D1.3 - Industry solutions on Smart Farming Technology

Document Summary

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Abstract

Smart AKIS project aims at examining the suitability and use of Smart Farming Technologies (SFT) in the EU Agriculture involving farmers, the agricultural machinery industry, academia, research centers, agricultural engineering and public bodies.

The purpose of this document is to present the report on methodology, standards and current findings within the Smart-AKIS project. The report provides a selection guide, detailing the issues that have to be taken into account in order to ensure the collection of data in a homogeneous way, and avoid misconceptions. This document is an update on the progress made in the data assessment that is currently ongoing on captuing industrial products related to SFTs that have not yet reached mainstreaming agriculture.

This report is organized in three chapters. The first chapter will introduce current work on the Smart-Akis project as well as the objective of this document in the overall smart-akis framework. The second chapter will present the methodological approach that has taken to reach the industrial partners, the specific questions and the analysis procedure, wjhile the last chapter will present the interim results. The last chapter summarizes conclusions.

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1 Introduction

Smart-AKIS aims to provide an extensive overview of Smart Farming Technology (SFT). For a broader introduction on this topic it is recommended to turn to the preceding document (D1.2). Although some progress has already been made to synthesize current knowledge on smart farming technologies, many important questions still remain. As a result a new synthesis on current knowledge will be provided in the smart-AKIS project.

A few research questions were considered to be of particular relevance for SFT, which were the main driver for building the relevant questionnaire on this study.

Questions:

1. Which SFTs are there?

Which SFTs can be found and what is their level of technological readiness? The technological readiness level (TRL) is an indication of the development stage of the SFT. It is expected that we will find SFTs that are still in the conceptual stage, as well as SFTs that have been proven successful in the operational environment.

2. What kinds of benefits do these SFTs bring and conversely: *what kinds of desirable benefits are poorly addressed?*

We aim to examine the potential of SFT by looking at the benefits they will bring. Benefits could for example be a cost reduction, reduced emissions, reduction of physically demanding labour, etc. Furthermore, it is important to be able to identify what benefits are poorly addressed/covered by SFTs that are currently being developed. In this way knowledge gaps can be identified.

3. Where are SFTs currently used?

We are interested in the geography, type of farm/cropping system, type of farmer and production phase of the SFTs.

4. Which SFTs are used on the largest number of hectares?

After retrieving information on the different SFTs that are currently used, we would also like to find out more on the farm sizes that are related to different types of SFT.

5. What kinds of SFTs are research projects focusing on / what kinds of SFTs are on the market?

Attention will be paid to the differences in SFTs that are developed in the market vs scientific SFT development.

For answering these questions in a structured manner, the methodological approach that has been taken in terms of data retrieval and processing will be presented.

D 1.1 reported on the methodology and standards used. Several research phases and expectations have been explained. D 1.2 summarised results for SFTs in relation research results consisting of scientific papers and research projects. SFTs in the market will be elaborated in this follow-up report. This report will focus on interim results from market products that been uploaded on the Smart-AKIS permanent networking platform developed on WP4. The following sections will describe the methodology (Section 2), interim results (Section 3) and interim conclusions (Section 4), including the product entries till January 17th, 2017. A follow up report will be developed in the end of the project (Month 30) with all the product entries (Deliverable D.1.4).

2. Methodology

A systematic review was conducted in order to answer the research questions stated in chapter 1. To provide more insight in current SFT development, we have worked on two literature collection methods in order to build a database containing all current relevant SFTs.

We searched for scientific journals, EU-funded projects, national projects, and market products. A distinction was made between SFTs from scientific articles, scientific projects and marketed products. The methods and results relevant SFT products will be explained here.

A careful selection was done on relevant market stakeholders that are involved in the development of SFTs. These stakeholders have been approached for a survey. The survey has been developed for the collection of information on different SFTs in research articles and projects as well as SFTs in industry. Survey entries were captured in a database for analysis.

2.1 Approach of SFT industry

Websearch gave insight in the companies that are possibly involved in the development of SFTs. We searched for companies with relevant credentials for smart farming, such as involvement in the production of farming equipment and machinery or stakeholders involved in the development of agronomic software. The relevant networks of FIWARE FRACTALS, and Smart Agrifood II were consulted. Furthermore we used our own network of advisers to contact relevant stakeholders. The questionnaire was also sent to companies through CEMA partner (representing agricultural machinery in Europe) and other organisations of relevance that we could find. CEMA was a major player on this deliverable with continuous presentations about Smart-AKIS on their meetings. Spyros Fountas also gave a presentation of Smart-AKIS to the Board of CEMA on December 1st, hightlighting the importance of

Smart-AKIS for the farm machinery industry and the benefits of their members participating on this survey.

2.2 Survey

The survey was distributed online via a link on the www.smart-akis.com webpage. The construction of the survey was done systematically under EIP-AGRI format for projects and practices. It was used to retrieve information from three separate types of sources for SFT information, namely projects, papers and industrial SFTs. The latter category will be presented here.

The survey is divided in a few categories of relevant information on SFTs on products: required general background information on products (general identity questions), Questions about innovation (basic SFT information) and questions about the adoption of the SFT (SFT details).

2.2.1 Survey for industry

The survey starts off with distinguishing between research articles, projects and products (Figure 1). In the case of market only the section for "products" will be entered in the survey. The next figure encompasses the general identity questions related to SFT market products.

Figure 1: General identity

When it is not the first time the questionnaire is filled in, the company name is the last question and the questionnaire will move to the next section on the SFTs basic information. The following question asks about some general information on the provider of the product, such as the company name, the legal name of the company and address information. We asked for the country in which the company related to the SFT is situated. To get an impression on the size of the company, a question on the number of employees was added. We were also interested in the date of establishment and "unique selling points" of the company. Unique selling points are business characteristics that distinguish the business in question from other businesses in the market and makes the business stand out. We considered this an important aspect in order to get an impression on the ambitions related to SFT development by this particular provider of SFT(s).
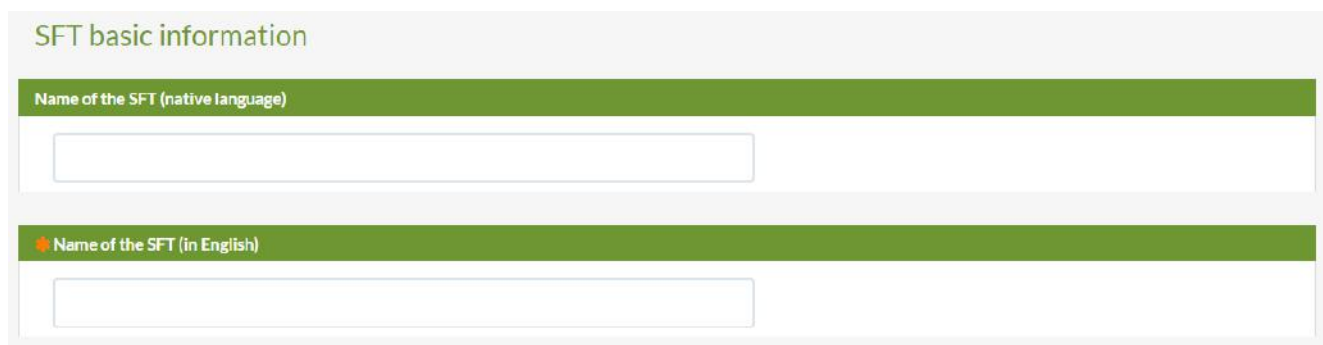
Figure 2: General identity details

After questions that were specific for the type of entry (product), some basic information and detailed information questions were asked related to the SFT product.

2.2.2 Basic information

After questions that were specific for the type of entry (scientific article or project), some basic information questions were asked about the SFT.

The survey basic information starts by asking to give up a general name for the SFT (Figure 3). This can also be done in a native language, so users will have the option of writing down information in their own language.

Figure 3: Name of SFT

We then asked about keywords that affiliate with the SFT (Figure 4). These keywords give a general impression on what this SFT is about. The SFT can be about the agricultural production system, so this keyword can be chosen when the SFT is about the actual agricultural system, (e.g. weed suppression in organic farming, farming practice, how to navigate on the field). Another keyword is about the equipment and machinery that is used in the field, mainly for SFTs with technical features. The SFT can be about plant production and horticulture specific crop growth elements. They can also be specifically designed for targeting fertilization, soil management and/or functionality, water management, climate aspects, energy management and the management of waste by-products and residues. A specific keyword was also added for the management of biodiversity and nature as a SFT goal. Lastly, SFTs can be about farming/forestry competitiveness. The option was given to provide five additional keyword to properly describe the SFT in term of keywords.

Figure 4: Keywords characterizing the SFT

The geographical location where the SFT is intented to be used was retrieved systematically via the entry of EIP-AGRI NUTS regions (Figure 5). A link was provided to give more detail on what this is about to the survey applicant. For situations in which a region did not meet the classification properly, an open field on the geographical location was provided.
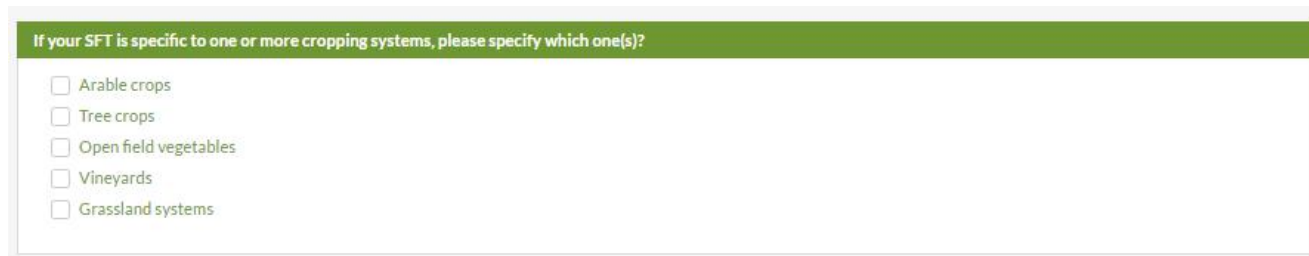

Figure 5: Geographical clasification of the SFT

SFTs are expected to be specific to one or a few of five major cropping systems: arable crops, tree crops, open field vegetables, vineyards and grassland systems (Figure 6). Applicants were asked to check one or multiple boxes.

Figure 6: Cropping System where the SFT is used

A similar question was added for the type of crop with which the SFT could be dealing (Figure 7). We distinguished between arable crops, grassland crops, horticultural crops and perennial crops. It was also possible to indicate the exact crop in a new box that appears after filling out this question.

Figure 7: Specific crop for the SFT

A few field operations can be chosen namely: tillage, sowing, transplanting, fertilization, pesticide application, weed control, pest- and disease control, irrigation, harvesting, post-harvest storage[1] and the scouting of crop, for example in the situation of field data retrieval (figure 8). The option to include another field operation was provided in the "other" box.

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[1]Post-harvest activities should not have been included in the survey considering an earlier decisions on the scope of the SFT's to include. This field operation was therefore not included in the analysis.

Figure 8: Field operation for this SFT

It was considered important to retrieve some information on the person that is expected to use the specific SFT (figure 9). This could be a farmer, contractor (including consultants), supplier, buyer of farm products or a processor of farm product.

Figure 9: User type of the SFT

All SFTs have a Technology Readiness Level (TRL) (Table 1), meaning that they fall in to different categories of "readiness" for use (figure 10).

Figure 10: Technology Readiness Level of the SFT

The first level (TRL1) means that only basic principles have been observed, meaning that the SFT is just available on a conceptual level with or without a research plan. The second level (TRL2) stands for 'technology concept formulated', so on this level the SFT is assumed to have a clear conceptual basis. The third level (TRL3) assumes a 'experimental proof of concept' meaning that the SFT is proven to be of interest in for example a lab setting. The fourth level (TRL4) goes one step further by stating that the SFT is actually validated in a lab. The fifth level (TRL5) assumes validation in a more relevant environment, for example in a test field. The sixth readiness level (TRL6) assumes that the technology is actually demonstrated in a relevant environment. The seventh level (TRL7) assumes there is a prototype that has been demonstrated in a relevant environment. The eighth readiness level (TRL8) means that we have a complete system that is also qualified for the job that was targeted. The last, ninth level of technological readiness (TRL9) assumes that the entire actual system is proven to be effective in the operational environment, meaning the environment in which the SFT will be used.

Table 1: Technological Readiness Level (TRL)[2]

TRL (Technology Readiness Level)	
1	Basic principles observed
2	Technology concept formulated
3	Experimental proof of concept
4	Technology validated in lab
5	Technology validated in relevant environment
6	Technology demonstrated in relevant environment
7	System prototype demonstration in operational environment
8	System complete and qualified
9	Actual system proven in operational environment

It was considered relevant to know if there is any patent on the SFT (Figure 11). There could be no patent, the patent could be pending, submitted, expired or in-force. If no information is available the answering box can be left blanc.

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[2] https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf

Figure 11: Patent of the SFT

A final question in this category presents a box in which a link to other websites can be provided that could be of relevance for clarification of the basic information on the SFT (Figure 12).
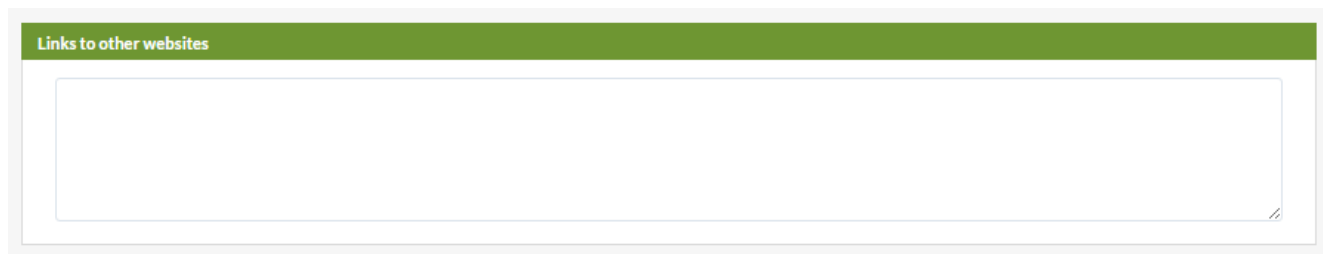

Figure 12: other websites relevant to the SFT

2.2.3 Details

The last section of the survey consists of questions about the detailled information of the SFT.

A large box in the survey was used to get a detailed description of the SFT (Figure 13). An option to answer in a native language was also provided. After this a question was asked on the objective of the SFT, in order to find out what this SFT was actually set out to achieve.

Figure 13:Description and objectives of the SFT

An option is provided to add audiovisual material on the SFT if this is available (Figure 14). A link could be provided as well as a direct upload. We also asked for relevant webpages of the SFT company that may be involved or just a general SFT web page.

Figure 14: Audiovisual material for the SFT

To be able to estimate the current applicability of the SFT, we asked to give an indication of the total area in Europe in which this SFT is used (Figure 15).

Figure 15: total area in Europe where this SFT is used

A large box is included to find out more about the effectiveness of the SFT (Figure 16). Effects were expected on 26 possible critical subjects: productivity (crop yield per ha), the quality of a product, revenue-, profit and farm income, soil biodiversity, biodiversity (other than soil), input costs, variable costs, post-harvest crop wastage, energy use, emmissions of CH4, CO_2, N_2O, NH_3 and NO_3, the use of fertilizer and pesticides, irrigation, labor time, stress and fatigue, the amount of physical labor, number and severity of accidents, number and severity of accidents resulting in spills, property damage or the incorrect application of fertilizers and pesticides, pest residue on products, weed pressure, pest pressure (insects) and disease pressure from for example bacteria and fungi. Effects could be expressed using

a scale ranging from a large decrease up to a large increase. An open checkbox provided the possibility to supplement this scale with relevant percentages, providing the option to give an even more precise indication of the effects of the SFT when this is possible.

This SFT has the following effect on:

	Large decrease	Some decrease	No effect	Some increase	Large increase	If possible, please quantify percentage of change
Productivity (crop yield per ha)	○	○	●	○	○	
Quality of product	○	○	●	○	○	
Revenue, profit, farm income	○	○	●	○	○	
Soil biodiversity	○	○	●	○	○	
Biodiversity (other than soil)	○	○	●	○	○	
Input costs	○	○	●	○	○	
Variable costs	○	○	●	○	○	
Post-harvest crop wastage	○	○	●	○	○	
Energy use	○	○	●	○	○	
CH4 (methane) emission	○	○	●	○	○	
CO2 (carbon dioxide) emission	○	○	●	○	○	

N2O (nitrous oxide) emission	○	○	●	○	○	
NH3 (ammonia) emission	○	○	●	○	○	
NO3 (nitrate) leaching	○	○	●	○	○	
Fertilizer use	○	○	●	○	○	
Pesticide use	○	○	●	○	○	
Irrigation water use	○	○	●	○	○	
Labor time	○	○	●	○	○	
Stress or fatigue for farmer	○	○	●	○	○	
Amount of heavy physical labour	○	○	●	○	○	
Number and/or severity of personal injury accidents	○	○	●	○	○	
Number and/or severity of accidents resulting in spills, property damage, incorrect application of fertiliser/pesticides, etc.	○	○	●	○	○	
Pesticide residue on product	○	○	●	○	○	
Weed pressure	○	○	●	○	○	
Pest pressure (insects etc.)	○	○	●	○	○	
Disease pressure (bacterial, fungal, viral etc.)	○	○	●	○	○	

Figure 16: Effectiveness of the SFT

In order to find out more on what kind of SFT is presented a yes/no checkbox was included asking to check on whether the SFT is a recording/mapping technology, a reacting/variable rate technology, a guidance/ controlled traffic farming technology, a farm management information system/application or a robotic system/smart machine (Figure 17).

This SFT is a:	Yes	No
Recording or mapping technology	○	○
Reacting or variable rate technology	○	○
Guidance or Controlled Traffic Farming technology	○	○
Farm Management Information System application or App	○	○
Robotic system or smart machine	○	○

Figure 17: Kind of the SFT

Another relevant detail is the price of the SFT, this was included in a separate question (Figure 18).

Please indicate the price of this SFT (in local currency; please indicate currency)

❓ In case the price is not defined, write NA.

Figure 18: Price of the SFT

The following question consisted of a few statements one could agree with or not, considering the relevance of the statement for the SFT (Figure 19). The check box included a scale ranging from strongly agree up to strongly disagree. The seven statements are:

1. *This SFT replaces a tool or technology that is currently used. The SFT is better than the current tool.*

This question is specifically aimed at SFTs than are aiming at creating added value over existing tools.

2. *The SFT can be used without making major changes to the existing system*

Some SFTs are expected to require more changes to the existing system than others.

3. *The SFT does not require significant learning before the farmer can use it*

The answer to this statement can give an indication on the learning effort that need to be made by the farmer. This can be useful information in order to compare the difference in learning requirements between different SFTs

4. *The SFT can be used in other useful ways than intended by the inventor*

Some SFTs may hold multiple purposes making them useful for the achievement of many very different effects.

5. *The SFT has effects that can be directly observed by the farmer*

It is considered an advantage when effects can be directly observable by a farmer, because this will make it more likely that the farmer will find the SFT relevant for his/her situation.

6. Using the SFT requires a large time investment by farmer

The answer to this statement will give an indication on the time investment that is needed from the farmer in order to use the SFT. The time investment will play a role in how attractive the SFT is to use.

7. The SFT produces information that can be interpreted directly (example of the opposite: the SFT produces a vegetation index but nobody knows what to do with it)

It is desirable when results are presented in such a manner that they are easy to interpret. This makes the results more interesting for end-user and results in consistency in the interpretation.

Figure 19: Statements regarding the SFT

The type of farmer that uses the SFT is considered, this can be all farmers, farmers with a primary education, farmers with secondary education, farmers with an education at a technical school and farmers with an university education (Figure 20). An open answering box was included to be able to enter other types of education, when this is necessary.

Figure 20: User of the SFT

Another detail that has been included is the farm size, answering field ranges from less than 2 ha to more than 500 ha (Figure 21).

Figure 21: Farm size to use the SFT

Finally, there is room for additional information and comments (Figure 22).

Figure 22: Aditional information on the SFT

3 Results

The total amount of survey entries is 1103, of this number we had 164 product entries as of 17 January 2017 at close of business. The results for these entries will be discussed in the next sections. Firstly the most important results related to the types of SFT are discussed. Next are results related to the actual application of SFTs. Some results from D1.2 will also be presented next to the results for the product SFTs, so as to gain a better overview on all the entries that have been analysed, which will facilitate comparison between SFTs from different sources.

3.1 Types of SFTs

Table 2 shows the results for the question about the type of SFT that is being or has been developed

Table 2 Types of SFT

	Type of SFT	Scientific articles	Research projects	Products
1	Recording or mapping technology	35	224	77
2	Reacting or variable rate technology	10	66	59
3	Guidance or Controlled Traffic Farming technology	7	21	43
4	Farm Management Information System application or App	50	95	64
5	Robotic system or smart machine	16	67	44

Similarly to the entries of the research projects most product entries are about SFTs that are being developed for recording or mapping of relevant variables. However, there are also many efforts directed at the development of information systems in the form of system applications or apps. Slightly fewer entries were about SFTs that are involved in guidance or controlled traffic farming technology or robotic systems. Overall, entries were spread quite evenly over the different types of SFT that we have classified between.

In Table 3 information is summarised on the different relevant field operations that SFTs could be used for. Many products that were presented can be used for fertilisation, pest- and disease control and pesticide application related operations. On the contrary very few SFTs are about post-harvest storage, similarly to the SFTs found in research. In comparison to research SFTs there are many more SFTs involved in sowing technology.

Table 3 Field operations

	The field operation in which the SFT is used	Scientific articles (Yes)	Research projects (Yes)	Products (Yes)
1	Tillage	17	12	55
2	Sowing	4	14	59
3	Transplanting	2	12	46
4	Fertilisation	64	31	93
5	Pesticide application	31	15	92
6	Weed control	48	12	66
7	Pest and disease control	43	20	81
8	Irrigation	60	27	48
9	Harvesting	32	25	54
10	Post-harvest storage*	3	4	14
11	Scouting of crop and/or soil	189	26	41
12	Other	**	**	**

3.2 Application of SFTs

The SFTs on products hold a wide range of possibilities for application.We had entries from 18 different countries in Europe. The applicability of the SFTs is not region specific, most SFTs can be applied througout Europe, only in very few cases countries were listed as the best location for application of the SFT. Spain, the Netherlands, France and Germany are some examples that have been chosen a few times.

3.2.1 SFT application general

Six statements on the application of the SFT could be filled in by level of agreement (Table 4). 143 entries were given in total for this question.

In 62% of the cases the SFT product replaces a tool or technology that is currently being used. SFT can be often used without making major changes to the existing system (66%). The SFT products are presented as very easy to use and in most cases do not require significant learning (69%), although this is different in a few cases (9%). In 45% of the SFTs there is an expectation that the SFT could be beneficial in other ways than what is originally aimed by the inventor. In 74% of entries, the SFT is estimated to have effects that can be directly observed by the farmer. Only 3% of entries foresee a large time investment by the farmer and 75% disagree. In 61% of the entries the SFT produces information that can be interpreted directly.

Table 4 statements on application

	Application statement	SD	D	A	SA	NO
1	This SFT replaces a tool or technology that is currently used. The SFT is better than the current tool.	2	10	50	39	42
2	The SFT can be used without making major changes to the existing system	1	10	57	38	37
3	The SFT does not require significant learning before the farmer can use it	2	11	45	54	31
4	The SFT can be used in other useful ways than intended by the inventor	2	17	43	22	59
5	The SFT has effects that can be directly observed by the farmer	1	5	43	63	31
6	Using the SFT requires a large time investment by farmer	54	53	4	0	32
7	The SFT produces information that can be interpreted directly (example of the opposite: the SFT produces a vegetation index but nobody knows what to do with it)	3	5	42	45	48

SD = Strongly disagree, D = Disagree, A = Agree, SA = Strongly Agree, NO = No Opinion

3.2.2 SFT users

In Table 5 different users of SFTs are listed. Similarly to the research SFTs entries, the stakeholders that are most likely to actually use the SFT are contractors meaning also consultants that are advising farmers directly. Users of SFTs are similar to results that were found earlier in research SFTs.

Table 5 SFT users

	Who will use the SFT?	Scientific article	Research projects	Product
1	Contractor	333	53	104
2	Supplier	28	25	23
3	Buyer of farm products	17	7	16
4	Processor of farm products	21	8	12

3.2.3 Keywords

In Figure 23 a pie chart of the different keywords that could be chosen as relevant for the SFTs is shown.
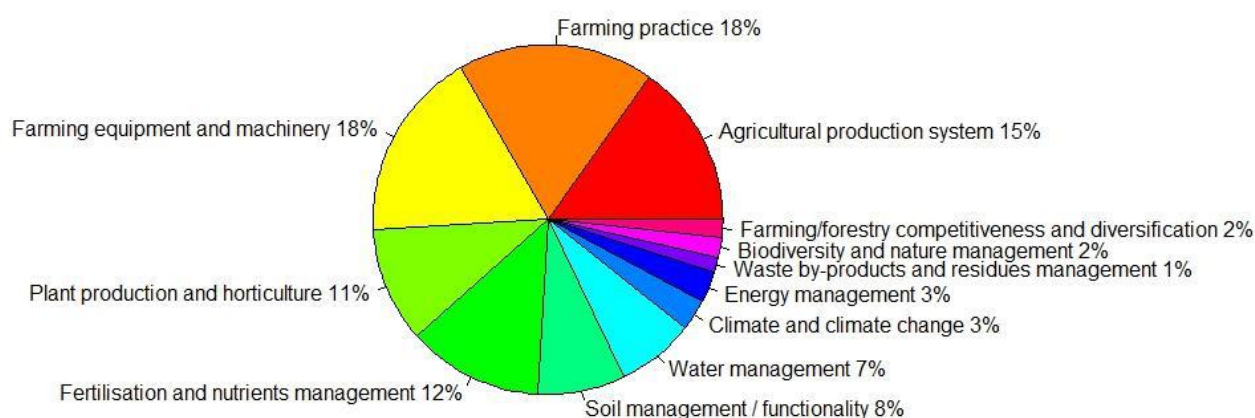
Figure 23 Relevant keywords (incl rounded %)

The options farming equipment and machinery, farming practise and agriculture production were checked most cases. These keywords have often been combined with one of the other options. Production, feritisation and soil and water management are chosen quite often in contrast, however, the options that are more often related to environmental aspects such as farming/forestry competitiveness, biodiversity and nature management, waste byproducts and residues management, energy management and climate and climate change were less frequently chosen.

3.2.4 Farm Size

Table 6 Farm size

	Farm size (ha)	Scientific article	Research projects	Products
1	<2	303	67	62
2	2-10	306	71	68
3	11-50	311	76	97
4	51-100	368	78	107
5	101-200	283	73	110
6	201-500	271	72	110
7	500>	254	69	113

Table 6 lists the amount of entries by SFT developers in the market on the different options for farm size. There is a slight tendensy towards larger farmsizes, starting from 50 ha's. An opposite result was found in the scientific articles entries, in these, a slight tendency to smaller farm sizes was seen.

3.2.5 Effects

Table 7 lists the different effects on the 26 different agronomic subjects that we have identified.

Table 7 SFT effects

	The SFT has an effect on	No effect	Large decrease	Some decrease	Some increase	Large increase
1	Productivity (crop yield per ha)	35	1	0	67	40
2	Quality of product	47	1	0	50	45
3	Revenue, profit, farm income	25	0	1	52	65
4	Soil biodiversity	100	0	2	31	10
5	Biodiversity (other than soil)	113	0	2	17	11
6	Input costs	42	33	40	18	10
7	Variable costs	51	28	46	11	7
8	Post-harvest crop wastage	95	9	30	6	3
9	Energy use	65	26	35	12	5
10	Variable costs	129	3	10	1	0
11	CO_2 (carbon dioxide) emission	106	9	19	8	1
12	N_2O (nitrous oxide) emission	123	5	12	2	1
13	NH_3 (ammonia) emission	124	4	11	3	1
14	NO_3 (nitrate) leaching	125	4	11	2	1
15	Fertilizer use	67	29	32	6	9
16	Pesticide use	60	37	31	6	9
17	Irrigation water use	100	18	18	3	4
18	Labor time	57	38	37	7	4
19	Stress or fatigue for farmer	48	45	35	6	9
20	Amount of heavy physical labour	112	10	15	2	4
21	Number and/or severity of personal injury accidents	117	13	8	5	0
22	Number and/or severity of accidents resulting in spills, property damage, incorrect application of fertiliser/pesticides, etc	104	19	14	3	3
23	Pesticide residue on product	89	20	27	4	3
24	Weed pressure	103	6	26	4	4
25	Pest pressure (insects etc.)	96	7	32	3	5
26	Disease pressure (bacterial, fungal, viral etc.)	96	5	33	4	5

The market stakeholders indicate strong effects on most of the 26 effects that have been identified. The results from product entries also show quite strong effects in comparison to the previously listed research entries. Most positive effects are seen in productivity, quality, revenue, (soil) biodiversity and variable and input costs. On the other hand emmission reductions are often expected to decrease as well as a relief of stress or fatigue for farmers. Quite often reductions are also expected in the amount of pesticide residue that stays behind on produce and weed pressure.

3. Conclusions

SFTs can be classified mostly as recording or mapping tools. The development of applications is also an important type of SFT. This is a smilar result compared to the research entries from D1.2. There are also many efforts directed at the development of applications or reacting or variable rate technology. Slightly fewer entries were about SFTs that are involved in guidance or controlled traffic farming technology or robotic systems. Overall, there is a quite even variation in the different types of SFTs that we have classified between.

Many products that were presented can be used for fertilisation, pest- and disease control and pesticide application related operations. On the contrary very few SFTs are about post-harvest storage, similarly to the SFTs found in research.

Market SFT inventors are positive about the application of products. Often the SFT product replaces a tool or technology that is currently being used. SFT can often be used readily without making major changes to the existing system. In contrast to research SFTs, The SFT products are mostly presented as very easy to use and in most cases do not require significant learning. Sometimes, the SFT could be beneficial in other ways than what is originally aimed by the inventor. SFTs are estimated to have effects that can be directly observed by the farmer and they do not require large time investments. Results from SFTs can often be interpreted directly.

Similarly to the research SFTs entries, the stakeholders that are most likely to actually use product SFTs are contractors.

The options farming equipment and machinery, farming practise and agriculture production are often chosen as relevant keywords for market SFTs. These keywords have often been combined with other options: production, feritisation and soil and water management are chosen quite often. In contrast, the options that are more often related to environmental aspects such as farming forestry competitiveness, biodiversity and nature management,

waste byproduct and residues management, energy management and climate and climate change were less frequently related to market SFTs.

The results from product entries show quite strong effects in comparison to the previously listed research entries. Most positive effects are seen in revenue, (soil) biodiversity and variable and input costs. On the other hand emmission reductions are often expected as well as a relief of stress or fatigue for farmers.

APPENDIX I Survey

Mapping of Smart Farming Technologies

Please register to complete this survey.
Enter your details below, and an email containing the link to participate in this survey will be sent immediately.
Your name

SFT title

Email address (we will send you a link to the survey to this address)

Continue

Mapping of Smart Farming Technologies

Aim of Smart AKIS:

Smart-AKIS is a European Network mainstreaming Smart Farming Technologies among the European farmer community. The project will collect existing knowledge related to Smart Farming Technologies and will produce easily accessible end-user material under the EIP-Agri common format. The project will also integrate the socio-economic aspects involved in the innovation processes and will bridge the gap between practitioners and research on the identification and delivery of new Smart Farming solutions fit to the farmers' needs.

Goal of this survey:

The goal of the project is mapping of relevant existing research results, projects and products all across Europe whose scope are Smart Farming Technologies. The Inventory of all collected Smart Farming Technologies will allow searching available categories of solutions, so the end-users can easily find and implement them in their working routine.

Next

General - Identity

What is your SFT?

- ● Product
- ○ Project
- ○ Article

Is this the first time you are filling in this questionaire?

| Yes | No |

Company name

[   ]

Legal name of the company

[   ]

Street name and number

[   ]

Postal code

City

Country

Please choose... ▾

Number of employees

○ 1 - 10   ○ 501 - 1000
○ 11 - 50   ○ 1001 - 10000
○ 51 - 100   ○ 10000+
○ 101 - 500

Establishment (month, year)

Value proposition/ Unique selling points

Previous   Next

General - Identity

What is your SFT?

- ● Product
- ○ Project
- ○ Article

Is this the first time you are filling in this questionaire?

| Yes | No |

Company name

[   ]

Previous   Next

General - Identity

❋ What is your SFT?

- ○ Product
- ● Project
- ○ Article

❋ Project name

[   ]

❋ Project coordinator

[   ]

Coordinator's email address

[   ]

Project partners

[   ]

❷ Enter no more than 90 partners. Once you fill in the existing field, a new empty field will appear. Please enter one partner per field.

❋ Project period

Start of the project (year)	[ ]
End of the project (year)	[ ]

Project status

○ ongoing
○ finished

Funding source

☐ EU - H2020
☐ EU - FP7
☐ EU (other)
☐ National
☐ Industry
☐ Self-funded
☐ Other: [   ]

Total budget
ⓘ Only numbers may be entered in this field.

[   ]

Final report

[   ]

❓ Please provide a link to the final report.

Objective of the project (native language)
ⓘ

[   ]

❓ Please enter up to 300 words.

Objective of the project (in English)
ⓘ

[   ]

❓ Please enter up to 300 words.

❋ Description of the context

ⓘ

Please enter up to 300 words.

Previous   Next

Mapping of Smart Farming Technologies

General - Identity

❋ What is your SFT?

○ Product
○ Project
● Article

❋ Title of the article

✳ Author(s)

✳ Source (Journal / proceeding)

✳ Year of publication
❶ Your answer must be between 1950 and 2017
❶ Only an integer value may be entered in this field.

DOI (Digital Object Identifier)

Previous   Next

Mapping of Smart Farming Technologies

Resume later   Exit and clear survey   Question index ▾

SFT basic information

Name of the SFT (native language)

[   ]

✳ Name of the SFT (in English)

[   ]

✳ Please check the keywords that describe your SFT?
❶ This question is mandatory
❶ Please check at least one item.

☐ Agricultural production system   ☐ Water management

☐ Farming practice   ☐ Climate and climate change

☐ Farming equipment and machinery   ☐ Energy management

☐ Plant production and horticulture   ☐ Waste, by-products and residues management

☐ Fertilisation and nutrients management   ☐ Biodiversity and nature management

☐ Soil management / functionality   ☐ Farming/forestry competitiveness and diversification

---

Please give up to 5 additional keywords that describe your SFT

[   ]

✳ Please refer to the Eurostat NUTS classification to indicate where this SFT is intended to be used.

[   ]

❓
Please visit Eurostat NUTS classification website.
Structure your answer using the following examples:
EU = SFT is used in all or most of Europe
FR = SFT is used in all of France
FR5 = SFT is used in France NUTS-1 region 5 ("Ouest")
FR52 = SFT is used in France NUTS-2 region 52 ("Bretagne")
FR524 = SFT is used in France NUTS-3 region 524 ("Morbihan")
Two or more regions may be indicated as follows:
FR, NL22, NL321

Other geographical location

[   ]

If your SFT is specific to one or more cropping systems, please specify which one(s)?

☐ Arable crops

☐ Tree crops

☐ Open field vegetables

☐ Vineyards

☐ Grassland systems

If your SFT is specific to one or more crops, please specify which one(s)?

- ☐ arable crop
- ☐ grassland crop
- ☐ horticulture crop
- ☐ perennial crop

✳ In what kind of field operations is this SFT meant to be used?
ⓘ This question is mandatory
ⓘ Please check at least one item.
ⓘ If you choose 'Other:' please also specify your choice in the accompanying text field.

- ☐ tillage
- ☐ sowing
- ☐ transplanting
- ☐ fertilization
- ☐ pesticide application
- ☐ weed control

- ☐ pest and disease control
- ☐ irrigation
- ☐ harvesting
- ☐ post-harvest storage
- ☐ scouting of crop and/or soil
- ☐ Other: [   ]

✳ Who will use the SFT?
ⓘ This question is mandatory
ⓘ Please check at least one item.

- ☐ Farmer
- ☐ Contractor
- ☐ Supplier
- ☐ Buyer of farm products
- ☐ Processor of farm products

✳ How close to the market is this technology? (TRL - Technology Readiness Level)

Please choose... ▾

Patent status

no patent ▾

Links to other websites

[   ]

SFT details

Description of the SFT (native language)
❶

❷ Please enter up to 300 words.

✱ Description of the SFT (in English)
❶

❷ Please enter up to 300 words.

✱ Objective of the SFT
❶

❷ Please enter up to 300 words.

✱ Audio/visual material

○ The material is online, I would like to provide a link.
● I would like to upload material
○ No material available

Audio/Visual material (upload)
ⓘ Please upload at most one file

⬆ Upload files

Website (company, article)

Website for this SFT

Please estimate the total area in Europe (ha) on which this SFT is being used.

✳
This SFT has the following effect on:

	Large decrease	Some decrease	No effect	Some increase	Large increase	If possible, please quantify percentage of change
Productivity (crop yield per ha)	○	○	●	○	○	
Quality of product	○	○	●	○	○	
Revenue, profit, farm income	○	○	●	○	○	
Soil biodiversity	○	○	●	○	○	
Biodiversity (other than soil)	○	○	●	○	○	
Input costs	○	○	●	○	○	
Variable costs	○	○	●	○	○	
Post-harvest crop wastage	○	○	●	○	○	
Energy use	○	○	●	○	○	
CH4 (methane) emission	○	○	●	○	○	
CO2 (carbon dioxide) emission	○	○	●	○	○	

N2O (nitrous oxide) emission	○	○	●	○	○	
NH3 (ammonia) emission	○	○	●	○	○	
NO3 (nitrate) leaching	○	○	●	○	○	
Fertilizer use	○	○	●	○	○	
Pesticide use	○	○	●	○	○	
Irrigation water use	○	○	●	○	○	
Labor time	○	○	●	○	○	
Stress or fatigue for farmer	○	○	●	○	○	
Amount of heavy physical labour	○	○	●	○	○	
Number and/or severity of personal injury accidents	○	○	●	○	○	
Number and/or severity of accidents resulting in spills, property damage, incorrect application of fertiliser/pesticides, etc.	○	○	●	○	○	
Pesticide residue on product	○	○	●	○	○	
Weed pressure	○	○	●	○	○	
Pest pressure (insects etc.)	○	○	●	○	○	
Disease pressure (bacterial, fungal, viral etc.)	○	○	●	○	○	

★ This SFT is a:

	Yes	No
Recording or mapping technology	○	○
Reacting or variable rate technology	●	○
Guidance or Controlled Traffic Farming technology	○	○
Farm Management Information System application or App	●	○
Robotic system or smart machine	○	○

Please indicate the price of this SFT (in local currency; please indicate currency)

[   ]

❷ In case the price is not defined, write NA.

	strongly disagree	disagree	no opinion	agree	strongly agree
This SFT replaces a tool or technology that is currently used. The SFT is better than the current tool.	○	○	●	○	○
The SFT can be used without making major changes to the existing system	○	○	●	○	○
The SFT does not require significant learning before the farmer can use it	○	○	●	○	○
The SFT can be used in other useful ways than intended by the inventor	○	○	●	○	○
The SFT has effects that can be directly observed by the farmer	○	○	●	○	○
Using the SFT requires a large time investment by farmer	○	○	●	○	○
The SFT produces information that can be interpreted directly (example of the opposite: the SFT produces a vegetation index but nobody knows what to do with it)	○	○	●	○	○

Who will use this SFT?

- ☐ all farmers
- ☐ Farmers with primary education
- ☐ Farmers with secondary education ("high school")
- ☐ Farmers with apprenticeship and/or technical school
- ☐ Farmers with university education
- ☐ Other: _____

✿ On what size farm do you think this SFT will be used?

- ☐ < 2 ha
- ☐ 2 - 10 ha
- ☐ 11 - 50 ha
- ☐ 51 - 100 ha
- ☐ 101 - 200 ha
- ☐ 201 - 500 ha
- ☐ > 500 ha

Additional information

Additional comments

smart**AKIS**
Smart Farming Thematic Network

SMART AKIS PARTNERS: