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DiverIMPACTS
Diversification through Rotation, Intercropping, Multiple cropping, Promoted with Actors and value-Chains Towards Sustainability

Deliverable 6.3
Needs for training and advisory as well as for formal education

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Contents

Summary

Knowledge and innovation are key factors to help farmers to transition to diversified cropping systems as well as to help advisors foster diversification. To induce the required paradigm shift, strategic adaptations and changes in the agricultural knowledge and innovation system (AKIS), Task 6.3 aims at developing (i) specific training strategies and programmes for continued professional development; and (ii) strategies for formal education for future scientists or engineers. As a first step in this task, there is a need to identify the knowledge and skills needed by farmers to diversify their cropping systems, as well as by advisors and teachers to provide support and promote such diversification. Deliverable 6.3 aims to summarise the outcomes of seven workshops organised in six European countries to collect the needs and expectations from key actors of AKIS: farmers, advisors and teachers and researchers in the agricultural field.

We have identified three types of needs that are important to all involved actors: (i) theoretical and technical knowledge (to understand the response of the agroecosystem to crop diversification and knowledge on crop diversification practices); (ii) means to implement, accompany or teach diversification, i.e., knowledge exchange through multi-actor networks, methods and tools (co-design, experiments, etc.), and soft skills (coaching, facilitation, support to risk-taking); and (iii) up-scaling the understanding of crop diversification to the whole food supply chain (knowledge on upstream input industries, downstream trading and processing, retailers and consumers, focus on farm and cropping system level rather than on the crop level to identify crop diversification opportunities). The workshops also contributed to bring to light new training forms, with more interactions and multidisciplinary approaches, use of various media and different frequency.

Deliverable 6.3 emphasises the need to change the content, form and posture in training and education. The outcomes of Task 5.2 which deals with "addressing barriers and drivers of crop diversification at farm level" will complete these results. As a next step, the gap between knowledge and skills needed to foster diversification and the current vocational education and professional training will be identified in order to propose and develop a more adapted strategy. This step will be led in close collaboration with WP2, WP3, and WP5 and will build on existing results from the project.

Preamble

Over the last 50 years, there has been a trend towards specialisation and intensification with the aim of increasing the economic efficiency of food production and of the agri-food sector as a whole. Farms as well as territories have specialised in either livestock or annual crop production. Public policies, upstream and downstream industries, professional training and formal education and research, in other words the whole sociotechnical system (Geels, 2002), have accommodated this trend.

DiverIMPACTS aims to promote the realisation of the full potential of crop diversification by demonstrating its technical, economic and environmental benefits for famers, along the value chain and for society at large, and by providing innovations that can remove existing barriers to crop diversification.

Knowledge and innovation are key factors to help farmers to transition to diversified cropping systems as well as to help advisers to foster diversification. To induce the required paradigm shift, strategic adaptations and changes in the agricultural knowledge and innovation system (AKIS) and durably foster crop diversification, Task 6.3 aims at developing (i) specific training strategies and programmes for continued professional development and (ii) strategies for formal education for future scientists or engineers.

To do so, there is a need to identify the knowledge and skills needed by farmers to diversify their cropping systems, as well as by advisers and teachers to promote such diversification. The present deliverable describes the approach and the analysis of collected materials to inventory these needs.

1. Introduction

The specialisation and simplification of European agri-food systems has started with the green revolution of the 1960s (Kronberg et Ryschawy 2019). Driven by food market globalisation and output-based subsidies from the European Common Agriculture Policy (CAP), the number of cultivated plant species grown in Europe has considerably dropped throughout the past 60 years leading to a shortening of crop rotations and an increase in field size (Fuzeau et al., 2012; Kronberg and Ryschawy, 2019; Meynard et al., 2015). This simplification of agri-food systems, enabled by the use of synthetic inputs (fertilisers and pesticides), has led to strong adverse impacts on the environment. Among them are chemical pollution, soil degradation, biodiversity loss and important emissions of greenhouse gas (GHG) which contribute to global climate change (Campbell et al., 2017; COMIFER, 2017; Grunwald et al., 2011; IPCC, 2014; Laurance et al., 2014; Vermeulen et al., 2012).

In this context, a transition from the current external input-based to a biodiversity-based agriculture is recommended by experts (Duru et al., 2015; HLPE, 2019; Therond et al., 2017; Tittonell, 2014). One important lever of this transition consists in diversifying cropping systems in both time and space (Gaba et al., 2015; Pelzer et al., 2012; Watson et al., 2017). However, the process of diversification encounters difficulties to gain importance in Europe, especially in conventional agriculture because of various barriers along value chains and a strong socio-technical lock-in (Magrini et al., 2019, 2016; Meynard et al., 2018; Morel et al., 2020).

1. The lack of knowledge as a barrier to crop diversification

Barriers to crop diversification are present from the upstream to the downstream of value chains and concern all actors of the sector (Meynard et al., 2013a; Morel et al., 2020), i.e., agri-feed and food suppliers, farmers, collection and storage operators and processing and distribution operators. For farmers, a major barrier to crop diversification is **the availability of technical and agronomical knowledge regarding crop diversification** (Meynard et al., 2013). Unlike references related to “major crops” which are readily accessible, those related to “minor crops” are scarce or may not even exist. The cash crop in a rotation requires an effective crop management which involves a large amount of knowledge (e.g. position in rotation, sowing density, fertilisation or pest regulation), adapted to local pedo-climatic conditions. The acquisition of these references requires significant investment in time and money from farmers or technical institutes who may prefer to invest in “major crops” which may be considered economically “safer”. Also, some outputs of crop diversification need to be assessed at the cropping system level, e.g., the gross margin or input costs. Yet, farmers, cooperatives, agricultural institutes and accounting organisations generally focus on the crop level and lack knowledge not only at the cropping system level but also at the farm system, value-chain and territory levels.

Against this context, there is a need to create technical and agronomic knowledge on the benefits and drawbacks of crop diversification at different levels of agri-food systems, and on the management of “minor crops”. Knowledge creation should involve actors of value chains, farmers, advice organisations, cooperatives and public research. Besides, coordination between actors should be promoted to improve the efficiency of knowledge creation by reinforcing experimentation and advice networks, and by sharing innovative experiences within farmer groups (Meynard et al., 2018).

2. *Key actors of Agricultural Knowledge and Information Systems (AKIS) in Europe*

The concept of Agricultural Knowledge and Information System (AKIS) is used to describe the exchange of knowledge and services which support these exchanges in rural areas. AKIS is also referred to by the European Commission (EU SCAR 2013), as 'Agricultural Knowledge and Innovation System'. In the European project pro-AKIS (http://www.proakis.eu/ Dec. -12 to May -15), AKIS were defined as a system that links people and organisations to promote mutual learning, to generate, share, and utilise agriculture-related technology, knowledge and information. Diverse actors from the private, public and non-profit sectors relating to agriculture may be considered as components of an AKIS system. It may include actors such as farmers, farm workers, agricultural educators, researchers, non-academic experts, public and independent private advisers, value chain actors, and other actors in the agricultural sector (Knierim et al., 2015).

Although AKIS differ widely among European countries (Knierim and Prager, 2015), key actors can be identified across these countries:

- **Farmers** and farm workers, who are in the core of the system as being the end-users of the knowledge and information;
- **Advisers**, who play a key role in exchanging, transmitting knowledge and information to (and from farmers) in the form of advice either through a profit or non-profit relationship;
- **Researchers**, experts, and all actors that may be considered as knowledge producers;
- **Teachers** and agricultural educators that also allow for information transfer and knowledge acquisition.

A major barrier to crop diversification is the availability and level of mastery of technical and fundamental knowledge by all actors of the AKIS system. Among recommendations produced by pro-AKIS project, support to training and education appears as one of the most important points to address. Lifelong learning and training for AKIS actors is put forward (Knierim et al., 2015b), especially for farmers and advisers. New skills and competences are needed to ensure crop diversification and switch to more sustainable farming systems.

To address this barrier to crop diversification, and based on the outcomes of seven workshops in six European countries, we report on (i) the state of knowledge of key actors of AKIS, i.e., farmers, advisers, researchers and teachers on crop diversification; (ii) the type and source of knowledge these actors use to implement (for farmers) or to promote (for advisers, teachers and researchers) crop diversification; and (iii) gaps identified in their knowledge on crop diversification.

2. Methodology

2.1 Sample of AKIS actors in workshops

Seven workshops were carried out by T6.3 partners in six European countries (France, the United Kingdom, Germany, Sweden, Belgium and the Netherlands) between 29/11/2018 and 27/01/2020 with key actors of AKIS: farmers, advisers and teachers and researchers in the agricultural field (Table 1; Figure 1).

Table 1 List of workshops and attendance

Organisation	Country	Date	Actors				Total
			Farmers	Advisers	Teachers or Researchers	Students	
LWK	Germany	29/11/18		5	4		**9**
ORC	United Kingdom	21/01/19		8	3		**11**
SLU - in VÄXA (advisory org)	Sweden	28/01/19	3	1			**4**
ESA	France	22/02/19	10	14	9	3	**36**
SLU	Sweden	11/03/19			5		**5**
INAGRO	Belgium	19/06/19		11			**11**
WUR / BioNext	Netherlands	27/01/20	1	5	2	5	**13**
	Total		**14**	**44**	**23**	**8**	**89**

Figure 1:A and B. Workshop carried out in the United Kingdom by ORC. C and D. Workshop carried out in France by ESA-APCA

In total, 89 persons attended to the workshops, among which 44 advisers, 23 teachers or researchers, 14 farmers and 8 students.

Most attendees were advisers. Besides, most attendees and most farmers were gathered in France (36 out of 89 and ten out of 14, respectively). Farmers of other countries were not or scarcely represented. As such, we zoom in on the outcomes of the workshop held in France in 3.2.

2.2 Format of workshops

Common guidelines were provided to partners (Annex 1). First, the DiverIMPACTS project and objectives of the workshop were presented in a plenary session. Each workshop was then divided into four sessions.

Session 1: Attendees were asked about their perception of crop diversification to assess their current level of knowledge on the topic. Session 1 was dropped when the workshop was held during a larger and specific event on diversification (e.g., the workshop held in France).

Session 2: Needs of farmers to diversify their cropping systems, and of advisers and teachers/researchers to promote such diversification were collected. A semi-structured questionnaire was provided to attendees so that they describe (i) their current vision and practices on crop diversification; (ii) the knowledge and skills they mobilise; and (iii) the knowledge and skills they miss (Annex 1). Depending on the number of attendees, these were split into breakout groups and when possible into breakout groups of specific AKIS actors, i.e., farmers, advisers and teachers. This allowed to give more time for each type of actors to express their needs.

Session 3: A semi-structured questionnaire was provided to attendees so that they give ideas and propositions, both on content and form of ideal training sessions on crop diversification (Annex 1).

Session 4: Answers to questionnaires were reported on in plenary session. This session allowed further discussion and exchange with attendees.

Each facilitator provided a detailed report on the workshop. In addition to these reports, individual questionnaires were used as material for our analysis.

3. Results

3.1 Identification and typology of needs on crop diversification

Based on workshop material, three types of needs were identified:

- Theoretical and technical **knowledge** on crop diversification;
- **Means** to implement crop diversification and disseminate related concepts;
- **Levels of agri-value chains** to address in order to implement crop diversification.

Results per type of needs and type of surveyed AKIS actors are summarised in Table 2. Advisers' and farmers' needs were more entwined. This is likely due to the fact that their activities are closely linked. Nevertheless, advisers were more focused on the theoretical aspects of crop diversification when farmers were more focused on the technical and practical aspects of crop diversification.

Table 2: Summary per type of needs on crop diversification and per type of surveyed AKIS actors

		Farmers	Advisers	Teachers/researchers
	Fundamental knowledge: understanding the response of the agroecosystem to crop diversification	Understand the relationship between their actions and the response of the agroecosystem	Understand the relationship between crop diversification and the response of the agroecosystem	Reviews on crop diversification; Dependency on environmental conditions
KNOWLEDGE	Technical knowledge on crop diversification practices	Choice of species and cultivars; Land preparation methods; Setting of agricultural machines for new crops		
MEANS	Knowledge exchanges on crop diversification	Create networks between farmers and other actors; Use social network to boost information sharing	Create networks between advisers and other actors	Use of multidisciplinary approaches
	Methods and tools	On-farm experiments on innovative crop management practices	Experiments on crop diversification; Co-design of innovative cropping systems with other actors; Methods and tools to analyse cropping system experiments and identify crop diversification options; Facilitation methods and tools	
	Skills	Risk management	Coaching and facilitation; Support risk-taking	Coaching and facilitation
LEVELS OF AGRI-VALUE CHAINS	Upstream input industries (breeding, seed availability)	Knowledge on input availability	Knowledge on input availability and exchanges with upstream input industries	Use of multidisciplinary approaches
	Farms	Focus on the farm and cropping system levels rather than on	Focus on the farm and cropping system levels rather than on the	Use of multidisciplinary approaches

	the crop level to identify crop diversification options	crop level to identify crop diversification options	
Downstream trading and processing industries, retailers and consumers	Knowledge on processing options, farm-gate prices, collection options, market outlets	Knowledge on processing options, farm-gate prices, collection options, market outlets and exchanges with downstream actors	Use of multidisciplinary approaches

3.1.1 Fundamental and technical knowledge on crop diversification

During workshops, attendees pointed out their lack of **fundamental knowledge to understand the response of the agroecosystem to crop diversification** and thus of its potential benefits and drawbacks in a particular context. Attendees were conscious of the need to have a holistic view on the farm and cropping systems to identify crop diversification options and manage diversified cropping systems. They, however, admitted that they lack knowledge on interactions between the different components of the agroecosystem (e.g., soil, plant, pests, etc.) and additionally on the effects of crop diversification practices on these interactions. It appeared that produced knowledge in this field is hardly transferred to farmers, advisers or teachers. Favouring the transfer of existing fundamental knowledge on crop diversification was thus found crucial to support crop diversification and identify options fitting particular contexts.

Alongside the lack of fundamental knowledge on crop diversification, attendees, and farmers in particular, pointed out their **lack of technical knowledge on crop diversification practices**, e.g., the choice of intercropped species or cultivars, sowing densities in intercrops, and the setting of agricultural machines for new crops.

3.1.2 Means to implement crop diversification and disseminate related concepts

During workshops, attendees highlighted **means to address fundamental and technical knowledge gaps on crop diversification**. Attendees indicated that **knowledge exchanges on crop diversification** between peers but also with other actors were missing, even though all actors were already somehow interconnected through their activities. Attendees expressed a need to exchange more through, e.g., websites, forums, group meetings, seminars, etc. As for them, although challenging, teachers pointed out their need for multidisciplinary approaches to address all aspects, including social aspects, of crop diversification.

Workshop attendees indicated that **methods and tools to support crop diversification** were missing. Farmers and advisers highlighted **experiments in local contexts as a means to develop fundamental and technical knowledge on crop diversification**. They, however, mentioned that time, space and costs were factors limiting experiment implementation.

Farmers, and advisers in particular, expressed their need for **methods and tools to analyse cropping system experiments and identify crop diversification options adapted to local contexts**. Decision support system tools were mentioned, including multi-criteria assessment tools from the field to the landscape levels. Interest was expressed in spending time and energy to be trained on such tools.

Teachers, and advisers in particular, expressed their need to **develop new coaching and facilitation skills**, and thus to be trained to new methods and tools alongside with the shift in theoretical perspectives on agricultural innovation. Rather than transferring technical knowledge and artefacts as experts, their role has changed to coaching and facilitating actor interactions to capacitate them to innovate, learn and change. Advisors expressed their need to support farmers' risk-taking and to consider uncertainties in results as knowledge evolves. Teachers expressed their need to provide more practical training through, e.g., case studies.

3.1.3 Levels of agri-value chains to address in order to implement crop diversification

Finally, the **needs expressed by workshop attendees covered the whole agri-value chain**, from the upstream input industries to downstream trading and processing industries, retailers and consumers, including farms. The need for **knowledge on the upstream level of agri-value chains** was highlighted, e.g., information on seed availability for minor crops or on the adaptability of available cultivars to local environments or innovative crop management practices. The need to **focus on the farm and cropping system levels** rather than on the crop level to identify crop diversification options was also highlighted. Finally, the need for **knowledge on the downstream levels of agri-value chains** was highlighted, e.g., information on processing options, farm-gate prices, collection options, and market outlets.

3.2 Zoom in on the outcomes of the workshop held in France

In this section, we zoom in on the outcomes of the workshop held in France, which gathered most of workshop attendees (36 out of 89) as well as most farmers (ten out of 14) (Table 1). This workshop was part of an event on agro-ecology and crop diversification organised in Angers on the 22nd of February 2019 by the research unit ESA/INRAE LEVA.

3.2.1 Needs on crop diversification per type of AKIS actors

3.2.1.1 Farmers

Farmers mentioned the diversity of crop diversification strategies that they are currently implementing:

- Increasing the duration of rotations;
- Multiple cropping;
- Intercropping, including agroforestry;
- Variety mixtures.

They indicated that crop diversification allow them to address different objectives and performance criteria, including balancing working hours, reducing risks, reducing pesticide treatments, reducing machinery costs and improving their carbon footprint.

In order to implement these crop diversification strategies, farmers indicated that they rely on: (i) their own experience as "farming researchers"; (ii) their initial education and continuous training; and (iii) various information sources and networks. Farmers indicated that they particularly rely on the following information sources and networks:

- "Crop diversification advisers";
- Accountants (economic aspects);

- Actors of value chains (e.g., cooperatives);
- Social networks: forum exchanges, internet;
- Farmer discussion groups;
- Conferences and events of agricultural extension;
- Field visits;
- Technical factsheets;
- Scientific and economic papers, the press, magazines.

However, farmers pointed out that they miss the following knowledge on crop diversification:

- Knowledge on prices and market opportunities (agri-food value chains);
- Knowledge on soil, interactions between crops, fauna and flora, biodiversity;
- Appropriate technical knowledge: farming practices (e.g., direct sowing);
- Knowledge on required investments (e.g., storage equipment, tools).

In conclusion, farmers highlighted that they need various knowledge and skills regarding crop diversification techniques and also a better understanding of the effects of crop diversification at the field and farm levels. Moreover, they highlighted the need to combine different means to address these issues: training, research, technical advisers, exchanges, discussion groups, etc.

3.2.1.2 Advisers

Advisers identified the following lines of thinking and actions:

- An increased need for technical knowledge (farming techniques) to provide technical advice and training to farmers;
- Data assessment (systemic, economic data) and capitalisation of results;
- An increasing role of advisers as moderators and facilitators in knowledge exchange;
- Promotion of on-farm system trials and experimentation;
- Fostering of innovations at farm level;
- Knowledge transfer and dissemination.

According to advisers, actions should be carried in a coordinated way to ensure wide dissemination of practices and create a regional momentum.

Advisers emphasised the importance of training and exchange networks that allow to cross-check information, develop experimentation projects and encourage farmer innovation. They also highlighted the importance of advisers' attitude to support the acquisition and co-design of new knowledge. This requires more skills in active listening, facilitation techniques (especially for group moderation) and training (objectives, scenarii, etc.). Beyond the transfer of practical knowledge, research and experimentation should be reinforced. Participating in different networks or projects (French RMT - Technological Network -,(similar to EIP-AGRI Thematic Networks; GIEE - Group of Economic and Environmental Interest (similar to EIP-AGRI Operational Groups-, etc.) and collaborating with scientific and technical institutes would help advisers to strengthen their skills and ability to support farmers engaged in crop diversification.

Advisers identified a lack of knowledge in several areas:

- Crop production, to design innovative cropping systems;

- Technical and economic references (on which advisers base their discussions with farmers), in particular on agro-ecological practices;
- Global vision of the farm: working time, equipment, field management, etc.;
- Potential market opportunities and organisation of the agri-food value chains;
- Implementation of multi-criteria experiments over several years.

They also pointed out the lack of:

- Participation in multi-actor research projects that would help to address some of the needs expressed above;
- Exchanges between advisers to cross-check information and promote a holistic approach of farming systems;
- Skills in facilitation, whether to train farmers or to encourage knowledge exchange and innovation in farmers' groups (facilitation methods, moderation of innovative design workshops), as well as in the way groups function (sociology of groups, barriers to change, etc.).

3.2.1.3 Teachers

The teacher group distinguished between what is currently being done and what to aim for. They emphasised the importance of:

- Innovative and more adapted pedagogies such as project pedagogy, systemic pedagogy, problem-based pedagogy;
- Field approaches (starting both from the students' experiences and practical cases in the field and explaining them in light of theoretical knowledge);
- Changing their posture with students from a top-down attitude to a supportive attitude so that students develop their autonomy.

The importance of a renewed pedagogy was explained by the fact that there is no turn-key model, no one solution that would fit all contexts, but a diversity of options to discuss and identify in a given context. This requires a supportive attitude and accepting more uncertainty for teachers and students both involved in co-learning.

In order to allow students to acquire knowledge and skills on crop diversification, teachers need to apply different methods and means, e.g., field work, practical cases, farmers' and professionals' feedback on their experience and experimental results.

According to teachers, various knowledge should be considered. First, teachers emphasised that interdisciplinarity is essential to give advisers and students a holistic approach of systems (cropping systems, farm systems, agri-food systems) which is fundamental to address in crop diversification. Besides, to teach on crop diversification, various sources should be combined: scientific, technical and empirical. Finally, the outcomes of research projects involving teachers should also be mobilised.

Furthermore, teachers feel the following elements are missing:

- Strengthen interdisciplinarity and establish links between research, advice and training in order to share knowledge and apply more holistic approaches;

- Train the teachers to develop new teaching methods and work in smaller groups to encourage exchanges and allow for field work;
- Develop skills to analyse an increasingly complex environment.

In conclusion, teachers highlighted their need to strengthen their knowledge on crop diversification and interdisciplinarity in order to share views and knowledge with a holistic approach to the subject. In addition, educational methods should be better adapted to the complexity of the subject.

3.2.2 Ideal training session on crop diversification per type of AKIS actors

3.2.2.1 Farmers

In terms of content, farmers stressed the importance of addressing the following points:

- "Neutral" scientific results allowing an objective point of view on the different agronomic practices and levers;
- Knowledge on the ecological benefits of diversification in farming systems: biodiversity, preservation of fauna and flora, etc.;
- Scientific knowledge on soil life (biology, components, processes) but also practical knowledge to stimulate it;
- Knowledge on the soil-plant relationship;
- Identification of crop rotations adapted to the pedo-climatic conditions;
- Cross-references for the farm and local or regional levesl;
- Holistic approach to farming systems;
- Knowledge on different market opportunities (taking into account the upstream and downstream of value chains) and their profitability;
- The importance of considering the financial management of farms.

In terms of form, farmers had various ideas:

- During a technical day (once a year, every quarter, two days every two months or one day a month);
- Via short learning materials on the Internet;
- Via popularisation articles published in the specialised press;
- During conferences and networking events, by combining scientific knowledge and practical applications;
- Via advisers competent in agronomy and moderation;
- Through testimonials and field visits in addition to the time indoor;
- Preferably during the winter period and before the harvests.

3.2.2.2 Advisers

In terms of content, advisers stressed the importance of addressing the following points:

- A diversity of practices with a territorial approach (the way in which farmers mobilise the territory to think about their practices, etc.);
- Targeting sub-themes to acquire fine knowledge;

- Reassuring oneself through scientific research results (fundamental, expeditions and field experiments);
- Importance of being trained on human support as much as on technical support.

In terms of form, advisers proposed:

- Short explanatory videos;
- Technical data sheets;
- Agricultural extension events;
- Alternating periods of theory, field practice and popularisation;
- Distance Learning;
- Promote exchanges to share and cross experiences.

3.2.2.3 Teachers

In terms of content, teachers stressed the importance of addressing the following points:

- Identification of possible and varied levers to crop diversification;
- Knowledge on challenges of crop diversification and its effects;
- Tracking of innovations at different levels of agri-value chains;
- Co-design of methods for identifying diverse options;
- Human accompaniment.

In terms of form, teachers proposed:

- Interactions with other organisations to cross references and knowledge;
- Observe existing concrete cases in the field highlighted by empirical knowledge;
- Enable students to go to the field to identify complex systems and then work on them in class;
- Crossing the territory and value chain levels;
- Multi-disciplinarity on crop diversification.

3.2.3 Summary of needs

The three professional groups shared a number of common needs, each at its own level, to strengthen their skills to support crop diversification.

Based on the results of the workshops, crop diversification is seen as a means and not an end to develop more resilient cropping and farm systems that can adapt more easily to different hazards (climatic, economic, social, etc.).

The three groups shared the need to deepen their knowledge on crop diversification both in theory (functioning of plant, soil and environment) and practice (farming techniques).

They all emphasised the importance of using different channels to disseminate technical and economic references, economic and ecological benefits and the results of various field research projects and/or experiments to help farmers adopt these new farming methods.

Designing diversified cropping systems requires support, which should be multifaceted in order to cross references, viewpoints, knowledge and system levels. Training is considered as a pillar and

should also be diversified, in order to share more practical and theoretical knowledge. In this respect, there is a need to promote training that combines indoor sessions with participatory training methods based on case studies integrating theoretical knowledge (agronomic, economic, work organisation, market, etc.) and sessions in the field.

4. Conclusion

The methodology used allowed the collection of needs and expectations from three types of AKIS actors (farmers, advisers and teachers), from different countries, with different profiles and backgrounds. When questioning these stakeholders, not only a set of needs related to training and education was expressed but also a wider range of needs around their professions.

This report shows that we could identify three types of needs: (i) theoretical and technical knowledge on crop diversification; (ii) new means to implement, accompany or teach on crop diversification, including soft skills; and (iii) up-scaling the issues of crop diversification to the whole agri-value chain and territory to develop a global approach.

Expressed needs about theoretical and technical knowledge include the different strategies of diversification (rotation, intercropping and multiple cropping), but also a systemic approach and understanding of the upstream and downstream environments of value chains.

A large range of needs on "how-to-do" have been expressed dealing with exchanges, networks, experimentation, assessment, and facilitation.

It is also important to underline the human approach and posture as a need expressed by the three types of actors: coaching, facilitation, accompaniment to change, but also new pedagogical and more practical approaches.

To achieve crop diversification using a global approach, we need to consider different levels, beyond the plot and field levels: the cropping system, farm system, value chain and territory levels.

These two last points stressed by the different actors, show the necessity of constant questioning and review of the system and professional practices. It results in a new cognitive cost, which needs to be dealt with. Thus an emerging need is to be considered: how to deal with the mental burden. This was rarely explicitly expressed but was underlined in some workshops.

Training and education are important vectors to accompany a large part of these needs and the implementation of crop diversification. As shown with results on the "ideal training session", the ways to develop and implement these new skills have to be rethought and enlarged: more diversified ways of appropriation and more participative activities.

In the DiverIMPACTS project, the outcomes of T5.2 which deals with "addressing barriers and drivers of crop diversification at farm level" will complete this overview and add complementary information for the next steps and especially for the formulation of recommendations.

5. Partners involved in the work

ESA (Rim Baccar) and APCA (Aline Vandewalle and Sophie Duhamel) were in charge of this deliverable as leader of Task 6.3.

Partners who organised workshops were:

- LWK (Hauke Ahnemann)
- ORC (Anja Viewvger)
- SLU (Raj Chongtham and Erik Steen Jensen)
- INAGRO (Lieven Delanote)
- Bionext (Marian Blom)
- WUR (Walter Rossing)

6. Annexes

Annex 1: Methodological guidelines for T6.3 workshops

6.3 - Guidelines for brainstorming sessions to identify needs for preparing training sessions

26/09/2018 - Final version

Rim Baccar (ESA), Aline Vandewalle (CRA PdL-APCA) and Sophie Duhamel (Resolia-APCA)

The aim of this document is to give guidelines for facilitators of brainstorming sessions to identify needs for preparing training sessions

Main goal of the brainstorming session: Identify the knowledge and skills needed by farmers to diversify their cropping systems, as well as by advisers and teachers to promote such diversification

Intended audience: farmers, advisers and teachers (for farmers and advisers)

Guidelines for the facilitator:

- Organise workshop sessions with farmers, advisers and teachers (Preferably mix farmers, advisers and teachers to get an overview of needs. If not possible, try to mix with at least two type of audience, e.g., farmers and advisers or advisers and teachers)
- Depending on the time available, workshops can last half a day or 2 hours (two scenarios are provided below)
- At least two facilitators are needed to work with breakout groups
- Take notes to report on sessions and if possible, record the sessions
- Keep in mind that we are trying to identify needs, which are not always clearly defined in the mind of attendees
- Materials needed: paper board, sticky notes, markers
- Think about taking pictures during the sessions to keep a track of the workshop

Table 1: Content of the session

	Content	Method	Duration – case of a half-day workshop	Duration – case of a two-hour workshop
Introduction (plenary session)	- DiverIMPACTS presentation - What is crop diversification in the project? - What do we expect from this workshop? Round table: who is attending the workshop? (name and type of actors, i.e., farmer, adviser or teacher)	A presentation, which can be adapted to your audience, will be provided	20’	10’
Perception of crop diversification (plenary session)	What does crop diversification mean to you? - What about crop diversification in your situation? - What does it bring to your situation?	In plenary session, with sticky notes (different colors for the different types of actors) First, each person has 10’ to think about his answer. Then, attendees explain their own sticky note(s) and paste it (them) on the paper board	30’	15’ Session to be dropped if the workshop is held during a larger event on crop diversification
Introduction to the next session		Split attendees into breakout groups (ideally 5-6 persons) by type of actors (if not possible, mix two types of actors)		
Breakout groups (5-6 persons)	Three topics are discussed in groups (see detailed questions for each type of actors in Table 2): - Current vision and practices - Mobilised knowledge and skills - Missing knowledge and skills	During this session, it must be clearly specified that we will not be dealing with barriers to crop diversification but that we aim at collecting the needed knowledge and skills for the different actors to support or implement crop diversification Each one takes 5’ to think about his answers to questions (Table 2). Instructions: - A secretary takes notes and a reporter will	45’	45’

		report on these notes - Prepare a paperboard sheet in each breakout group to report on answers		
Short break			15’	To be dropped
Restitution	The reporter of each group report on answers in 5’ Answers of groups are discussed.		30’	20’
Final session: your dream training session	Give ideas and propositions both on the content and form to build training sessions	Each one takes 5’ to fill in Table 3 Each one tells one idea to the group Collect sheets at the end of the meeting	30’	20’
End of the workshop	Thanks to participants			

Table 2: Questions addressed in breakout groups

Topic	Farmer	Adviser	Teacher
Current vision and practices	- How did you come to implement crop diversification? - What led you to implement crop diversification? What convinced you? - Which crop diversification strategy do you implement (rotation, intercropping, multiple cropping)? - What are your main strengths to implement crop diversification? - What are your main weaknesses to implement crop diversification?	- What type of support do you provide today to help farmers in implementing crop diversification? - In your opinion, what are the needs of a farmer planning to implement crop diversification? - Do you adopt a new way of doing to advise farmers undertaking crop diversification?	- What type of support do you provide today to teach on crop diversification to future farmers or advisers? - In your opinion, what are the needs of a future farmer or adviser undertaking diversification?
Mobilised knowledge and skills	- What type of knowledge was useful (for you) to implement crop diversification? - What skills learned in your initial or continuous training were useful to help you implement crop diversification?	- What type of knowledge was useful (for you) to support farmers in implementing crop diversification? - What skills learned in your initial or continuous training were useful to help	- What type of knowledge was useful (for you) to teach on crop diversification to future farmers or advisers?

		farmers in implementing crop diversification?	
Missing knowledge and skills	- What skills were you missing to implement crop diversification? - How did you find missing information? Which means did you use? - What type of knowledge the most missed you: technical, economic, regulatory, other?	- What are your missing skills to better support farmers in implementing crop diversification? - What knowledge did you miss to support farmers in implementing crop diversification? - How did you find missing information? Which means did you use? - What skills did you miss in your initial training to help farmers implementing crop diversification?	- What are your missing skills to better teach on crop diversification to future farmers or advisers? - What knowledge were you missing to better teach on crop diversification to future farmers or advisers? - How did you find missing information? Which means did you use?

Table 3: My dream training session

	For farmers	For advisers	For teachers
About the content, my dreams are…			
On the format, my dreams are…			

7. References

Campbell, B.M., Beare, D.J., Bennett, E.M., Hall-Spencer, J.M., Ingram, J.S.I., Jaramillo, F., Ortiz, R., Ramankutty, N., Sayer, J.A., Shindell, D., 2017. Agriculture production as a major driver of the earth system exceeding planetary boundaries. Ecology and Society 22. https://doi.org/10.5751/ES-09595-220408

COMIFER, 2017. Guide de la fertilisation raisonnée, Éditions F. ed.

Duru, M., Therond, O., Martin, G., Martin-Clouaire, R., Magne, M.A., Justes, E., Journet, E.P., Aubertot, J.N., Savary, S., Bergez, J.E., Sarthou, J.P., 2015. How to implement biodiversity-based agriculture to enhance ecosystem services: a review. Agronomy for Sustainable Development 35, 1259–1281. https://doi.org/10.1007/s13593-015-0306-1

Fuzeau, V., Dubois, G., Thérond, O., Allaire, G., 2012. Diversification des cultures dans l'agriculture française - état des lieux et dispositifs d'accompagnement, « Études et documents » du Service de l'Économie, de l'Évaluation et de l'Intégration du Développement Durable.

Gaba, S., Lescourret, F., Boudsocq, S., Enjalbert, J., Hinsinger, P., Journet, E.P., Navas, M.L., Wery, J., Louarn, G., Malézieux, E., Pelzer, E., Prudent, M., Ozier-Lafontaine, H., 2015. Multiple cropping systems as drivers for providing multiple ecosystem services: from concepts to design. Agronomy for Sustainable Development 35, 607–623. https://doi.org/10.1007/s13593-014-0272-z

Grunwald, S., Thompson, J.A., Boettinger, J.L., 2011. Digital soil mapping and modeling at continental scales: Finding solutions for global issues. Soil Science Society of America Journal 75, 1201–1213. https://doi.org/10.2136/sssaj2011.0025

HLPE. 2019. Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome.

IPCC, 2014. Climate Change 2014 Synthesis Report Summary Chapter for Policymakers. Ipcc 1–32. https://doi.org/10.1017/CBO9781107415324

Knierim, A., Boenning, K., Caggiano, M., Cristóvão, A., Dirimanova, V., Koehnen, T., Labarthe, P., Prager, K., 2015a. The AKIS Concept and its Relevance in Selected EU Member States. Outlook Agric 44, 29–36. https://doi.org/10.5367/oa.2015.0194

Knierim, A., Dirimanova, V., Kania, J., Labarthe, P., Laurent, C., Madureira, L., Prager, K., 2015b. PRO AKIS - Policy recommendations (No. EU FP 7/ GA n° 311994).

Knierim, A., Prager, K., 2015. Agricultural Knowledge and Information Systems in Europe: Weak or strong, fragmented or integrated? (PRO AKIS, European Commission 7th Framework Programme project).

Kronberg, Scott L., Ryschawy, J., 2019. Chapter 5 - Negative Impacts on the Environment and People From Simplification of Crop and Livestock Production∗, in: Lemaire, G., Carvalho, P.C.D.F., Kronberg, S., Recous, S. (Eds.), Agroecosystem Diversity. Academic Press, pp. 75–90. https://doi.org/10.1016/B978-0-12-811050-8.00005-4

Kronberg, Scott L, Ryschawy, J., 2019. Negative Impacts on the Environment and People From Simplification of Crop and Livestock Production, in: Lemaire, G., Faccio Carvalho, P.C. De, Kronberg, S., Recous, S. (Eds.), Agroecosystem Diversity. pp. 75–90. https://doi.org/10.1016/B978-0-12-811050-8.00005-4

Laurance, W.F., Sayer, J., Cassman, K.G., 2014. Agricultural expansion and its impacts on tropical nature. Trends in Ecology and Evolution 29, 107–116. https://doi.org/10.1016/j.tree.2013.12.001

Magrini, M., Befort, N., Nieddu, M., 2019. Technological Lock-In and Pathways for Crop Diversi fi cation in the Bio-Economy, in: Lemaire, G., Faccio Carvalho, P.C. De, Kronberg, S., Recous, S. (Eds.), Agroecosystem Diversity. Elsevier Inc., pp. 375–388. https://doi.org/10.1016/B978-0-12-811050-8.00024-8

Meynard, J., Charlier, A., Charrier, F., Fares, M., Bail, M. Le, Magrini, M., Messéan, A., 2015. La diversification des cultures : comment la promouvoir ? Notes et études socio-économiques 7–29.

Meynard, J., Charrier, F., Fares, M., Bail, M. Le, Magrini, M., Charlier, A., Messéan, A., 2018. Socio-technical lock-in hinders crop diversification in France. Agronomy for Sustainable Development 38:54. https://doi.org/10.1007/s13593-018-0535-1

Meynard, J.-M., Messéan, A., Charlier, A., Charrier, F., Fares, M., Le Bail, M., Magrini, M.-B., 2013a. Freins et leviers à la diversification des cultures. Synthèse du rapport d'étude 52.

Meynard, J.-M., Messéan, A., Charlier, A., Charrier, F., Farès, M., Le Bail, M., Magrini, M.-B., 2013b. Freins et leviers à la diversification des cultures. Etude au niveau des exploitations agricoles et des filières. Rapport d'étude, INRA.

Morel, K., Revoyron, E., San Cristobal ,M., Baret, P.V., 2020. Innovating within or outside dominant food systems? Different challenges for contrasting crop diversification strategies in Europe. PLoSONE 15(3): e0229910. https://doi.org/10.1371/journal.pone.0229910

Pelzer, E., Fortino, G., Bockstaller, C., Angevin, F., Lamine, C., Moonen, C., Vasileiadis, V., Guérin, D., Guichard, L., Reau, R., Messéan, A., 2012. Assessing innovative cropping systems with DEXiPM, a qualitative multi-criteria assessment tool derived from DEXi. Ecological Indicators 18, 171–182. https://doi.org/10.1016/j.ecolind.2011.11.019

Therond, O., Duru, M., Roger-Estrade, J., Richard, G., 2017. A new analytical framework of farming system and agriculture model diversities. A review. Agronomy for Sustainable Development 37. https://doi.org/10.1007/s13593-017-0429-7

Tittonell, P., 2014. Ecological intensification of agriculture-sustainable by nature. Current Opinion in Environmental Sustainability 8, 53–61. https://doi.org/10.1016/j.cosust.2014.08.006

Watson, C.A., Reckling, M., Preissel, S., Bachinger, J., Bergkvist, G., Kuhlman, T., Lindström, K., Nemecek, T., Topp, C.F.E., Vanhatalo, A., Zander, P., Murphy-Bokern, D., Stoddard, F.L., 2017. Grain Legume Production and Use in European Agricultural Systems. Advances in Agronomy 144, 235–303. https://doi.org/10.1016/bs.agron.2017.03.003