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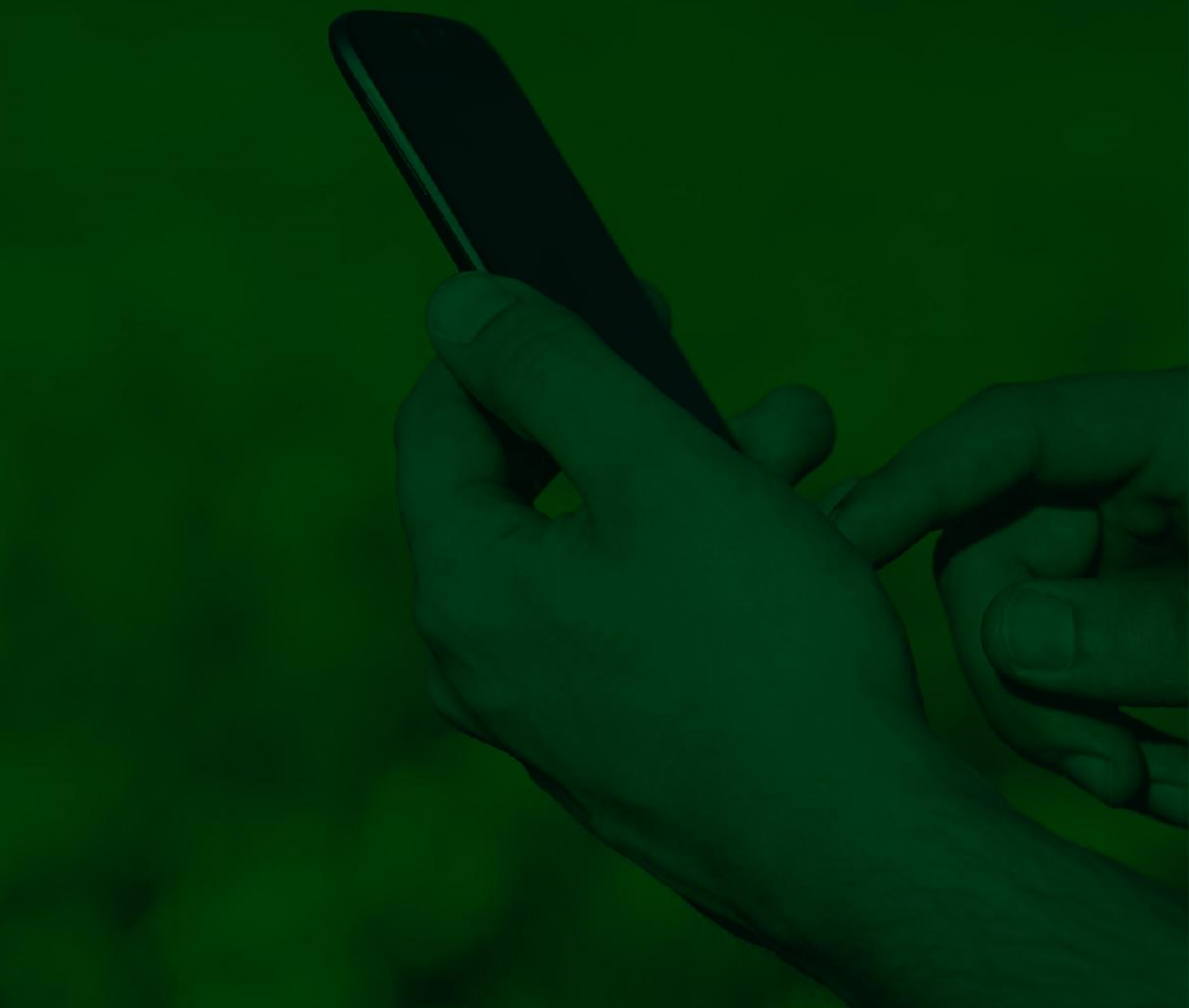
DIGITAL TOOLS FOR FARM ADVISORS



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DIGITAL TOOLS FOR FARM ADVISORS

Deliverable 4.3: Learning from ongoing pilot adoptions of DATs –

Identifying the economic, social and demographic issues impacting the success of these pilots

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Acronyms

DATS	Digital Advisory Tools and Services
DST	Decision Support Tool
UC	User Case
UC-BC	User Case – Business Case

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1. Introduction

The general aim of FAIRshare is to ensure the effective use of digital advisory tools and services (DATS) of farmers and advisors to support productive and sustainable agriculture. Within WP4, we focus on the change management and innovation process issues arising from the introduction of novel DATS in the different farm advisory contexts of 30 User Cases (UCs). Task 4.3 in particular intends to identify the various influencing factors (e.g. economic, social, demographic, technical) that impact the success for 1-2 pilot DATS for at least 15 out of 30 UCs. Pilot DATS are DATS with which the UCs already have some initial experience. These can be different from the DATS which are used further along in the UCs (as part of the business plan). The aim is to collect information from a minimum of 15 UCs that tell us how easy or hard it was to use/introduce DATS, what the problems were and if the process of adopting these DATS could have been improved. This information was captured through semi-structured interviews with 1-2 actors per UC to identify the different issues at stake for the selected pilot DATS. At the time of the interviews, UCs were still at an early stage of activities, so insights mostly come from prior experience with a diverse range of tools. We also discussed how this helped to shape the current plan for their UC.

The work done in Task 4.3 can be considered as being part of the Living Lab approach, as explained in the conceptual framework (D4.1), which forms the basis for the work to be done in the UCs. Observations and preliminary lessons learnt from the experience with pilot DATS in 17 UCs will serve as input for a more elaborate process in WPs 5 and 6.

This document is structured as follows: we start with explaining the background work that shaped this current task, both in and outside the context of FAIRshare. This is followed by a short methodology section, explaining the process of data collection and analysis, and the main findings, structured along four main parts. First, we provide some descriptions on the pool of DATS that were explored during the interviews. Second, we describe the main drivers, which shape the current needs for development and adoption of DATS. In a third section, we explore in detail the early experiences of the UCs, looking at both positive experiences, supporting development and adoption of DATS, and the main barriers and hurdles they experienced at three different levels, i.e. the institutional/organizational level, the individual level (also including aspects related to relationships between people), and the technological/DATS level. Finally, we elaborate on lessons learnt by UCs about the main influencing factors, and how this translates into a number of considerations which need to be made during the process of tool development and adoption, and into a number of preconditions and requirements for successful

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DATS. We conclude this deliverable with a brief discussion and conclusion section in which we offer some brief reflections on how the results in this deliverable adds to the work done in WP3, and how this can inform the next steps to be taken in WP5 and WP6.

2. Background

2.1. Relevant literature sources

There is a wide body of literature around the acceptance of (IT/digital) technologies, with several authors developing frameworks and models to understand the influencing factors around technology acceptance and use. Quite a comprehensive model in this respect is the UTAUT (Unified Theory of Acceptance and Use of Technology) model. Combining the various theories and models of technology acceptance, Venkatesh et al. (2003) developed a unification theory in which they integrated the components of eight technology acceptance models and theories: the Theory of Reasoned Action (TRA; Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980); the Technology Acceptance Model (TAM; Davis et al., 1989); the Motivation Model (Davis et al., 1992); the Theory of Planned Behaviour (TPB; Ajzen, 1991); combined TAM-TPB (Taylor & Todd, 1995); the model of PC utilization (Thompson et al., 1991); innovation diffusion theory (Rogers, 1995; Moore and Benbasat, 1996); and social cognitive theory (Bandura, 1986; Compeau and Higgins, 1995). UTAUT proposes three direct determinants of intention to use (performance expectancy, effort expectancy, and social influence) and two direct determinants of usage behavior (intention and facilitating conditions). Performance expectancy is defined as the degree to which an individual believes that using the system will help him or her to attain gains in job performance. Effort expectancy is defined as the degree of ease associated with the use of the system. Social influence is defined as the degree to which an individual perceives that important others believe he or she should use the new system. Facilitating conditions are defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system. These stand alongside four moderators, namely gender, age, experience and voluntariness of use.

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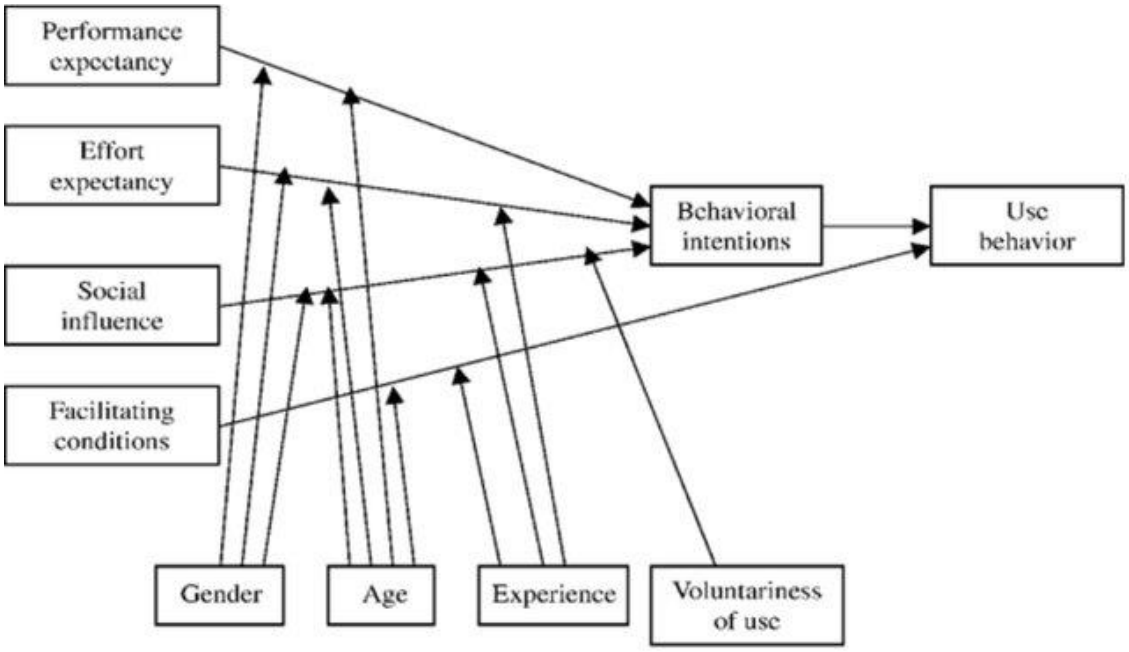

Figure 1: The research model UTAUT (Venkatesh et al., 2003).

This theory is considered to be more robust than other technology acceptance models in evaluating and predicting technology acceptance (Venkatesh et al., 2003). However, it has been criticised for having too many independent variables for predicting intentions and behaviour (Bagozzi, 2007), and further adaptations and refinements of the model have been suggested (e.g. Dwivedi et al., 2019). These models have been used in a wide range of sectors, looking at the acceptance of specific digital technologies across the world (e.g. Aboelmaged et al., 2010; Kim et al., 2008; Rana et al., 2017).

In the field of agriculture specifically, Rose et al. (2016) have examined factors determining the use of decision support tools (DSTs) by farmers and advisors, looking at both digital and paper-based DSTs. They found that particular factors affected uptake of DSTs: performance, ease of use, peer recommendation, trust, cost, habit, relevance to user and farmer/advisor compatibility. Linked to this, they also identify a number of modifying factors (i.e. age, scale of business, farming type, IT education), one enabling factor (i.e. facilitating conditions) and two driving factors (i.e. compliance (legislation), level of marketing). The results are quite similar in nature to key factors identified by Venkatesh et al. (2003). Although Rose's theory incorporates specific factors related to agriculture, the similarity with research conducted in other disciplines suggests that designers of DST and other DATS for agriculture could learn from expertise elsewhere.

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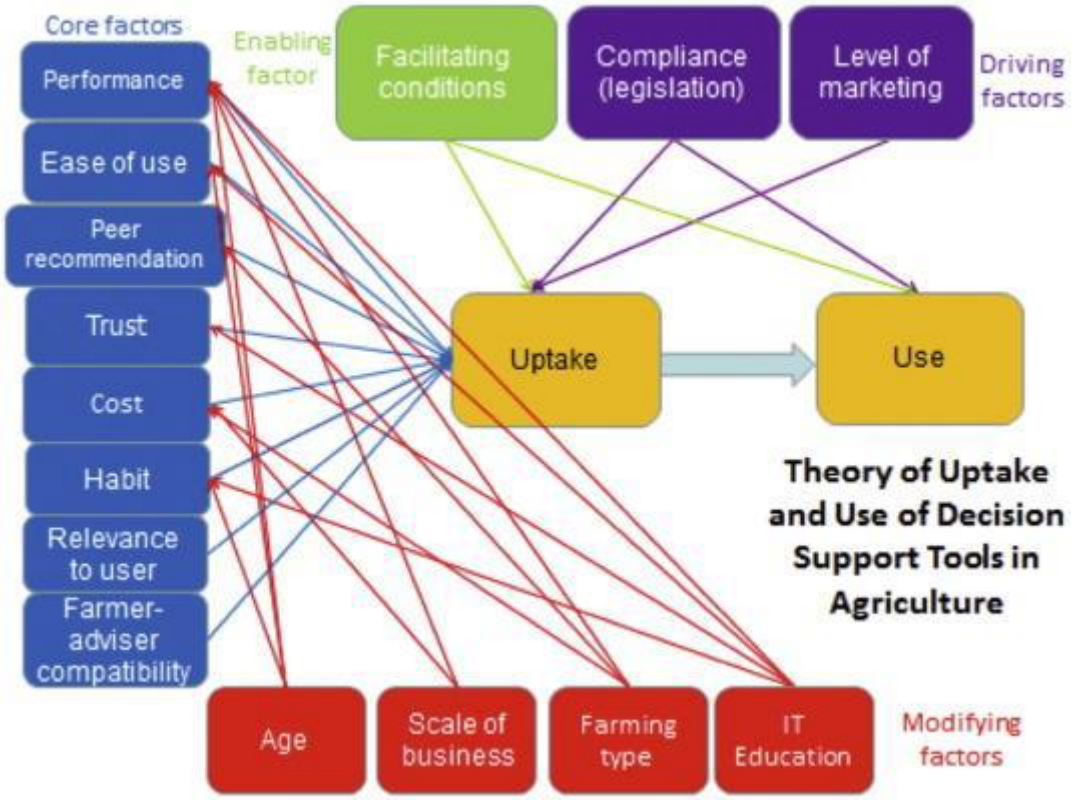

Figure 2: Theory of uptake and use of DSTs in agriculture (Rose et al., 2016)

2.2 Information from prior FAIRshare Tasks

A first deliverable with a close link to Task 4.3, is Deliverable 3.1 - Factors influencing adoption of digital agriculture tech by farmers and advisors. D3.1 focuses on the different factors that can affect or improve the engagement of novel digital technologies by farmers and advisors especially in the interface between the advisor and farmer. This includes aspects of knowledge exchange, cooperation and mutual influence. It presents findings from workshops conducted during project consortium meetings in Dublin and Athens, and supports this with scientific and industry literature, and lists a wide number of factors influencing the use of digital tools. Based on workshops, two main types of factors (both motivating factors and barriers) were defined for adoption of DATS, i.e. factors involved in the coverage of needs, and factors involved in communication and dissemination. A clear distinction is also made between farmers and advisors in this respect. Regarding the coverage of needs, a main factor for farmers was considering the increase of on-farm efficiency, while for advisors a main motivating factor was improving his/her impact by fulfilling farmers' needs and expectations (customer satisfaction). Regarding communication it is expected that

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DATS should support greater engagement between actors through digital platforms, easier access to information, and new tools to ease administrative procedures. However, there are clear concerns around trustworthiness of information provided through DATS. Other important obstacles mentioned in D3.1 which warrant attention, are the digital divide, innovation uncertainty and the advisor skills and behaviour. The work by Rose et al. (2016) is also included in D3.1, identifying the core factors influencing the intention to use agricultural DSTs by farmers and advisors (see section 2.1). Finally, the importance of the enabling environment is also emphasised in D3.1.

Secondly, Deliverable 3.3 - Contextual advocacy and animation approaches - describes a number of barriers that were listed related to uptake of tools and technologies, used to address specific day-to-day farming challenges, based on input obtained during four 2-hour focus groups, one in each of the main geographic areas (Western Europe, Central Europe, South-Eastern Europe and North-Eastern Europe).

Looking at these barriers in detail (Table 1, adapted from Table 15 in D3.3), we can link most of the identified barriers to the main influencing factors as determined by both Venkatesh et al. (2003) and Rose et al. (2016).

Table 1: Barriers to uptake of tools & technologies, identified in D3.3, and linked to factors determined by Rose et al. (2016) and Venkatesh et al. (2003)

BARRIERS	**Western EU**	**Central EU**	**S-E EU**	**N-E EU**	**Linked to factor as determined by Rose et al. (2016) & Venkatesh et al (2003)**
Too many different tools – what to choose/ appropriate one			x	x	?
Lack of independent advisors on DATS				x	Farmer-advisor compatibility/Facilitating conditions
Lack of/poor internet connection	x		x	x	Facilitating conditions
Poor skills/lack of skills/lack of training to use digital tools (both farmers and advisors)	x	x	x	x	IT education/Experience
Low importance of data for decision making				x	Performance expectancy
Lack of time/willingness/motivation to learn DATS		x	x	x	Habit/Effort expectancy
Language		x	x		Ease of use/Facilitating conditions

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Fragmentation of tools which address only 1 or a few problems	x	x			Relevance to user/Performance expectancy
Unique data formats		x			Ease of use/Facilitating conditions
Region specific tools not applicable on large scale		x			Performance expectancy
Output not easy to understand/ no straightforward data presentation		x	x		Trust-ease of use/effort expectancy
Unknown tools or technologies/unawareness		x	x		Level of marketing
No independent tool		x			Trust
Tools not updated after project end		x			Tool cost
Not enough focus on specific user problem		x	x		Relevance to user/Performance expectancy
Too expensive (for small farmers)		x	x		Cost/Performance expectancy – facilitating conditions
Value/benefit not clearly visible		x	x	x	Relevance to user/Performance expectancy
Data collection and security too complex	x	x	x		Ease of use/Effort expectancy
Tools promise more than they deliver/not always complete		x	x		Performance expectancy
Not user friendly (+ take into account profile/age group)	x	x			Ease of use/Effort expectancy
No marketing for free tools		x			Level of marketing
Too much tools without clear benefit/benefit or added value not recognizable	x	x			Performance expectancy
Too much work for data input (in different tools, same data)	x	x			Ease of use/effort expectancy
Older farmers not interested in tools			x	x	Age
Tools look complex to start with			x		Ease of use/Effort expectancy
Willingness to cooperate in problem solving is limited			x		?
Unpleasant public tenders			x		?

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Finally, as briefly mentioned in the introduction section, Task 4.3 is firmly rooted within the conceptual framework for DATS pilots and User Cases (D4.1), since we believe this work both supports the Living Lab methodology and the process of reflexive monitoring. The interviews have the aim to help UC leads to reflect on the steps they have taken so far (before the actual implementation of the UCs), and how these previous experiences can inform their search for DATS to address the challenge identified for the UC. Linked to the Living Lab building blocks (D4.1 – pages 32-34), we consider the tests with pilot DATS as a first cycle of exploring and experimenting, where the interviews should help to provide a first evaluation. Linked to the stages of design thinking (D4.1 , pages 10-13), the interviews could be seen as a step in helping to empathise and define, by reflecting on what could be considered as "prototype" testing, where the pilot DATS can be considered as such prototypes. By discussing early experiences with these pilot DATS, it may help UCs to better understand (or more clearly define or delineate) their specific need, and thus support their search for DATS to successfully address that need. As such, the interviews done for Task 4.3 can be seen as a step in a larger process of reflexive monitoring. We want to note however, that given the setup of Task 4.3, this is to be considered as an explorative task, especially since it is not done for all UCs.

3. Methodology

The background information listed in the section before was used to develop an interview guideline, to conduct semi-structured interviews with UC participants. The interview guide is provided in Annex 1 and has four main sections. A first section is intended to provide an introduction to the UC and explore the challenge identified by the UCs. In the second section, we zoom in on experiences (so far for 1-2 pilot) DATS, preferably linked to the challenge they identified for their UC. Third, there is a short scoring exercise (using Mentimeter (https://www.mentimeter.com/)). For this scoring exercise, participants indicated, on a scale from 1-5, to what extent they agree or disagree with a number of statements based on their experience with the pilot DATS. These statements are modified from the ones suggested by Rose et al. (2016). As a fourth and final part, we briefly reflect on how they see the future use of the pilot DATS. In preparation of the interview, the interviewer read the UC-BC description, prepared by the UC partners, as part of Task 4.2, to support a good understanding of the DATS and overall UC before starting the interview.

Semi-structured interviews were conducted between February 26th and March 11th, 2021. An informed consent form was sent to all interviewees before the

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interview (Annex 2). Interviews were done online, using Microsoft Teams, and were recorded for analysis purposes. We performed 15 interviews, from which 2 interviews covered 2 UCs, meaning that our analysis covers experiences from 17 UCs in total. Between 1-4 people participated per interview, leading to a total of 28 UC participants being interviewed, with different profiles (researchers, advisors, tool/IT developers, …). The duration of the interviews ranged between 1 to 2 hours, depending on the number of participants, UCs and pilot DATs discussed during the interview. The 15 interviews were divided between two researchers. Interviews were transcribed, and the qualitative data was coded in the data analysis software, NVIVO12. In addition to the interviews, the UC-BC description documents (one for each UC, compiled in D4.2) were also considered a valuable source of information, thus imported in NVIVO12 and coded in addition to the interviews. We followed an open coding approach, focusing our analysis on both external and internal factors influencing DATS development and adoption. For triangulation purposes, a first joint coding exercise was done for 3 UCs (interview + UC/BC description), after which preliminary codes and results were discussed. The remainder of the UCs was split between both researchers for further analysis, with regular meetings to discuss and fine-tune findings. As a final step, both coding structures were compared, merged and discussed to build the results sections below. Quotes from the interviews are included throughout the results, as a form of illustration. They do not aim to be comprehensive for the different views of all interviewees and UCs, but are included to provide a clear illustration of a specific aspect that is presented.

4. Results

The results are structured along four main parts. We start with descriptions of our 'dataset'. Within the 17 UCs that are discussed, there is a huge diversity, and this diversity is explained in more detail in the first section. Second, we outline a number of so-called drivers for tool development and adoption. These are mentioned as challenges by the UCs and are the main reasons why they feel the need to explore the different pilot DATS in the first place. Thirdly, we present an overview of both positive and negative experiences that UCs had with the pilot DATS, and end with a final section on what UCs indicated as lessons learnt from these experiences, as well as the main influencing factors, preconditions and requirements to consider for successful DATS development and/or adaptation and adoption.

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4.1 Description

In this first part of the results, an overall description is given that relates to the diverse environments and contexts wherein tools are located and used. In fact, for the 17 UCs, we found differences on many aspects, and will describe these along the country and/or regional, organisational and/or institutional, individual and technological/DATS level.

Firstly, when looking at the **country and/or regional level**, we have to consider very diverse farming systems and contexts in which the UCs operate. Some countries or regions have a more dispersed landscape of farms, while in other regions farming is more concentrated in specific regions. The same is said for advisors, where it was indicated that in some regions there is a surplus, while in other regions there is a shortage of advisors. UCs cover all different types of production (intensive and extensive livestock production systems, arable farming, greenhouse production, …), and different scales of farming (small to large). An important aspect to consider also are differences in socio-cultural beliefs and values which in turn affect the other levels.

Secondly, on the **institutional/organisational level,** we again could identify a number of differences. There are notable differences in how the government has an impact on the advisory systems, through for instance financial support, data collection and provision, etc.. In some countries, advisory organisations fall under the government control, while in other countries private companies or independent consultants are the main business model. We experienced bureaucracy in some countries, while the structural forms of others tended to be more entrepreneurial. This also relates to the diversity of public as well as private organisations. Similar across UCs, was the fact that all interviewees worked in well-established organisations. Another difference was the interaction with external companies, for some this was quite limited, but for others they were indispensable to overcome lack of in-house expertise.

Next, on an **individual level,** we also encountered diversity in various aspects, starting from the diversity in interviewees, which had different profiles, e.g. field advisor, economist, (senior) team leader, (senior) computer scientist, fundraising manager, R&D manager, researcher, agro-strategist (bridge between IT-people and field advisors). There was also a difference in work experience amongst the interviewees. This led to different insights and focuses when discussing experiences of DATS. Furthermore, the way advisors have contact with and interact with farmers differed significantly. Some advisors visit farms (or have contact with the farmer) weekly, while others once a year (or less). These social relationships are important, and have an impact on the interaction between the different actors. The interaction between farmers varied (per region). In some

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regions, farmers were described as being in competition with each other, while in other regions they were seen as colleagues. Besides describing these differences in interaction, there are also differences in personal characteristics, such as being motivated to work with technology or being open to learn new things. While most interviewees were motivated and open, they do have to interact with a wide range of (potential) end users, who possess more varying degrees of openness and motivation.

To end, there was a wide **range of tools** used by the UCs, covering different aims and functions. Some tools are used for monitoring purposes (with the use or need of specific sensors), others allow for more analysis and management and decision support, while there are also a number of tools focused on communication, knowledge exchange, e-learning and training. There was also a diversity in the target groups for the tools that is largely comparable with the target users mentioned on the inventory on the FAIRshare website: farmers, agronomists, advisors, veterinarians, policy makers and national authorities, suppliers and industry, and in some cases even consumers were seen as potential target groups (but mostly as a future perspective). In addition, some are paid tools for the farmers and/or advisors because it was part of the advisory services, while others were free tools for the farmers and/or advisors. In these cases, the interviewees often mentioned it was part of the annual fee that needed to be paid by the user. We also encountered a difference in maturity of the tool. Several tools existed already for more than 10 years, while other tools were still in an initial phase. This was also linked to the complexity level of the tool, some are more basic spreadsheets, requiring mostly manual input, while others already use more automated processes.

4.2. Drivers for tool development and adoption

As a second section of the results, we focus mainly on the challenges identified by the UCs, which are an important driving force for both tool development and adoption. In short, why do UCs think DATS are important and needed? We can distinguish between drivers and needs at a global/societal level, and a number of drivers and needs linked to the ongoing ambition to maintain future-oriented and efficient advisory systems.

4.2.1. Global and societal challenges

Perhaps unsurprisingly, the **COVID-19 crisis** was considered by several UCs as a main driver for DATS adoption. The global crisis forced all of us to make the switch to online contacts, meetings and network events, and this was no different for advisory organisations. COVID forced advisory services to look for tools that could help them overcome existing travel and meeting restrictions, this ranged from

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specific tools to simply support one-on-one advice, to the organisation of an online agricultural show. While there often used to be some reluctance or 'cold feet' before for offering advice in a digital format, experiences in the last year were often considered an eye-opener. What was considered impossible before, both due to unwillingness or inability with both farmers and advisors, now became a reality.

> *"It is worth noting that the COVID-19 crisis has changed the perspective quite drastically. While before some farmers and advisors were reluctant to use digital tools, and work with their computers and smartphones, this is much less of an issue now. It was in a way an eye-opener for many, to see that more was possible than they originally thought." (interview 3)*

Several UCs indicated that this will be a persistent change, even after travel and meeting restrictions will be lifted, since they believe this will continue to enable them to **reach farmers in more distant or hard to reach locations**, or organise group meetings for farmers spread across the country, acting as a strong driver for developing and/or adopting tools enabling remote interactions, where these interactions range from one-on-one advice, to trainings or specific knowledge transfer events and farmer discussion groups and even large scale events, like agricultural fairs. Each of the specific formats also require different tools, adapted to the needs of the format, with specific functionalities and characteristics.

> *"Advisors may also experience similar meeting restrictions for a variety of other reasons too, such as the bad weather. So, advisors have the challenge of exchanging valuable knowledge without the ability of face-to-face meetings and on farm consultation. A new way of communicating remotely with their farmers clients that allows them to share knowledge and best practices and improve interaction, is needed now more than ever." (UC-BC1)*

> *"Due to geography farm are quite dispersed and far away from another in certain regions, it's economically not feasible or not attractive to drive for information" (interview 12)*

A second element that was often mentioned is the need to **keep up with ongoing developments in society** overall. Digitalisation is not a story of agriculture and advisory organisations alone, but a strong global trend, one that the agricultural sector and advisory organisations should keep up with. Ideally, advisory organisations should take up a proactive role in this, in designing and developing specific tools and systems that fit their own needs, and the needs of the farming community. The younger generation, and thus also younger farmers and advisors,

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are generally more open to new technologies, and also more used to accessing information and services through their smartphones, and advisory organisations should find ways to service this need and support farmers in this transition process, however taking care to avoid an overload of information.

> *"Digitalisation is becoming our global challenge, as environments with accelerated digitization and thus increased efficiency and accelerated development will be significantly more competitive in the global field, …, so it is also necessary to find optimal concepts for agricultural production within global trends. This will improve the adaptability of the farmer, facilitate access to specialized markets and production, increase the efficiency of the advisory service, and above all increase the opportunities for the younger generation" (UC-BC3)*

4.2.2. Maintaining future-oriented and efficient advisory systems

Being a professional, efficient and future-oriented organisation is at the core of the advisory organisations' business model. To maintain their relevance and position as a valued part of the agrifood knowledge chain, they have to stay up-to-date with ongoing evolutions, keeping an eye on the future and developments in society. Especially for larger organisations, management has set **strategic directions for the organisation**, and digitalisation is often an integral part of that. One organisation also saw this as a way of caring for their employees, supporting them in their professional development by enabling their access to high-quality digital tools.

> *"This challenge is part of ongoing overall development in the field of advisory services, where we have to keep up with recent development, and have to make sure that we keep this system as efficient and effective as possible...Knowledge transfer is our core business… And thus to ensure efficient KT we need efficient infrastructure. Digital tools are an inherent part of this. Without them, we cannot talk about efficient advisory services." (interview 3)*

Structured and fluent communication is essential for a well-functioning organisation. This includes both internal communication, and communication to clients and other external stakeholders. Regarding internal communication, there is a need to connect advisors, who often work quite isolated, and scattered across the country, to share and exchange knowledge and experiences between them, and create a sense of being part of a team. There is also a need to maintain the

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accumulated knowledge within an organization, where it is a challenge for young advisors to catch up with the knowledge of an experienced/retired advisor, so there is a need for knowledge repositories, where knowledge is stored and structured over time, for the benefit of all advisors within the organization.

> *"Advisors have the challenge of exchanging internally valuable knowledge. All the expertise generated in this kind of communications should be recorded in a database, for generating knowledge and data for future advisors or future events" (UC-BC9)*

Regarding external communication, this is, as expected, in the first place about communication to the main target audience of farmers, although there are some reflections about also engaging other actors in the agrifood chain, policy makers, and consumers-citizens in the communication process. For farmers, the need is expressed to reach the farmer 'where he or she is'. Advisory services strive to be more innovative, as well as more responsive and accessible to farmers at any time, a need which became even more pronounced during the COVID-19 crisis. Mobile devices are central in this process, reaching farmers on their farm or even in their tractor. There are some concerns around the overload of different communication channels, so there is a need to bundle and align information, for which several UCs are exploring the development of centralised knowledge exchange platforms.

> *"By using different digital tools, combined into a common platform or a standalone digital tool for data collection, data analysis, knowledge transfer and easy communication between farmer and advisor, agricultural advisers would provide farmers with faster and better-quality services, supported by data and information gathered in one place." (UC-BC3)*

A third important driver is the need **to sustain the image of professional and skilled advisors.** DATS are perceived as a means to help offer more structured, high quality advice, in a transparent manner. However, some expressed concerns that the increased use of digital tools will make advisors more office bound, which could have a negative impact on the image that farmers have of advisors. It was stressed that fieldwork, on-farm visits and farmer discussion groups should remain an integral part of the advisor's job, with DATS supporting and strengthening the advice offered during such visits and meetings. In this respect, some interviewees also expressed the need for DATS that allow them to provide results and offer advice, in a digitised form, directly on the farm, without the need for follow-up actions in the office. For example, one of the UCs aims to address this issue directly by supporting advisors to use DATS on farm through the use of smart tablets which

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will be less cumbersome than laptops and allow them to use the DATS with the farmer rather than going back to the office to use systems after the farm visit.

> *"The problem addressed by this proposal is that digital advisory services are largely office-bound. This is leading to more advisors' time spent in the office and less time on clients' farms doing visits and discussion groups. This trend could lead to the lowering of clients' expectations regarding advisors' technical knowledge/awareness and damaging advisors' confidence and the currency of their skills and knowledge." (UC-BC16)*

And last, but certainly not least, there were a number of needs and drivers identified in relation to the farmer-advisor interface. The core business of future-oriented and efficient advisory organisations, is offering advice to **support future-oriented and efficient farms and farming systems,** with a number of DATS developed with that specific need in mind, e.g. DSTs. But even in tools where it is not the explicit goal - for example the main goal is improving knowledge exchange between advisors - in the end it is always about supporting farmers, in the different aspects of farm development and management. Linked to this, a main need and driver for tool development and adoption is **maintaining/improving the quality of advice,** and this in a changing and often challenging environment. The fact that agriculture is becoming increasingly knowledge-intensive, and that, at least in some cases, the direct contacts between farmers and advisors are decreasing, put high demands on advisors' competencies to keep up-to-date with all new knowledge and technologies in the first place, and in a second step, facilitate the process of knowledge transfer and exchange to and with farmers.

> *"Historically famers and advisors foster a close relationship for farm-related decisions. Thus over the years, farmers have come to expect high-quality personalized on-site advice. However, the increasing complexity and co-dependency of technology, expert knowledge and regulations require more and more effort from advisors in order to be able to keep a high quality standard and timeliness of advisory services provided." (UC-BC12)*

In addition, it was also mentioned that while there may be already a wide array of DATS available to address some of the aforementioned needs, it is a challenge for advisors to find the right tool to suit their specific needs, so they also expressed the need for **support in choosing the right tool**, and ensuring that existing tools are used to their full potential.

Finally, particular trends or challenges, be it global, societal or technological, create the need for developing specific tools. An example mentioned a number of

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times is related to the growing array of sensors, used on and off farm, that generate huge amounts of data, with the potential to further optimise production efficiency. However, as one interviewee clearly stated "*Data alone will not run the farm. Interpretation of this data is key.*" The emergence of big data and the associated need of **translating data into data-driven decision support** is an important driver for tool development and adoption, going from basic spreadsheet models, to more complex software packages where data from numerous sensors is automatically collected, monitored, in some cases analysed, and offered to the end-user in a visually attractive dashboard.

> *"Many relevant farm data come from the supply partners and dairy industry. Although farmers' organisations make an effort to make data interoperable, it's still a heavy job to collect all data in a way that allows farmers to make better decisions." (UC-BC17)*

> *"We are working a lot with automation, lots of data collection, and we kind of got stuck on it, collecting so much, but in the end not having an overview anymore. And that is why we started looking for how to improve the ways of collecting, visualising, analysing, …" (interview 6)*

4.3. Main barriers and opportunities for tool development and adoption

In this section, we present an overview of the main positive and negative experiences, identified by interviewees, based on their experiences with pilot DATS. These are discussed on three levels, i.e. institutional/organisational, individual and tool level. Table 2 shows an overview of the main barriers and opportunities that have been identified.

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4.3.1. Overview

Table 2: Overview of main barriers and supporting factors, at the institutional/organisational level, individual level and technological/DATS level

	Barriers	Supporting factors & opportunities
Institutional/ Organisational level	1. Government (e.g. bureaucracy) 2. Poor connectivity 3. Poor cooperation between different departments 4. Lack of organizational resources	1. Clear support from organization 2. Good IT-support 3. Good contact with tool development team 4. Possibility to update and/or adapt tool
Individual level	1. Ageing farmer/advisor population 2. End users are reluctant or sceptic 3. Inherent lack of motivation 4. Users lack right competencies or capabilities to use tool 5. Tool difficult to use 6. Not enough time to learn and work with new DATS 7. Advisors feel threatened by DATS 8. Affect advisor-farmer relationship negatively 9. Farmers and/or advisors feel in competition with tool	1. Younger farmers and advisors are more eager to use new technologies 2. Intrinsically interested or motivated end-users 3. Use of DATS strengthens or support advisors 4. Availability of clear (online) guidelines or trainings for end-users 5. Have the option to easily reach out for support 6. DATS strengthen relationship between farmer/advisor or between a team of advisors 7. Learning about positive experiences through colleagues 8. Availability of end-user feedback
Technological/DATS level	1. Finding a suitable tool adapted to a specific need or context 2. Not straightforward to exchange tools across borders 3. Development and use of DATS requires too much time 4. Cost for development and/or maintenance 5. Lack of clear added value for users 6. Poor or inadequate tool functionalities 7. Online tools still depend on following up with an advisor 8. Data ownership	1. Ease-of-use 2. Up-to-date 3. Attractive look and feel 4. Interoperability 5. Address a real need of users 6. Perceived as useful or interesting 7. Saves time and/or money 8. Improves farm results 9. Supports decision making 10. Supports knowledge exchange 11. Improving quality of advice 12. Good balance between cost and benefit

		13. Support farmer to determine who gets access to the data

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4.3.2. Institutional/organisational level

Barriers

While the **government** is considered in some cases as a driving force, by integrating digitalisation in various policies, in some countries they are also considered as a barrier, and feel that the support they offer is insufficient. They are also sometimes responsible for specific data sets, on which tool developers depend, but there are issues around these (not being updated or not compatible for instance). Some interviewees also indicated that **bureaucracy** in some countries makes innovation and digitalisation more challenging.

> *"The bureaucracy is also a challenge … and the bureaucracy is very slow, we have to push them so that farmers and advisors receive punctual values/advice." (interview 14)*

Poor connectivity in some specific areas or regions remains an issue for some UCs, especially since most of the DATS only function optimally online. Some DATS offer (more limited) functionalities offline, but overall a good internet connection is a basic requirement, which is not fulfilled across the different regions in Europe.

> *"It's a problem in xx. Still, as one of the most developed countries, we still have the problem with this connectivity. It's really a thing." (interview 15)*

Looking more at the level of the organisations, another important barrier is the **poor cooperation between different departments** within an organisation, despite having multiple benefits, such as efficiency. This fragmentation impacts the communication, resulting in crucial information that is accidentally sidelined or misunderstandings about the importance of each other's work, since a benefit for one department is not necessarily a benefit for the other.

> *"In this respect it is also important to consider the role of the IT department. It does not always consider the needs of the advisors in the field enough. They want to go for a uniform hardware and software as much as possible, since this makes the support from their side more easy. However, laptops are not really right for the advisors in the field." (interview 16)*

Closely linked to this, another important barrier is **the lack of organisational resources**. This comes in different forms, like lack of human resources for tool development and adaptation, the lack of time for people within an organisation to assist in the co-creation or feedback process for tool development, the lack of in-house technical support and even the lack of suitable material for advisors.

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> *"The resources within our advisory team are not as big as the problem requires." (interview 15)*

> *"We of course have to consider development costs, and also have to think about technical support afterwards. Since we don't have this experience in-house, the technical support needed should be minimal" (interview 3)*

Supporting factors - opportunities

Looking at the organisational level, **clear support from the organisation** generally favours DATS adoption. This covers several factors, such as (in)formal discussions, or openness for training. Communication about technology needed within a company is therefore important, to know the real need of the employees (in different departments). Some interviewees even indicated that using a specific DATS, helped to feel the different advisors being part of the team.

> *"This tool is very much supported, through all levels of the organization. It is considered as kind of a flagship tool, and is considered very important." (interview 16)*

Having good IT-support for using the tool, either in-house (having a person in the organization who knows the tool well, and can adapt if necessary), or through working with an external company is very important. Regardless of the fact if this support is in-house or from an external company, having a **good contact with the tool development team**, and **having the possibility to update and/or adapt the tool**, based on user feedback was another important positive factor.

> *"We can provide the basic technical issues and the basic technical things with our team. If there are hard problems or bigger things we think about to change, then we ask the organisation we work with. They are quite open for these kind of adaptions. At the moment we handle now 80-90% of the technical issues or questions, we can solve those by ourselves." (interview 15)*

4.3.3. Individual level

Barriers

Several interviewees indicated the **ageing farmer/advisor population** as being a barrier. In some interviews it was mentioned that older advisors and farmers are less inclined to use new technologies. They are often seen as being more set in their ways, and more reluctant to make changes in the way they work.

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> *"New technologies and ways of communication are struggling many times for acceptance, especially with an older generation of farmers and advisors, that are used to their manner of communication." (interview 15)*

However, several others suggested that this is a faulty stereotype of specifically small scale farms and aged farmers. The use of digital tools and technology of advisors is for them not so much based on age, but rather linked to the fact that some potential **end users are reluctant or feel sceptic** about using DATS. Some people just have an **inherent lack of motivation** or general disinterest to use digital tools.

> *"I think most of the people that don't use our tool, don't do it, because they don't want to use digital tools. That is one of the barriers. But it is one we cannot do much about." (interview 2)*

Closely linked to this, are the fact that **users lack the right competencies or capabilities** to use the tools, or at least fear they do, and think the system will be **too difficult to use**. In addition to this, several interviewees indicated that there is also simply **not enough time to learn and work with new DATS**, and thus develop those competencies. For those end-users it is really important to invest in training opportunities, or have them very closely involved in the development process, to help overcome their concerns and strengthen their competencies and confidence.

> *"For farmers with little to none IT skills or knowledge, we need an approach that makes most value with least effort. For instance, tackle a challenge that can be easily and quickly solved..." (interview 5)*

> *"The specific needs of the advisors will be technical support and training on DATS and hardware to help them to scope out and understand how the technology would help them to deliver their work. Advisors will also need training on the use of the technology to ensure that it adds value to their visits / discussion groups." (UC-BC16)*

Some interviewees also indicated that **advisors feel threatened by DATS**, seeing them as a form of competition, or having the concern that they will change their role as advisors. In this respect, they also pointed out the importance of integrity and a trustful relationship between farmers and advisors, and some worry that too extensive use of **DATS may negatively affect this advisor-farmer relationship**.

> *"I think, in the very beginning, the brakes were the advisors, because they were afraid that XX (name of digital tool) would be in competition with them." (interview 2)*

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> *"By being too much linked to the office, there is a risk that farmers will start associating us more with bureaucracy and state interference, ... rather than also offering technical expertise, while actually the latter should remain one of the core strengths." (interview 16)*

Finally another potential barrier on the individual level, is the **competition between farmers.** In some regions, farmers feel in competition with each other and thus feel concerns about sharing data with peers.

> *"Farmers were skeptical. They are competitors in the field. The financial part is difficult to share, but they did it." (interview 7)*

Supportive factors - opportunities

In contrast to the observation of some interviewees that older end-users may be a barrier, other interviewees mostly saw opportunities in the fact that **younger farmers and advisors are more eager** to use new technologies, and in general are more confident in using them, since they are digitally better educated. But also in older farmers there is often willingness to keep up with new developments, but may require some additional assistance in the process. So similar to the barrier of an inherent disinterest, having **intrinsically interested or motivated end-users** supports development and adoption of DATS.

> *"The young people really want to move forward with this. This is a tool optimal for young advisors, also because they are accustomed to work a lot with data through their education." (Interview 17)*

Perhaps the main opportunity described by interviewees was the fact that the **use of DATS strengthens or support the advisors in their work**. So, if the advisors see this benefit clearly, they will not hesitate to adopt such a tool. This benefit can either be in the form of improved advice, but also in the form of having more flexibility in their work, for instance for the organization of trainings or knowledge transfer events.

> *"Our soil advisors found it difficult to fix a date during which 20 farmers in a certain area could meet. However, doing it online or in the form of a hybrid event, was logistically easier and gives advisors more options." (interview 1)*

Linked to the aforementioned barrier of concerns around difficulty of use and the fact that they may lack the right competencies, another important aspect that supported adoption was **the availability of clear (online) guidelines or trainings for the end-users** (both advisors and farmers), or **have the option to easily reach**

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out for support, for instance by being able to directly go to the in-house IT department, or through a helpdesk.

> *"What worked very well, was the fact that there are very clear guidelines prepared for the tool, but also on how to conduct the workshops, linked to the use of the tool." (interview 3)*

Another opportunity was seen in the fact that **the use of DATS can strengthen the relationship between farmer and advisor, or between a team of advisors**. The first aspect is again linked to the fact that improving the quality of the advice through the use of DATS, positively affects the aspect of trustworthiness and credibility, and thus the relationship between farmer and advisor. But also tools that improve the ease of communication, either between advisors in a team, or again between farmers and advisors, and thus help to share knowledge, and fully understand each other's needs, were regarded positively.

> *"I think that it is a way in which all the advisors create a team, which I think is good... Now we are in the office, and we are with some people, but some of the advisors are isolated in some regions, and for them it is good to find out that you are not alone, and that you can consult other advisors." (interview 9)*

Another important aspect supporting DATS uptake is **learning about positive experiences through colleagues**, again for both advisors and farmers. Peer-to-peer sharing of experiences overall are regarded as important in innovation uptake, and this is no different when it comes to DATS.

> *"But now we get very good publicity from farmers … Our tool is known by the farmers, who talk about it also to other farmers, and they then call us." (interview 2)*

Finally, an aspect that is considered as having a positive influence specifically in the process of DATS development and adaptation, is the **availability of end-user feedback**, since this helps to develop a tool that truly fits the end-users needs and requirements. This feedback can be obtained in different ways, and through different channels, going from a very intense process of cooperation, and even co-design, through feedback by social media or helpdesk functions.

> *"So we had an idea how the tool should look like but in reality the development of the tool was an iterative process between end-users (farmers) and developers. That went really great. Only farmers really know what they need, and this interaction allowed us to build a custom dashboard and information that really suited the need of specific end-users." (interview 5)*

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4.3.4. Technological/DATS level

Barriers

A first barrier that was mentioned by participants was the difficulty in **finding a suitable tool adapted to a specific need or context**, in the multitude of tools that are available. One person stated that while he estimated that there are around 300 tools in the FAIRshare DATS inventory, there was not a single one adapted to the specific sector he was looking for. Also, some interviewees indicated there are issues around complexity levels (too simple or complex for their need) when trying to find a tool in the existing DATS pool. Furthermore, several interviewees indicated that it is **not straightforward to exchange tools across borders**. This is complicated by language barriers, but also by too large differences between for example farming systems and regulatory or legislative contexts.

> *"For fertilization for example, we have an agronomic model in the south of France, which is different to the north of France, and it is again different in other countries, and the regulations are too different between different countries." (interview 2)*

Second, **the development and use of DATS requires too much time,** which is not always available. This is closely linked to what is mentioned under the organisational level, about the availability of organisational resources (time, money and personnel), and the individual level, about the concerns around difficulty of use, but extends beyond that. Some tools are simply considered too time-consuming, either in the process of development, getting familiarised with the tool, or simply in the aspect of its use, e.g. by requiring too much manual input.

> *"Advisors are farmer focused, tools should ease that work, time investment in preparation is perceived as a burden." (interview 17)*

Also, the **cost for development and/or maintenance**, either in-house or through an external company, has been a barrier for several UCs, although it is important in this respect to highlight the importance of having a good cost/benefit balance. So, users are willing to pay for DATS or invest more time in its use or development, as long as the perceived benefit warrants such an investment. However, making end-users see the benefit can be a challenge, and thus the **lack of a clear added value for the user** was also mentioned as a barrier for adoption. This is again very closely linked to some aspects on the individual level (e.g. reluctance, skepticism, concerns around competencies), since this is also to some extent a matter of perception.

> *"Farmers find the measurements 'a waste of time', taking easily one or two hours of walking around on the farm, without a clear*

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> *or immediate 'return on investment', and it is not always easy to make them understand the benefit." (interview 16)*

Another important barrier is **poor or inadequate tool functionalities**. In this respect, a wide number of functionalities were mentioned. For some the main issue was the fact that results are not always readily or easily available was mentioned, others experience problems around interoperability and compatibility with other DATS and digital technologies. Other poor functionalities that were considered a barrier in some UCs were the lack of a mobile application, difficulties with registration and creating user accounts, miscalculations leading to faulty graphics, and the fact that the system was not error-proof, due to manual inputs.

> *"Data is analysed on a daily basis, but for the entrepreneurial farmer, having this data only once at the end of the day is not enough. He would like hourly updates, to know more quickly if things are going well or not. And this is a criticism we received from several farmers here." (interview 6)*

Another important limitation when using tools, is understanding that several **online tools still depend on following up with an advisor**. This was mentioned for different types of tools. For some DSTs, it was mentioned that the tool has no or little value without follow-up advice, either by the advisor, or a dedicated specialist, or through peer-to-peer exchanges. But also for an online Q&A tool, there was some concern that to truly understand a farmers' need, an online tool has limitations, and it is hard to evaluate as an advisor how helpful or accurate a specific advice was. So, while maybe not exactly a barrier, it is an important limitation to consider.

> *"... we don't have a connection to see that the farmer is actually satisfied with this answer. The answer depends mostly on the question. In the system - in my experience - there are a lot of open questions - it's very hard to provide the right answer..." (interview 13)*

Finally, several interviewees also indicated issues around **data ownership** as a possible barrier. For several of the pilot DATS farm-specific data is collected, so great care needs to be taken when using and sharing these data. Farmers are in control of their own data, and in some cases don't want to share this (sensitive) data with others, limiting the potential added value of the tool.

> *"we currently don't use data between farms, because we're not sure from legal standpoint how that could be made, I think it would be a valuable proposition for end-users not only in benchmarking (done by academics) but really know what in their region is being done in operations, prices, fertilisation,*

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treatments, ...However, the data belongs to user that produces so we cannot use it." (interview 5)

Positive factors - opportunities

Based on experiences with pilot DATS, interviewees also indicated several positive experiences and opportunities, which in the end supported the development and adoption of DATS. Most of these opportunities are either linked to good usability, or having a clear added value by using a particular tool.

Regarding good usability, a first crucial element is **ease-of-use**. A tool should be easy, intuitive, and preferably accessible also as a mobile application, although this depends on the kind of tool. Also important, is that the **tool is always up-to-date**, improving the trustworthiness of the tool.

"We had an online beer tent, which was done by a third organisation. We would incorporate this in-house, since it was very popular with website users, and easy to use." (interview 1)

"And another important thing, is that during all these years, the tool evolves, because of the advisors. The advisors tell us: "oh, the regulations changed or will change, be careful, we have to update the reglulation-", and hup, we update the tool. So, all the time, with the advisors, we also hear the need of the farmers, and the tool evolves based on this." (interview 2)

In addition to this, having a tool with an **attractive look and feel** is important, and also here the issue of **interoperability** was mentioned. A tool or a system that is interoperable with other tools or systems already in use, highly motivates farmers or advisors to use a tool.

"You have a lot of interoperability with all the different tools, … we heard from the farmers that they are tired of putting the same data on all the tools they use, so we try to put all the modules, and if there is one information that is already given by the farmers, we can use it for all the tools." (interview 2)

Having a clear added value, can be further split up in a number of different opportunities. First of all, if a **tool is developed to address a real need of the user**, either farmer or advisor, it significantly increases the chance of being used. Linked to this, if a **tool is perceived as useful or interesting**, this also triggers adoption.

"and I think one of the best things about our tool is that it answers a real need of the farmers. All the updates are based on input from our advisors, who explain the needs of the farmers to

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> *the developers, and we try to answer to this need, so that is why we have a lot of farmers that use this tool, because it is really helpful for them." (interview 2)*

> *"the more data this tool integrates, the more useful it is and the more acceptance it has on our organization." (interview 5)*

These real needs can take different forms, and based on this, tools are developed with specific aims or goals in mind. However, adoption then also depends if the tool is successful in achieving that particular goal, and addressing that initial need. For example, if a **tool saves time and/or money** for either the farmer or advisor, if it **improves farm results**, if the **tool supports decision making** or if it **supports knowledge exchange**, chances are that the tool will be used, because it successfully helped to overcome a real need of the farmer or advisor**.** This is also closely linked to what is described on the individual level, about the fact that the **use of a particular DATS can strengthen or support the advisors in their work, by improving the quality of the advice they can offer.**

> *It also functions as a logbook, where everything is stored automatically in a digital format, so you don't have to keep all the paperwork, etc. Everything is now stored on the pc, which makes it much easier and faster, also for instance to compare different rounds of production." (interview 6)*

> *"It worked very well on the aspect of knowledge exchange, and that is why we decided to develop this aspect further, and think how we could use this feature for more peer-to-peer exchange" (interview 1)*

Linked to what was mentioned before under the 'barriers' section, if there is a **good balance between costs and benefit**, this will also motivate potential users to take the step towards adoption.

> *"Experience from practice shows that the tool has been successful as it encourages those who are not convinced of the benefits of the tool and service, to try it as the user does not need to invest in it." (UC-BC1)*

Finally, and again linked to what was mentioned before as a potential barrier, was the example of a tool that was more readily accepted by farmers, because they could **determine who gets access to the data**. This was especially relevant, because these farmers work in a context with more commercially-linked advisors/sales people. The trust relationship is usually different with this type of advisor, and farmers feel more willing to adopt such a tool, if they keep clear control of this aspect.

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4.4. Learning from experience: main influencing factors, preconditions and requirements

Interviewees also reflected on these experiences, leading to a number of lessons learned. As was shown in the previous sections, depending on the overall context several factors can potentially act both as opportunities and barriers. For this reason, several elements were already described by interviewees more generally as influencing factors, where the actual situation determines if they exert a positive or negative influence. This section aims to present an overview of the main influencing factors, and also presents a number of preconditions and requirements to support tool development/adaptation and adoption. Like the previous section, findings are also structured along the institutional/organisational, individual and technological/DATS level.

4.4.1. Institutional/organisational level

A first important influencing factor is the **availability of government support** for digitalisation and DATS use and adoption. As was seen in the previous sections, government support can either exert a positive (for instance by providing funding or prioritising it in specific development programmes) or negative (lack of funding, lack of information) influence. Governments, and the linked public advisory organisations, may also have an important role to play in the development and adoption of DATS that support public goods delivery, which may be less addressed by more privatised advisory organisations, who work more on a client-needs basis. Based on UC experiences, having a supportive government is not an absolute precondition or requirement, but nevertheless an important aspect to consider in the overall process.

> *"The contact with farmers on-farm is quite essential for us, since the aim of xxx (as a largely state-funded organization) is to ensure the delivery of public goods, and the support to farmers in delivering this is a crucial task. This is also to be seen more as a 'push' function, so not something that we can expect farmers to ask us, but rather us motivating them to optimise management, in all aspects of their farming business." (interview 16)*

Second, there is the **availability of infrastructure**, looking both at internet connectivity and accessibility to specific hardware (e.g. computers, tablets, smartphones). For some UCs and DATS this is seen as an absolute precondition, i.e. some DATS only function well online, so not having internet connectivity, effectively makes the use of that tool impossible. But in most cases it is considered

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as an important influencing factor to consider when developing tools. E.g. find ways to overcome issues with poor connectivity, or consider carefully what hardware is most commonly used or accessible for the different end users.

> *You really need internet access, especially for importing the data, ok you can make some visualisations also without the most recent data, but still. And actually, it is a web-based tool, so without the internet, you simply cannot access the tool, so you really do depend on it." (interview 6)*

> *"A lot of farmers are not always in the office. Just some weekends or maybe on a cloudy, rainy Sunday. Mainly the younger generation is working a lot with only the mobile phones and applications on mobile phones. There's where we want to meet them: where they already are… That is very important." (interview 15))*

A third crucial influencing factor on this level is the **organisational capacity**. Throughout the interviews, people reflect on the different roles needed to support DATS development and adoption. Obviously there is the side of IT development, who tend to focus on functionalities and practicalities, ease-of-use, making the tool attractive. But on the other side there is the need for technical know-how and expertise of advisors and/or farmers to ensure that tools are developed which offer a real added value for the end user, so the distribution of each of these roles, and the available resources (time, money) for each aspect needs to be carefully considered. While the organisational capacity is thus mostly perceived as an influencing factor, thinking about the distribution of roles, and then reflecting on what expertise and resources are available within your organisation, and for what expertise and resources you may require external support, is however an important precondition for successful tool development and adoption. For this reason, several UCs are collaborating with external companies, specifically for IT-related support.

> *"we have here a very tiny IT department, and we are trying to cope with this, and trying to adapt a way of working for this, because we are not developers of tools" (interview 9)*

4.4.2. Individual level

A first important element on the individual level is the **advisors' and/or farmers' willingness or inherent need for a specific DATS**. Simply stated, if the DATS addresses a real need of advisors and/or farmers, their willingness to adopt such a tool will always be higher. However, there are other moderating factors at play, as was also described under the barriers and opportunities section: some people

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are simply more open towards accepting change, feel more comfortable or competent with the use of IT, are more eager or confident to develop new competencies. Also, **the effect of age on DATS uptake** was frequently discussed, and linked to willingness and openness towards DATS, where it was often mentioned that older people are less flexible in taking up these new technologies, while it is more common practice for younger people. Some interviewees were more cautious, offering examples of some older farmers or advisors who have no problems with keeping up with new IT developments, because of an inherent interest in IT, or simply because they are more open-minded, or of younger farmers and advisors who feel less confident when it comes to working with specific software. These factors are usually more considered as influencing factors, and not as preconditions and requirements. The fact that you are working for an ageing farmer population, or that some advisors are more reluctant to try new things, are seen as being beyond their control. It is however to be carefully considered, and is to be influenced by for instance closely involving end users in the process of tool development and optimisation, **supporting people in the development of new skills and competencies** (as also described in the previous section on opportunities at individual level), or by having **DATS with a clear added value for the end users**. The latter are then again more considered as preconditions for successful DATS development and adoption.

> *"The success of the DATS will be influenced by how much advisors believe they need support for their communication and knowledge exchange." (UC-BC9)*

> *"There may be still some issues with the small farms & older farmers, although the idea that older farmers are more adverse to digital technology is a faulty stereotype" (interview 3)*

> *"The successful implementation should be planned carefully. Because of the structure of farms and farmers we cannot force them too intensively. A similar situation is with older advisors. Mostly they are not accessible for new things. A visible additional value for all target groups is very important for successful implementation." (UC-BC3)*

On the individual level, we again want to come back to the **cooperation between advisors - IT developers - farmers**. As mentioned before under the institutional/organisational level, reflecting about the roles of the different actors, and the distribution between them, is important from the perspective of organisational capacity, but it is equally important to consider this aspect from the perspective of competencies, capabilities, personal relations, credibility and trust between different actors (developers, users). This again links closely to how the **process of tool development and optimisation** is organised. While this is done in

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very different ways across the UCs, it is clear that this is again an important influencing factor. Having a good understanding and contact between the different actors involved in the process tends to positively influence the outcomes, and thus appears to be the precondition for success. For this reason, some UCs prefer to have in-house development and support, because this allows for a more direct connection between developers and users, and reduces their dependence on external providers. However, even within organisations, communication between different departments is not always fluent or there is simply no organisational capacity, so others have benefited more from cooperating with an external, specialised IT company, and done so without problems as long as there were good lines of communication. Also, the way possible end-users are included in the process of tool development and optimisation differs between UCs. Some first plan to develop, and then provide training to users, and capture user feedback through for instance surveys, offering thus more limited opportunities for feedback, while others foresee a more active role for end users also in development and optimisation of the tool, and see this user feedback as a precondition for success.

> *"Credibility is fundamental when visiting a farm, the farmers only trust the ones that have knowledge of the field. So, the people that talk to the farmers are agronomists, since they understand the challenge, the pains and struggles, and the farmers feel understood. The challenge is then that the guys who know the technical part explain it to the IT guys. As an agronomy engineer, who specialised in DSTs, I am somewhat in the middle, so I try to be the bridge." (interview 5)*

> *"The idea is that the platform will be developed using a step-by-step approach, where new functionalities and features are added gradually, with an evaluation after each step." (interview 3)*

4.4.3. Technological/DATS level

After obtaining a good understanding of factors at play and important preconditions at the institutional/organisational and individual level, the final focus is on the tool, where we mainly find a number of important preconditions and where interviewees described a wide range of requirements and functionalities they envision for their DATS, based on early experiences with the pilot DATS. We will start with more general requirements, regardless of tool type, but also list some preconditions and requirements for data management and DSTs on the one hand, and knowledge exchange and information sharing platforms, on

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the other hand, as the two main categories of pilot DATS trialed, and in most cases to be further developed and optimised, in the UCs.

Preconditions

Based on experiences, we propose 3 main characteristics as preconditions, meaning that these are basic requirements that should be fulfilled for every single DATS that aims to be successful, regardless of the tool type. First, a tool should have a **good balance between ease-of-use and functionalities**. While user friendliness and ease-of-use in itself could be considered as a precondition, the complexity of some of the aspects covered by DATS do not always allow for very basic or easy-to-use interfaces. Some complexity is in some cases unavoidable, and in fact needed to ensure a good functionality. Developers should strive for maximal user friendliness and ease of use, including a professional look and feel of the tool, while ensuring excellent functionalities.

> *"I think there are more apps that are easier to use. But it's nearly impossible to help a young farmer who is 25 years old: He wants more information and more functions." (interview 15)*

> *"The peer-to-peer exchange is the main goal of the tool, so we want to reach a full score for this. I don't think the tool will be easier to use, it should be convenient, but will not be easier." (interview 9)*

A second precondition is ensuring a **good balance between costs and benefits**, where costs and benefits are of course not only understood as monetary costs and benefits. Some of the pilot DATS were free, others came at a cost, some required a substantial time investment, while for others this was much less, but that never determined the overall success. If a tool provides a clear added value or benefit (better farm management, enhanced knowledge, time and money saved, …), to the end user, users are willing to handle this cost. So, the key is in finding the balance, and this is also a balance that is often made on an individual basis.

> *"For me, it is up to every farmer if he is willing to pay such a fee for this… because I might see it as a disadvantage, and think it is quite pricy, but in the end everything comes at a cost, nothing is for free. Everything is good, but you have to pay for it, and it is up to the individual farmer to put costs and benefits in the balance for his own farm." (interview 6)*

As a third and final precondition, there is the need for **data management in line with GDPR requirements**. Apart from the fact that these are legal requirements, which should be followed under all circumstances, they are also essential in alleviating concerns around data privacy and ownership.

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Looking then specifically at tools for data management and DST, there is one element that can be considered as an important precondition for such tools, i.e. **the need for high quality data**. Without reliable, high quality data, it is impossible to develop reliable, high quality DATS.

> *Since the most of the recommendations is based on the data collected, the quality of data collection has to be monitored and further improved. (UC-BC13)*

Different tools = different requirements

Based on experiences with pilot DATS, UCs each tended to have a 'wish list' of requirements for the tool that they aim to introduce for their UC. These requirements are of course closely linked to the challenge that the UC defined, and the influencing factors at institutional/organisational and individual level, but even so, we could identify a number of more 'common' requirements. First of all, for nearly all tools it is a requirement that it should **improve effectiveness and efficiency**, either in the way that the advice is offered to the farmer, or of the farming operations themselves.

> *"The chosen DAT must give the value of less work for both parts of the target group. This point should be obvious so that saved worktime stands as a value itself." (UC-BC15)*

Equally important is the requirement that the tool should help to **improve the quality of advice** and strengthen the advisors' knowledge base, and support the provision of high-quality, reliable information. Also, a few interviewees indicated that the DATS should not only strengthen advisors' capacities, but should also help to **empower farmers**. These requirements are again linked to the fact that the tools should address a real need and provide clear added value to the end users.

> *"Advisors will be equipped with the Q&A knowledge base, specialist knowledge, relevant information and answers base, so as to provide the most convenient approach, the most appropriate solution to farmers' challenges in everyday business." (UC-BC13)*

> *"Increase advisor service quality by enabling farmers to develop more self-reliance using digital tools with low entry barriers/learning curves, while at the same time improving animal health and digital record keeping proving compliance with regulatory/legal measures" (UC-BC12)*

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Second there are a number of requirements linked to the support of interaction, at different levels. Again, the requirement is here clearly linked to the context and goal of the specific UC. For some tools the main requirement is **enabling peer-to-peer learning**, while for others the main requirement is **supporting two-way interaction** between different types of actors, and again others want a tool **supporting social interaction for larger groups**, and finally some want the tool to serve specifically as a **tool supporting real-life interactions**.

> *"The platform should also support dynamic interaction, where exchange is two-way, and taking part between all types of actors (farmers, advisors and researchers)." (interview 3)*

> *"There is a social dimension in the development of such a platform, since these agricultural shows are an important moment in the calendar of farmers, so we did want to integrate this social element really clearly (in the form of a beer tent)." (interview 1)*

A third important group of requirements are related to the technical aspects of the tool. These include aspects such as having a **self-learning system**, a system that **allows to follow user actions**, having the tool available as a **mobile application**, and tool **interoperability**. Ideally, the tool should require **minimal technical support**.

> *"well, if you want to have interaction, then the tool must be online. And also for updating, or looking behind what users are doing with the tool, so if the tool is not designed for online use, you cannot have any information on what is happening, so I think it is important" (interview 3)*

> *"It would be a great assistance for farmers if all the relevant information they need to run their farm or comply with the guidelines from their growers' association were available on as less media as possible, ideally on a smartphone, of course, as it is usually at hand." (UC-BC15)*

Specifically for data management tools and DSTs, an important technical requirement, or at least ambition, is to have **continuous, automated data-input and record keeping**, while for knowledge exchange and information sharing platforms having a system in place that **supports a push-function**, where the information is brought directly to the end-user, and the ability to **generate quick or automated responses to users** were mentioned as desirable technical features.

> *Easier recording of data on farm e.g. fertilizer records etc. The device could also interface with farmers' own devices to capture*

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> *useful data e.g. GPS systems on machines, data recorders on milking robots etc. (UC-BC 16)*

> *"I think when you upload something in the discussion forum, you are going to receive a notification in your email, in your mail account, so you know that there is something new." (interview 9)*

Finally, there were a number of requirements, which were linked to the specific objective of a particular DATS. Since several UCs have similar objectives, they also have in this case similar requirements. This includes requirements such as that the tool should **support compliance with regulatory requirements**, that the tool should be able to **automate repetitive, non-complex tasks** for advisors, that the tool should **improve the data and information exchange between different actors** across the agrifood chain, and that the tool should **provide up-to-date information directly to the end user.**

> *The AI-driven chatbot DAT enables farmers to find relevant information/ the relevant expert online quicker and without needing to visit an advisory services office. (UC-BC12)*

> *"The advantage goes beyond remote consulting and provides advisors with opportunities for new knowledge exchange schemes that they can offer to their clients. This provides new business opportunities for advisors to bring together multiple parties on a virtual platform, to share knowledge and co-create solutions in an interactive/innovation approach with farmers." (interview 1)*

When looking specifically at data management and decisions support tools, important requirements linked to the DATS objective are the **ability to improve on-farm decision making** and/or **support benchmarking and monitoring**, while for knowledge exchange and information platforms requirements included the ability to **provide easy accessible and findable information**, **centralise communication and information**, to **enable more flexibility in knowledge sharing** for farmers and advisors, and to **allow for identifying farmers' needs and opportunities for research**.

> *The clean air DAT for livestock buildings enables farmers to better preserve the health of animals by correctly sizing the ventilations openings (in long pan and in ridge) and to choose the correct materials for cladding, according to the type and number of animals housed and the environment of the building. (UC-BC12)*

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Therefore both, advisors and farmers need one channel to communicate directly, quickly and safely. Neither farmer nor advisors should have more work but gain a benefit of a bundled and specific information asked and delivered just in time. (UC-BC15)

5. Some brief points of discussion and conclusion

To conclude this report, we would like to offer some brief reflections on how the results in this deliverable adds to the work done in WP3, and how this can inform the next steps to be taken in WP5 and WP6.

Comparing the findings presented here to earlier work done in WP3, and in particular D3.3, we find that the barriers listed there focus mainly on what we described under the individual and technological/DATS level. In fact, 11 of the barriers listed in Table 1 (based on D3.3) correspond with barriers we described at the individual level, and 14 with barriers at the technological/DATS level. They are however sometimes clustered into a single barrier. For example, on technological/DATS level the barrier 'not straightforward to exchange tools across borders' captures 'language' and 'region specific tools not applicable on large scale'. Organisational barriers were only mentioned twice (but are overall less frequently mentioned). In addition to this, we also identified a number of barriers which were not listed before, resulting in new insights for future work and research for the project (and beyond), such as 'poor cooperation between departments', 'not having enough time to learn and work with new DATS', or the fact that online tools have inadequate functionalities or depend on following up with an advisor and data ownership. Also, in addition to the barriers identified through the different tasks in WP3, we also want to highlight the numerous opportunities and positive factors that strengthen the use of DATS listed in this report.

Furthermore, it is important to note that some barriers and opportunities that exist may not have been mentioned by the interviewees. Due to the fact that we focused our interviews around pilot DATS, barriers that would have hindered a pilot in the first place were not reported, such as tools which have not been maintained or are no longer updated. All pilot DATS already passed some first kind of screening, before being used as a pilot tool. The 15 pilot DATS had also different maturity stages, so some had already overcome specific obstacles, and no longer recognised some aspects as barriers. Also, some profiles (such as IT specialists)

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were less present in the interviews, meaning that also specific barriers and opportunities from this perspective may be underrepresented.

We believe that the results presented here will allow UCs to get a better understanding of the wide range of possible influencing factors on institutional/organizational, individual and technological/DATS level which will determine how successful a DATS will be. Having a clear understanding of these influencing factors for the context of the UC, for instance through performing a SWOT analysis is thus crucial, to avoid any unforeseen problems linked to these factors.

To conclude, the work presented here, based on work done in 17 very diverse UCs and building on the complementary data obtained through the interviews on the one hand, and the UC-BC descriptions on the other hand, leads to the identification of a number of barriers and supportive factors, in addition to a broad range of so-called influencing factors, requirements and preconditions for success. Despite the diversity in contexts across the UCs, we could identify a number of common factors across UCs. First of all, main drivers for digital transformation and the quest for suitable DATS, appear to be quite universal. COVID-19 has been an important game changer in this respect, but also other ongoing global/societal developments and the challenge to maintain high quality, professional advisory services, in support of efficient and future-oriented farming systems, within this changing environment, were central across all UCs. However, these more universal drivers lead then to different challenges, depending on specific contexts and situations. Central in the search for suitable DATS to address these challenges, is in the first place having a good understanding of the challenge and the different end-users needs. In addition to addressing this real need and thus offering a clear added value to the user, DATS should have the right balance between costs and benefits, and ease-of-use and good functionalities, in addition to a number of UC specific requirements.

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Annex

Annex 1: Interview outline

Introduction

- What is the challenge you are dealing with (refer to the UC description, but ask them to give a bit more detail, further explanation)?
- How was this challenge identified, or how did it manifest itself? Who are the persons most affected by the challenge?
- How do you think digital tools & services could help in dealing with this challenge?
- What DATS have you already explored in this context?

(Select 1 or 2 DATS for further discussion, preferable ones with which the interviewee has experience)

Experience with 1-2 pilot DATS

- Can you please elaborate on the overall process of your experience with 'pilot DATS 1/pilot DATS 2', starting from the search for suitable DATS to the actual use and implementation of the tools.
    - Looking back, what went really well?
    - Looking back, what were problems you encountered?
        - What were steps/actions taken in handling these problems?
    - To what extent did the DATS help improve your job performance, in this case handling the aforementioned challenge.
    - How easy was/is the system to use?
    - To what extent do you think that other people whose opinion you value (e.g. boss, colleague advisors) believe you should use this system?
    - To what extent is the organizational and technical infrastructure available to support use of the system?

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- Please score the pilot DATS for each of the following elements (1-5; 1=not at all, 5=absolutely)(*adapted from checklist developed by Rose et al., 2016*):

	Score + short explanation
FOR ALL DIGITAL TOOLS	
The tool performs a useful function and/or enables me to accomplish tasks more quickly • *For you as an advisor* • *For the farmer*	
The system is easy to use	
The tool can encourage peer-to-peer knowledge exchange	
The cost of the tool is in proportion to the benefit	
This tool is useful for advisors in their interaction with the farmer	
The tool is adapted to skills and habits of different age and gender groups	
The tool is applicable for all scales of farming	
The tool requires good IT skills to use	
The tool can be used effectively • *Does it require internet access?* • *Does it fit workflows (for advisor/farmer)?* • *Is there compatibility with use of existing tools & devices?*	
The tool was easy to find	
My organisation supported the use of the system	
SPECIFICALLY FOR DECISION SUPPORT TOOLS	

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The tool is evidence-based	
The results are trusted by the end users	
The tool is useful for individual farms	

Future use of the pilot DATS

- Will you continue to use this DATS in the future? If yes, why? If no, why not?
- Why would/wouldn't you recommend this DATS to your peers?
- What changes could be made to this DATS could be improved to better fit your need, or address the challenge you presented?

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Annex 2: Informed consent

Dear participant,

We kindly invite you to participate in our interviews of Task 4.3. Before consenting to participate, it is however important that you read the following information with clear attention. If anything is unclear, please do not hesitate to ask further information.

DESCRIPTION OF THE RESEARCH

The aim of this explorative study is to collect information from 15 user cases to tell us how easy or hard it was to use/introduce them, what the problems were and if the process of adopting these DATS (digital advisory tools & services) could have been improved. Information is collected through semi-structured interviews. We'll carry out interviews (duration: approx. 1.5h), with one or two persons per UC (user case), to discuss experiences, challenges and successes.

The interviews are conducted from 24-02-2021 until 12-03-2021 and held in English on Teams (online-platform). To avoid losing valuable information during the interview – if the participant gives the permission – we would make an audio recording of the interview. The audio recording are saved on a secured location and will be deleted within 3 months.

The interviews are on the one hand conducted by Dr. ir. L. Debruyne, senior researcher at the social science unit at ILVO, specialized in interactive innovation and digitalization. On the other hand by ing. R. Van Gompel, a junior researcher at the social science unit at ILVO.

ASSOCIATED RISKS & BENEFITS

There are no risk associated with participating in this research. Adventages are sharing information to contribute towards the advancement of Agricultural science and getting knowledge about the successes and challenges of DATS.

VOLUNTARY PARTICIPATION

Participating in this research is completely voluntary. The legal basis for the processing of personal data in this interaction is 'consent'. This means that your interview answers and the results of the discussions can only be processed if you explicitly give permission for this (by signing this consent form). You have the right to withdraw your consent at any time.

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CONFIDENTIALITY

All data will be handled confidentially. All personal data will be anonymized/encrypted for the purpose of analyses and publications. The encryption key is stored securely by the researcher. Raw data will be stored for the duration of the research, and will be destroyed afterwards. Data can only be used for follow-up research upon written consent.

RESULTS

The successes, failures and challenges will be anonymously discussed in a rapport. Furthermore, a small brochure with the main conclusions of each user case will be offered to the participants of that UC. Specific experiences explained during the interview can be used in a next training in WP5, if the participant gives permission. This way, the participant can reflect successes and challenges on their real case during this training.

In case you have further questions don't hesitate to contact: lies.debruyne@ilvo.vlaanderen.be

Sincerely,
Dr. Ir. L. Debruyne & Ing. R. Van Gompel

CONSENT
Name:
Email:

Do you acknowledge to understand the information in this consent form and provide us with your full consent to collect and use your data as described (Y/N)?

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