ERA-NET ICT-AGRI

Coordination of European research within information and communication technology (ICT) and robotics in agriculture and related environmental Issues

Final assessment report and recommendations for further development of ERA-NET activities and solidification of the transnational cooperation and coordination
Deliverable 5.4

March 2017

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Table of Contents

1. Goal

This report aims, as a priority, to evaluate the impact of the ERA-NETs ICT-AGRI 1 and 2. Furthermore, this report also contains recommendations regarding the evaluation method itself, in order to help other ERA-NETs in their impact evaluation and to contribute to the discussion on a common evaluation framework.

2. What is ICT-AGRI

The ERA-NET (European Research Area - Network) scheme is one of the EU's programmes to support innovation and technological development throughout Europe. It aims to develop and strengthen the European Research Area (ERA) by facilitating practical initiatives to coordinate regional, national and European research programmes in specific fields. Under the ERA-NET scheme, national and regional authorities identify research programmes they wish to coordinate or open up mutually.

The ERA-NET programme ICT-AGRI 1 started in the EU's Framework Programme 7 on May 1st 2009 and ran for 65 months until September 30th 2014. It involved 18 partners, 3 associate partners and 14 observers from 21 countries. The objective of ICT-AGRI is to strengthen the European research within the fields of precision farming, ICT and robotics in agriculture by developing a common research agenda based on shared priorities and by launching joint calls. ICT-AGRI supports the development and implementation of the emerging technologies for a competitive, sustainable and environmentally friendly agriculture. The general aim is to pool the fragmented human and financial resources spread among countries to improve the effectiveness and efficiency of Europe's research efforts. The follow-up ERA-NET programme ICT-AGRI 2 was launched in January 1st 2014 and is scheduled to run 48 months until the end of 2017. The principal goals of ICT-AGRI 2 are to contribute to the development of an eco-efficient, resource-efficient and competitive agriculture through an enhanced and improved use of ICT and robotics. The ICT-AGRI 2 programme involves 23 partners from 16 countries.

Until 2016, during ICT-AGRI 1 and ICT-AGRI 2, four calls were conducted:

- **2010 - Integrated ICT and automation for sustainable agricultural production**

The aim of this joint call was to enable joint transnational research projects based on complementarities and sharing of expertise within ICT and Robotics in Agriculture. Projects were expected to apply a systems approach addressing farm level integration of information technology, communication technology, automation and robotics. Projects were expected to have a clear European added value by being carried out on a transnational level.

Seven projects were funded in this call.

- **2012 - ICT and Automation for a Greener Agriculture**

The call aimed at utilizing ICT and automation in primary agriculture for sustainable use of natural resources, reduction of agriculture's environmental footprint, mitigation of climate change while securing farm economy and good working conditions, food supply, quality and security, and animal welfare.

Eight projects were funded in this call.

- **2014 - Services & Applications for Smart Agriculture**

The call was in collaboration with the Future Internet Accelerator project SmartAgrifood. The goal of SmartAgriFood was to accelerate the use of FIWARE (Future Internet WARE) internet technologies for

smart services and applications, while the purpose of the ICT-AGRI engagement was to contribute with agricultural knowledge and experience.

Fifty projects were funded in this call, hereof nine projects with ICT-AGRI funded participation.

- 2015 - Enabling Precision Farming

Precision Farming is a key element in sustainable intensification, i.e. increasing food production with smaller environmental footprints. Although Precision Farming has been studied and developed for more than two decades, adoption of the technology in primary agriculture is still behind expectations. There are, therefore, needs for research, development and innovation concerning the adoption of Precision Farming in primary agriculture.

Eight projects were funded in this call.

2.1. The goals and design of ICT-AGRI 2

The goals of ICT-AGRI 2 are described within the following Work Packages:

- WP 1: Mapping and analysis of research and innovation and update of the Strategy Research Agenda (SRA)
- WP 2: Transnational joint calls for coordinated research and innovation
- WP 3: Coordination within the European Research Area (ERA)
- WP 4: Dissemination, online tools and sharing of good practices
- WP 5: Impact assessment and evaluation of ERA-NET effectiveness
- WP 6: Management

Work Package 5 is defined as three tasks and four deliverables (see Table 1).

Table 1: Within Work Package 5, three tasks and four deliverables were defined.

	Tasks			Deliverables	
Work Package 5	**Task 5.1**	Definition of objectives and indicators for the assessment of ERA-NET ICT-AGRI 2 activities	**D 5.1**	Impact model with evaluation objectives and list of indicators	
	Task 5.2	Data collection – Online questionnaires for project applicants, platform users and ICT-AGRI 2 partners, and monitoring tools	**D 5.2**	Online questionnaires for project applicants, platform users and ICT-AGRI 2 partners, and monitoring tools	
	Task 5.3	Impact evaluation and recommendations: report on the analysis and results of the data collection	**D 5.3**	Report on the analysis and results of the data collection	
			D 5.4	Final assessment report and recommendations for further development of ERA-NET activities and solidification of the transnational cooperation and coordination	

The present report (D 5.4) provides recommendations and best practices for future collaborations (regarding the process of an ERA-NET, including the evaluation method), as well as describes the impact evaluation of funded projects. The impact evaluation is based on data collected between September 2015 and March 2016 using an online questionnaire addressed to researchers that applied for funding from ICT-AGRI (see paragraph 3.2 "Evaluation instruments: online questionnaire (D 5.2).

2.2. Impact Model (D 5.1)

The impact model (IM, i.e. D 5.1 [1]) serves to compile a complete set of questions which, when answered, allows a conclusive and comprehensive evaluation of the project achievements. Did the calls and the funded research projects fulfil the expectation of the ICT-AGRI partners and stakeholders? What were the main outputs of the funded projects? How were the funds used? What effects did the project produce, directly and on the long term? How effective was the support of the Meta-Knowledge Base (MKB) for networking? These are examples of questions the impact assessment and evaluation intended to answer.

In order to take the whole process of the ICT-AGRI projects into account, the model is structured according to five main stages: (1) call process, (2) inputs, (3) outputs, (4) outcomes and (5) impacts. Theoretically, the first two stages (1-2) consider aspects that can be evaluated before or at the beginning of the projects, whereas the three others stages (3-5) consider aspects that can be measured conclusively only after the projects have been finished.

The questions for each stage are subdivided into different categories according to the target or the effects (e.g. immediate, intermediate or final outputs). Each category (e.g. immediate outputs) contains several indicators (e.g. publications, trainings, contacts with stakeholders, conferences). The categories are described in the model (Figure 1) and are roughly described hereafter.

Call process

As part of the questionnaire, the call process comprises questions regarding for example the quality of the call documents, the clarity of the call procedure as well as the given time frame and the available tools to find partners and build a consortium, respectively. The questions aim at identifying the potential for improvement of future calls. Thus, asking the project participants about their experiences with the call procedures will allow to better design them.

Inputs

Analysing the inputs will give an idea of the funding sources and amounts entering the projects. An important question is whether the funding of ICT-AGRI stimulated other funding sources. Inputs include not only financial means but also human resources, equipment, knowledge and ideas.
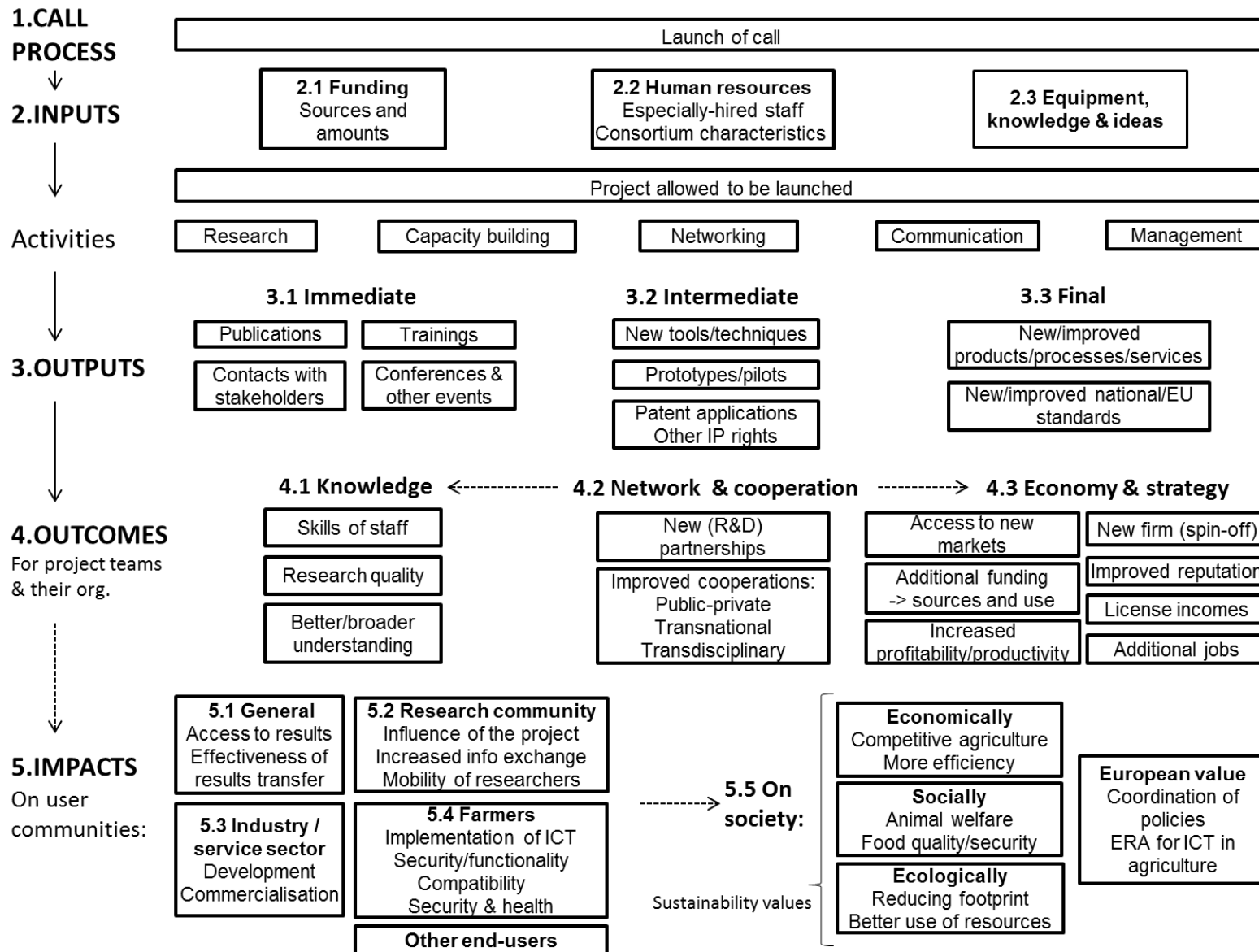
1.CALL PROCESS

Launch of call

2.INPUTS

| 2.1 Funding Sources and amounts | 2.2 Human resources Especially-hired staff Consortium characteristics | 2.3 Equipment, knowledge & ideas |

Project allowed to be launched

Activities

Research | Capacity building | Networking | Communication | Management

3.OUTPUTS

3.1 Immediate
- Publications
- Trainings
- Contacts with stakeholders
- Conferences & other events

3.2 Intermediate
- New tools/techniques
- Prototypes/pilots
- Patent applications Other IP rights

3.3 Final
- New/improved products/processes/services
- New/improved national/EU standards

4.OUTCOMES
For project teams & their org.

4.1 Knowledge <---------- 4.2 Network & cooperation ----------> 4.3 Economy & strategy

4.1 Knowledge
- Skills of staff
- Research quality
- Better/broader understanding

4.2 Network & cooperation
- New (R&D) partnerships
- Improved cooperations: Public-private Transnational Transdisciplinary

4.3 Economy & strategy
- Access to new markets
- Additional funding -> sources and use
- Increased profitability/productivity
- New firm (spin-off)
- Improved reputation
- License incomes
- Additional jobs

5.IMPACTS
On user communities:

5.1 General
Access to results
Effectiveness of results transfer

5.2 Research community
Influence of the project
Increased info exchange
Mobility of researchers

5.3 Industry / service sector
Development
Commercialisation

5.4 Farmers
Implementation of ICT
Security/functionality
Compatibility
Security & health

Other end-users

Sustainability values

----------> 5.5 On society:

Economically
Competitive agriculture
More efficiency

Socially
Animal welfare
Food quality/security

Ecologically
Reducing footprint
Better use of resources

European value
Coordination of policies
ERA for ICT in agriculture

Figure 1: The Impact Model

6

Outputs

Outputs represent the direct results of the activities realised. Questions regarding the outputs are separated into immediate (publications, public events, etc.), intermediate (patent applications, new methods or tools etc.) and final results (new products or services).

Outcomes

Outcomes are defined in the IM as the effects of the outputs on the research teams themselves and their organisations or on the SMEs, respectively. High outputs may significantly improve the situation of the project participants by an enhanced reputation and prestige as well as by an improved competitive position in the scientific community and in the case of SMEs in the commercial market. The answers to corresponding questions allow to assess how researchers, research institutions and SMEs benefit in terms of increased knowledge, improved networking and cooperation skills or access to new markets.

Impacts

Impacts are the wider effects of the research projects. According to Figure 3 in D 5.1 [1], impacts are defined as the benefits for the immediate target audience and users of the outputs. The project benefits for the society at large are called relative impacts.
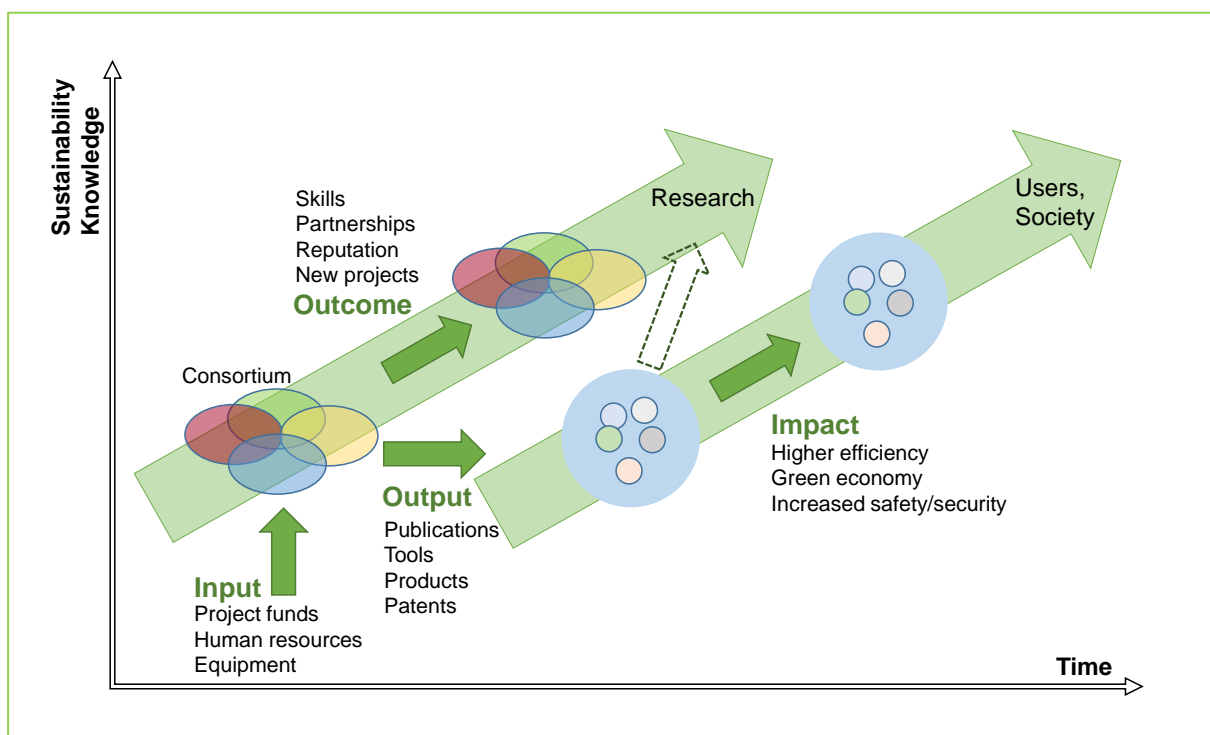

Figure 2: Principles of the Impact Model (IM).

The principles of the IM are shown in Figure 2. The outputs from a specific project (i.e. publications, developed tools, products or patents) have to reach not only the research communities, but the users and society, i.e. public and private stakeholders, as well. Only when outputs are available for a wider

set of actors (i.e. the farming community as a whole, the rural economy in general as well as the public sector administrations) they can have a tangible impact on society and favour, among other things, a higher economic efficiency, a greener economy and increased safety and security. For instance, in the case of the themes studied in ICT-AGRI, the use of ICT and robotics in internal farm operations and in external farm business relations is growing fast, and having compatible systems is becoming increasingly crucial for achieving the full potential of the technology. Thus taking into account not only the outcomes and outputs, but the impacts for the others stakeholders (e.g. users) is necessary.

3. Impact Assessment Evaluation

3.1. Evaluation Scope

The evaluation of ICT-AGRI 1 and 2 was carried out at the research project level (see Figure 3). Therefore, it mainly addresses questions regarding:

- **call process quality**, e.g. to know the use and efficiency of the Meta-Knowledge Base (MKB), (IM 1);
- **project inputs** as well as additionality at the input and output levels, e.g. to know what would have happened without EU funding (IM 2.1), to describe which role the ICT-AGRI network played at the beginning of the project development (IM 2); to find out how effective were the ICT-AGRI grants in attracting other financial sources (IM 2.1);
- **project effectiveness** in reaching goals at the output, outcome and impact levels of the projects including success factors (mainly for outcomes). The goal is to find out e.g. how effective the projects were in promoting research and networking between researchers in the targeted research and development areas (IM 4.3) and how to strengthen the ICT-AGRI network benefits (IM 4.2) as well as to estimate the added value generated by the ERA-NET scheme specificities, namely, the joint and transnational aspects of all submitted projects (IM 4.2 and 5.2);
- **project efficiency,** e.g. their performance (cost-benefit) as regards publications, development of new methods and tools patent application etc.;
- projects' **contributions to overarching ICT-AGRI and ERA-NET targets** (which correspond to the goals set at the impact level of the projects, i.e. contribution to sustainability and ERA).

The evaluation does not address:

- the effects of the sum of all projects (as only projects of the first of the four calls were finished and could be fully taken into account in the evaluation, see Figure 4);
- the question whether goals relating to national funding agencies and their cooperation and networking with other research coordination initiatives have been reached;
- the question whether the overall concept of ICT-AGRI 1 and 2 is coherent ("are the ICT-AGRI's instruments and resources adequate to reach its targets?");
- the question whether the overall concept of ICT-AGRI 1 and 2 is coherent with related initiatives like the Joint Programming Initiative FACCE;
- the relevance of ICT-AGRI goals for reaching overarching goals of ERA-NETs and the 7th EU Framework Programme (2007-2013)/Horizon 2020 (2014-2020).
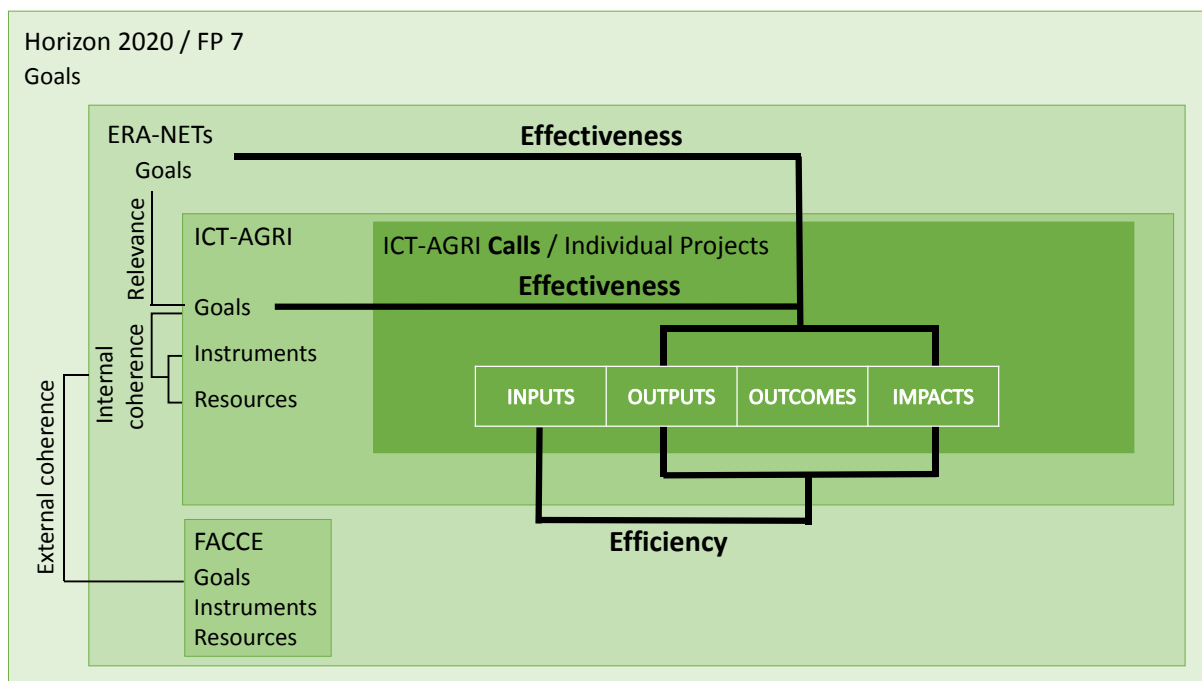
Figure 3: Scope of the ICT-AGRI evaluation. Lines in bold are the scope of our evaluation. Source: adapted from **[2]**.

Most evaluation results are of a summative[1] nature (inputs, effectiveness and efficiency of projects, additionality, and contribution to overarching goals). The results regarding the quality of the call process are of a formative[2] nature in the sense that they can help national authorities improve documents and processes (the terms "summative" and "formative" are from [3]).

3.2. Evaluation instruments: online questionnaire (D 5.2)

To collect the necessary data, a questionnaire (D 5.2 [4]) was implemented on the Meta-Knowledge Base (MKB, http://ict-agri.eu/), based on an IM (D 5.1, see also paragraph "2.2 Impact Model (D 5.1)"). The link to the questionnaire forms was sent on September 30 2015, to all ICT-AGRI project partner applicants regardless of the approval of their project and the year of their application. Thus evaluation results include participants of the calls 2010 "ICT and Automation", 2012 "Green Agriculture", 2014 "SmartAgriFood" and 2015 "Enabling Precision Farming". When the survey was open, the calls were at different stages, i.e. projects were either finished, running or at the proposal evaluation stage (see Figure 4). Therefore, the questionnaire was divided into four parts, according to the stages in the IM: (1) call process evaluation, (2) input evaluation, (3) output evaluation and (4) outcome and impact evaluation. Depending on the status of the respondent's ICT-AGRI project (i.e. rejected, not started yet, running or finished), the respondent had access to one, two, three or all four parts of the evaluation. As regards of the questions concerning impacts on user communities and society, the approach to ask researchers can be characterised as an indirect approach. The questionnaire was open to researchers until March 2016. Afterwards, answers were analysed and graphically explained (D 5.3 [5]). However, at that time no specific recommendations for further calls were drawn from the results. To draw conclusions from the collected data and give best practices for the future of ICT-AGRI was the aim of the present deliverable D 5.4.

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[1] *"A "summative" evaluation takes places following research completion and is used in subsequent allocation of resources*" [3].

[2] *"A "formative" evaluation takes place before or during the research and is employed in its management* [3].
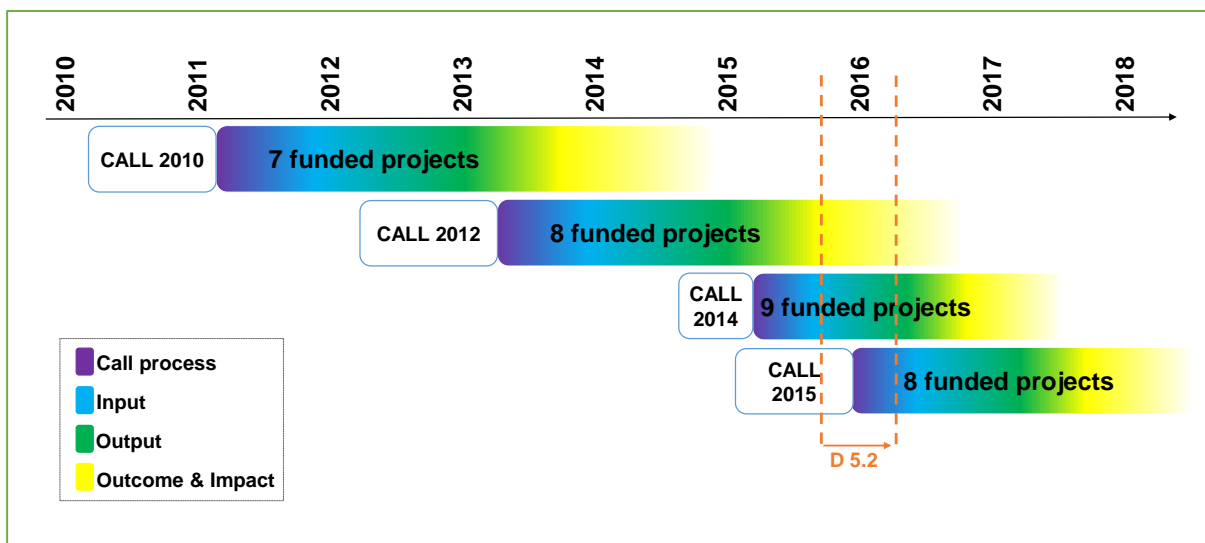
Figure 4: Timeline for the different calls and their related projects. The process of all projects is separated into the four phases (1) Call Process, (2) Input, (3) Output and (4) Outcome & Impact. D 5.2 marks the date of the survey.

Partner (D 3.4) versus Researcher (D 5.4) survey

It may be important to remember that a previous survey D 3.4 [6] had already been carried out during ICT-AGRI 1, in October 2013. This survey targeted ERA-NET partners including governing board, network management group and funding bodies that participated either in ICT-AGRI 1. It examined the call procedures and the Meta-Knowledge Base (MKB), focusing on questions to determine whether these activities were functional and efficient. Information and feedback about the stages in which the respondents took actively part (i.e. the call procedures and, for some, inputs) were collected (see ICT-AGRI 1, Deliverable 3.4 [6]). The analysed results from D 3.4 were also used for this present impact assessment D 5.4.

3.3. Evaluation versus monitoring

The difference between the present evaluation versus monitoring needs to be clarified. The evaluation based on the IM presented in this deliverable aims to assess the achievements of the funded projects and of the funding initiative itself. The gathering of information for an evaluation ideally only takes place after the projects have been fully completed. In contrast, monitoring data on project activities are collected while they are being carried out. The project coordinator uses them to manage the funding initiative. Monitoring is not only an important task of the project coordinator but also of the ERA-NET scheme. Within ICT-AGRI, project monitoring activities are performed by the Danish Agency for Science, Technology and Innovation (DASTI) as a part of ICT-AGRI 1 and 2 Work Package 2.

4. Recommendations from a methodological point of view

As different workshops and courses organised by ERA-LEARN show (e.g. [7], [8] and [9]), a common methodological framework for impact assessments is being developed in order to improve the quality of evaluations but also to improve comparability between different projects within an ERA-NET as well as between different ERA-NETs. To provide an input into this ongoing work this part makes some recommendations based on the experience gained in the course of the ICT-AGRI evaluation.

4.1. Timing

The right timing of the evaluation depends on its goals. According to the Description of Work [10], the evaluation "*is targeted at optimising the ERA-NET funding activities and the networking*" (p.22). The early timing of the evaluation made it possible to generate inputs to improve the call procedure for a following call (WP 2, in case of ICT-AGRI) and generate inputs for reports on networking activities concerning research coordination (WP 3, in case of ICT-AGRI). As regards mainly project impacts, a later timing of the evaluation would have allowed a more complete assessment.

Recommendation for future ERA-NETs

When designing an evaluation, special attention must be paid to carefully define the evaluation goals. If they are mainly of a formative nature and results are expected to benefit the current ERA-NET or needed for the design of a subsequent research initiative [11], an early evaluation makes sense. If, however, the summative aspect is important, it should be carried out when most projects have been completed (and to assess impacts even some time after that). If both goals are important, splitting the evaluation in two parts should be considered. For an example of dividing evaluation activities into cycles, see FACCE's monitoring and evaluation framework [12]. Carrying out one part of the evaluation or even the whole evaluation some time after the end of a project poses, however, specific challenges. One challenges lies in the fact that in the academic world, researchers are very mobile and change university or position fairly frequently, therefore it will be difficult to reach all of those involved a few years after projects are completed. Another challenge is of a financial nature, because evaluations would be carried out after the end of the ERA-NET's funding time or even after the end of the ERA-Net itself.

4.2. Evaluation focus

The evaluation carried out is broad in terms of elements addressed. The question is whether its ambition is coherent with the resources and time available to collect and assess the necessary data.

Recommendations

Every effort should be made that an evaluation project is realistic, i.e. to design it in a way that its goals can be reached with the resources and time available. To design a realistic project in a first step it is suggested to define and prioritise a limited number of evaluation goals. In a second step, precise evaluation questions (which are formulated in a broader way than the questions in the questionnaire) need to be formulated based on a logic/impact model (cf. Table 2 in the FACCE monitoring and evaluation framework [12]). As resources are generally limited, it is necessary to select the number of elements that an evaluation wants to address. Only very seldom is it possible or indeed does it make sense to define questions relating to all elements and all possible relationships between elements of the impact model (concept, input, output, outcome, impact; effectiveness, efficiency, coherence, relevance, etc.). As regards ICT-AGRI, dropping questions on societal impacts to the benefit of more in-depth questions regarding impacts on user communities could have been considered, in view of the limited number of projects, which were terminated when the evaluation was carried out. Only on the basis of precisely formulated evaluation questions should one then proceed to create the survey-instruments.

4.3. Evaluation instruments

The approach to collect data mainly via a questionnaire sent out to partners and rejected applicants can be considered adequate to survey inputs, to evaluate effectiveness and efficiency of the projects up to the outcome level, the quality of the call process, and to assess some general impacts like the availability of open access results. To assess impacts on user communities (other than researchers) and society indirectly via researchers can be considered a second-best approach.

Due to the broad scope of the evaluation, the questionnaire is rather long (more than 120 items). It contains many questions, which ask for facts (answers to so-called "descriptive" evaluation questions).

Recommendations

To get a more complete and in-depth picture regarding impacts on user communities a direct approach should be considered in future initiatives, e.g. directly interviewing user communities like industry representatives or farmers or proceeding to case studies on a limited number of projects. Such an approach was taken in the EMRP/EMPIR evaluations [13]. However, using such additional instruments would mean investing more time and resources in an evaluation project.

Rejected applicants' motivation to fill in questionnaires is generally limited. If their feed-back is considered especially valuable, e.g. to improve call procedures, contacting them for an interview should be considered instead of sending a questionnaire.

When carrying out an evaluation, every effort should be made to limit as much as possible demands on partners' time [11]. Therefore, it should be considered to collect information of a factual/quantitative nature (answers to descriptive evaluation questions) by the way of standard project reporting/life cycle/monitoring documents, thereby creating as many synergies as possible [3]. Questions in questionnaires should be as a general rule more of a qualitative/evaluative nature (asking for a judgement, e.g. "How do you rate the performance of the project concerning transdisciplinary cooperation, compared to before your part of the project started?") or of a causal nature (asking for links e.g. "Did your project achievements lead to additional funding during or after the completion of your part of the ICT-AGRI project?").

4.4. Data assessment

Based on the survey data the evaluation report summarises the results. Most often it reports the results without forming a judgement. For example, it reports what respondents have said regarding how they rate their project as regards transnational cooperation. The result is that 75 percent of respondents said that their project met their corresponding expectations while 25 percent said that the outcome was above their expectations.

Recommendations

A core step in the process of carrying out an evaluation is to form a judgement on the collected data. Therefore, it is advisable before gathering the data to define a scale regarding how the results will be interpreted. In the example mentioned above, the evaluator needs to define and make transparent what kind of result regarding transnational cooperation is considered good (for an example, see JPI on Antimicrobial Resistance [14]). Ensuring transparency regarding the way judgements are made is especially important, if it is not possible to mandate independent experts to carry out the evaluation [11].

4.5. Use of evaluation results

The document "Annex I – Description of Work" [10] (p. 23) states how evaluation results will be used[3]. The text mainly refers to the formative part of the evaluation results.

Recommendation

Prior to evaluating, such a reflection needs to be made for all parts of the evaluation, i.e. also for the summative part, if there is one. To create maximum added-value it is recommended on top of producing a written report to discuss the results and recommendations not only with national and Commission authorities but also with project partners and stakeholders to generate as much "ownership" as possible. Such ownership is necessary to make sure that all stakeholders learn from the evaluation exercise and are motivated to apply the lessons learnt in subsequent ERA-NETs/transnational initiatives. However, this means that substantial resources are earmarked for this last but important part of the evaluation exercise.

4.6. Comparison with FACCE evaluation design

To illustrate some of the previous recommendations, we compare the evaluation design of another ERA-Net (FACCE) with ICT-AGRI's (Table 2). FACCE's evaluation framework [12] is broader in scope than ICT-AGRI's. Furthermore, the proposed instruments to collect data are more diverse and the evaluation lasts much longer. However, the document stresses that its implementation depends on whether the necessary funds can be made available, showing the trade-off evaluation quality / financial resources of the different impact assessment methods that also need to be taken into account when designing the evaluation.

Table 2: Comparison between FACCE and ICT-AGRI evaluations.

	JPI FACCE	ERA-NET ICT-AGRI
Objects/Level	JPI (as a whole); Actions (calls and others); Projects (research projects and others).	ICT-AGRI 1 and 2 Actions (calls); Projects (research projects, MKB).
Assessment	Summative: Effectiveness (for all objects)[4], organisational structures and processes (JPI, actions)	Summative: Effectiveness, efficiency (research projects), effectiveness (MKB) Formative: Effectiveness, efficiency (call process)
Duration in years	up to 15	3
Methods	Monitoring, questionnaires, interviews, case studies etc.	Monitoring (Work Package WP 2), questionnaire (researchers; i.e. D 5.2 [4])

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[3] "The analysis of the data will provide recommendations for 'best practices' in conducting transnational calls with a specific focus of target-oriented definition of call objectives and sustainability in financing research projects, and to further facilitate and develop transnational collaborations as well as and to establish ways to assure a durable network (contribution to task 1.5). The results will be integrated into the activities of WP2 (design and implement appropriate ERA-NET funding activities) and WP3 (support of networking facilities)." [10] (p. 23)

[4] Formative questions are addressed in the framework of the monitoring exercise.

4.7. Outlook

The ERA-LEARN 2020 project dedicates a specific Work Package (WP3 [15]) to monitoring and impact assessment, which aims to develop a more integrated and systematic framework for monitoring and assessing the impacts of P2P networks and associated co-funded projects. Task 3.2 of WP3 involves an annual series of focused impact assessment surveys to explore important policy issues for P2P networks. The framework used for the assessments is as shown in Figure 5. It uses a terminology and definitions which in some points differ from the ones used in the ICT-AGRI evaluation. For example, intermediate impacts (which in standard evaluation literature are called outcomes) go beyond effects for project teams and their organisations.
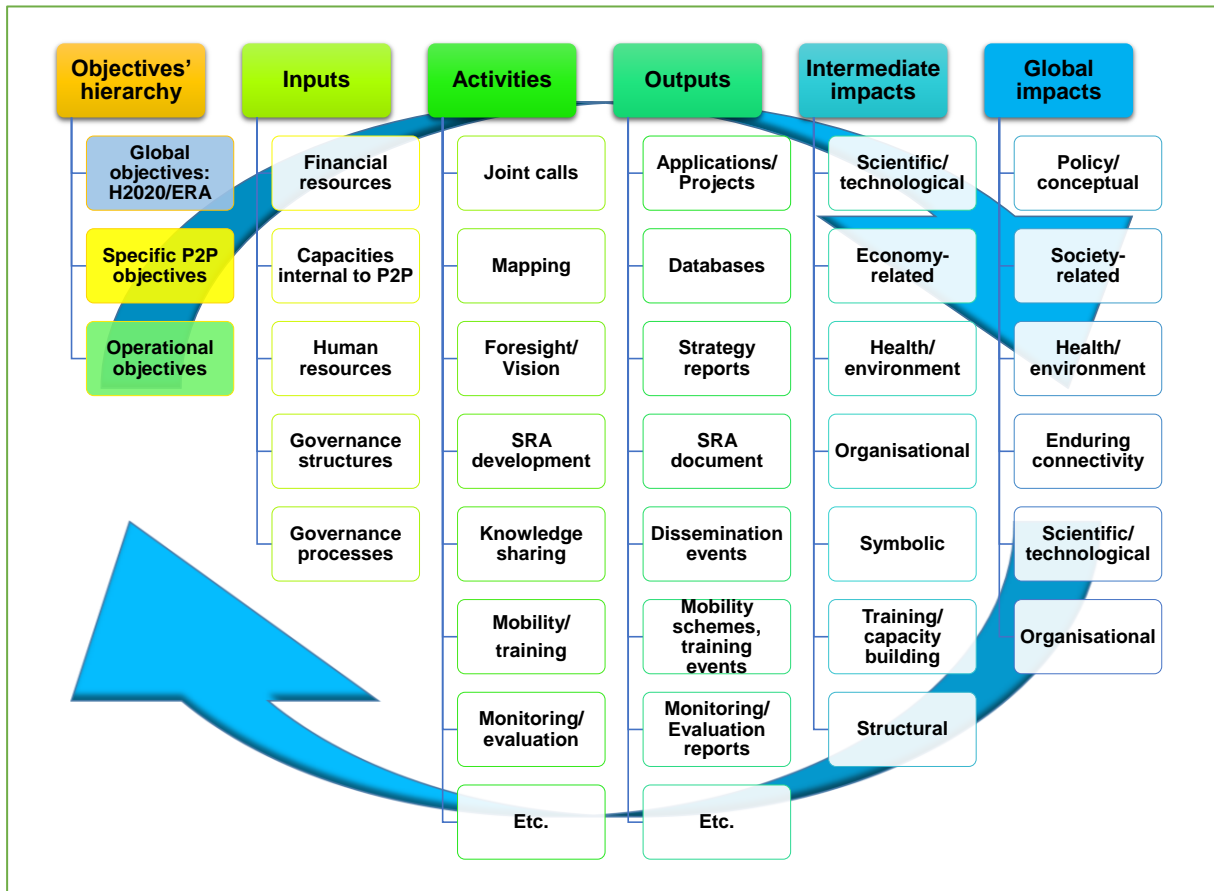

Figure 5: Framework for assessing networks (ERA-LEARN 2020). Source: **[2]**

We suggest that ERA-LEARN 2020 should ultimately come up with an evaluation framework that is based on the conceptual work it has carried out so far, but which also takes into account existing overarching evaluation frameworks like the ones used by the European Commission [16].

5. Interpretation of the funded projects results (D 5.3) and recommendations

5.1. Identifying survey respondents

In total, 85 project partners from 17 countries completed the questionnaire. At the time the questionnaire was sent out, only the projects of Call 2010 were completed and therefore only the researchers involved in those projects were able to give a feedback on outcomes and impacts of their

research (see Figure 4). The respondents of call process represent 26% of all participants. Among the respondents of the Call 2015, twenty-eight participants (representing 32% of the applicants of 2015) were involved in projects which have been rejected afterwards (Table 5).

A recommendation to increase the number of respondents, and thus, to improve the representativeness of the evaluation results, would be to make the questionnaire mandatory and as concise as possible (see "4.3 Evaluation instruments"). In addition, to have a better overview mainly of the outcomes and impacts, a second questionnaire should be sent after the end of the project (see "4.1 Timing").

Table 3: Respondents per part of the call, all calls included.

	1. Call Process evaluation	2. Input evaluation	3. Output evaluation	4. Outcome and Impact evaluation
Nb. of project partners that responded (percentage)	85 (26%)	29 (15%)	20 (21%)	9 (20%)

Table 4: Representativeness of the projects within the respondents. For each call, it is shown how many projects were funded and their representation in the questionnaire participation (i.e. response rate).

Call	2010	2012	2014	2015
Nb. of funded projects that responded (percentage)	6 (86%)	8 (100%)	7 (78%)	7 (88%)

Table 5: Number of funded project partners that responded, all calls included.

Call	2010	2012	2014	2015
Nb. of project partners that responded (%)	11 (34%)	18 (35%)	9 (35%)	21 (38%)

5.2. Call process procedures

Overall, the researchers were satisfied with the applied processes, but a few had some difficulties during the call process procedure. However, the ICT-AGRI call procedure was considered, overall, as clear and transparent by all participants and the given period of time for the preparation of the full-proposal was judged as adapted by a good majority. However, 15% of the accepted project partners defined this duration as "too short". When looking only at rejected projects' answers, most of the project partners identified the call procedure as moderately clear to very clear and transparent, however a third of them found the given period "much too short". Thus the lack of time might have negatively influenced project proposal quality, particularly concerning the establishment of a consortium. Indeed 19% of the non-funded participants judged the call process as "ineffective" to build a consortium, whereas 97% of the participants from accepted projects found the call process from moderately effective (17%) to effective (46%) and very effective (32%).

National and transnational funding rules

A difficulty during application that both funders and researchers encountered, was the discrepancy between national and ERA-NET rules, documents and timetables, as well as between national and international funding requirements. Indeed ERA-NET programmes such as ICT-AGRI are funded by consortium partners and associated national funding agencies, which add funding to a so-called virtual common pot, meaning that funding is restricted to consortium partners from the same country as the country of the funding agency. The applicants therefore need to take into account both the ERA-NET rules as well as the national funding requirements. According to the respondents this feature has been quite challenging.

5.3. Input

Funding

From both sides (funders and researchers, through D 3.4 ICT-AGRI 1 [6] and D 5.2 ICT-AGRI 2 [4], respectively), it emerged a need for a bigger budget. In each call, ICT-AGRI funded 70-80% of the total projects' costs (see Table 6 for details per year).

Table 6: Financial contributions of ICT-AGRI programme for the different calls.

Call	Nb. of funded projects	Total costs [mio€]	Costs covered by ICT-AGRI [mio€]	Percentage of costs covered by ICT-AGRI
2010	7	4.065	3.306	81%
2012	8	7.788	5.434	70%
2014	9	2.562	1.812	71%
2015	8	5.297	3.646	69%
Total	**32**	**19.712**	**14.198**	**72%**

Table 7: Financial contributions within and ICT-AGRI and other (13) ERA-NETs programmes. For further details about the ERA-NETs and their data, see Table 8 in the Appendix. The value of "Other ERA-NETs" are calculated without ICT-AGRI data.

	ICT-AGRI Mean	Other ERA-NETs	
		Mean	Median
Nb. of participants	28	25.8	24
Nb. of countries involved	18.5	18.4	19
Nb. of funded projects (2006-2016)	17	15.2	15
Total budget [mio €]	15	15	8.5

From the comparison with other ERA-NETs programmes (13, see Table 8 in "7 Appendix"), which have also a link in the agricultural field, we can clearly notice that ICT-AGRI is very near, if not above, the mean or the median of many other ERA-NETs programmes active in an agricultural context.

Human resources

Use of the ICT-AGRI MKB for consortium building

The Meta-Knowledge Base (MKB, http://ict-agri.eu/) was a tool created for the online ranking of project proposals, i.e. to manage and evaluate the incoming proposals, and to help creating connections between compatible partners, as well as to facilitate networking and consortium building. Among researchers, about half of the respondents found their consortium partners via known research partners; the half of the others respondents found partners via other contacts and the other half via ICT-AGRI MKB. Nevertheless, half of the funders considered quite difficult to motivate researchers to provide an input into their profiles and research section of the MKB. Only when enrolment and contribution to MKB were made obligatory to apply to the second call, an increase in profiles number in the MKB was reported. However, MKB was considered by researchers and funders as a helpful tool and played an important role in supporting the operational activities of the ICT-AGRI ERA-NET throughout the whole project period. The utility and potential of the developed MKB was positively recognised by other ERA-NETs and was consequently used for their programmes, too. Other ERA-NETs, such as SUSFOOD, also successfully use a Meta-Knowledge Base[5].

To improve the appreciation of the MKB among researchers, it was proposed to integrate existing databases, e.g. LinkedIn, ResearcherID and ResearchGate, for contact and research information. Providing inputs into multiple databases may be seen as inefficient and time-consuming by many researchers. Making more use of scientific social media may also enable to reach a larger network and potentially improve transnationality and interdisciplinary. Other ERA-NETs programmes use interesting tools or actions that improve the communication between researchers, funders and society overall. For instance, the ERA-NET CORE-ORGANIC requests the upload and constant update of results, developed tools and publications on the platform e-print (http://orgprints.org/view/projects/eu-coreorganicII.html). Such a tool could be implemented to the existing ICT-AGRI MKB and extended to other or all results implementation (e.g. outcomes, impacts).

Furthermore the MKB could be used to giving access to the research to all documents (e.g. mid- / report, evaluation questionnaire). Indeed, as done and shown by CORE-ORGANIC[6], templates help researchers and funders to base their understanding of the aims of each other in a standardised way: the funders know where to find information in the report, researchers knows where to put information (inputs, outputs, etc).

Finally, the need and utility to maintain the platform up-to-date should be clearly specified in the contract, as it is a very important and demanding task.

Interdisciplinary

The complexity of building a consortium mentioned by the respondents is most probably due to the interdisciplinary that characterises the ICT-AGRI projects. The calls aimed to involve people with an ICT background such as computer scientists and statisticians, as well as scientists with a more agricultural background such as agronomists, environment engineers and animal physiologists. A different knowledge background and a missing common network may have limited the chances to get in touch, or made collaboration more complex at the start. However, this interdisciplinary is precious and it is

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[5] http://susfood-db-era.net/drupal

[6] http://www.coreorganic.org/Pages/Documents/Documents.html

the added value of ICT-AGRI. For instance, other well-established ERA-NETs such as CORE-ORGANIC or ANIHWA, only involve researchers from the same domain, e.g. with an agricultural background (organic farming and farming systems) or with an animal health and welfare background, respectively. Fortunately, the evolution of the projects partner composition towards more interdisciplinary in ICT-AGRI projects was positive. In 2010, the participation of computer specialists was limited, but in 2015, after four calls, disciplines with an ICT component were represented by 67 partners. This may be due to the good feed-back and advertisement of ICT-AGRI in the two different disciplines or to the adaptation of ICT-AGRI via the call topics.

Equipment, knowledge and ideas

End-users

The multi-stakeholdership is a crucial success factor for an interdisciplinary field such as ICT-AGRI and represents an important element in an EU programme. Thus, an essential part was the participation of end-users from the beginning of the project, namely their active involvement during the project design as well as for the evaluation (see "4.5 Use of evaluation results" for more details). In 60% of the projects, farmers were involved in the project design, whereas SMEs were involved in only 37% of the projects at the project design stage.

5.4. Output

Because projects of the Calls 2014 and 2015 were still running at the time of the survey, only researchers involved in projects funded under the framework of the Calls 2010 and 2012 were able to give a feedback on the output of their work (Figure 4). The general satisfaction of the funded projects was positive, with a majority of positive answers (Figure 6, left). ICT-AGRI funding played an important role for reaching the results' aim, as 70% of the funded projects answered that without ICT-AGRI funding, between none and only 20% of their actual results would have been achieved (see Figure 6, right). The immediate outputs generally reached the expectations with, for instance, an average of 5.6 publications (peer-reviewed articles, books and conference proceedings) and 7.2 meetings with the stakeholders (2.1 with service providers, 2.7 with industry and SMEs, 1.5 with advisors and 0.9 with other stakeholders) per project partner. The negative results for expectation were mostly from partners whose projects were still ongoing at the time the questionnaire was sent out. Regarding intermediate outputs, a total of 13 new methods, 17 new techniques and 20 new tools were developed within 8 projects. No patent applications were generated at that time, however, a total of 22 prototypes were already created and 22.2% of the projects created a marketable product or service.

Even if the questionnaire did consider the stage of the project, some questions may have been ambiguous and could be improved for a next evaluation. For instance the question about "the level of satisfaction about the outputs/results achieved", should have been phrased as "… so far achieved". As, with the first formulation, researchers may have interpreted the answer in comparison of the expected results of the global project and not only for their stage, biasing the evaluation's results.
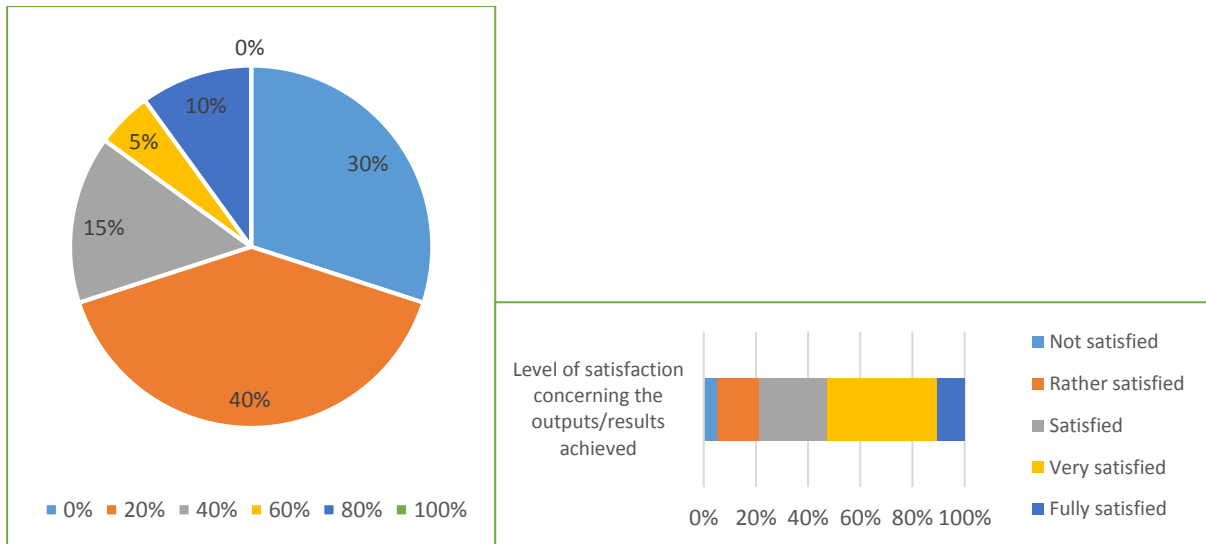
Figure 6: Percentage of results that would be achieved without ICT-AGRI funding (left). General level of satisfaction concerning the outputs (right).

Another improvement for the evaluation process, would be to send another questionnaire a 1 or few years after the end of the project, depending of the project conditions (size, trade-off between evaluation quality and resources, etc.). This would allow a more complete picture of the results. Indeed, it does not only take time to create the outputs, but also to transfer them to the users, and finally for the users to implement them. Some outputs need one or two years to materialise (e.g. publications), thus asking about the output several years later would not only increase the sample size, but also improve the accuracy of the evaluation (see also "4.1 Timing"). This is the case in the present deliverable: we could analyse some outputs from ICT-AGRI's project, because we are in the time period of ICT-AGRI 2, using data from ICT-AGRI 1.

Regarding another improvement, evaluation questionnaire would need to ask detailed questions about publications (e.g. topic, authors and journals), tools and methods, as well as questions about the achievement in regard of ICT-AGRI goals in detail, to allow a more complete picture (See also "4.2

Evaluation focus" and "4.4 Data assessment"). Another approach, made by CORE-ORGANIC regarding the publication, is to add every publication on a common platform (e-print).

An additional difficulty in evaluation is the comparison of projects within and between ERA-NETs. A common method and, ideally, a common metric system of evaluation would be very useful. A method was developed by Pederson et al. [3] which gives points depending of the different outputs in different categories (e.g. scientific effect, embedment of knowledge or impact on industry and society). Thanks to this common system, comparisons between projects, such as the cost effectiveness (i.e. points/invested money), can be calculated. This comparison also informs in which category most of the achievements occur (outputs, outcomes, and impacts) and thus if the project is still in the research phase or has already implemented the results (See Figure 7 for a rough and non-exhaustive analysis).
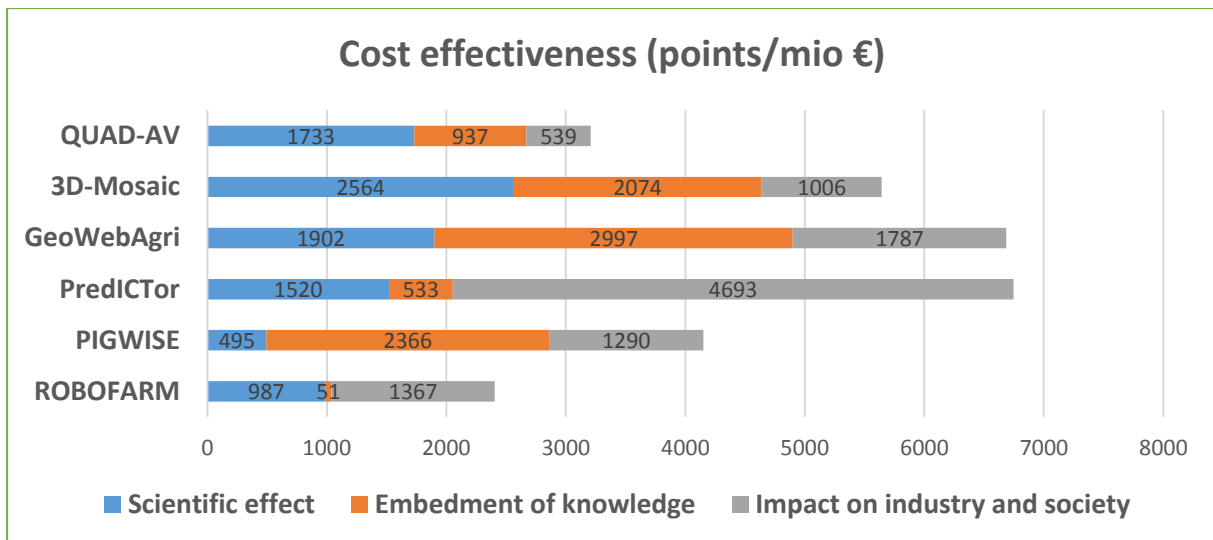
Figure 7: Cost effectiveness of the projects of ICT-AGRI 1 using the method described in [3].

As outputs concern not only scientists but users and society as well, it would also be valuable to involve more funders, end-users and stakeholders representing (civil) society in the evaluation. For instance an additional questionnaire could be sent out, also several years after the end of the project, to the funders, potential end-users and NGOs (see "4.3 Evaluation instruments" and "4.5 Use of evaluation results" for more details). The data collection should be via a different tool than in the first round, e.g. interviews or case studies, to ensure a high response rate. This would enable to better assess the outputs (and impacts, cf. "5.6 Impacts (effects of the project on users and society at large)") of the projects. The feedbacks of these different stakeholders would considerably increase the evaluation's value. Independent experts could be mandated to do the whole evaluation to avoid biases.

5.5. Outcomes (effects of the project on your institution and your team)

The evaluation is based on the available results of all respondents of finished projects (i.e. 6, all from Call 2010). The increase in research quality, skills, understanding of the research field were all regarded as positive and stakeholder expectations were considered to have been met. However, the focus of the projects did rather little to increase the researchers' understanding of end users' and farmers' needs (Figure 8). From the researchers' point of view, the projects funded by ICT-AGRI contributed positively to public-public collaboration (such as new R&D partnership), but had no or few effects on transdisciplinary and public-private cooperation. In 33% of the projects, additional funding occurred during or after the completion of respondents' parts of their ICT-AGRI project, creating in total 6 new projects (three from them were funded in successive ICT-AGRI Calls).
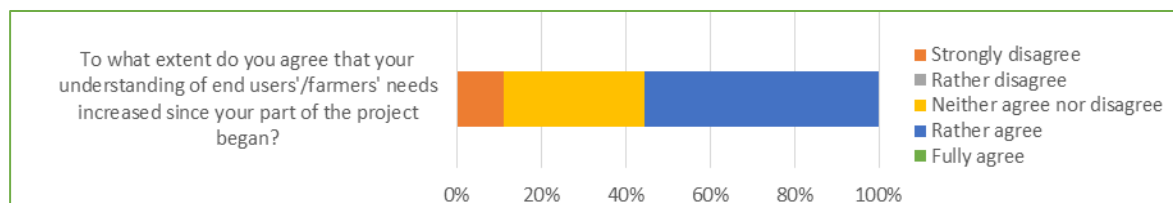

Figure 8: Outcome of the projects according to knowledge regarding end-users'/farmers' needs.

5.6. Impacts (effects of the project on users and society at large)

The respondents were very positive regarding the transfer of results and information to users and the society at large. However, it was not easy for the respondents to assess whether the result reached the desired stakeholders. The respondents also indicated that compared to the beginning of their project, a slightly improved information exchange and an increased research activities between ICT and agriculture were observed. At the end of the research projects, 85 requests were received from farmers or companies concerning the use of the project results, showing a good impact on the society. One of the partner had the project's results commercialised. In 17 cases, farmers have implemented the project results. Finally, the three most often mentioned effects of their research results on society at large were "increased productivity", "optimized fertilizer and pesticide use" and "improved farmers' working condition".
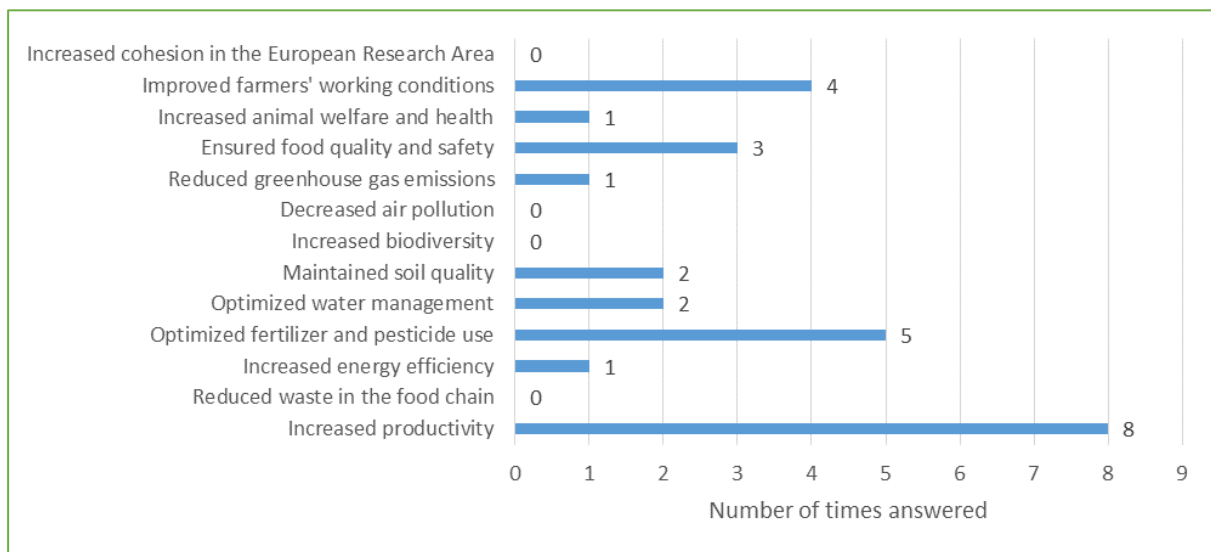

Figure 9: Effects on society at large of the ICT-AGRI projects.

6. Conclusions and Best Practices

6.1. Regarding the evaluation method

- **Timing:** Consider separating the evaluation into two parts: one to assess the process, input and short term outputs, and a second to evaluate the mid- to long-term results. When one part of the evaluation is carried out some time after projects have ended, financial issues (out of which budget is this part of the evaluation funded?) and practical issues (how to reach researchers who have moved on to other positions/universities?) need to be addressed. One possible solution for the latter challenge is to choose an evaluation design which does not rely on a questionnaire but on face to face interviews to achieve a good participation rate.
- **Evaluation focus:** Define realistic evaluation goals and limit the number of evaluation questions, in order to be able to reach the goals with the resources available and within the given timeframe.
- **Evaluation instruments:** Consider including the user communities in the evaluation process. Consider using a broader set of evaluation tools (e.g. include also interviews to get more in-depth answers to crucial qualitative question). Make sure that the questionnaire is concise and user friendly, to ensure that most questions are answered. A second best solution to improve

representativeness of the answers could be to make the filling in of the questionnaire mandatory.

- **Data assessment:** Assessments (value judgements) in the evaluation report need to be replicable, therefore they need to be made on the basis of criteria which are be defined before the evaluation is carried out and which are later, for transparency reasons, also included in the report itself.
- **Use of evaluation results:** Results of the evaluation should be discussed with stakeholders and end-users and shared outside the limits of the ERA-NET to foster mutual learning and ultimately improve future programmes. Methodological lessons learnt in the course of carrying out the evaluation should be shared with bodies striving to develop a common evaluation framework such as ERA-LEARN. This crucial step should be included in the evaluation design and sufficient funds need to be made available to carry it out.

6.2. Regarding ICT-AGRI

- Some difficulties were encountered by the participants, mostly regarding consortium building. The different national rules along with the transnational funding rules are probably a recurring challenge for all ERA-NETs, in addition to the interdisciplinary specificity of ICT-AGRI. Advising and informing the leading coordinator may help in a better foresight of the issues.
- The Meta-Knowledge Base (MKB) IS a helpful tool to simplify communication between the potential participants, and may be improved if integrated with already existing scientific internet social networks. Implementing an additional platform within the MKB such as the e-print of CORE-ORGANIC and extending its use to all results (e.g. outcomes, impacts, etc.) could be useful for the communication during (e.g. report, questionnaire) and after the project (e.g. impact). The management of such a base and platform should be specified in one of the WP.
- End-users are mostly represented in the projects, but improvements can still be made, as the multi-stakeholdership is a crucial point and represents an important element in an EU programme.

Despites the mentioned conditions and the recommendations to improve the programme, ICT-AGRI seems to have mostly fulfilled its goals in the researchers' view.

Table 8: Detailed overview of the comparison between ICT-AGRI and other ERA-NETs.

ERA-NETs in FP 6/7	Total budget invested in the call											Partners	Countries	Funded projects (up to 2015)	Tot. Budget [mio €]	Source
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016					
ANIHWA							14	11		10		30	19	21	35	[17]
ARIMNet						6						8	7	10	6	[18]
C-IPM										5	7	32	21	16	12	[19]
CORE-ORG1		8										13	11	8	8	[20]
CORE-ORG2				5		9	1					26	21	14	15	[20]
EMIDA				20		20						27	19	25	40	[21]
ERA-ARD1				2								15	14	5	2	[22]
ERA-ARD2						1.5						17	15	6	1.5	[22]
ERA-CAPS								22	20		NA	26	24	26	42	[23]
EUPHRESCO1	2											24	17	17	2	[24]
EUPHRESCO2						7						69	55	30	7	[24]
RURAGRI							8.5					24	20	5	8.5	[25]
SUSFOOD								10	7			24	15	15	17	[26]
ICT-AGRI1					4		6		1			33	21	24	11	[27]
ICT-AGRI2										4		23	16	10	4	[27]
Mean of ICT-AGRI 1+2												28	18.5	17	15	
Mean of all ERA-NETs												26.1	19.7	15.5	14.1	
Mean of all ERA-NETs without ICT-AGRI												25.8	18.4	15.2	15.1	
Median of all ERA-NETs												24	19	15	8.5	
Median of all ERA-NETs without ICT-AGRI												24	19	15	8.5	

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