higher education establishments, research organisations and SMEs, have declared to have verified their legal status. Any changes have been reported under section 3.2.3 (Project Management) in accordance with Article II.3.f of the Grant Agreement.

Name of scientific representative of the Coordinator: Olavur Gregersen

Date: 21/10/2015

For most of the projects, the signature of this declaration could be done directly via the IT reporting tool through an adapted IT mechanism and in that case, no signed paper form needs to be sent

3.1 Publishable summary

Introduction: ALL-SMART-PIGS aimed at demonstrating the viability of smart farming technologies in European pig farming. The project used a process of open innovation through a LivingLab (LL) to co-create smart farming applications ready for commercialisation on European pig farms. These applications provided by innovative SMEsand have been tested and validated in ALL-SMART-PIGS with their technological prototypes and services in real life conditions together with pig farmers and other stakeholders. The project initiators had identified health, growth rate, feed usage and environmental conditions as key parameters to monitor in this project.

For further introduction please see http://prezi.com/n7_gxrdyt4ej.

Problem (background): The worldwide demand for meat products is expected to increase over 40% in the next 15 years, a serious challenge for worldwide livestock production. Simultaneously, the total number of livestock farms is steadily decreasing. The combination of these two trends means that the size of the average livestock farm continues to rise and as a consequence, modern farmers have less time to spend with individual animals. Major concerns are raised about the impact of this on animal health and welfare and the environmental sustainability of animal production for large herds. In order to guarantee accurate and continuous monitoring of individual animals at a modern livestock farm, farmers nowadays need reliable and affordable technologies to assist them in performing this task. The application of the principles and techniques of process engineering to livestock farming in order to monitor, model and manage animal production is called 'precision livestock farming' (PLF), and PLF seems the only realistic way to support farmers and other stakeholders in the livestock production chain in the near future, whilst at the same time coping with the rising demand for meat.

Aims: ALL-SMART-PIGS aimed at demonstrating the viability of smart farming technologies in European pig farming. The project used a process of open innovation through a LivingLab to co-create smart farming applications ready for commercialisation on European pig farms. A consortium of 3 high-tech SMEs, an established provider to the European farming community, regional R&D partners and an experienced SME and Living Lab facilitator implemented the project, assessed its economic costs and benefits, developed a business model for future smart pig applications and showcased that the Living Lab methodology can pave the way for innovative technologies to the market.

Results in 2012/2013: The first 14 month of the project were dedicated to installing Smart Pig Farming Technology on the four commercial farms in Hungary and Spain, solving all related problems such as internet access in the fattening units, cable biting by rodents (or pigs), integration issues between the hardware providers and so forth. Since the technologies need to be remotely controlled, additional development of software was necessary. Installations were finalised beginning of November 2013 (M13).

Together with the LivingLab participants an exciting concept of chain information exchange between feed-animal-food was developed and implemented. In December 2013 and January 2014, where possible due to production cycles, recording of fully commercial fattening rounds commenced.

Results in 2013/2014: The last 10 months of the project were dedicated to demonstration and evaluation activities. The experience of installation of PLF technologies on commercial farms discovered a number of operational challenges spanning from internet and power connection, fly faeces on camera lenses, measurement dispensed feed, data acquisition and data quality. However, solutions have been either found

or identified for most encountered problems, and there is clear technological and business impact have been demonstrated.

The fact that some of the technologies were not working as expected until late in the project limited the range of possible tangible valuations to include the weight of the livestock delivered to the slaughterhouse.

It is also possible that the challenges in the implementations of the technologies can have affected the farmers' evaluations of the technologies since they not had the time and opportunity to realise the full potential of the technologies for a longer period than 10 months.

Even with the limitations mentioned above the conclusion of the analysis was that the PLF-technology clearly gives an added value to the farmers both as a direct monetary gain and in more intangible ways through better control of the farms.

There was not a clear conclusion on a market value of the PLF-technologies. The farmers valuation was around 3.900 €/year while the calculations on the monetary gains of the technology showed 12,614€ / year. It thus seems clear that a fuller demonstration of the technology in action is desirable in order to get a better picture of the full potential and value of the technology.

To sum up there is still a need to keep working on the most important open issues for the farmers:

- The lack of confidence on the information that the PLF platform offer the farmers in order to ensure higher gain and better control of the livestock.
- Solve the feed consumption sensor to offer the FCR (Feed conversion rate) information to the farmer.
- Find a market price for paying to get information and charging for offer information along the supply chain.

Potential applications:
The evaluation of the demonstration of the PLF technologies have indicated how a new service concept for pig farmers for Smart Pig Farming Application can be introduced to the market. A main deliverable of ALL-SMART-PIGS is a business model for how this service concept can be commercialised in the future.

In addition, the ALL-SMART-PIGS project has to a certain extent showcased the use of traceability to optimise feed usage in the feed-animal-food chain. Improving communication between the supply chain partners bear great economic potential for feed providers, farmers and slaughterhouses alike.

Another significant output of ALL-SMART-PIGS is to showcase how to pave the way from the development of scientific knowledge and technologies to the market by implementing a user driven innovation processes. The ALL-SMART-PIGS project has addressed the issue by using the Living lab methodology, where key performance indicators are identified and PLF technology and service concepts are co-created together with the main users: pig farmers, feed providers and slaughterhouses.

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3.2 Core of the report for the period: Project objectives, work progress and achievements, project management

3.2.1 Project objectives for the period

ALL-SMART-PIGS had the following objectives for the second year:

- Demonstrate the installed PLF technologies on selected Living Lab Farms.
- Use the LivingLabs to evaluate the demonstration activities at farms (primary target), feed manufacturers and abattoirs.
- Propose a business model for SMART Pig Applications.
- Disseminate the project results.

3.2.2 Work progress and achievements during the period

3.2.2.1 Summary and resource use

Precision Livestock Farming (PLF) is a series of practices aiming at increasing the farmer's ability to keep contact with individual animals despite the growing intensification of livestock production. PLF aims to achieve economic, environmentally and socially sustainable farming through the observation, behavioural interpretation and control of the smallest possible group of animals. It enables farmers to reduce operational costs such as expenditures to feed, medication and energy. Moreover, farmers can use PLF technologies to monitor animal health and welfare in order to ensure that animals live well and free of diseases. PLF systems aim to translate the output of the technology to useful information to the farmer.

ALL-SMART-PIGS is a demonstration project where research technology is deployed on commercial farms. The project works with farmers, feed providers and abattoirs to find ways to provide value using the integrated Smart Pig Farming technology.

The path "from the comfort zone of science to the battlefield of business" is never a straight one. For all planning, the unexpected always happens. Sometimes the unexpected speeds up implementation, but most of the time it delays it. ALL-SMART-PIGS has met the unexpected several times during the equipment installation and demonstration of the PLF technologies. Incompatible feeders, software problems, different feeding regimes, broken cables, internet problems, an unexpected decision by one farmer to change feeders altogether, overheating sound cards, hard disk troubles etc. All delayed the installation process significantly. Some of the technologies in particular on weight and feed measurements also required more development and adaptation than originally estimated. This is reported below in greater detail.

The project was initiated via a number of steps. First, initial LivingLab workshops were implemented in December, 2012 in Spain and Hungary. These workshops were well attended by representatives of the farmers, veterinarians, feed and the technology providers. The workshop consisted of a first round of presentations of the technology providers to briefly explain their technologies. Farm visits were also undertaken as part of the farm selection process. The farm selection process was formalised via a uniform scoring system that enabled all project partners to methodologically select the most suitable farms. Farmers were interviewed and the interviews with the farmers demonstrated that the project objectives were nicely aligned with the expectations of the farmers.

The LivingLabs, particularly in Spain, worked very well and were perfectly on time. The LivingLab participants developed together with the consortium a number of services, as reported in a publication and presentation

made at the EC-PLF conference in September 2013 (see Publications). This traceability system is to our knowledge unique in its depth and services.

Based on the lessons learnt from the individual technology partner during the second period of ALL-SMART-PIGS the following summary can be made on encountered problems, possible solutions, technological, and business impact:

The experience of installation of PLF technologies on commercial farms clearly shows that the technologies have to improve their robustness. Reliance on internet for data transmission is a particularly tedious problem. Other more mundane problems include for example the depositing of fly faeces on camera lenses, which impacts weight and activity measurements. Also ability to measure dispensed feed is a much wanted functionality by farmers, however, the technology used in the project could only measure pelleted and not mash feed. Other challenges are related to data acquisition, quality and storage procedures.

However, solutions have been either found or identified for most encountered problems, and there is clear technological and business impact have been demonstrated.

The fact that some of the technologies were not working as expected until late in the project limited the range of possible tangible valuations to include the weight of the livestock delivered to the slaughterhouse.

It is also possible that the late implementations of the technologies can have affected the farmers' evaluations of the technologies since they not had the time and opportunity to realise the full potential of the technologies.

Even with the limitations mentioned above the conclusion of the analysis was that the PLF-technology clearly gives an added value to the farmers both as a direct monetary gain and in more intangible ways through better control of the farms.

There was not a clear conclusion on a market value of the PLF-technologies. The farmers valuation was around 3.900 €/year while the calculations on the monetary gains of the technology showed 12,614€ / year. It thus seems clear that a fuller demonstration of the technology in action is desirable in order to get a better picture of the full potential and value of the technology.

If we use the annual savings identified in ALL-SMART-PIGS on this average number of pig farms, and we assume that pig farmers are willing to at least pay the same amount for the services as the tangible savings, then we can estimate the total potential market for SMART Pig Application in Europe to be between €390 million and €1.3 Billion per year. This estimated business-to-business market size represents an interesting business opportunity.

ALL-SMART-PIGS is generating significant interest from the private sector and from the EU community. Youris.com produced a film in February-March on the Spanish farms and created video news item afterwards. The project held a webinar together with the British Nutrition Foundation to educate school children on Smart Livestock Farming. From the private industry, one of the largest Spanish pig integrator companies and a UK pig product marketer with a supply base of about 1,000 farms have expressed strong interest in piloting our Smart Pig Farming technologies. A major German retailer called ALL-SMART-PIGS "timely" and expressed an interest to work with the project in the context of the new German animal welfare initiative "Aktion Tierwohl".

It was recognised that further work will be required before these PLF tools can be presented as fully commercial products to producers. As a minimum, some development of the hardware components (including wire-less/remote communication development) will be required before this technology can be released to commercial users. Behavioural analysis might be incorporated into weight prediction systems in the future. Such system would be able to track and identify different behaviour traits of individual animals (indicative of welfare) in small pen settings as well as record weight output when the correct pig contour shape is found. Sick or dead pigs might also be easily identified via identifying inactive individual animals especially if they inactive for a prolonged period of time.

The immediate and longer term applications of the technologies are listed below.

- As a minimum, some development of the hardware components (including wireless/remote communication development and software/user interface finalisation) as well as a larger scale verification of the results will be required before this technology can be released to commercial users.
- The core technology used in relation to the Feed-Detect sensor (solid-flow measurement) can be further developed to allow producers to measure the amount of feed flowing from feed silos to buildings.
- The above mentioned technologies could (and probably should) be marketed to the research community in the first instance as a data collection tool for large scale farm trials.
- Behavioural analysis might be incorporated into weight prediction systems in the future. Such system would be able to track and identify different behaviour traits of individual animals (indicative of welfare) in small pen settings as well as record weight output when the correct pig contour shape is found. As the pigs are being tracked it might be possible to assign individual weights to individual pigs and monitor their movements.
- Sick or dead pigs might also be easily identified via identifying inactive individual animals especially if they inactive for a prolonged period of time.
- The lack of confidence on the information that the platform offer the farmers in order to ensure higher gain and better control of the livestock.
- Solve the feed consumption sensor to offer the FCR (Feed conversion rate) information to the farmer.
- Find a market price for paying to get information and charging for offer information along supply chain.

These developments would also enhance the commercial potential of the system and therefore should be undertaken in collaboration with commercial partners.

The project consortium has found easily enough its way into a successful collaboration. All partners were very result-oriented and cross collaborated in a very efficient manner. The consortium reacted quickly to delays and ramped up the meeting frequency to micro-manage progress and assure that the delay were kept to a minimum. Smaller disagreements could be resolved in an amicable and democratic manner. The Project Management Group meetings were opened to all partners to allow free information flow.

The project has had a well-designed website since month 2 and updated it regularly to reflect progress.

Most of the objectives for the period have been met in spite of the delays.

EFFORTS										
Participant number	Participant short name	Total PM Y1 & Y2		Total PM year 2						
			WP1	WP2	WP3	WP4	WP5	WP6	WP7	
1	SYN	22.00	0.15	0.59	0.13	3.9	3.98	1.72	4,29	14.76
2	SOUND	2.50		0.28			0.28	0.19		0.75
3	AGRI	21.50		4.9	3.22	1.85	1.0	0.25		11.22
4	IRTA	13.50	4.22	1.6	0.81	3.27	0.12	3.3		13.32
5	SIU	11.50	1.0	0.76	2.39			0.95		5.1
6	FAN	2.50					0.5	0.2		0.7
7	NEMA	9.50	0.13	0.56	3.22	0.13	0.08	0.17		4.29
TOTAL		83.00	5.5	8.69	9.77	9.15	5.96	6.78	4.29	50.14

Other direct cost incl. subcontracting										
Participant number	Participant short name	Total cost Y1 & Y2 (€)	Cost in year 1							Total cost year 2
			WP1	WP2	WP3	WP4	WP5	WP6	WP7	
1	SYN	25,300			947			4,701		5,648
2	SOUND	7,980		1,460				449		1,909
3	AGRI	130,400		982				3,245		4,227
4	IRTA	20,300	1,825	2,808	7,627	2,007		393		14,659
5	SIU	16,800	2,329					2,800		5,129
6	FAN	7,980					850			850
7	NEMA	55,450			1,781					1,781
TOTAL		264,210	4,154	5,250	10.354	2,007	850	11,588	0	34,204

Comments on the resources used in the second reporting period

The total resources spent on person months (PM) in the 1 and 2 period are 86.58PM compared to 83PM in the project budget. Most partners are within +/- 5% compared to their original PM budget, but partner IRTA has an overspending of 5PM, corresponding to 36%. For the second year, partner NEMA has requested to convert the remaining equipment budget into personnel cost with no change in the EU contribution. Partner NEMA assured the consortium that it would fulfil its obligations even in the case it ran out of budget.

3.2.2.2 WP1 User driven co-creation

SUMMARY AND SIGNIFICANT RESULTS

The first specific objective of the project "All Smart Pigs" was to identify user needs and key performance indicators relevant for the selected parameters health, growth rate and feed consumption. For that, Work Package 1 of the ALL-SMART-PIGS project had the objective of collecting inputs and information from selected farmers and other stakeholders regarding their needs, expectations and improvement strategies towards PLF technologies that will be implemented in WP2. The Living Lab approach used in this WP1 will promote co-creation, in order to create true SMART farming.

The specific objectives of WP1 are:

- Organize an initial and final workshop for different stakeholders to present the PLF technology concept and the ALL SMART PIGS project (objectives and results) in particular.
- Collect initial information from the 4 selected farms regarding their needs and expectations from the 4 PLF technologies implemented in the project; hereby identifying user needs and key performance indicators relevant for the selected parameters health and feed.
- From the 4 selected farms in the LL, collect information after each fattening round regarding the problems encountered when using the 4 PLF technologies and the suggestions for improvements.
- Collect information from the feed suppliers and slaughterhouses after the fattening rounds, in order to further improve the proposed PLF technologies.

PROGRESS TOWARDS SPECIFIC OBJECTIVES AND RESULTS

The progress towards the first two specific objectives has been successful without deviations.

Task 1.1 Organization of an initial workshop.

It was completed as expected. Two workshops were organised in Sitges (Spain, 10th-11th of December 2012) and Budapest (Hungary, 17th-18th December 2012).

Task 1.2. Initial interview of the Living lab participants.

This task was also completed successfully during January 2013. The interview was developed by IRTA following the Living Lab methodology.

Task 1.3. & 1.4: Second and third (final) interview of the living lab participants and *Task 1.5. Final workshop on the ALL-SMART-PIGS project*

Task 1.3 should have been carried out in month 10-11 of the project and was carried out in month 15 because of a delay in the setup of the technologies.

The information regarding the suggestions of farmers to improve the technologies was collected through three mechanisms:

- Interviews during the regular visits of the IRTA and SIU technicians to the farms when setting up the technologies and monitoring their proper functioning.
- A workshop on PLF farming held in Copenhagen, August 2014, as part of the European Association of Animal Production (EAAP) satellite events.
- The final workshop of the All-Smart Pigs project held in Vic, October 2014 (Task 1.5).

According to the DoW task 1.4 the original plan was to do a final interview of the farmers after the completion of the 4 successive fattening to discuss how further improvements of the 4 PLF technologies cold be implemented and to obtain a final assessment of the advantages of using PLF.

The methodology for obtaining this information was slightly changed during the project. The interviews should have been carried out with the farmers after some rounds of fattening with the technologies. As the technologies were not working as expected, the formal interviews with the farmers were delayed, since the farmer would not have enough information, and we did not want to demand a lot of time from them. In addition the regular visits of the technicians to the farms provided more spontaneous information, based on the problems to be solved on a daily basis.

In contrast, for the two workshops the farmers were specifically interviewed regarding some aspects. The workshop in Copenhagen, Denmark, in August 2014 served as an occasion to obtain information on what farmers expected to improve the technologies.

At the final workshop on 2nd of October 2014 the farmers were asked again about those elements that were missing in the previous interview rounds. The original plan was to have one workshop in Hungary as well. However, only one farmer expressed interest in participating in the workshop. Furthermore, in the planning of the workshop the estimated budget were higher than originally anticipated – and especially compared to the expected local effect (number of participants). It was therefore decided to invited the interested Hungarian Living Lab participant to the Spanish workshop.

In Deliverable 1.2 the collected information by both IRTA and St. István technicians has been summarised, including both the oral interviews and the discussions of the workshops, and it is presented in relation to the main questions asked to the farmers.

Figure 1. Images of the workshop held in Vic

The main objective of WP1 was the close interaction with the farmers to firstly define the needs and expectations towards PLF farming in general and more precisely with regards the technologies tested (Deliverable 1.1), and to secondly collect their suggestions of improvement. This objective was fully accomplished, with an important involvement of the farmers in the implementation and fine tuning of the technologies. The project served to them as a real basis to understand the potential of using PLF technologies. In general terms, they considered PLF useful and with great potential to save time and provide a better quality of life. However, the technologies would have needed a better precision for the farmers to be able to build up a more sound opinion on the economical revenue that could be expected. They also pointed out the need of an adaptation process and a change in attitude for first increase their confidence in PLF technologies and second learn how to incorporate PLF results in their decision making process.

The major suggestions of improvement were about increasing the reliability, the ease of interpretation of the results and enhancing practical applications like the use of SMS warnings.

DEVIATIONS TO THE DOW

Task/ MS/D	Title or Change in approach	Delays in Milestone	Delays in Deliverable	Justification
MS8	In depth interview with living lab participants	M11-M13 -> M15		Delay in the setup of the technologies.
1.4	How, where and when the interview with the farmers were conducted			There was a need to adjust the survey design according to how and when the information from technology was available to farmers
MS12	No final workshop in Hungary			Since only representatives from one farmer would attend it was decided to invite the person to the workshop in Vic.

RESOURCE USE

The main deviation in WP1 for the effort use compared to budget was the cancellation of the planned workshop in Hungary due to reason justified above for MS12. The consortium decided two months before project end to focus the effort regarding the last workshop on having a good representation of LL participants and stakeholders on a single workshop, where also all the technological partners could have in debt discussion about pros and cons of their technology performance. All other efforts are considered to be in line with Annex I and resources are considered to have been spent in accordance with the provision.

3.2.2.3 WP2 Technological Exploration

SUMMARY AND SIGNIFICANT RESULTS

The main aim of WP2 is to specify PLF technologies/services, provide hard/software solutions and implement the systems on four farms in Europe (2 farms in Spain and 2 farms in Hungary) as part of the Living Lab for Smart Pig farming package.

Specific objectives are to: implement four different technologies:

a. Contactless weight measurement of pigs (Weight-Detect™) (AGRI)
b. Feed amount measurement (Feed-Detect™) (AGRI)
c. Air Quality Monitoring (Enviro-Detect™) (AGRI) (restricted to one or two farms)
d. Early detection of respiratory diseases via sound monitoring (SOUND)
e. The sensor outputs of these technologies has been combined in a data collection and data management system named Farm Manager (FAN); which software tools also provide information to the farmer. Furthermore, chain feed optimization will be realized by using traceability in the complete feed-farm-food chain by NEMA.

In addition the WP2 translated the output of sensors into PLF service packages for farmers referred to as SMART Pig Applications and specifed how to technically connect different technologies from the SMEs to the existing data managing systems of market players.

PROGRESS ON SPECIFIC TASKS

Task 2.1: Introduction to demonstrated technologies
Lead: SYN
Description: *The technology providers (AGRI, SOUND, FANCOM and NEMA) will introduce and inform the other project partners in WP1 and WP3 about the PLF technologies used in the ALL-SMART-PIGS project, since not all project partners are familiar with the PLF technologies used here. It is very important to inform all partners thoroughly about the operating modes, service schedules and troubleshooting related to the four PLF technologies, since a) the technologies shall work together providing information to the farmer, and b) the daily contact with the farmers is not ensured by the technology providers but by the local partners (SIU, IRTA). Therefore the technology providers need to know possibilities and limitations for information interaction/exchange among the different technologies demonstrated. The output is a manual for partner SIU and IRTA the use in relation to the different technologies, including a preliminary troubleshoot description.*

This task was finalised in the first period of ALL-SMART-PIGS. The project was initiated via a number of methodological steps. First, initial workshops were implemented in December, 2012 and coincidentally farm visits were also undertaken that formed part of the farm selection process as well. Two workshops that were initially organised were presented in Sitges (Spain, 10th-11th of December 2012) and Budapest (Hungary, 17th-18th December 2012). In both countries representatives of farmer and veterinarians participated in the workshop, together with the feed providers and the technology providers. The workshop consisted of a first round of presentations of the technology providers to briefly explain their technologies. In addition, the farm selection process was formalised via a uniform a scoring system that enabled all project partners to

methodologically select the most suitable farms. A guidance for troubleshooting on-farm instruments was developed by the technology partners

Task 2.2. Develop an on-line logbook
Lead: NEMA
Description: For the gathering of process information about production, health, logistics and legal issues related to the fattening of pigs in the selected farms. The module makes the relation between different stakeholders such as the farmer, technology providers, researchers, slaughtering houses, etc. The output is an operational on-line logbook for the farm in question, where the different stakeholders can input all relevant process parameters.

This task was completed in the 1. Period of the project. NEMANEMA developed an online system where all measured data as well as data regarding production, health and logistics is collected on a central server. For the measured data, an agreement was made with the technology providers to deliver their data in a folder on a PC placed at the farm. From there, NEMANEMA collects the data into the central server. For farm production data the NEMANEMA system contains forms, where data like number of pigs in each pen, breed, treatment, mortality etc. can be added. This data is then linked to the data automatically collected on farm. It is also possible to register logistical data regarding feed deliveries and slaughter transports in the same system. In this way, slaughtered batches of pigs get linked to the production data as well as the feed they have eaten. Finally, to enable the farmer to input his observations regarding the daily farm operation, Fancom has developed an input form placed on an on-farm tablet. These digital logbooks are used by the farmer on a daily basis. During the normal inspection routine, the farmers only need approximately five minutes per day to complete the scores in the logbooks. A screenshot of the digital logbook can be seen in Figure 1:

Figure 1. Picture of the digital logbook used on farms by farmers.

Task 2.3: Develop a chain traceability
Lead: NEMA
Description: Implement food traceability standards for identification of forward and backward information from the farm to/from feed providers and slaughterhouses. This will enable feed and food quality optimization based on information from the complete feed-farm-food chain.

The aim regarding the traceability system is to identify what kind of information the various partners in the Feed-Animal-Food chain would like to exchange, and then try to accommodate as many of those as possible. To find this information, NEMA participated in workshops and held interviews with the participating farmers

as well as their feed companies and slaughterhouses. The result was a specification of the information that the participants wanted to exchange and which were available in our system. Based on this information NEMA implemented the system such that all partners can log on to view the exchanged data together with their own. More specifically, the feed provider can see the performance of his feed; the farmer can see the state of his operation while the slaughterhouse gets a report regarding the delivered batch of pigs.

A user manual for introduction to the traceability system has been written. Furthermore NEMA has had continuous meetings with the regional partners about the operation of the system.

In collaboration with Fancom, NEMA developed a solution where farmers input data on farm using an iPad. The data is then collected into the traceability system. The part of NEMA has primarily been to upload the data to a server and present the data on the web.

The main challenge of producing the traceability system has been to develop a business model for the collaboration of the partners of the food chain. Through the Living Lab processes NEMA has proposed, implemented and then improved on a data interchange model between Feed providers, Farmers and Slaughterhouses. This development has been based on interviews and workshops with the stakeholders.

One underlying requirement for developing a traceability system like this, is to have access to all the relevant data. In order to make it possible, the traceability system has been integrated with the measuring technologies to collect all the data on the farms and upload it to a central server. In this way the system is able to display everything together on a single web site, and the farmers are able to give feed providers and slaughterhouses access to the data through the web.

NEMA's part has been to implement data collection software that could take data collected on farm and transmit it reliably to a central server. Included in this has been a web site, where the farmer has been able to register medication of pigs as well as pig mortality. The problems that arouse throughout the project have been solved, primarily with data collection and data integration.

Task 2.4: Link the different SME technologies
Lead: AGRI
Description: Link AGRI and SOUND technologies to the data collection system of the market player (FAN). The different technologies are currently acting as individual systems; the technologies will be combined with the data collection system of the market player (FAN) in order to act as a complete SMART Pig application package.

A key objective of the project is to translate the output of sensors into PLF service packages for farmers referred to as SMART Pig Applications. In figure 3.2 a diagram showing the general dataflow of the SMART pig application system is presented:

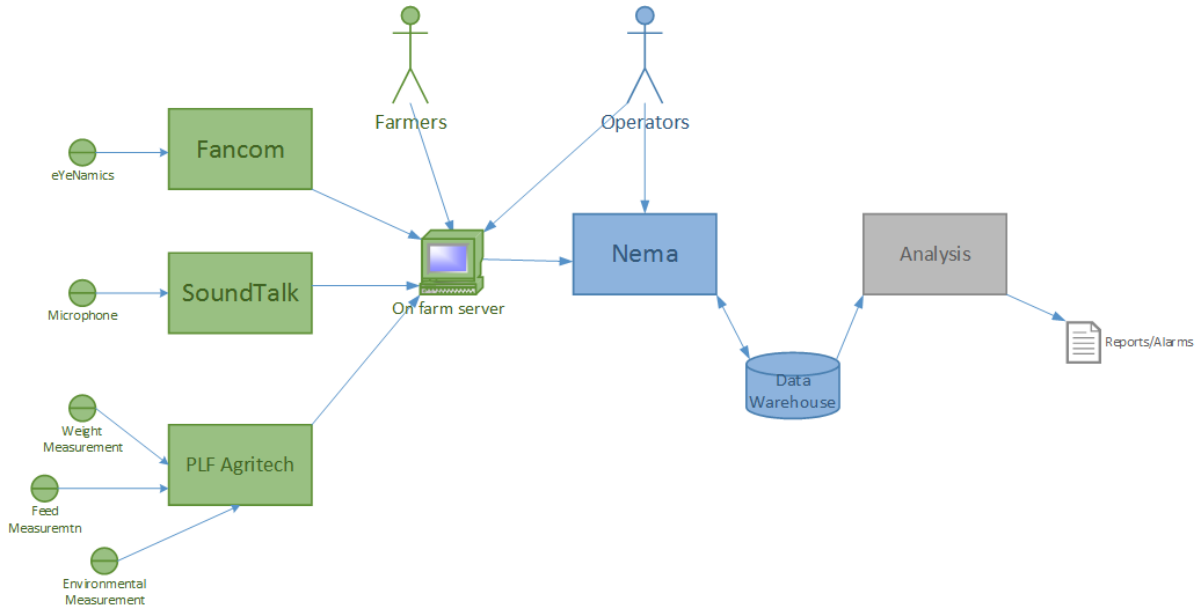


Figure 2: Diagram of the general dataflow of the system

The arrows show the direction of data flow. The nature of the data will be different at different stages in the flow, because all components process the data.

Symbol description

- The green circles on the left correspond to measuring instrument/systems.
- The green rectangles correspond to technology providers data processing components.
- The green "monitor" corresponds to an on-farm installation or server.
- The blue rectangle box corresponds to the central data collection system.
- The blue disc drum corresponds to database storage
- The grey components correspond to analysis and presentation of collected information.

In general, green items correspond to on-farm systems or tools, while blue items correspond to central systems or tools. The grey items correspond to parts of the system that have been addressed in the 2. Period of the project.

Component description

- Fancom: Is the component that is processing the information from the eYeNamics camera and converts this to activity data.
- SoundTalks: Is the system processing sound data from a microphone and converts this to cough counting data.
- PLF Agritech: Is the component processing data from the instruments of PLF Agritech, converting them to weight data, feed data and environmental data.
- On farm server: Is a central system on the farm that collects all the processed data on the farm, and passes it on to the central system.
- NEMA: Is the central data collection system that collects data and saves it into a data warehouse.
- Data Warehouse: Is a database containing all the collected data.
- Farmers: Farm workers with an obligation to log activities and observations to the log book.

- Operators: Researchers of IRTA and SIU that do other data collection both on farm and online from their offices.
- Analysis: The results of the analysis are reported in section 2.6.

Interface descriptions

- Connectors from the instruments to the initial processing components are generally representing raw data measurements.
- Connectors from processing components to the on farm server in general correspond to saving csv-files on a disk for later data collection.
- The connector from the on farm server to the central NEMA system corresponds to sending the collected and converted csv-file data to the central NEMA system.
- The connector from Farmers to the on farm server corresponds to the farmer filling out the online logbook and the logbook saving the values as csv-files on the server.
- The connector from Operators to the on farm server corresponds to the operators filing in data when working on the farm.
- The connector from Operators to the NEMA system corresponds to the operator inputting data online from his office.

Task 2.5: Install the different technologies on the selected farms

Lead: AGRI

Description: AGRI, FAN, SOUND, NEMA will do the actual deployment of the four technologies on the selected farms, including the start-up of the software and the delivery of the hardware to the farm.

This task was not fully completed as anticipated in M6 as Milestone 4 indicated, but the milestone was achieved in M14 of the project. The reason for the delay is extensively described in the 1st reporting period

In summary, the implementation of the work package has been challenging due to the innovative nature of the technologies involved and due to the nature of the underlining technology used i.e. internet.

Task 2.6: Perform the daily operation of the technologies over internet from a remote location

Lead: AGRI

Description: AGRI, FAN, SOUND, NEMA must ensure the quality of the data produced by the technologies and solve reliability problems concerning the operation of the different technologies. The output will be delivery of measurement data coming from the different technologies.

A number of problems have been encountered during installation. First, the reliability of the internet provided by local internet providers proved to be varying on some of the farms. Many hours of trouble shooting was undertaken to resolve these internet/communication issues, but by large the internet now is reliably supplied at the study farms.

PLF Agritech experienced problems in relation to the Feed-Detect system. As motioned previously, the feed sensors were originally developed to detect the flow of pelleted feed, while on most study farms the feed used is mashed. This required the software to be completely re-organised. In addition, the delivery system of feed on most study farms is also different to the conditions the feed sensors were developed under. The previously developed feed sensors were tested using a feeding system that delivered feed via auger system. The study farms usually employ a chain-based feed delivery system that result in much smaller ‘portions’ delivered to the sensor head at each time. This resulted in loss of signal; sometimes to levels that were below

detection thresholds. A number of attempts have been made to increase the detection threshold of the signals, so the chain-based delivery lines can be accommodated. In addition, on two farms the feed-sensor had to be installed inside the feeders (due to the physical design of the system) rather than above the feeders that the Feed-detect sensors were designed for. All of these issues have delayed the full commissioning of all installed sensors.

In relation to the Weight-Detect sensors, some technical challenges were also presented to the project team. Unexpectedly the camera lenses were dirtied by flies to the extent the vision of the lenses were blocked in some instances (figure 3). The large degree of dirt was not anticipated in the design of the lenses.

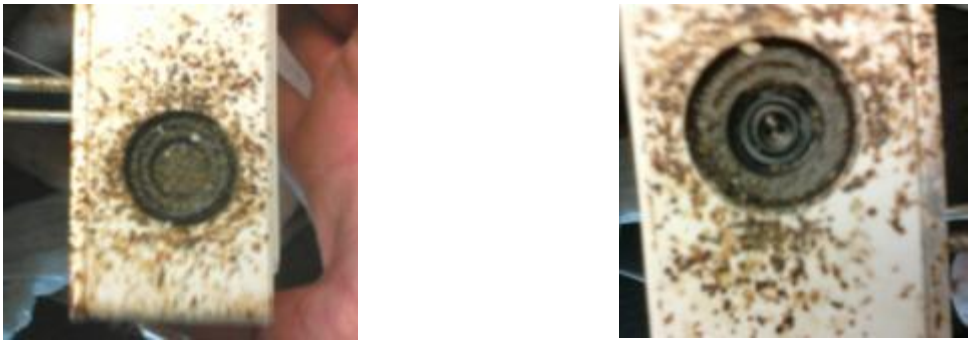


Figure 3: Partner AGRI camera lenses blurred by dirt/faecal matter produced by flies on study farms

A number of possible actions are being implemented to counter these matters. These actions include the investigation (1) to use a protective barrier in front of the lenses that can be replaced periodically while keeping the lenses clean and the application of long-lasting insecticide around the lenses. Cameras will also be kept at heights where regular cleaning and maintenance of these cameras can be undertaken by farm workers that will involve the physical cleaning of lenses at regular intervals.

Equally rat-proofing the installations were also a challenge. This was achieved by using protective cables, protective barriers around the boxes containing the instruments and by spraying a repellent (paprika essence) on the cables that we exposed.

After the installations SoundTalks also faced two major issues: hardware failure of the PCM (PigCoughMonitor) and the data storage on the external hard drives. The hardware issues were solved by sending all PCM's back to Fancom and slightly redesigning the hardware. The problem was a malfunctioning connection between the motherboard and the soundcard, caused by overheating problems in long measurement runs.

The second issue relates to storing the data on external hard drives. These external hard drives are used for collecting all data and send them to a central place for backup. From the backup location other partners in the project have access to the data. The main problem was that the power supply of the central farm pc was too low to provide enough power for continuously using four external hard drives. This was resolved by using the USB 3.0 ports instead of USB 2.0 ports. With the help from the local partners IRTA and SIU, the problems could be solved quite easily, but they caused a small delay in the measurements.

One of the microphones showed a humming problem. Humming is typically caused by bad connection, or short-circuits. It is unclear how the humming started in this set-up, since the microphone first worked for

more than 2 months without any problems. After loosening and fixing the microphone again, the humming disappeared.

In table 1 there is a summary of the encountered problems related to the different technologies, their possible solutions, the technological impact in relation to an installed PLF system and the business impact in relation to using the PLF systems in the daily operation of the farm.

Table 1. Summary of lessons learnt

Technology	Encountered problems	Possible solutions	Technological impact	Business impact
Power supply	Unstable	Install Uninterruptible Power Supplies (UPS)	Precondition for PLF technologies	PLF
Internet	Unstable or non-existing	Install 3G connec-tion and neces-sary bandwidth	Data transfer	On-line real-time monitoring
Provider	Language barrier	Local interpreter	Farmer must understand functionality	Use information for daily management
Data	Collection and storage from different technologies	Shared data backbone/server solution	All data accessible in an accepted standard	Increased efficiency in PLF data analysis
Cables and instruments	Rats on farms attacks cables and instruments	Rat-proofing the installations	Protective cables, spraying and barriers around the boxes	Secure operation ability of the PLF instruments & systems
Weight-Detect™	Dirty camera lenses	Weekly cleaning and develop protection	Register changes in livestock	Monitor growth rates and weight gain. Identified constantly underperforming pens.
	Inadequate level of light (esp. during winter)	Increase artificial lights and more sensitive lenses		
Feed-Detect™	Originally developed for pelleted feed –could not measure mash feed	Alternative sensor technology needs to be developed suitable for measuring trickling mash feed	Register feed intake	On-line estima-tion of feed conversion rate
Enviro-Detect™	Data collection delays due to damage, Ammonia sensors not robust	Improved hardware, positioning in barns and data quality software	Measures temperature, humidity, CO_2 levels and ventilations rates	Lower risk of disease with faster detection of problems
	Regular need of maintenance	Available, reliable and competent ground crew	Stable operation	Useful data
Cough monitor	Hardware problems with solid state drives	Alternative drive installed	75000 hours of sound recording used for further post-processing,	Detection of respiratory health problems
	Software problems related to noise from fan	Solved during the project		Useful SMS warning for farmers
eYeNamic	Natural light from window causing shadows & non-uniform illumination	Install artificial light	Affects measurement of zonal occupation, but not activity	Better understanding of activity patterns an early warning systems
Digital logbook	Difference in usage by farmers	Improved discipline	Collect additional information – between 30-130 days per farm	Verify and interpreter the automatized data collection
NEMA Traceability System	Manual input of farmer data	Automating as much data as possible	All data collected in one system	Quick response time on early warning
	Wrong or poor quality of data	Implement a data quality control system		
	Ambiguities in data communication	Improve user interface	Clear and understandable information	Improve usefulness of the PLF systems

All of these matters highlight the fact that installing electrical tools in livestock buildings is not a trivial undertaking and many of the practical considerations need to be taken into account when finalising the most effective installation options. These issues are discussed in detail in deliverable 4.1 Report on evaluation and impact assessment of SMART pig farming

Task 2.7: Demonstrate an SMS and e-mail warning system for the farmer
Lead: SOUND
Description: SOUND and FAN will develop a system, where the different technologies shall warn the farmer in an automated way. Suitable alert levels will be developed for the different technologies, in relation with the farmer. The output will be an operational SMS and e-mail warning system for the farmer.

The SMS notification system has been developed and is running in the traceability system and has successfully sent SMS messages to farmers as a response to rise in cough activity.

A user manual has been written for introduction to the basic features of the system. Furthermore the system has been translated into local language to enable the farmer to better understand the basic functionalities of the system. For the more advanced tasks, we have relied on training through IRTA and SIU. Finally, IRTA and SIU have been able to contact NEMA directly for 2nd level support of the system.

The system can be expanded to other PLF technologies, but an alert system such as SMS warning system is dependent on reliable high quality real time data – otherwise there is a risk of too many false alarms – leading to dissatisfaction of the user tending to ignore the system. There reliable monitoring systems are a precursor for successful real time warning systems – see also the problems encountered with systems in task 2.6.

Task 2.8: Develop a service plan for the different technologies
Lead: AGRI
Description: AGRI, FAN, SOUND, NEMA will develop a plan for Maintenance and Troubleshooting. In order In order to achieve this, a service plan will be developed for the different technologies.

This task was completed in the 1st reporting period and no major changes have been made to the plan.

DEVIATIONS TO THE DOW

Task/ MS/D	Title or Change in approach	Delays in Milestone	Delays in Deliverable	Justification
MS4	Equipment installed on farms	M6->M13		Delays in installation as described in 1st periodic report. These delays were also caused by unforseen produtions priorities by the involved farmers that was out of project control.
MS6	Baseline information 1. Fattening round	M11->M13/M14		Caused by the delays in installations and on-farm production cycles. The farmers were not willing to re-arrange their farm production to the ALL-SMART-PIGS project plan.
MS9	Startup information 2. Fattening round	M15-M18/M19		Direct consequence of delays in MS 6
MS10	Demonstration information 3 fattening round	M19->M24		Direct consequence of delays in MS 9

MS11	Final demonstration information 4 fattening round	M22->		Project ended before the 4 fattening round commenced

RESOURCE USE

Even though there were delays in the installations in WP2, all equipment was installed according to the Annex I with the expected effort and resource usage, please also see the corresponding tables in the RESOURCE USAGE section.

WP3 On-farm experimentation

SUMMARY AND SIGNIFICANT RESULTS

The objective of WP3 (activity type DEM) is to demonstrate the technologies and PLF systems provided by WP2 . The specific objectives are:

1. Keeping continuous contact with the farms where the technologies are implemented.
2. Facilitate the interaction between the farmers and technology providers during the study period.
3. Organization and performance of additional data gathering from local feed producers, farms and slaughterhouses.

WP3 is basically a service work package for the other work packages. In the case of WP1 and based on the continuous communication with the farmers their needs were forwarded to the project participants, especially to the technology providers. For WP2, during the technology set up on the farms they were very active (not just as observer) in the preparation, implementation and fine tuning of the installation. And finally for WP4, all additional data that was needed by other WPs was provided by WP3.

In the second reporting period, on the four pig farms the local actors (SIU and IRTA) have kept continuous contact with both farmers and technology providers. Each farm was visited on average every two weeks. Contact with farmers and local actors was also kept by telephone and email.

As a result farmers are well aware of the installed technologies and the project progress. Partners on the other hand are well aware of the advances on the farms, the needs of farmers and the issues arisen. .

PROGRESS ON SPECIFIC TASKS

Task 3.1 Training of farmers.
Lead: SIU, IRTA.
The Living Lab participants, including farmers, feed providers and slaughterhouses, will need introduction and training to the technologies they will be exposed to. For feed providers and slaughterhouses the introduction will be limited to tapping into a web based document handling system for chain traceability provided by NEMA. For the farmers, the training will be more extensive, as the training will be related to the technology in use for the on farm demonstration and training related to the service plan for the different technologies.

The training of the farmers should have started in month 6, but this task was delayed since the installations were not finalised before M14. Subsequently farmers have been trained in using the traceability system, and since most of the technologies use a black box approach, the task of training the farmers on site have been conducted during regular visits of IRTA and SIU when setting up the technologies and monitoring their proper functioning.

Task 3.2. On-farm data gathering for validation and completion of the logbook.
Lead SIU, IRTA
This task validates the PLF technologies. The data gathering includes manually weighing the pigs, scoring the coughing of the pigs, a physical assessment of the general health status of the pigs, verification of the feed sensor data and completion of missing parameters in the on-line logbook (e.g. slaughtering house data). In addition SIU and IRTA shall perform scoring on key performance indicators as specified by relevant partners in project EU-PLF.

The on-farm gathering of data for validation started partly in the 1st reporting period and continued into the 2nd period. Fancom developed a digital logbook to be used by farmers and assessors to collect additional information about the pigs and their environment. This information was used to verify and interpret the automatized data collection on regular basis. In November 2013 (M13) all logbooks where operational on all farms.

In the development of the on-line logbook SIU/IRTA collaborated to get a Hungarian and a Spanish version of the tool. The work included negotiation with farmers about the possible useful inputs /outputs.

During the installation of all equipment at demonstration sites partner SIU and IRTA were present with their staff who collaborated actively in the installation. The farmers were trained for the usage of the on-line logbook and the usage was supervised by SIU/IRTA. The parameters are listed in the table 2. below:

Table 2: Parameters to be filled in by farmers in the logbook.

Principle	Parameter	Level	options		
Environment	*How is the temperature?* Temperature	compartment	normal	high	low
	How is the air quality? Air quality	compartment	normal	moderate	bad
	How is the air distribution? Air distribution	compartment	normal	moderate	low
	How is the humidity? Humidity	compartment	normal	dry	humid
Health	*What is the number of coughs?* Cough	compartment	normal	moderate	many
	What does the manure look like? Manure	pen	normal	dark manure	light manure
	How many pigs are breathing heavily? Breathing	pen	none	few	many
	How many pigs have a thin belly? Belly not filled	pen	none	few	many
	How many pigs have a pale skin? Pale	pen	none	few	many
	How many stragglers are there? Straggler	pen	none	few	many
	How may pigs are lame? Lame	pen	none	few	many
Welfare	*Is there aggression in the pen?* Aggression	pen	none	little	a lot
	Is the lying area dirty? Dirty floor	pen	no dirt	little dirt	dirty
	How is the stress level? Peace	pen	normal	moderate	high
Production	*Did the animals consume their daily portion?* Feed	pen	normal	less	more
	How about the water intake? Water	pen	normal	leakage	spoilage

The list is build up in two levels, compartment and pen level. There is chosen for maximum of three answer per question, this was a practical choice. Otherwise there was a scrollbar, and that is not user friendly.

For the farmer it is also easy to use. He can take the tablet out of the switchbox (see the image to the right), which is installed close to the compartments. He goes to the compartments with the PLF sensors, fills in the 16 questions and then he can place the tablet back in the switchbox. After filling in the list there will be made

an CSV file that can be used by NEMA with all the answers. In Appendix 1 is the user manual for the Logbook ALL SMART PIGS.

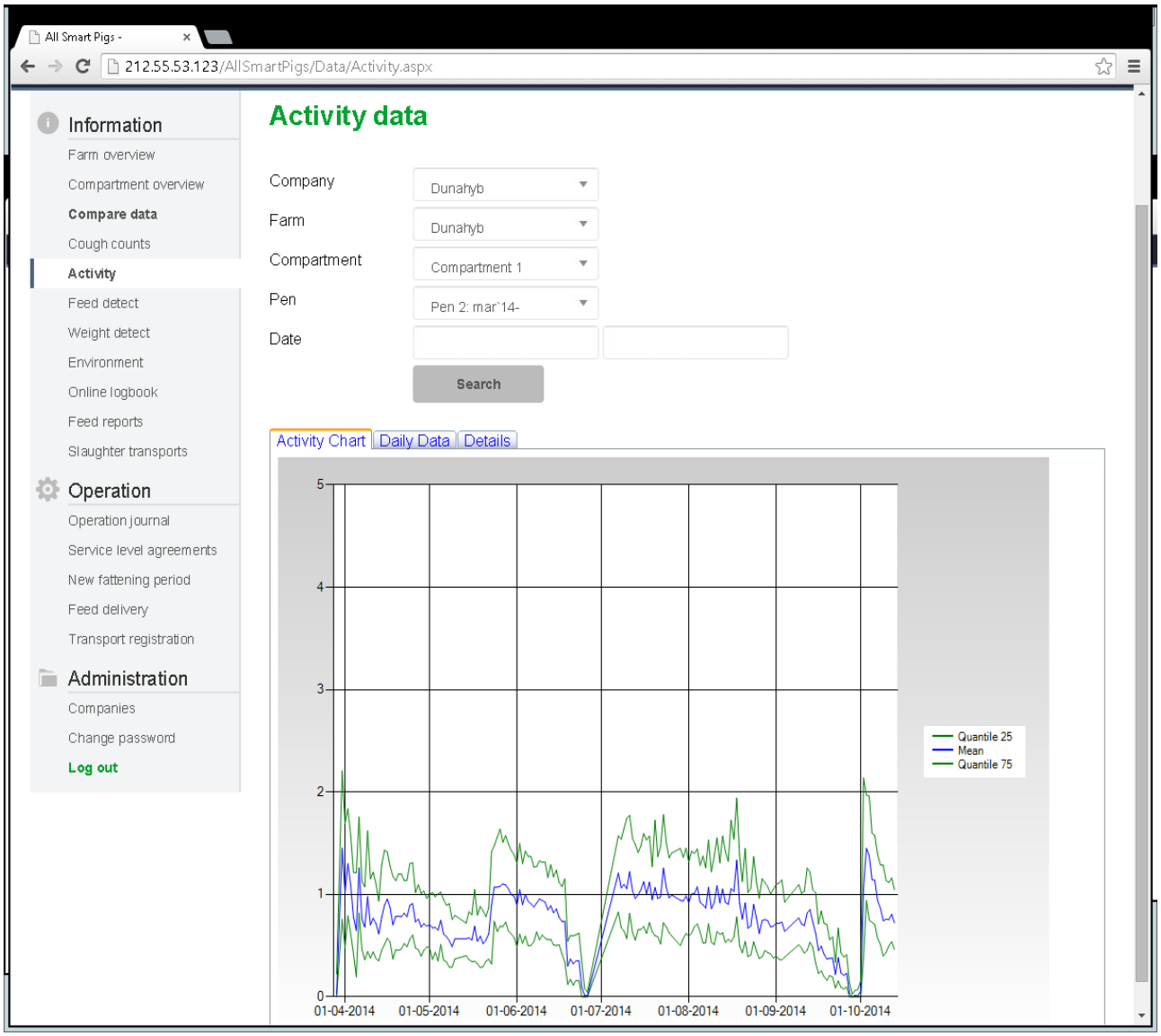
Each farm was visited with a bi-weekly frequency, on average. In addition farmers were contacted telephone and email.

From time to time the farmers neglected of forgot to use the logbook – then the staff from SIU/IRTA reminded the farmers of the importance of usage of the logbook for validation purposes.

When SIU/IRTA made farm visits the installed technologies were checked and interventions done if needed (e.g. cleaning lenses). Partner SIU/IRTA have also arranged for additional farm visits when needed, e.g. hard disk replacements, rebooting the central computer, rebuild internet connection and transport technicians to the farm etc.

The data generated by the installed technologies are stored in a central database. The coughing count and environmental data is detected on compartment level. Weighing, feed consumption and activity estimation data is based on pen level. These data are available by a web based interface for the authorized users (available at: http://212.55.53.123/AllSmartPigs/Logon.aspx). By that web based system one can query data generated by the installed technologies for certain time periods, compartment or pen depending on the type of measurement. Data is available in tabular and graphical formats and some part of the on feed producer/farm/slaughterhouse manually collected data is also merged into the central database. For those data were collected by SIU/IRTA on the farm some examples are presented in Deliverable 3.1.

The efficient use of the digital logbook was different over the farms. In total the logbooks were used during 30 up to 130 days per farm. Cough and the aggression level data are gathered using the logbook, but other validation data had to be collected by IRTA and SIU, and they have also collected the relevant information for the EU-PLF project.



Screenshot of the web-based performance reports developed in ALL-SMART-PIGS

Task 3.3. Interpretation & translation of performance reports.
Lead SIU, IRTA

The performance reports created in WP4 after each fattening round were translated to the mother language of the farmers and discussed with them. For early detection of respiratory disorders, or for noticing decreasing daily weight gains, the „remote sensing" PLF technologies that will be implemented on the farms will in itself produce useful alerts to the farmer. However, there is a need to gather „additional" data, i.e. supporting variables that are needed for the thorough evaluation of the PLF system in terms of the final results of the fattening periods. By this we mean that for a producer the final production is the most important parameter in the evaluation of a health management support system. For the analysis of the benefits of the PLF systems, it is very important to collect actual data on inputs (e.g. feed) and the final outputs, which are the amount and quality of slaughtered pigs in our case. According to this goal in WP3, we have to perform a data gathering of the most important parameters of the feed, weight gain and pathological features.

All farms involved in the project were visited regularly. During the visiting rounds SIU/IRTA assisted the farmers in understanding the available information provided by the web interface. Since the farms in Hungary produce their own feed there was no external feed producers involved into the data gathering processes.

When possible the slaughterhouse reports were collected and the pathological features were scored. The farmer communication was continuous via personal contact, phone and email. With one of the Hungarian farms collaboration encountered difficulties.

Task 3.4. Pathology in the slaughterhouse
Lead: SIU, IRTA
If there is a monitoring system in the slaughterhouses where the pigs are slaughtered, this could pose a limitation to the pathological parameters that may be collected. But if there is no such system, then we manually gather data on the following pathological features:

- *Enzootic pneumonia*
- *Plevritis/ruptured pulmonary abscess complex*
- *Pericarditis*

For the simplification of reporting of these features, we propose a presence/absence approach. While more detailed systems might provide more accurate information, these come with serious difficulties and costs so a simplified approach seems more reasonable here. Although the evaluation of weight gains, we also need weight data of slaughtered pigs that can be traced back to the compartments in which the fattening pigs had lived.

This task was completed by SIU and IRTA. However, the work was made difficult since the slaughterhouses were reluctant to share information with the other partners in ALL-SMART-PIGS.

When the farms transported fattened pigs from the investigated pens to slaughterhouse directly (not to dealer) the the pathological features (enxootic pneumonia; pleuritis/ruptured pulmonary abscess complex; pericarditis) were scored by the staff f SIU/IRTA due to the presence/absence approach described in the project proposal. This was done for two fattening rounds during the project.

Task 3.5. Consultation of farmers
Lead SIU, IRTA
During the experimentation, the farmers can be in daily contact with the researchers in case problems occur. When bugs are detected in the PLF systems, they are immediately reported to the technology providers. Farm visits are planned once every two weeks for each farm, in case problems are reported, the visit will be immediately.

This task was performed by SIU/IRTA as described in task 3.3 and 3.4.

DEVIATIONS TO THE DOW

Task/ MS/D	Title or Change in approach	Delays in Milestone	Delays in Deliverable	Justification
MS4	Equipment installed on farms	M6->M13		Delays in installation as described in 1st periodic report
MS6	Baseline information 1. Fattening round	M11->M13/M14		Caused by the delays in installations and on-farm production cycles

MS8	In depth interview with living lab participants	M11-M13 -> M15		Delay in the setup of the technologies.
MS9	Startup information 2. Fattening round	M15-M18/M19		Direct consequence of delays in MS 6
MS10	Demonstration information 3 fattening round	M19->M24		Direct consequence of delays in MS 9
MS11	Final demonstration information 4 fattening round	M22->		Project ended before the 4 fattening round commenced

RESOURCE USE

In WP3 the demonstration period was shortened by approximately 7 months due to the delay in MS4. Consequently the total number of completed fattening rounds were 2.5-3 compared to the anticipated 4 in Annex I. Taken into account the reduced number of completed fattening round this could cause a request for a reduced grant equal to the cost of monitoring one fattening round. However, partner IRTA and SIU have been in continues contact with the LL farmers in the anticipated period of 4 fattening rounds. Furthermore, they will continue to follow the 4th fattening round for the "sister" FP7 project EU-PLF without any specific funding. Therefore we argue that the claimed effort will be used to obtain data for PLF development and otherwise, all efforts in WP3 are considered to be in line with Annex I.

3.2.2.4 WP4 Evaluation and impact assessment

SUMMARY AND SIGNIFICANT RESULTS

The objective of WP 4 is to evaluate and quantify the level of success in implementing the PLF technologies and services on farms and to evaluate the effect of the 'Smart Pig' service package on farm efficiency. This will be achieved by analysing data collected on farms and from other involved stakeholders to quantify the level of improvements achieved. WP4 has two specific objectives:

1. Verification of automatically measured variables
2. Analysis of socio-economic key performance indicators in Smart Pig Farming compartments in relationship with reference compartments

Given the delays in the installation of the on-farm technologies, it was decided that baseline measurements were to be performed in parallel with the fattening rounds under evaluation, but for different compartments.

PROGRESS ON SPECIFIC TASKS

Task 4.1: Information collection

Lead: AGRI

The objective of this task is to ensure that all relevant information is collected in an appropriate manner and required frequency. On-going operational information will be electronically collected by the FAN and NEMA information systems and made accessible via internet. Information collected on-farm for validation purposes by IRTA and SIU will be sent to AGRI who will review the collected information together with SOUND, FAN and NEMA. The collected data will be securely stored. Identified shortcomings will be communicated to IRTA and SIU to ensure that all required information is collected and to make sure that the data collection procedures are fine-tuned.

Delays in the finalisation of the installations caused delays in task 4.1. Protocols for data collection were decided very early (M2) and gradually over the first year the exchange protocols of electronically captured information were decided. For the computer system developed by NEMA interfaces were defined and exchange mechanisms put into place. This system worked for all data delivered from the technology providers SOUND, FAN and AGRI. NEMA used state-of-art servers and secure storage in their data centre in the Faroe Islands. Data validation was delayed, and the consortium decided to start data capture immediately in order to recover the delay.

In the beginning of the 2. Period it became clear that each compartment on both (Spanish a Hungarian) installations have his own cycle/round of fattening. However, the consortium decided to commence collection of data immediately after installations of equipment, and start to share with stakeholders instead of the fattening round has started.

The basis for collecting information was reorganized and other compartments were selected as sources for information collection. This gained important time in the work package with respect to compensate for the delays in relation to the installation processes.

Task 4.2: Analysis of information after each fattening round.

Lead: SYN

After the completion of each fattening round, an interim report will be produced. This will ensure that all project partners will be aware of the results achieved during online evaluation sessions after each fattening round for each farm with participation of the relevant LL participants. The following key performance indicators will be calculated and evaluated:

- *Production level rate (standard production – real production/standard production)*
- *Mortality rate (dead animals/population)*
- *Environmental impact (Value placed by society on reduced emission)*
- *Feed Conversion rate (feed intake/body weight gain)*
- *Productivity (total output/total input)*
- *Net Present Value (Each cash inflow/outflow is discounted back to its present value)*

After each fattening round a period report will be issued with economic conclusions in the key performance indicators.

The original aim was to evaluate four fattening rounds, but this was not possible due to the fact that some of the technologies were not working as expected until late in the project. Due to these issues the project was not able follow as many fattening rounds with all technologies as anticipated in the DoW. Thus "formal" interim reports were not made as anticipated – instead partner SIU and IRTA presented and discussed the available data on web from different technologies with the farmers during the demonstration period. Table 3 illustrates the completed fattening rounds for each technology on each farm:

Table 3: Completed fattening rounds on technology and farms

Farms	Spain 1				Spain 2				Hung 1				Hung 2			
Fattening rounds	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Sound monitoring																
Air quality monitoring (two farms)																
Contactless weight measurement via image																
Feed amount measurement via sensor																
Traceability & SMS warning system																

The installation of technology on farms was completed in November 2013. The first fattening round on the Hungarian farms stared in December 2013 and in the Spanish farms in January 2014. The second fattening round started in April 2014 on Hungarian farms and in May 2014 on the Spanish farms. In June one of the Hungarian farms became less enthusiastic participating in the Living Lab project. In August and September 2014 the third fattening round commenced in Hungarian and Spain respectively. The green colour in Table 3 indicate stable operation and data collection of the tested technology, while the yellow colour indicate problematic operation. Because of the delays in installation of technologies, it was impossible to conduct 4 fattening round within the project time limit (ending October 2014). However all technologies have been in use for 3 fattening rounds, and it was possible to evaluate a reasonable fully functioning PLF system in one fattening round – especially on the Spanish farms.

The technical problems demanded changes in the analytical process and the evaluation was instead conducted in the following manner:

- At least one interview was conducted on each farm at the beginning or at the end of a fattening round to collect general economic information on the farm.

- Follow-up interviews (face or teleconference) were held during the round in order to evaluate the use of technology and encourage the use of the web tools (answering farmer questions, etc.)

Table 4 shows the dates and activities of the evaluations. All farms were visited for a first interview in May or July 2014 and had a follow-up visit two months later. Farm 1 and 2 were again contacted in a follow-up for the questionnaires

Table 4: Interview list from the evaluations.

	First interview	Follow up	Follow up
Farm 1	Farm visit 21/5/14	Farm visit 28/7/14, within EU-PLF (Prof Hartung)	Email questionnaire, fill out by the farmer by telephone 30/9/14
Farm 2	Farm visit 21/5/14	Farm visit 28/7/14, within EU-PLF (Prof Hartung)	Email questionnaire sent 15/9/14
Farm 3	Farm visit 22/7/14	Email questionnaire, fill out by farmer and Norbert 18/9/14	
Farm 4	Farm visit 23/7/14	Email questionnaire, fill out by farmer and Norbert 22/9/14	
Feed provider		Email questionnaire	
Slaughterhouse		Email questionnaire	

The questionnaires

Questionnaires were prepared in order to standardize the data collections from the farms and to ensure that all necessary information was collected in an orderly manner.

The assessment questionnaire had three different parts:

1. PART A: Quantitative technical data related to the farm business.
2. PART B: Qualitative data to be able to evaluate the sense of control and the event detection for the farmer provided by the technology.
3. PART C: Qualitative data to be able to evaluate how the technology could improve the performance of the full supply chain (feed provider -> farmer -> slaughterhouse)

PART A:

Part A consisted of the quantitative technical data related to the farm business.

Examples of the gathered info in part A: Labour, Farm size, Rounds per year, Weight at purchase, Feed conversion, Mortality, Price per piglet, Price for feed, Health care, Delivery costs, etc.

Table 5 shows a sample of part A in the questionnaire filled out by one of the farmers.

Table 5: Technical parameters from part A in the questionnaire.

Techincal parameters	
Labour	14
Labour hours	1.920
Farm size	2.400
Length of growth period	90
Length of cleaning and disinfection	6
Rounds per year	3,80
Weight at purchase	30
Weight at delivery	100
Slaughtered / live weight ratio	95,00%
Feed conversion	2,80
Mortality	1,00%
Buildings and inventory	
Investment (building and inventory)	
Replacement value PLF technology	
Depreciation period	
Nominal interest rate	
Maintenance	
Prices (in €)	
Price piglet (30 kg)	77,53 €
Price fattening pig (slaughtered weight)	1,32 €
Feed	0,23 €
Labour	3,62 €
Other costs (in €)	
Health care	5,31 €
Delivery costs	no
Other costs (manure, electricity, water)	8,92 €

PART B:

Part B consisted of qualitative data to be able to evaluate the sense of control and the event detection for the farmer.

Five different values were defined from none to excellent (0% to 100%) in order to qualify in some way the control over the farm that the technology provides to the farmer compared to a traditionally managed farm that has no access to such technologies.

Table 6: Part B of the questionnaire evaluates the sense of control and event detection for the farmer.

Sense of control		Event detection	
0%	None	0%	None
25%	Some	25%	Some
50%	Regular	50%	Average
75%	High	75%	More
100%	Excellent	100%	Much more

PART C:

Part C involved the full supply chain (feed provider -> farmer -> slaughterhouse) and it comprised several questions about how the technology could improve the performance of the chain. As in part B this is also a qualitative evaluation scoring ranging the answers from 1 to 5 points.

The first column in part C evaluates the feed provider's part of the value chain, while the column in the middle evaluates the farmers and the last column evaluates the slaughterhouses.

Chain

① a lot worse with technologies ② worse with technologies ③ the same with technologies ④ better with technologies ⑤ much better with technologies

Surveys		
Feed provider	Farmer	Slaughterhouse
Helps improve profit margin thanks to improve the growth curve ① ② ③ ④ ⑤	Monitoring animals everywhere ① ② ③ ④ ⑤	Avoid quality problems ① ② ③ ④ ⑤
Helps to improve customer loyalty ① ② ③ ④ ⑤	Helps control feed quality ① ② ③ ④ ⑤	Avoid welfare problems ① ② ③ ④ ⑤
Helps marketing: new clients, quality animals etc. ① ② ③ ④ ⑤	Avoid welfare problems ① ② ③ ④ ⑤	Avoid health problems ① ② ③ ④ ⑤
Social recognition ① ② ③ ④ ⑤	Possibility to control incidencies ① ② ③ ④ ⑤	Helps to improve customer loyalty ① ② ③ ④ ⑤
Attractiveness for investors ① ② ③ ④ ⑤	Helps to improve customer loyalty ① ② ③ ④ ⑤	Helps marketing: new clients, quality animals etc. ① ② ③ ④ ⑤
Labour conditions ① ② ③ ④ ⑤	Helps marketing: new clients, quality animals etc. ① ② ③ ④ ⑤	Social recognition ① ② ③ ④ ⑤
Job satisfaction ① ② ③ ④ ⑤	Social recognition ① ② ③ ④ ⑤	Attractiveness for investors ① ② ③ ④ ⑤
Others ① ② ③ ④ ⑤	Attractiveness for investors ① ② ③ ④ ⑤ (no interest on)	Labour conditions ① ② ③ ④ ⑤
	Labour conditions ① ② ③ ④ ⑤	Job satisfaction ① ② ③ ④ ⑤
	Job satisfaction ① ② ③ ④ ⑤	Others ① ② ③ ④ ⑤
	Others ① ② ③ ④ ⑤	

Task 4.3: Final analysis using all data collected during the ALL-SMART-PIGS project

Lead: AGRI

Final analysis done using all data collected during the ALL-SMART-PIGS project. Final analysis of the collected data will be undertaken to assess the success of implemented technologies and the resulting improvements achieved on farms. This work includes an economic cost/benefit analysis of the data, and technical/performance analysis of the technologies.

The technology provides a range of benefits for the farmer and enables farmers to:

1. Reduce operational costs such as expenditures to feed, medicine and energy
2. Monitor animal health and welfare in order to ensure that animals live well and free of diseases, for example by early detection of lameness or the occurrence of respiratory disease in various livestock species.

Thus the technology has a range of impacts on the farms economy, but only a small part of them can be quantified and valuated.

It is not always possible to establish a direct link between the technology installed and a direct monetary return, or often is hard to quantify this return.

The more direct and tangible the impacts are for the farmer the more precisely they can be valuated.

<u>Direct and indirect impacts</u>

The economic impacts from the technology can be divided into direct and indirect impacts:

1. **Direct impacts** for the technology user: for example, the farmer's revenue will rise if the technology allows him to optimize the weight of the livestock when delivered to the slaughterhouse.
2. **Indirect impacts**, in the supply chain: for example, if the farmer can monitor the feed performance and share it with the feed provider in an automated way, the feed provider can change very quickly the feed mix, creating value.

The direct impacts are easier to measure and quantify while the indirect impacts may require considerable longer experience with the technology before they fully emerge and can be evaluated.

Tangible, semi-tangible and intangible impacts

From an impact point of view the results can also be classified into: tangible, semi-tangible and intangible.

1. Tangible: easy to identify the value generated in €. For example monitor the weight or feed consumption.
2. Semi-tangible: sometimes it is possible to identify the value generated in € fully or partially. For example, monitor coughing, activity or occupation.
3. Intangible: hard to identify the value generated in €. For example, reputation won when the animal wealth increases due to the technologies installed.

In the following some tangible, semi-tangible and intangible impacts are evaluated in various ways.

In the following some tangible, semi-tangible and intangible impacts are evaluated in various ways.

Evaluating tangible impacts

In the project, we conducted interviews with farmers after each fattening round using a standardised questionnaire where we collected economic farm data according to a simplified economic model of pig farms developed in the EU-PLF project, qualitative data evaluating sense of control and detection of incidents (e.g. outbreak of disease) and soft values.

After farmer interviews and our analysis of farm data, it became clear that the continuous weighing of pigs using video analysis (Banhazi *et al.*, 2011a) is the clearest case for measureable economic return. Measurable economic return stems mainly from a better detection of the ideal moment for slaughter, because (a) the weight growth curve slows down or (b) the ideal slaughter weight is reached within the precision of the measuring technology.

Figure 4 shows the price and gain from a carcass as a function of the weight of the carcass. The price is the price paid to the farmer for the animal and the gain is the net income after subtracting feeding cost. The feeding cost is assumed to be around 0.3€/kg (carcass weight).

The optimal price and gain for the farmer is actually 90 kilos even after subtracting the penalty on the price. This means that it is advantageous for the farmer to deliver a higher livestock-weight to the slaughterhouse and to make sure that the carcass weight is as close as possible to 90 kilograms thus securing the farmer an optimal revenue. A carcass weight of 90 kilograms is equal to a livestock weight of approx. 122 kilograms.

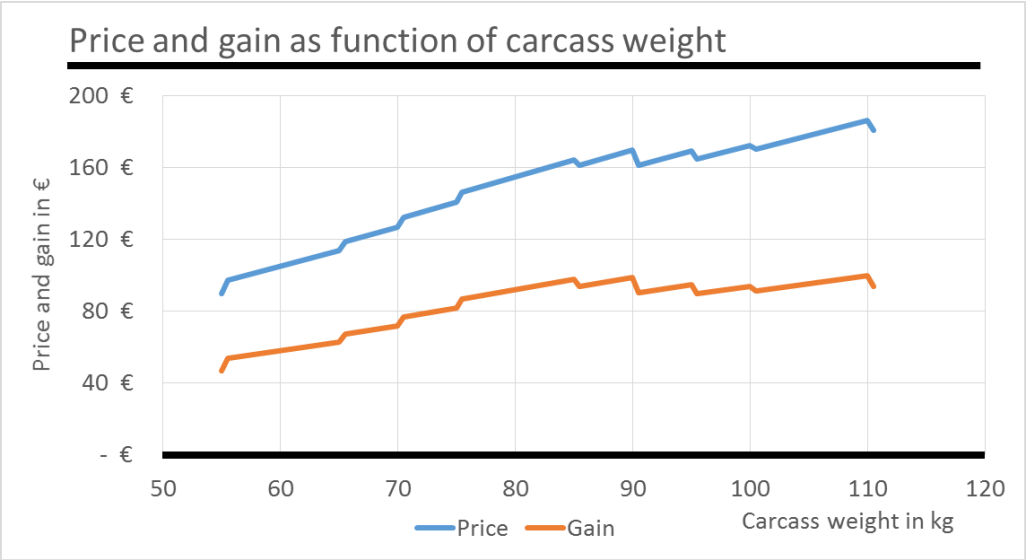


Figure 4: The price and gain as a function of the carcass weight

Figure 4 also reveals that if the weight surpasses the target weight of 90 kilograms, there is a relatively large penalty on the price and since the farmer has an estimation error of 5 percent he has to stay well below the target-weight in order to avoid the penalty. In contrast the PLF-technology has an estimation error of only 1 percent which allows the farmer to deliver a more optimal weight to the slaughterhouse.

Determination of ideal slaughter weight (around 85kg carcass weight for the above slaughterhouse) is subject to an error in estimating the weight. Particularly with narrower weight distributions (i.e. where most of the pigs have very similar weights), the precision is very important. If weight is determined incorrectly, the farmer suffers an opportunity loss and/or a price penalty at the slaughterhouse.

In Figure 5 (left) we show the optimal gain of one farm delivering to the above slaughterhouse in function of the standard deviation of the pig weight. As can be seen clearly, a lower standard deviation leads to better financial results.

It is a known fact (Black *et al.*, 2001) that several factors impact the width of the weight distribution, health issues being one of them. We are convinced that technologies such as respiratory health detection, activity measurements and feed intake measurements have the potential to demonstrate their measurable economic value from this curve. However, it is still unclear how to isolate the impact of early warnings.

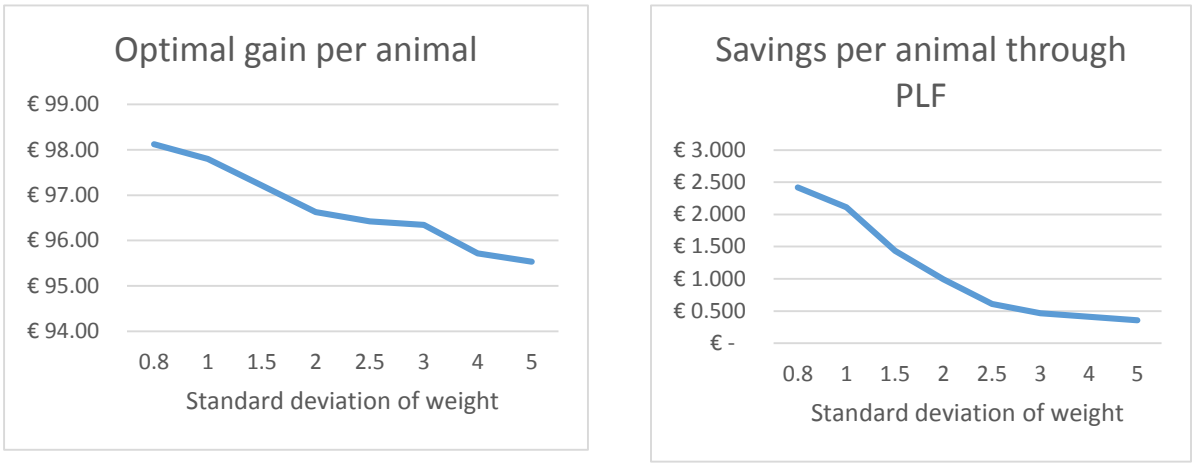


Figure 5 On the left, optimal gain per pig in function of the standard deviation of the weight distribution. On the right, optimal savings per 1,000 animals when using a PLF technology with 1kg error as opposed to visual estimation with about 5kg error.

On the right hand side we show the savings per 1,000 animals assuming that the PLF technology measures weight with 1kg error and the visual estimation of weight has an error of 5kg, as reported by farmers. The 1kg error is supported by on farm measurements of the contactless weighing technology cited above.

It can clearly be seen that SmartFarming has an impact on those farms that attempt to optimise their returns – and at the same time wish to monitor welfare of the animals (which in Spain has currently little economic incentive). With 2.5 fattening rounds per year, a 1,000 animal farm can improve its result by almost 9,000€ per year, which certainly gives rise to an investment case for the weighing technology.

Evaluating semi-tangible impacts

From the analysis of the tangible impacts we can conclude that the PLF-technology does add value to the farmers. But it is only in a limited number of cases that it is possible to estimate the earnings directly related to the installation of the technology. In many cases an evaluation of the technology has to be done through assessments of more indirect effects.

One example of this is that the technology offers the farmer the possibility to monitor the livestock through automatic detection of temperature, coughing, activity etc. Thus the farmer has, through the technology, added control over the livestock. This increases the control and allows the farmer to act in advance in order to solve the problems before they escalate.

Figure 7 shows a real example from one of the farms of the project, where coughing was detected and logged in compartment A and B. It can be seen that increased coughing was detected between 13/8 and 24/8 on both compartments.

The farmer received a message via SMS which allowed him to act faster and the animals were treated with medicines to prevent the spread of the disease and try to avoid deviation from the target growth curve.

Even though it is clear that the technology both reduces the need for medication and gives a better growth curve – both of which affect the earnings in the farm - it is still not easy to get a value in € for these actions.

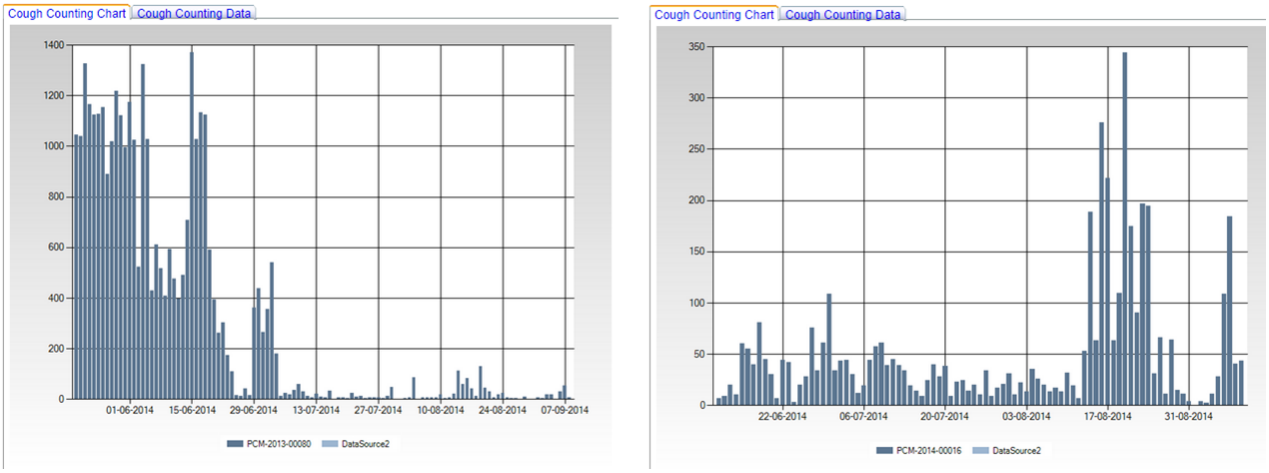


Figure 7: Coughing detection and logging in compartment A (left) and B (right)

Since it is difficult to estimate the monetary value of the semi-tangible aspects of the technology the questionnaire is designed to get the farmer to evaluate them. Part B of the questionnaire evaluates some of these aspects.

Table 5 shows the results from the questionnaire part B on semi-tangible aspects.

Regarding **monitoring the activity of the animals**, answers were mostly on the side of some sense of control and that it helps to detect some incidences. One of the farmers declared better event detection and higher sense of control, while two farmers indicated a somewhat better event detection and some sense of control.

Regarding **SMS alarm when coughing** (only installed on two farms) there was no clear answer since one farmer indicated better event detection and higher sense of control, while the other farmer indicated a somewhat better event detection and some sense of control.

Regarding **environmental detection** answers were mostly on the side of some sense of control and that it helps to detect some incidences. One of the farmers declared better event detection and higher sense of control, while two farmers indicated a somewhat better event detection and some sense of control.

Table 7: Farmers evaluations on activity monitoring, coughing and environmental sensors

Sense of control		Event detection	
0%	None	0%	None
25%	Some	25%	Some
50%	Regular	50%	Average
75%	High	75%	More
100%	Excellent	100%	Much more

PLF Technology		Sense of control	Event detection
Activity monitor	0%		
	25%	2	2
	50%		
	75%	1	1
	100%		
SMS alarm coughing	0%		
	25%	1	1
	50%		
	75%	1	1
	100%		
Environmental sensors	0%		
	25%	2	2
	50%		
	75%	1	1
	100%		

The results from the questionnaire thus indicate that the technology gives the farmers some better sense of control in running the farms.

Evaluating intangible impacts

With an intangible impact it is hard to identify the value generated in € and the value must instead be estimated through the response of the farmers.

One example of intangible impacts of a technology already implemented on many farms is AMS, automatic milking systems that are widely accepted in the dairy industry although it has never been demonstrated that there exists a positive monetary return on the investment.

The farmers clearly prefer not to spend time on this activity so the conclusion must be that there is a value, otherwise the farmer would milk the cows in a traditional manner instead of using AMS.

Part B and C of the questionnaire was designed to evaluate the response of the farmers.

Table 8: Answers on the questionnaire regarding the impact of the PLF-technology.

PLF impact	Lot worse with technologies	Worse with technologies	The same with technologies	Better with technologies	Much better with technologies	n/a
Question						
Monitoring animals everywhere				2	2	
Helps control feed quality				3	1	
Avoid welfare problems			1	2	1	
Possibility to control incidences				3	1	
Helps to improve customer loyalty			1	2	1	
Helps marketing: new clients			1	1	2	
Social recognition				2	2	
Attractiveness for investors				3		1
Labour conditions				3	1	
Job satisfaction			1	2	1	

Table 8 shows the farmers answers to some of the intangible impacts.

From a technical point of view, control of the feed quality and incidences was most important for the farmers and the technology improved the control in both cases.

From a social point of view, improved labour conditions and attractiveness for investors were the most important questions and the evaluation showed that the technology improved both labour conditions and attractiveness for investors.

In fact most of the answers were 'Better with technologies' or 'Much better with technologies'. Thus the overall conclusion was clearly that the performance was better with PLF in spite the fact that the technologies were not fully operational.

Farmers' evaluation of the PLF-technology

Furthermore the farmers were asked the following question:

> "How much would you pay for a daily report service including feed consumption for the full farm?"

There was a mixed response from the different farmers with an average of 325 €/month.

Assuming paying 325€ / month this would correspond to 325€ x 12 months = 3.900€ / year.

It can be reiterated that the calculations from the tangible part showed that by lowering the estimation error of the weight of the animals delivered to the slaughterhouse from 5 percent to 1 percent the farmer can gain an extra yearly income of 12,614€ / year.

PLF and supply chain value creation

However, the ALL-SMART-PIGS project wanted to go one step beyond simple data capture and on-farm visualisation for more efficient management that normally is considered the focus of Precision Livestock Farming. The project explored the value of exchanging data using traceability between supply chain partners (see Figure), in particular between:

1. Feed providers
2. Farms
3. Slaughterhouses/cutting rooms

Due to the lack of access to real data, feed manufacturers have to rely on test or research farms, farmers have to rely on experience and the offering of the feed industry and slaughterhouses have little influence on the meat quality, with exception of fines for off-spec animals. Given that even slight decreases of feed need make huge differences on micro and macro level, the current approach is not optimal.

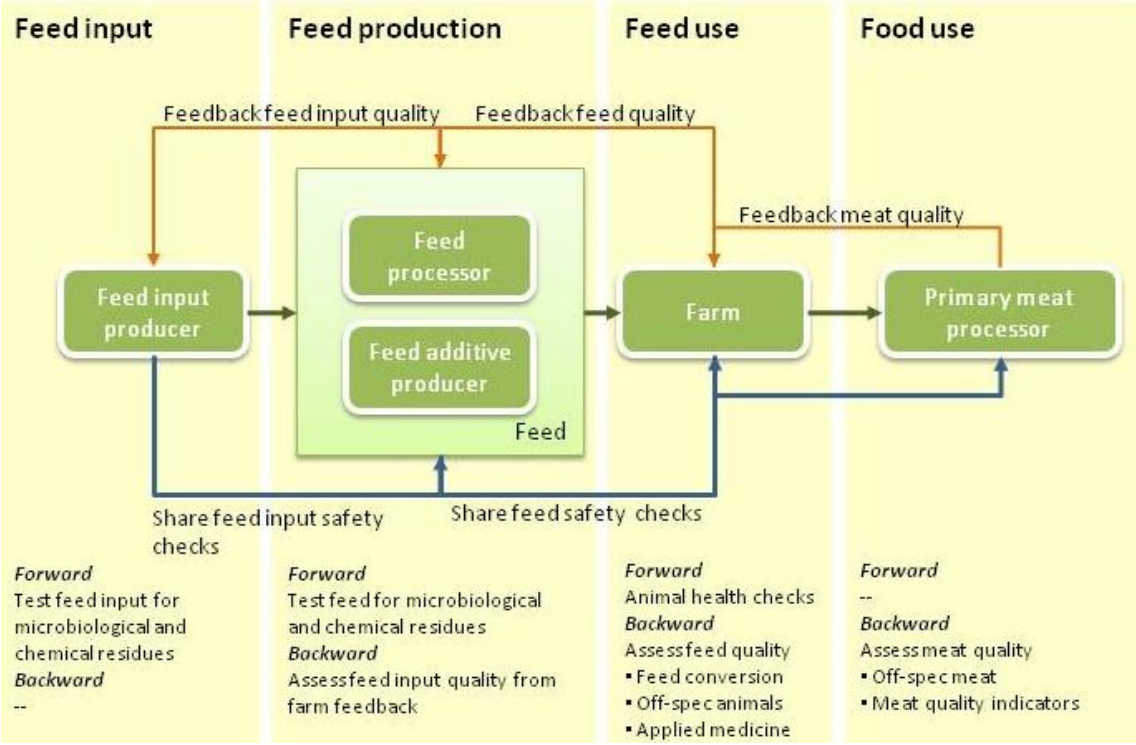


Figure 8 Feed(back) on the feed-animal-food chain

The starting point was our suggestion for a privately run system where carcass composition data is made available to farmers for their individual animals. Farmers would then (via an electronic system) make averaged data available to the respective feed producers who can aggregate this data with that from other farms to judge the performance of their feed compositions (Lehr, 2011, Lehr, 2013). Based on real and massive data, feed producers can on one hand optimise their products and on the other hand offer better products to individual farms.

The Danish Catellae System is an example where such an approach has been used, in this case for poultry. After some initial resistance, the system is now used by 100% of the Danish poultry farmers thanks to pressure by larger buyers, but also due to the optimisation potential that such a system allows (Bunkenborg, 2013).

Through the open co-creation method described above, ALL-SMART-PIGS was able to confirm the value of such a feed-animal-food traceability system. In particular, the parameters shown in Table 7 have been considered to be of interest by feed companies, farmers and slaughterhouses.

Table 9 Validated concept for information exchange along the feed - animal - food chain

Feed provider to farmer	
Purpose	1. Historic cost of feed per kg of meat 2. Target growth curve for service agreement 3. Service level (e.g. % protein, minimum % corn etc)
Main data elements	1. Historic cost of feed per kg of meat 2. At beginning of fattening period growth curve (set of data points, potentially in function of target start and end weights) 3. Updated nutritional profile per delivery
Other data	Feed identification (Feed type, delivery identifier/date and a farm/silo)
Farmer to feed provider	
Purpose	Manage changes in composition with respect to farm indicators such as weight gain and feed consumption
Main data elements	Per feed identifier (may require a link between pen and silo; for project we can assume one feed per farm) and per day 1. Avg. weight (kg) 2. Avg. feed dispensed per animal (kg) 3. Avg. activity index 4. Avg. cough index 5. Avg. effective temperature 6. Change in ammonia concentration with respect to 1-2 days before
Other data	Number of pigs per pen over time
Farmer to farmer	
Purpose	Understand the performance of the farm relative to peers (weight gain at a particular age, incidences of respiratory diseases, variability of pig weight and lean meat %, activity indexes (under certain environmental conditions and/or feed composition), mortality
Main data elements	1. Deliver to the system: weight gain at day of production, weight variance, cough index, activity index, variance in lean meat % at end of cycle, mortality 2. Receive from system: offset from average of the above indicators
Farmer to slaughterhouse/cutting room	
Purpose	1. Quality control (and risk control) 2. Being able to offer differentiated products
Main data elements	1. Transport date, time and duration 2. Transport type (smooth road or unpaved path, ventilated/non-ventilated lorry) 3. Time of last feeding 4. Genetics 5. Feed type 6. Cough index 7. Treatments
Slaughterhouse/cutting room to farmer	
Purpose	8. Weight and composition data to optimise the feeding process 9. Understanding non-compliances
Main data elements	1. Per pig: live weight, carcass weight, carcass classification and lean meat % 2. Observations meat quality 3. Vet report/quality department report
Slaughterhouse/cutting room to feed provider	
Purpose	Weight and composition data to optimise the feeding process (on average over farms)
Main data elements	Via farm: Avg. pig weight, carcass classification and lean meat %
Other data	1. Environmental conditions 2. Farm age 3. Type of production systems 4. Health problems before fattening (e.g. diarrhoea in piglet)

This research is now being continued within the EU-PLF project and an economic evaluation of such information elements will be published in due time.

DEVIATIONS FROM THE DOW

The accomplishment of the objective of WP 4 was severely hindered by the difficulties in obtaining reliable data from the installed PLF equipment. As explained in detail in task 2.6 and Deliverable 4.1 the problems ranged from simple internet connections issues to significant engineering design problems in observing and detecting the feed due to its composition compared to what the particular PLF technology was able to detect. In addition delays in installation and different farm management practices affected the data gathering process, e.g. collecting the baseline information and commencement of fattening rounds.

However, it is important to keep in mind that the demonstrated technologies are in the late stage of their development stage and ALL-SMART-PIGS is an opportunity to test them under real life conditions. The project has clearly demonstrated a range of challenges, and many of them of such basic nature, that comprehensive data analysis for economic performances are meaningless due to the low data quality.

Task/ MS/D	Title or Change in approach	Delays in Milestone	Delays in Deliverable	Justification
T4.2	The original aim was to evaluate four fattening rounds. Instead one fattening round was fully evaluated and data are available from 2,5 fatening round			Not possible to make a full evaluation due to the fact that some of the technologies were not working as expected until late in the project.
T4.2.	Formal interim reports were not made as anticipated – instead partner SIU and IRTA presented and discussed the available data on web from different technologies with the farmers during the demonstration period.			It was meaningless to present data reports to farmers which with poor data quality and there misleading values. In addition, farmers were not interested in report as such, but in online information and comparison.
T4.3.	In order to compensate for lack of tangible data the project decided to use A) quantitative technical data related to farm business, B) qualitative data to evaluate the sense of control and the event detection for the farmer provided by the technology, and C) qualitative data to be able to evaluate how the technology could improve the performance of the full			In this way we have been able to obtain reliable information about quantification of level of improvements archived on farms using the SMART Pig Applications and how well these addresses the needs and expectations of the farmers – and this was the main objective with the WP.

	supply chain (feed provider -> farmer -> slaughterhouse).			

RESOURCE USE
Please see the general section on resource use.

For WP4, all efforts are considered to be in line with Annex I and resources are considered to have been spent in accordance with the provision. For effort use as a consequence of fewer completed fattening rounds, please see comments to resource use in WP3.

3.2.2.5 WP5 Living Lab Facilitation

SUMMARY AND SIGNIFICANT RESULTS

The main aim of WP5 is to demonstrate the LivingLab (LL) method as a way to market and develop Smart Pig Farming Applications.

A LivingLab is a gathering of partnerships in which businesses, authorities and citizens work together in a shared arena creating, validating and testing new ideas, services and technologies in real-world environments.

The specific objectives for WP5 are:

1. Select LL participants related to the 4 pig farmers in the LivingLab
2. Train the regional partners in LL facilitation
3. Supervise and monitor the LL activities with respect to co-creation, exploration, demonstration and evaluation.
4. Collate information and develop potential business plans for Smart Pig Farming Applications.
5. Evaluate the LL methodology in terms of translating scientic knowledge to applications and innovative products and services.

From the early start of the ALL-SMART-PIGS, users (primary and secondary) have been engaged to take an active part in the creation of the innovative technology solutions, and it has been essential to interact with the primary users in their real-world context i.e. on their farms. Except from the initial workshops the contact with farmers have been in their day to day setting during this first year.

The work process in the LivingLab is based on the spiral model illustrated below and during the first year the iterative cycles, *Concept design* and *Prototype design*, have been "run through". At the end of the 1st Report period (M10/11) the work in the LivingLab process moved into the third interactive cycle *Final system design*.

See the spiral model below.

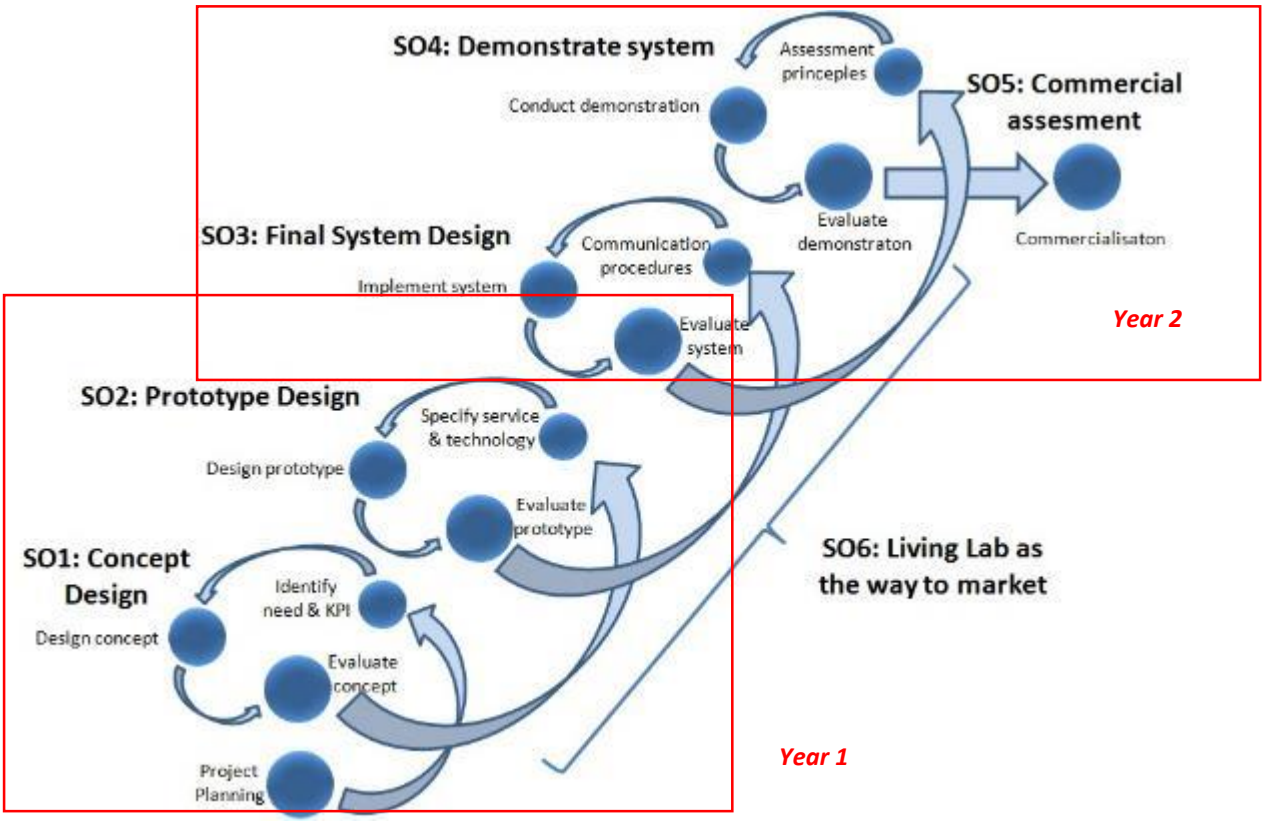


Figure 8 The ALL-SMART-PIGS LivingLab process

The work in WP5 is of a methodological nature and the delays outlined in WP2 and WP3 has not had any significant impact on the supervision- and facilitation activities in the LivingLab process, but the project work has moved into the third and fourth iteration phase with a delay of approximately 5-6 months before moving to the fourth iteration cycle "Demonstration".

PROGRESS ON SPECIFIC TASKS

Task 5.1: **Selection of LivingLab participants**

Lead: SYN

Description*: Based on recommendation from WP1 and in agreement with the ALL-SMART-PIGS partner decide on LL participants.*

This task was completed in the first reporting period. In accordance with the LivingLab method the participants were categorized as primary and secondary users respectively. The four farmers in Spain and Hungary are defined as primary users of the PLF technologies and has a high degree of user involvement in the LivingLab process. Representatives from slaughterhouses, food suppliers, veterinarians and consumers are defined as secondary users of the PLF technologies and are involved to a lower degree in the LivingLab process (have weak control).

The two Spanish farms selected are located at:

- La Lluçanesa-GEPORK
- Granja Mir

The two Hungarian farms selected are located at:

- Gyor
- Zalagerszeg

All farms have four identical compartments of 100-200 pigs per compartment on same or similar pig house.

Task 5.2: **Provide training to Partner IRTA and SIU on LL facilitation**

Lead: SYN

Description: *Ensure understanding among the other ALL-SMART-PIGS partners for the LL methodology and provide training on facilitation techniques relevant for LL processes to partner IRTA and SIU.*

This task was completed in the first reporting period.

Task 5.3: Supervision of LivingLab activities

Lead: SYN

Description: *Partner SYN will be responsible for the activities and anticipated achievements of the LL. This implies supervision based on principles for situational based leadership during the lifetime of the LL. The ALL-SMART-PIGS project is committed to an open and transparent communication between all partners and stakeholders. It is necessary in a LL project that partners at any time have a common understanding of the project activities in order to be able to identify needs, problems and obtain results. This means that communication and integration between the ALL-SMART-PIGS, the partners and its user groups are important issues. In addition to regular WP meetings, seminars and workshops, tools are implemented for inter-communication, which includes intranet and project discussion forums such as webinar. An open character is necessary in order to create commitment and therefore the ALL-SMART-PIGS will greatly benefit from an open and trust based approach. As a principle, the ALL-SMART-PIGS is committed to share knowledge among all partners involved – both internally and externally.*

During the iterations of the LivingLab process, the LL supervision motivated the participants to Co-create, Explore and Evaluate in the development phases in order to come up with a sufficient system implementation.

At the same time the supervision was based on the LL principles of: continuity, openness, realism, empowerment of users and Spontaneity. Transparent and open communication has been an important principle in the communication with the LivingLab. Project meetings have been almost weekly during the first year and apart from the workshops and survey interviews Partners - IRTA and SIU, has been in a steady contact with the four farmers and their staff conveying useful information between project partners and LivingLab participants.

On the meeting on June 17th, 2013 the LL participants agreed to trial the information system and its services and contribute data to it if such data is not shared between competitors. The trials were planned to begin in January 2014 thereby moving the project to the fourth LL iteration cycle “Demonstration”.

During the demonstration phase of the project the technology providers have visited the farms regularly. The LL supervisor from SYN and the two facilitators from partner IRTA and partner SIU have visited both farms in relation to survey activities. The following table sums up the visits during 2014:

	First interview	Follow up	Follow up
Farm 1	Farm visit 21/5/14	Farm visit 28/7/14, within EU-PLF (Prof Hartung)	Email questionnaire, fill out by the farmer by telephone 30/9/14
Farm 2	Farm visit 21/5/14	Farm visit 28/7/14, within EU-PLF (Prof Hartung)	Email questionnaire sent 15/9/14
Farm 3	Farm visit 22/7/14	Email questionnaire, fill out by farmer and Norbert 18/9/14	
Farm 4	Farm visit 23/7/14	Email questionnaire, fill out by farmer and Norbert 22/9/14	
Feed provider		Email questionnaire	
Slaughterhouse		Email questionnaire	

In June 2014 a workshop was arranged for representatives from the feed provider and slaughterhouse to discuss and evaluate important issues in relation to the technologies and the measurement results.

The agenda for the different LL events are attached and presentations are available on the project webpage www.all-smart-pigs.org.

Task 5.4. Business Plan for SMART Pig Applications

Lead: SYN

Collate information relevant for assessing and developing a business plan for SMART Pig Applications. The idea is that a PLF Service provider can be assigned by the farmer to analyse, design, implement and monitor the operational processes covered by PLF. This should make it possible for the farmer to implement PLF without being a "PLF process expert" from day one. To some degree this can be compared with an accounting system and the fact, that many SME's outsource financial management to service providers of accounting systems and book keeping services. This task will seek to develop and verify a business plan based on this idea. The payment of the PLF service provider could be a mixture of fixed payment, performance based and leasing of tools and instrument provided. Such a "low investment" profile would also ease the access to the farmers with PLF technologies. One recommendation of the BRIGHT ANIMAL FP7 project was to demonstrate full scale and real time showcase of PLF on a very concrete level in order to enable a more rapid adaption by farmers, as it will be possible to demonstrate economical costs and benefits and a balanced view with respect to the stakeholder groups. However, in ALL-SMART-PIGS the scope is limited to only one animal group – pigs, the cost-benefit analysis are limited to the data obtained from the four LL farms in two countries/cultures, and a limited number of technologies, which by no means do embrace the full extent of business opportunities and models that can be applied within the PLF domain. The output will be a template business plan for a service provider of SMART Pig Applications.

Technology uptake is increasing in all areas of humankind, and there is very little doubt that this will extend in the future to livestock farms. SmartFarming is certainly the future of livestock farming, in particular since it addresses the balance between practicality (efficiency, economic return) and acceptability (concern for animal health and welfare).

Experience of installation of Smart Pig Farming technologies on commercial farms clearly shows that the technologies have to improve their robustness. Reliance on internet for data transmission is a particularly tedious problem. Other more mundane problems include for example the depositing of fly faeces on camera lenses, which impacts weight and activity measurements.

There is a clearly measurable value in some technologies. In fattening animals the easiest directly measurable economic impact is related to determining the slaughter weight correctly and/or shortening the fattening period once growth flattens out.

However there are many SmartFarming technologies whose value is clear, but not yet directly quantifiable. Most of these have an impact in animal health and welfare, where the hard economics need to be substituted by softer values.

Further socio-economic research, currently being carried out in the EU-PLF project will make value creation on farm and in the supply chain more concrete. Models are under development that will allow a more direct cost-benefit calculation.

In figure 10 the processes are illustrated as a flow chart with four main categories: Design, Monitoring, Decision and Correction. The system is based on a total quality management principles, where corrected actions feed into a loop of new monitoring and control. The economic analysis gives a persuasive rationale about the benefits of PLF. The flow-chart supports this rationale by ensuring that any divergence from optimal economic performance is rectified by control and correction mechanisms, that are automated.

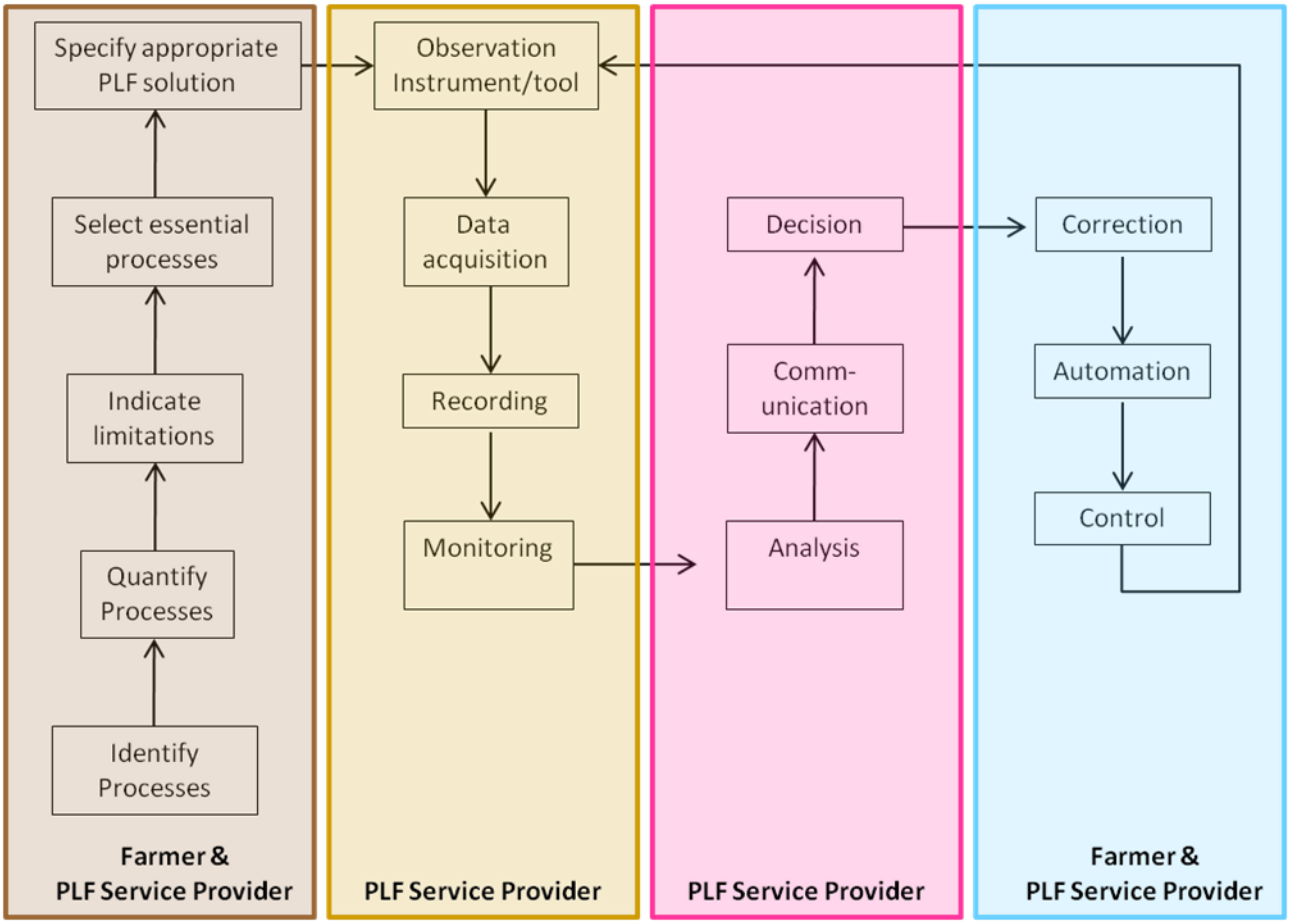


Figure 10: SMART Pig farming service flow

The practical approach is partly based on the fact, that only the most essential elements are selected to the PLF system, partly that the system is automated and finally the idea is, that a "PLF Service Provider" is assigned by the farmer to analyse, design, implement and monitor the processes covered by PLF.

According to Deliverable 1.1 in ALL-SMART-PIGS the most important user needs and key performance indicators regarding the 6 PLF technologies implemented in ALL-SMART-PIGS, detected with a Living Lab approach (questionnaires and workshops) with 4 farmers in Spain and Hungary.

User needs

1. Lower feed usage
2. Feedback on feed composition performance
3. Lower risk of disease with faster detection of problems
4. Lower aggression
5. Breeding help
6. Optimal control of slaughter weight

Key performance indicators

1. Feed conversion rate
2. Feed composition performance
3. Healthier pigs
4. Lower losses because of aggression (penalization and death)
5. Shorter fattening rounds (growth speed)
6. Improved price

A key objective of the project is to translate the output of sensors into PLF service packages for farmers referred to as SMART Pig Apllications. In ALL-SMART-PIGS deliverable 4.1. the following diagram showing the general dataflow of the SMART pig application system was presented:

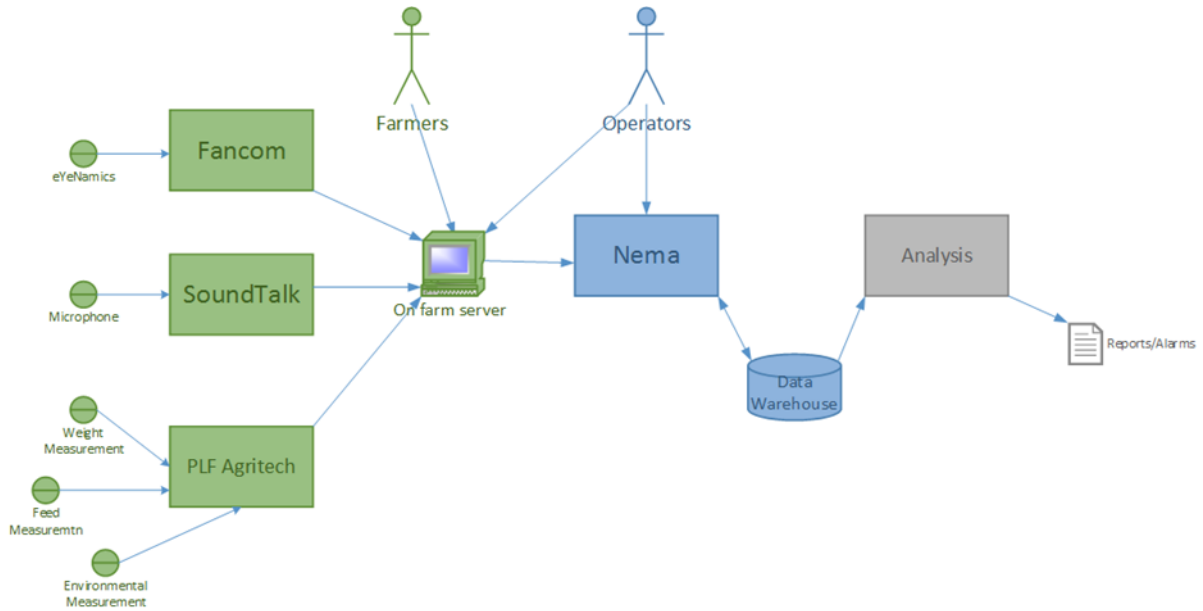


Figure 11: Diagram of the general dataflow of the SMART Pig Application

The economic impacts from the technology can be divided into direct and indirect impacts:

- **Direct impacts** for the technology user: for example, the farmer's revenue will rise if the technology allows him to optimize the weight of the livestock when delivered to the slaughterhouse.
- **Indirect impacts**, in the supply chain: for example, if the farmer can monitor the feed performance and share it with the feed provider in an automated way, the feed provider can change very quickly the feed mix, creating value.

The direct impacts are easier to measure and quantify while the indirect impacts may require considerable longer experience with the technology before they fully emerge and can be evaluated.

From an impact point of view the results can also be classified into: tangible, semi-tangible and intangible.

- Tangible: easy to identify the value generated in €. For example monitor the weight or feed consumption.
- Semi-tangible: sometimes it is possible to identify the value generated in € fully or partially. For example, monitor coughing, activity or occupation.
- Intangible: hard to identify the value generated in €. For example, reputation won when the animal wealth increases due to the technologies installed.

The tangible, semi-tangible and intangible impacts were evaluated in delvierabl 4.1. in ALL-SMART-PIGS.

This should make it possible for the farmer to implement PLF without being a "PLF process expert" from day one. To some degree this can be compared with accounting system and the fact, that many SME's outsource financial management to service providers of accounting systems and book keeping services.

The farmers valuation of the implemented PLF-technologies was a mixed response from the different farmers with an average of 325 €/month. Assuming paying 325€ / month this would correspond to 325€ x 12 months = 3.900€ / year.

It can be reiterated that the calculations from the tangible part showed that by lowering the estimation error of the weight of the animals delivered to the slaughterhouse from 5 percent to 1 percent the farmer can gain an extra yearly income of 12,614€ / year.

It thus seems clear that the value of the PLF-technology for the farms should be at least 12,614€ / year which clearly indicates that the full potential of the PLF-technology is not yet fully demonstrated to the farmers.

The payment of the PLF service provider could be a mixture of fixed payment, performance based and leasing of tools and instrument provided. Such a "low investment" profile would also ease the access to the farmers with PLF technologies.

The technologies demonstrated in ALL-SMART-PIGS do not carry a sales price from the providers – neither as a one off purchase nor Software/Hardware as a Service. Thus it is impossible to perform an exact net present value calculation of the system. However, if we make the assumption, that the SMART Pig Applications will follow a value based price strategy and that system has maximum depreciation time of 5 years, the cost of equipment and system ranges from €19.500 to €63.070 based on the annual savings for the farmer as described above. This includes equipment and service. If we use an average interest rate of 10% the net present value of equipment + service + profit is between €14.764 and €47.816. The latter number seems to contain business potential – the other is very doubtful as a business prospect. This number will also be affected by the size of the pig farm – and thus the potential saving due to scale of operation compared to investment.

According to the FAO the global pig production counts almost 1 billion heads of pigs. China is the largest producer with 49% and EU is the 2nd largest producer with 16%, while USA and Canada produces 8% of the total pig production.

In 2010 there were 152 million heads of pigs in EU-27, a slight decrease of 2 % compared to 2005. In figure 12 the top 15 pig producing countries in Europe are listed

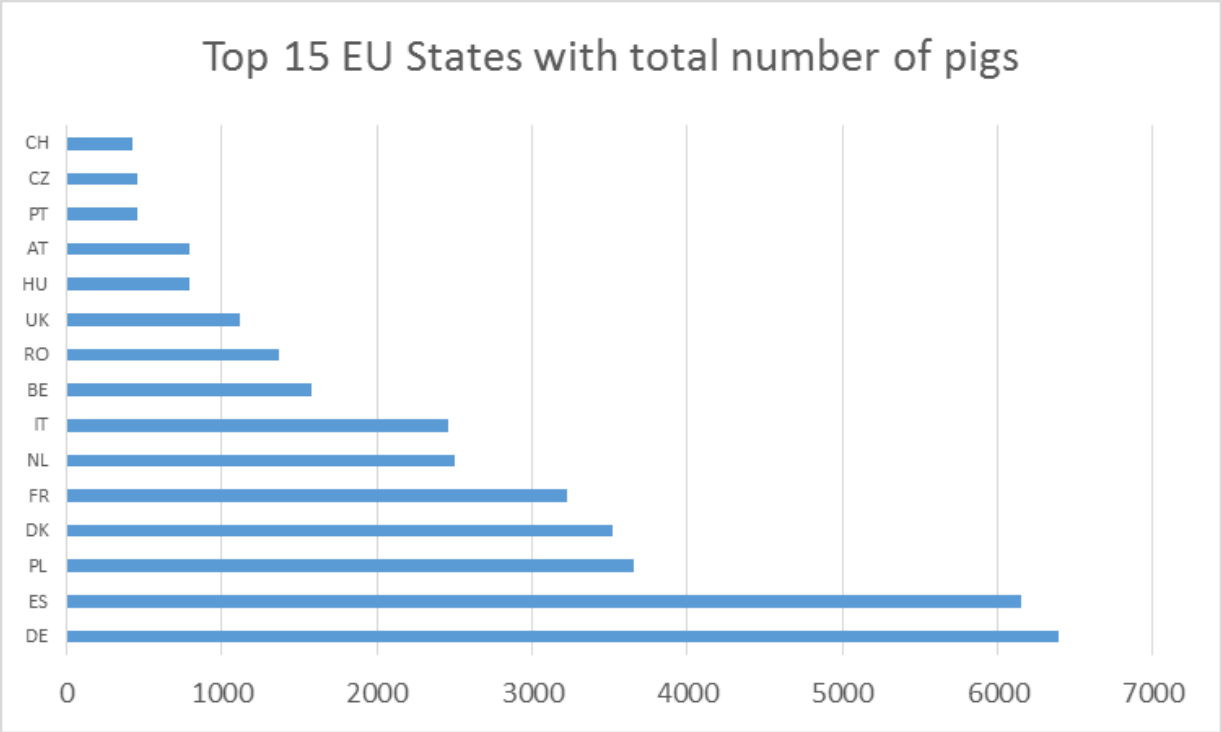


Figure 12: Top 15 EU states with total number of pigs (in 1000) produced in 2010.
Source: FSS 2010 in Eurostat (2015)

A large part of the pig population in 2010 in EU-27 is found in Germany (17 %), Spain (17 %), Poland (10 %), Denmark (9 %), France (9 %), Netherlands (7 %) and Italy (7 %). The pig population (decreased between 2005 and 2010 in most Member States with reductions over 20 % in Bulgaria, Czech Republic, Cyprus, Lithuania, Hungary, Slovenia and Slovakia, while pig populations increased in Denmark (+10 %), Estonia (+13 %), Greece (+4 %), Spain (+5 %), Italy (+7 %), Netherlands (+5 %) and remained more or less stable in Belgium, France, Austria, Portugal, Finland and Romania.

In EU-28 in 2010 70 % of the pigs are found on holdings with 1000 or more heads of pigs, 14 % is found on holdings with 400 - 999 heads of pigs and the remaining 16 % is found on holdings with less than 400 heads of pigs.

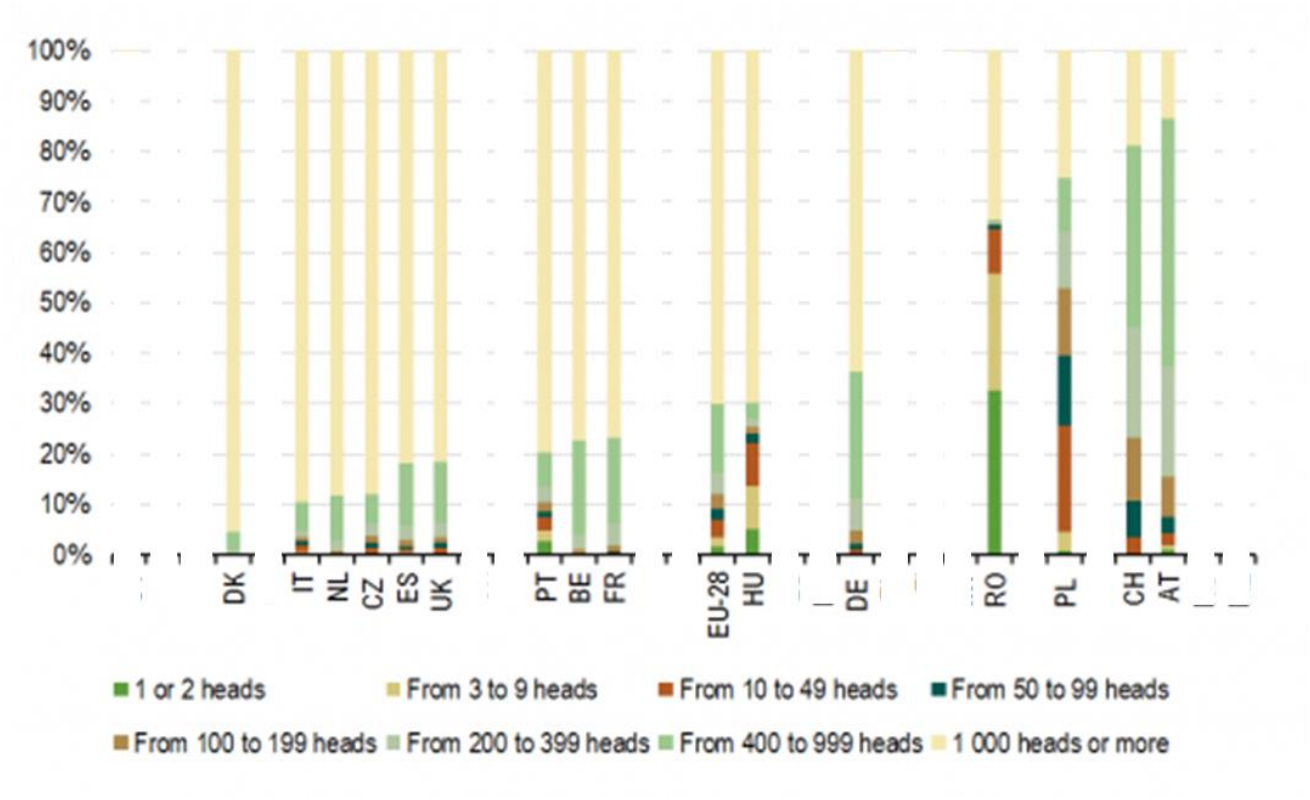


Figure 13: Heads of pig by size of holding (number of heads of pig) in Top 15 EU states
Source: FSS 2010 in Eurostat (2015)

If the target market is defined to be the top 15 pig producers countries in Europe, between 70% and 95% of the farms will have heards of pigs larger than 1000 heads of pig. However in Germany almost 30% of the farms have heards of 400-999 heads of pigs). In Romania 34 % of the pigs is found on holdings with 1 000 or more heads another 56 % on holdings with 1-9 pigs.

In order to estimate the market potential for SMART Pig Applications we need to know the number of farms in the target market, and how many heads of pigs these farms have. It has not been possible to find exact information on these parameters. However we can make some assumptions based on national statistical information. According to INRA, France (2012) there are 22.300 pig farms in France with in average 620 pigs/farm. According to Danish Agriculture & Food Council (2014) there are 3042 pig farms in Denmark with in average 5200 pigs/farm. If we decide on a average number of 1500 pigs/farm, we can assume that there are approximately 100.000 pig farmers in the top 15 producers countries in Europe.

If we use the annual savings identified in ALL-SMART-PIGS on this average number of pig farms, and we assume that pig farmers are willing to at least pay the same amount for the services as the tangible savings, then we can estimate the total potential market for SMART Pig Application to be between €390 million and €1.3 Billion per year. This estimated business-to-business market size represents an interesting business opportunity.

Task 5.5. Evaluation of the LL methodology
Lead: SYN

In order to contribute to search for an efficient way to bring scientific knowledge to applications and innovative products and services, this task will evaluate the LL methodology as a mean to boost the translation

of FP research into commercial solutions, based on the experience in the 4 farms and the obtained results. In order to contribute to search for an efficient way to bring scientific knowledge to applications and innovative

When evaluating the LL methodology we focused on the ability of the method to translate scientific knowledge into applications and innovative products and services that will reach the market.

The Living Lab method has five core principles that act as guidelines in the innovation development processes. When Living Labs bring the core principles into practice, they are expected to reach goals like efficiency and creativity[3].

To evaluate the method in relation to translating scientific knowledge into applications, innovative products and services we evaluate the five core or key principles. Did the project process reach creativity and efficiency (based on the five core principles)?

The five core principles are:

1. Openness
2. Continuity
3. Realism
4. Spontaneity
5. Empowerment of users

Openness

The key principle of openness regards the involvement of stakeholders that possess varying perspectives, knowledge and expertise. Through networking and collaborations with different stakeholders, many different perspectives and competences are gathered that enable living labs to innovate at high speeds.

The ALL Smart Pigs has gathered users and stakeholders at several workshops, visits and webinars. As end users farmers have been an important stakeholder but the farmers network like e.g. farmers managers and workers, farms veterinarians, feed providers and farm advisors have been invited to participate in the workshops and to be involved in the development processes. The principle of openness has been explained and particularly enforced at all events and the approach has been received positively among the participants. Gathering diverse expertise and perspectives in this way has been appreciated by all project partners as well.

Continuity

The principle of Continuity is linked to the duration and frequency of the relationships in a Living Lab. In long-term and stable relations, trust develops over time, as partners are willing to be more susceptible to the risks of collaborating with other organizations, as they are ensured that their counterparts will not take advantage of their vulnerabilities. When they interact regularly, actors are presumed to be more involved in a relationship, which strengthens their mutual trust. Therefore, when regarding the continuity of a

[3] The Key Principles of Living Labs pp 12

partnership, not only is it important to regard the stability of that relation, but also to take the frequency of interactions between actors in consideration.

Considering that the ALL Smart Pigs is a relatively short and time limited cooperative project it has been challenging from time to ensuring the involvement of all stakeholders throughout the project period. A substitute for trust is the use of control mechanisms, such as written agreements and contracts. By formally agreeing over issues like confidentiality, the sharing of resources and intellectual property, the need for trust is limited.

In living labs, stable partnerships are expected to better facilitate the development of trust. However, not only the stability of networks enhances trust. The more frequent actors interact, the more familiar they will get.

Realism

Realism is concerned with the results that are generated in living labs. The results of living labs are not only developed innovations, but also the identification of users' needs, design ideas, or the outcomes of prototype testing. In a living lab, concepts and prototypes should be tested by users in situations that reflect their daily life as accurately as possible. As it is often too complex to express problems or needs in text, the richest possible picture is often represented visually.

Given the framework of the ALL Smart Pig project the *realism* principle has been enforced as far as possible. Project partners as well as technology providers have interacted with farmers, feed providers and slaughterhouses in their real working environment. The suitability of solutions is examined in the actual problem situations, with the involvement of the problem owners. This principle has been highly appreciated by users and also necessary in order to reach project output and performance.

Spontaneity

The principle of spontaneity is focused on identifying and analysing the needs and ideas of the users. Where realism is concerned with the extent to which the setting of the innovation process approximates reality, the key principle of spontaneity regards the quality and value of the information taken from that setting. Spontaneity is about detecting, aggregating and analysing the needs and ideas of users in order to develop innovations that answer and fit users' needs.

The LL supervisor and facilitators have attempted to enforce the principle of spontaneity in all communication with farmers, feed providers and slaughterhouses with satisfying feedback that have been incorporated in the user surveys – see project deliverables D2.1, D3.1 and D4.1.

Empowerment of users

An innovation process is effective if little time and effort is lost in the creation of ideas or concepts that will not be developed further as they do not meet the needs and desires of the targeted users. The key principle of user empowerment is concerned with this efficiency. Users are those individuals that are expected to benefit directly from using a product or a service.

By enabling these users to be active and empowered participants, they can steer and direct the innovation process in a desired direction, also known as user-driven innovation. However, while user involvement is valuable in innovation development, users usually lack the required knowledge or competences to

participate independently. Therefore, users have to be enabled to be engaged and participating in the development of innovations.

In this respect extensive and good communication between technology providers and users has been essential. Understanding the technologies and supporting the maintenance after installation has been challenging and might have contributed to a lower degree of empowerment of the users – less than anticipated.

Participants, users, should have access to information that is relevant for the innovation process. Information might be difficult to comprehend for persons with limited expertise in innovation development and users need to be able to make sense of that information.

Pros and cons of the Living Lab approach

In order to give an overview of the experiences with the Living Lab approach the following "pros and Cons table has been developed based on the experiences in the ALL-SMART-PIGS project:

PROS	CONS
Openness	
The Living Lab enabled an active participation from technology providers, main users (farmers) and value chain actors (slaughterhouses, feed providers and also veterinarians). Furthermore other stakeholders have been able to follow the projects through dissemination activities and collaboration with the FP7 project EU-PLF.	There are organisational and cultural differences with respect how open you can or shall be in innovations processes – especially if it concerns problems with technology that already have commercial interests to respond to. Since openness is a core element in the Living Lab methodology – the lack of openness of one or several actors make the Living Lab less efficient.
Continuity	
The local partners IRTA and SIU ensured local representation of the project, and that increased the sense of "on going" activity among the Living Lab participants. In addition, the farmers were allowed to take over the installed equipment after the end of the project, and that also increased the feeling of continuity among key users.	The limited time period of the ALL-SMART-PIGS project was not beneficial for the continuity of the Living Lab. Also the fact that the technology providers were individual suppliers scattered around Europe made it difficult to the key users to see how a SMART Pig Farming applications could be supplied on practical and commercial terms.
Realism	
A clear benefit of the Living Lab process is the high degree of realism it brings to especially the technology developers – also on issues that prior to the ALL-SMART-PIGS project were not at all considered as major implementation challenges, such as on farm installation and maintenance of internet, cabling etc.	The Living Lab process will increase expectation and excitement among key users about the technology. When the technology does not perform as anticipated – there is a risk of disappointment and demotivation among user. Expectation management is therefore very important during the process.
Spontaneity	

Ongoing communication and bi-weekly visits from the local partners enabled spontaneity with regards to adjustment of installation and monitoring practices.	The technologies used in ALL-SMART-PIGS had to a large degree reached an advanced technology development level. Therefore major re-design of the technology was difficult – also due to the limited time of the project.
Empowerment of users	
The general feedback from farmers and feed provider is that if the data shown is reliable the farmers are very interested in using the technology. Furthermore it became evident that this interest increased during the project lifetime compared to when the ALL-SMART-PIGS project commenced.	Lack of reliability of data collection form some monitoring devices, and especially the feed monitoring which is an important key performance indicator, hindered the empowerment of users during the demonstration phase of project.

Conclusions

The core aspects of the Living Lab key principles have been outlined and discussed in relation to the project development process. To really explore the practice of the key principles a comparative case study should be performed, but to deal with the question whether the LL method is suitable for translating scientific knowledge into applications and innovative products the answer is positive. The project succeeded in implementing three of four technologies and the practical approach was possible due to the LL approach involving the users and adapting the PLF technologies to the pig farmers needs and expectations. It should be noted that the pig farmers have requested to retain the equipment after the project is ended and this reflects that the 4 farmers feel it's usable.

In ALL-SMART PIGS we find the Living Lab methodology useful for accomplishing the needs for risk reduction and user acceptance in the efforts of bringing the PLF technologies to the European market – to EU pig farmers.

The user driven approach of LL with pig farmers has ensured acceptable and practical solutions.

DEVIATIONS TO THE DOW

The

Task/ MS/D	Title or Change in approach	Delays in Milestone	Delays in Deliverable	Justification
D5.1	Proposal for a Business Model form for SMART Pig Applications		M23->M24	The amounts of in-tangible data was not foreseen and took longer time than anticipated
D5.2	Report on LL methods		M23->M24	Awaiting final information from the demonstration activities

RESOURCE USE

For WP5, all efforts are considered to be in line with Annex I and resources are considered to have been spent in accordance with the provision.

3.2.2.6 WP6 Dissemination

SUMMARY AND SIGNIFICANT RESULTS

The main aim of WP6 has been to ensure adequate and wide scale dissemination of the project developments for the project partners and beyond the project boundaries. Specific objectives have included setting up of a project website to act as a means of dissemination, produce information material, attend at relevant workshops/conference, publications in relevant magazines, newspapers, newsletters, etc. and arrange for dissemination events.

The work package has surpassed its objectives. Not only have the obligatory elements been met in a timely fashion, but the project has received much more public attention than anticipated. The website was set up in time. A flyer was created, together with a modern and inspirational presentation. The project has been present at a number of international events, creating significant interest. The project and its partners have published in the scientific literature, but are also very proud of having been included in the Innovation Catalogue[4] and a video has been produced by youris.com and commnet.eu.

The collaboration with CommNet has been very useful for ALL-SMART-PIGS.

In the other strategic area of dissemination, i.e. direct industry contact, the project has been able to make very significant progress.

PROGRESS ON SPECIFIC TASKS

Task 6.1: Launch the website www.all-smart-pigs.eu.
Lead: SYN
Description: *The goal for the website is to be a powerful dissemination tool and interface between the project and the external community as well as an internal project communication tool. The project website will be set up by partner SYN with the assistance of the other partner organisations and will include:*

- *A public platform with general information about the project's approach, objectives, results, and methodology (public).*
- *A private platform for LL participants where the relevant project documents, drafts, etc. can be presented for consultation and discussion (e.g. of project results, calls for workshops, repository for project documents and images).*
- *An ALL-SMART-PIGS presentation for downloading (public).*
- *A news section with ALL-SMART-PIGS news (public).*
- *Relevant links to other web pages (public).*

SYN will be responsible for the maintenance of the web page until the end of the project duration. After the project duration the website will continue to disseminate project results. SYN will maintain the website for at least one year after the project terminates using its own financial resources and by searching for potential

[4] http://commnet.eu/01_About_CommNet/Commnet_Community/Business/Innovation_Catalogue_2013.kl

sponsors. A link directed to the ALL-SMART-PIGS website will be established on all partners' websites and on the websites of other interested stakeholders.

The website was launched on time for the kickoff meeting of ALL-SMART-PIGS on December 10th, 2013.

Figure 10 The ALL-SMART-PIGS logo in colour and in black-and-white

The website is accessible through www.all-smart-pigs.com, www.allsmartpigs.com, or www.all-smart-pigs.org.

The news section was updated regularly by Syntesa and will be operational until the end of 2016.

Task 6.2. Produce ALL-SMART-PIGS information material

Lead: SYN

Description: *Information material is essential for getting the message out to the public. Material will be produced and made available for all and will include*

1. *Production of a semi-professional video of the demonstration activities in the LL, for publication on website. The video will cover the individual technologies that are included in the ALL-SMART-PIGS project. With this video, a much larger group of farmers and other stakeholders can be reached through the placement on the website.*
2. *An ALL-SMART-PIGS presentation available for downloading.*
3. *An ALL-SMART-PIGS flyer and poster.*

The following materials were created:

- Project flyer: the flyer was made available to all partners for distribution. Printing in larger quantities is not envisaged.
- Project presentation: a modern style, inspirational presentation using Prezi was created[5]. This presentation can be given online or copied and executed locally.
- A variation of the project presentation was created in PowerPoint, this being the standard for public presentations

  A poster has not been created for the lack of need of such material.

Initial material for a semi-professional video was created and the material made available to the partners. Youris.com produced a professional video with the title "Big Brother enters pig farms" about ALL-SMART-PIGS – by the end of the project the video had more than 500 views in youtube.com.

Figure 9 The project flyer

[5] http://www.all-smart-pigs.com/index.php/2012-11-27-10-57-49/introduction

Figure 10 Screenshot of the video produces by youris.com

Task 6.3: Publication in relevant magazines, newspapers, newsletters, etc.

Lead: SYN
Description: *A further dissemination initiative will include publishing of articles in newspapers, magazines, conference proceedings, journals, etc. of relevance with the aim of promoting the work achieved under the project. The project will enter close collaboration with the magazine PigProgress and use them as a prime communication channel to the European farming community with news items on topics related to ALL-SMART-PIGS.*

ALL-SMART-PIGS decided early on in its project dissemination strategy meeting that in the first year we would not seek to publish in sector-specific newspapers and magazines, such as PigProgress. The consortium believed that it should await first results before contacting the sector press.
It should also be stressed that the Consortium does not understand ALL-SMART-PIGS as a fundamental research project: we understand it as an implementation project of research that has been already carried out to some extent using public funds. The role of ALL-SMART-PIGS is to demonstrate that these developments (a) work in commercial environments, i.e. not only under laboratory conditions or on research farms and (b) can be integrated to create real value to the farmer. Therefore it is not our focus to produce scientific publications.

Main publications during the project

- CommNet Innovation Catalogue, a catalogue of 12 hand selected EU projects in the area of bio-economy
- H. Lehr, Bogi Lenvig and Emma Fàbrega, Traceability in the feed-animal-food chain, Proceedings of EC-PLF ’13, Leuven University, p. (2013)
- Dr. Heiner Lehr from Syntesa was invited to publish an editorial about Precision Lifestock Farming in a recognized sector magazine (www.animalhealthmedia.com). The editorial introduces the results of the ALL-SMART-PIGS project as a Smart Farming showcase. The article also publishes original economic research on the profitability of continuous weight measurements by video analysis.

Task 6.4: Public dissemination events

Lead: SYN

Description: *In collaboration with regional partners arrange four ALL-SMART-PIGS LL workshops - 2 in Hungary and 2 in Spain as described in task 1.1. & 1.5. In addition ALL-SMART-PIGS will make a presentation on the 6. ECPLF conference in Leuven, Belgium, in 2013 and will also attend other relevant workshops and conferences with presentation of the project's activities.*

In relation to the second workshop held in Hungary and Spain, the project will have a half day public seminar session with presentation of project results. This seminar shall preferably be organised in collaboration with the regional or local industry associations for pig farmers, feed providers and slaughterhouse, and it will be ensured, that other relevant stakeholders will be invited.

Workshops and conferences attended during the 2nd period of the project (with presentation)

- Heiner Lehr was invited by GLOBALG.A.P., a holder of internationally well-accepted agricultural production standards, to present smart farming in pigs and poultry. Heiner was accompanied by Simon Lague, business development director of partner FANCOM. Results from both ALL-SMART-PIGS and EU-PLF were presented to members of the committee from Brazil, Germany, Netherlands and Denmark..
- DG AGRI of the European Commission brought experts in animal health to its third focus group meeting on antibiotic free pig farming. The purpose of the focus group is to allow European experts to brainstorm on pig health and the use of antibiotics, with a view to generate idea how to eliminate antibiotics from pig farming altogether. Experts included Derek Amstrong from BPEX, Prof hc Dieter Schillinger – who also serves on the advisory board of our sister project EU-PLF – and the head of the Spanish pig producer's organisation (Miguel Ángel Higuera Pascual, ANPROGAPOR) amongst others. ALL-SMART-PIGS was invited to join the exclusive meeting and present Smart Pig Farming as a way to reduce antibiotic usage in pig farming. Heiner Lehr presented how ALL-SMART-PIGS uses short and long term health indicators such as feed intake, growth monitoring and cough counting to detect health issues as soon as possible, locate them in the compartment and allow thus the selective early treatment of animals. Treating animals as early and as selectively as possible decrease the amount of antibiotics required, to the benefit of the animal, the farmer and the consumer.

- ALL-SMART-PIGS participant Dr Heiner Lehr was also invited to make an oral presentation of the paper “Traceability in the feed-animal-food chain” on the 6th EC-PLF conference in Leuven. Most efforts in the area of traceability related to animals concentrate on the animal lifecycle (birth, death and movements in between) without utilising the full range of opportunities that the bidirectional transport of information along the supply chain of feed-animal-food offers. The optimisation of feed quantities and composition, as well as feedback on the effect of management practices is of great value to farmers, feed producers and slaughterhouses. In addition to deploying on-farm technology, ALL-SMART-PIGS will attempt to evaluate the economics of information transport on the feed-animal-food chain. For this purpose slaughterhouses and feed producers have been chosen as participants in the project LivingLab. In Hungary, the pig farmers produce feed mostly independently, whereas in Spain feed is purchased. In the presentation first results from the LivingLab were presented, in particular on information elements that are economically interesting in the chain as well as the willingness to actually share such information elements.

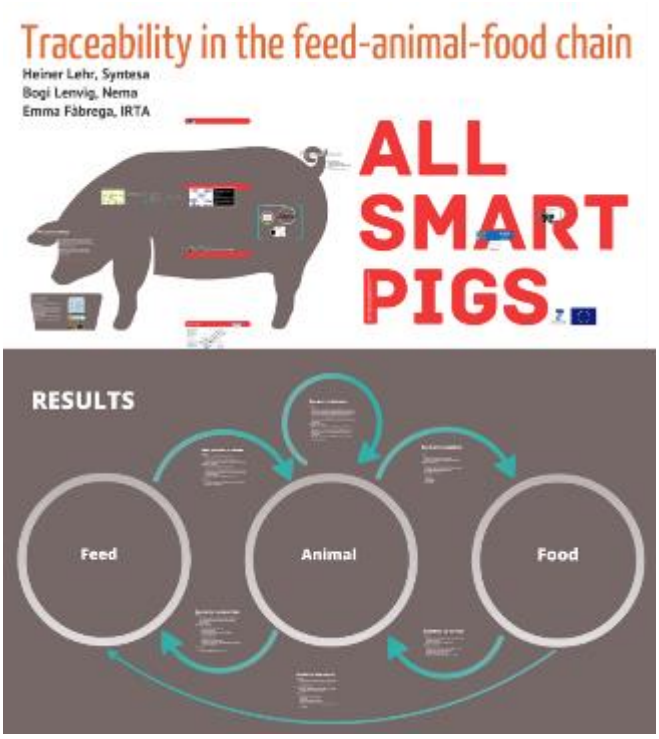


Figure 2 Impressions from the presentation at EC-PLF '13

- On 26 of August 2014, the partners of the EU-PLF and ALL-SMART-PIGS projecst met with ten farmers who are currently using PLF technology on their farms. The meeting allowed the project partners to have a better understanding of the needs and expectations of the farmers and where the equipment and tools could be improved. It was an invaluable interaction for the partners of the project. In session 5b of the Joint Session, one of the EU-PLF participants, Heiner Lehr, presented the first year results of the project on coaching and developing entrepreneurship in the field of PLF in a paper titled “Developing SmartFarming entrepreneurship – first year results EU-PLF”. In the same session, Dries Berckmans, presented a paper titled “Practical problems associated with large scale deployment of PLF technologies on commercial farms”. The paper focused on the main issues that were identified as well as solutions developed during the installation, use and maintenance of the following equipment: SoundTalk’s Cough-monitor, Fancom’s eYeNamic, PLF Agritech’s Weight-Detect™, PLF Agritech’s Feed-Detect™ and PLF Agritech’s Enviro-Detect™.
- Final Living Lab workshop and Smart Farming Seminar (public) in Vic, Barcelona (Spain) on October 2, 2014.

DEVIATIONS TO THE DOW

No devitions from Annex I.

RESOURCE USE

For general resource use please see the corresponding tables in the RESOURCE USAGE section.

For WP6, all efforts are considered to be in line with Annex I and resources are considered to have been spent in accordance with the provision.

3.2.3 Project management during the period

SUMMARY AND SIGNIFICANT RESULTS

In general, ALL-SMART-PIGS has shown to be a very efficient project with excellent cooperation between the partners.

The project has suffered a significant delay in finalising the on-farm installation of the equipment. Installations started timely, but a series of problems normal in initial installations in commercial environments have delayed the finalisation. In particular, the feed sensor encountered great difficulties due to physical space in the bins and had to be re-designed first before it could be installed. One farmer decided to change his feeders and the project had to wait before it could install some of the technology which needed to be fitted to the feeders. In-barn internet connection also proved to be a challenge. On one farm the internet provider had to install a complete new antenna in a nearby village to achieve the required network speed. Cables were broken, computer sound boards overheated etc. This must all be considered normal problems when going "from the comfort zone of science to the battlefield of business". Nevertheless, they delayed the project.

The project partners found solutions to most of these problems and managed to enter the demonstration phase of the project.

Other tasks, such as the design of a traceability system were fulfilled on time. LivingLab sessions were held where participants have grown more and more interested in the exchange of data.

Dissemination was very successfully delivered with the help of CommNet and Youris.com has produced video news item from ALL-SMART-PIGS. Industry has expressed strong interest in the project. One very large Spanish pig integrator has expressed and interest to associate itself in the form of funding a pilot with Smart Pig Farming technology. Retailer Metro has expressed an interest. UK meat producer Cranswick Country Foods has entered a conversation with ALL-SMART-PIGS and partner FANCOM. Dissemination on the very interesting market for PLF in China was successfully delivered.

Project partners collaborated in an excellent fashion. Communication usually via skype was efficient. The partners were keen to collaborate and resolve issues as fast as possible. Some of the partners have put very significant effort in making the project move forward, independently of their budget constraints.

CONSORTIUM MANAGEMENT TASKS AND ACHIEVEMENTS

Task 7.1: Activation of the project

Lead: SYN

Description: *This task is the activation of the project, which includes organising of the project secretariat, supporting the PCO, the set-up of the individual WP, the PMG and the preparation of the consortium agreement. The PCO will organise a kick-off meeting in collaboration with the EU-PLF FP7 project, where all partners will be invited, along with the Project Officer (PO) and the External Advisory Group. The agenda for*

this meeting will be the presentations of the partners, detailed plan for activity and the partners' responsibilities, to develop and obtain agreement on terms of reference and operational procedures for the PMG and provide a compatible work plan for the WPs, which will be for decision by the PMG. Invitations, agenda and minutes will be provided by the PCO.

The consortium was successfully set up and started operating on 01/11/2012. The kickoff meeting was held in a coordinated fashion with our sister project EU-PLF. ALL-SMART-PIGS kickoff was held on 10/12/2013 in Sitges (Spain).

Daniel Berckmans as representative of the Advisory Board provided a presentation to set the conceptual scene for PLF and the two sister projects EU-PLF and ALL-SMART-PIGS.

The project officer was partially present during the week and had the opportunity to listen to some of the presentations.

Task 7.2: Set up a system for project monitoring, reporting and interface with EU
Lead: SYN
Description: *To ensure and monitor progress and quality of work within the WPs, frequent communication during the project will be ensured between the PCO, PAM, PMG and all the ALL-SMART-PIG partners. Electronic or physical meetings involving everyone in the PMG will be conducted at least every 3 months, to discuss the progress, subsequent work and plan the annual project meetings. WP7 participants will decide on internal deadlines, arranging for quality control and harmonisation of input from the participants to ensure the envisaged project progress and scientific and technological excellence. An efficient web based project management system will be organised for financial and scientific project reporting, monitoring of milestones and deliverables, interacting with the WP leaders, provide transfer of knowledge and deal with all payments related to the project. The PCO will be permanent operative contact point for all reporting issues and be linked with all Partner Managers and WP leaders. This person will ensure guidelines, common formats and common tools. Furthermore, the PAM will be handling all financial issues, including bookkeeping, payments and distribution of funding to project partners. The partner managers and WP leaders will compile all reports defined in the timetable (incl. Periodic and Annual progress reports including cost statements) and a Final Report with information on milestones, deliverables and plans for the subsequent periods within three months after expiration of the WP or the project. All project participants will report on project and financial progress every six months. In case of delays in reporting from participants, the issue will be brought to the PMG. The Final Report should contain a critical evaluation of the results obtained according to the deliverables set. The PCO will present reports to the Commission and disseminate all communications received from the Commission to partners.*

The PCO has set up an email/skype meeting based system for monitoring the project's progress. Initially, the Project Management Group (PMG) had meetings every month. When it was detected that the exclusion of the few partners not in the PMG created communication problems, the methodology was changed to include all partners in the regular meetings. Since most decisions in ALL-SMART-PIGS are taken on a consensus basis, there was little need for closed meetings.

On the annual meeting on September 2013 it was decided to monitor project progress much tighter and until the end of the reporting period week update meetings were held on Fridays 10-11am. This proved to be an effective tool to finalise the installations which were done on time in the modified schedule.

For deliverables and the annual report, the PCO has provided partners with guidance and templates. A two hour presentation was prepared on scientific and financial reporting and conducted over skype. Partners were also provided with links to the original information for further information.

Task 7.3: Liaison activity with other projects
Lead: SYN
Description: *The PCO will be responsible for liaisons with other projects. Information and knowledge resulting from this activity will be made available to ALL-SMART-PIGS partners on a regular basis.*

Figure 3 Early invitation to the EC-PLF conference 2013

The PCO has maintained very close contact with our sister project EU-PLF. Syntesa sits on the Project Coordination Committee of EU-PLF and leads two work packages in that project. Since the pig farms are shared, there is a natural need to work closely together. The PCO has incorporated EU-PLF wherever possible, e.g. in the dissemination efforts.

The 2013 EC-PLF in Leuven was initially co-organised by three EU projects: BioBusiness, EU-PLF and ALL-SMART-PIGS. The PCO was part of the scientific evaluation committee. Due to the change in budget requested by the European Commission when trying to remove potentially overlapping tasks in EU-PLF and ALL-SMART-PIGS, the project was not able to contribute financially to the EC-PLF conference and its organiser status was withdrawn.

On 26 of August 2014, the partners of the EU-PLF and ALL-SMART-PIGS projecst met with ten farmers who are currently using PLF technology on their farms. The meeting allowed the project partners to have a better understanding of the needs and expectations of the farmers and where the equipment and tools could be improved. It was an invaluable interaction for the partners of the project.

In the course of its implication with CommNet, ALL-SMART-PIGS has been able to expose its work to a series of other European projects.

Task 7.4: Maintain Consortium and legal issues
Lead: SYN
Description: *PCO will support the PMG in maintaining and enforcing the Consortium Agreement of the Proposal. PMG will deal with legal issues, supported and executed by the PCO. Also, procedures for incorporating new participants will be defined and executed in this task. The maintenance of ALL-SMART-PIGS consortium will further require the organisation and execution of regular project meetings. Where necessary, PCO will support the organisation of meetings and workshops by providing invitations, agenda setting, choice of location, production of minutes and communication.*

In the course of the first project year there were no changes in the Consortium Agreement; in particular no new partners were added to the project.

The PCO has arranged regular meetings in addition to the Kickoff meeting on December 10th, 2012 in Sitges and the Annual Meeting on September 12, 2013 in Leuven, and the final meeting in Vic Spain on October 3, 2014. In addition there have been 18 skype meetings with all partners present to follow project progress,. The frequency of skype meetings increased rapidly in the fall 2013 when the risk of delay became apparent due to technical problems with installations. The PCO has provided organisation, invitation, agenda, choice of location and minutes. Such minutes are available upon request.

Problems which have occurred and how they were solved or envisaged solutions

The major problem that the project encountered was that some of the technologies could not be installed as-is, because of physical configuration issues at some of the farms. We also encountered problems typical for on-farm deployment of technology, such as network installation in the barn, network speed, broken cables, computer hardware problems etc. Despite the good effort made by the project partners, this delayed the date of operational equipment installation to November 1st, 2013. In the process, we found it helpful to monitor progress very closely in weekly meetings. This provided a status to all partners and ensured that actions were taken to meet the November 1st deadline. However even if the equipment was installed at this time, we still experience severe operational problems during the spring 2014 – especially with some parts of the equipment.

Other minor issues were discussed and resolved in the regular skype meetings of the project. One issue regarding installation costs was taken to vote by the PMG. The dissenting partner respected the decision by the PMG and executed the requested actions immediately.

In summary, ALL-SMART-PIGS has shown to be a very effective project with excellent communication and with problem resolution skills. Partners have demonstrated their dedication to the project's objectives.

Changes in the consortium, if any

No changes

List of project meetings, dates and venues

Physical project meetings in the reporting period:

Meeting type	Date	Venue
Kickoff meeting	10/12/2012	Hotel Sitges, Sitges, Spain
LivingLab session	10/12/2012	Hotel Sitges, Sitges, Spain
Farm visits	11/12/2012	Near Vic, Spain
LivingLab session	17/12/2012	St Istvan University, Hungary
Farm visits	18/12/2012	Near Budapest, Hungary
LivingLab session	31/01/2013	Vic, Spain
Creation dissemination plan	11/02/2013	Dublin, Ireland
LivingLab session	28/02/2013	Vic, Spain
LivingLab preparatory session	10/04/2013	Vic, Spain
Farm installation kickoff	16/06/2013	Near Vic, Spain
Farm installation kickoff	20/06/2013	Near Budapest
LivingLab session	17/06/2013	Vic, Spain
Data visualisation	11/09/2013	Leuven, Belgium

Annual meeting	12/09/2013	Leuven, Belgium
BioEconomy Forum meeting	30/09/2013	Brussels, Belgium
Farmer meeting	30/10/2013	Harrogat, United Kingdom
EIP Focus group meeting	03/02/2014	Barcelona, Spain
GlobalGAP meeting	19/02/2014	Düsseldorf, Germany
LivingLab session	21/07/2014	Budapest, Hungary
EEAP meeting	25/08/2014	Copenhagen, Denmark
LivingLab session	02/10/2014	Vic, Spain

All other project meetings were held on skype.

Project planning and status
The project suffered a delay in resolving the issues around on-farm installation of the technologies. The precise reasons for the delay were discussed above. At the end of the reporting period the installations were finalised and data is flowing into the electronic traceability system.

Impact of possible deviations from the planned milestones and deliverables, if any
The impact of the delays in installation of technologies was especially on the number of fattening rounds, that could be completed during the project lifetime. This had a further impact on the data richness for economic analysis. In addition, the operational challenges with some of the technologies demonstrated made the data quality poor, and this made reduced the on-line information value for farmer in daily use of the system.

Any changes to the legal status of any of the beneficiaries, in particular non-profit public bodies, secondary and higher education establishments, research organisations and SMEs
None.

Development of the Project website, if applicable
The project web site was launched for the kickoff meeting (10/12/2012). In the section on WP6 Dissemination details are provided. The project website can be accessed at www.all-smart-pigs.org.

Cooperation with other projects and programmes

Please see above under Task 7.3.

DEVIATIONS TO THE DOW

No devitions from Annex I in this WP.

RESOURCE USE

For general resource use please see the corresponding tables in the RESOURCE USAGE section.

For WP7, all efforts are considered to be in line with Annex I and resources are considered to have been spent in accordance with the provision.

3.3 Deliverables and milestones tables

Deliverables

The deliverables due in this reporting period, as indicated in Annex I to the Grant Agreement have to be uploaded by the responsible participants (as indicated in Annex I), and then approved and submitted by the Coordinator. Deliverables are of a nature other than periodic or final reports (ex: "prototypes", "demonstrators" or "others"). **The periodic reports and the final report have NOT to be considered as deliverables**. If the deliverables are not well explained in the periodic and/or final reports, then, a short descriptive report should be submitted, so that the Commission has a record of their existence.

If a deliverable has been cancelled or regrouped with another one, please indicate this in the column "Comments".

If a new deliverable is proposed, please indicate this in the column "Comments".

The number of persons/month for each deliverable has been defined in Annex I of the Grant Agreement and cannot be changed. In SESAM, this number is automatically transferred from NEF and is not editable. If there is a deviation from the Annex I, then this should be clearly explained in the comments column.

This table is cumulative, that is, it should always show all deliverables from the beginning of the project.

TABLE 1. DELIVERABLES										
Del. no.	**Deliverable name**	**Version**	**WP no.**	**Lead beneficiary**	***Nature***	**Dissemination level[6]**	**Delivery date from Annex I (proj month)**	**Actual / Forecast delivery date Dd/mm /yyyy**	**Status No submitted / Submitted**	**Comments**
D.1.1	Report on user needs and key performance indicators	1	1	4	Report	PU	3	20/06/ 2013	Submitted	
D1.2	Report on further improvements of the	1	1	4	Report	PU	22	10/10/2 014	Submitted	

[6] **PU** = Public

PP = Restricted to other programme participants (including the Commission Services).

RE = Restricted to a group specified by the consortium (including the Commission Services).

CO = Confidential, only for members of the consortium (including the Commission Services).

Make sure that you are using the correct following label when your project has classified deliverables.

EU restricted = Classified with the mention of the classification level restricted "EU Restricted"

EU confidential = Classified with the mention of the classification level confidential " EU Confidential "

EU secret = Classified with the mention of the classification level secret "EU Secret "

	PLF technologies presented in ALL-SMART- PIGS									
D2.1	Operational system installed in the four farms of the LL, with integration of the four technologies	1	2	3	PP	Demonstration	M6	31/12/ 2013		All equipment installed
D3.1	Data package of reports from the demonstration activities	1	3	5	PU	Report	23	20/10/ 2014	Submitted	
D.4.1	Report on evaluation and impact assessment of SMART pig farming	1	4	1	PU	Report	23	30/06/ 2015	Submitted	
D5.1	Proposal for a business model form for SMART Pig Applications	1	5	1	PU	Report	23	30/06/ 2015	Submitted	
5.2	Report on LL as a method to translate scientific knowledge into app and innovative prod. & services	1	5	1	PU	Report	23	27/10/ 2014	Submitted	
6.1.	Annual report 1 regarding status of dissemination	1	6	1	PU	Report	13	26/11/ 2013	Submitted	

Milestones

Please complete this table if milestones are specified in Annex I to the Grant Agreement. Milestones will be assessed against the specific criteria and performance indicators as defined in Annex I.

This table is cumulative, which means that it should always show all milestones from the beginning of the project.

TABLE 2. MILESTONES

Milestone no.	Milestone name	Work package no	Lead beneficiary	Delivery date from Annex I dd/mm/yyyy	Achieved Yes/No	Actual / Forecast achievement date dd/mm/yyyy	Comments
MS1	Kick-off meeting and 1st workshops in Hungary & Spain in succeeding weeks and webpage in operation	WP1, WP5	4	30/11/2012	Yes	10/12/2012	
MS2	Farmers and other LL participants selected	WP1,WP5	4	31/12/2012	Yes	20/02/2013	
MS3	Report published on user needs and key performance indicators	WP1, Wp2, WP5	4	31/01/2013	Yes	26/03/2013	
MS4	Equipment installed on farms	WP2, Wp3, WP5	3	30/04/2013	Yes	31/12/2013	
MS5	Data collection	WP2, WP3, WP4, WP5	3	30/04/2013	Yes	30/08/2013	The data collection started for some technologies

MS6	Baseline information	WP2, WP3, WP4, WP5	3	30/09/2013	Yes	31/01/2014	
MS7	All farmers trained in 1st and 2nd fattening round	WP2, WP3	3	31/12/2013	Yes	28/02/2014	
MS8	In depth interviews of the living lab participants	WP1, WP2, WP3, WP5	4	31/12/2013	Yes	30/06/2014	
MS9	Start-up information	WP2, Wp3, WP4, WP5	3	31/01/2014	Yes	30/04/2014	
MS10	Demonstration information	WP2, WP3, WP4, WP5	3	31/05/2014	Yes	30/09/2014	
MS11	Final demonstration information	WP2, WP3, WP4, WP5	2	31/08/2014	Yes	30/09/2014	