



CASA

Common Agricultural
and wider bioeconomy
reSearch Agenda

Exploring digitalisation to enhance knowledge flows in EU AKIS



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The overall objective of CASA, a Coordination and Support Action (CSA), is a **consolidated common agricultural and wider bioeconomy research agenda** within the European Research Area.

CASA will achieve this by bringing the Standing Committee on Agricultural Research (SCAR), which has already contributed significantly to this objective in the past, to the next level of performance as a research policy think tank. CASA will efficiently strengthen the strengths and compensate for the insufficiencies of SCAR and thus help it evolve further into “SCAR plus”.

EXECUTIVE SUMMARY

This report presents the results of the study entitled 'Exploring digitalisation to enhance knowledge flow in EU agricultural knowledge and innovation systems (AKIS)'. The study was commissioned by the strategic working group (SWG) SCAR AKIS and financed by the EU CASA project. The SWG SCAR AKIS has identified digitalisation as a core issue in the development of future AKIS in EU countries. Therefore this study was commissioned for which the key question was how various digital platforms and digital tools can be used by and developed with and for various AKIS actors in the EU, enhancing knowledge flows within the AKIS. The study focused on identifying digital infrastructures and digitalisation strategies, which enable the uptake of existing and new knowledge by end-users (such as farmers and advisors) and enhance interconnections between different actors in AKIS.

The study approach consisted for the largest part of a questionnaire which was sent out to most EU Member States (MSs) in May 2019, an expert meeting held in June 2019 to discuss the preliminary results and supporting desk research. The questionnaire was developed in close collaboration with the SWG SCAR AKIS management team as delegated commissioner of the study. A draft questionnaire was presented and discussed at the SWG SCAR AKIS plenary meeting in Dublin, in April 2019. The questionnaire contained three sections with open and closed questions. For the analysis, the answers of the returned questionnaires were first processed and combined in one large excel template.

First of all, the study results showed that in several MSs a digitalisation strategy has been put in place at national and/or regional level. These digitalisation strategies often affect different policy areas and in some cases a digitalisation strategy is already developed related to farming at national/regional level. Many respondents indicate they are in the process of developing a digitalisation strategy for agriculture and it is often still under discussion if this strategy will be (fully) in line with the CAP Strategic Plan. However, detailed inventories of the end-user needs, in particular of farmers, are often still lacking, while these mappings should be made and used as a basis for a co-design approach with farmers, farmer and advisory organisations strongly involved. Most MSs and regions which have implemented a digitalisation strategy linked to agriculture, have developed a set of quantitative and qualitative, operational and impact indicators for monitoring and evaluation. To monitor the efficacy of the digitalisation strategies, and to be able to adopt accordingly, proper evaluation assessment methodologies, including digitalisation indicators and end-user satisfaction levels, have to be in place. Digitalisation strategies should cover both digital tools and field data, as well as digital infrastructure to stimulate knowledge flows between all actors in the AKIS. This includes enhancing digital connections in EIP-AGRI, between multi-actor H2020 projects, operational groups and other projects. There is a strong need to connect different actors and increase their collaboration in frame of digitisation of knowledge flows, in particular the farming and food sector, the IT-sector, governments and the educational sector. Furthermore, MSs can take advantage of the results of European H2020 projects such as FAIRshare, EURAKNOS, EUREKA and NEFERETITI.

A second objective of the study was to identify barriers and success factors either hindering or supporting the uptake of R&I results and exchanging knowledge through digital platforms and tools. Ten important identified barriers are: 1) sustainability of digital infrastructures (including regularly up-dating), 2) ageing and willingness of farmers to use and adopt digital infrastructures, 3) lack of digital skills, e-competences and lack of professional training/advice/coaching, 4) privacy concerns related to data sharing and ownership, 5) lack of user-friendly interfaces and a lack of interoperability to combine digital data or platforms/tools, 6) cost-benefit ratio and lack of confidence in returns of investment in using digital technologies, 7) lack of promotion and awareness of digital infrastructures, 8) information overload, 9) incomplete coverage or insufficient data and information connected to the farmers' needs, 10) and a significant proportion of the EU agricultural community does not have smart phones or (easy) access to internet in rural areas. Ten important identified success factors are: 1) the increase in digital platforms linked to social media enhancing interaction and exchange, 2) digital support services for farmers/end-users, 3) digital platforms and tools which motivate farmers to develop/innovate their farms and businesses, 4) easy access and directly applicable data and information for the end-users, 5) digital infrastructures and tools increase the skills and competences of farmers, 6) hubs or centralised systems which connect different types of

information, knowledge services and AKIS actors, 7) tools for CAP compliance support farmer environmental friendly farm practices and avoid CAP payment penalties, 8) increase in publicly available, free and easy accessible digital platforms and tools, 9) increase in personalised data and information systems 10) confidence in the quality of R&I results.

Third, the study inventoried different examples in EU MSs and regions as good practices of existing digital tools and platforms enhancing knowledge flows in AKIS. These examples provide a wide range of opportunities for AKIS services addressing local conditions, economic, environmental or social knowledge and innovation needs. The main drivers of the mentioned examples are environmental legislative requirements, mitigation effects and market volatilisation. Most examples are initiated by legislation, primarily for environmental compliance. However, access to latest market information, legal amendments and open calls also motivate the launch of digital platforms. The operators and managers of current digital infrastructures can be both public and private actors. Public-private cooperation between research, advice, chambers, ministries and IT companies is essential for well-functioning and complete knowledge transfer and exchange. However, only few examples of existing open source 'living tool' infrastructures were mentioned in which end-users can upload/adjust own information.

Fourth, the study inventoried plans for digital tools and platforms enhancing knowledge flows in AKIS (or under construction). Most responding MSs and regions are indeed planning or discussing to build new or further develop digital platforms and tools enhancing knowledge flows in AKIS. The main initiators of the mentioned plans and developments are research institutes, taking into account that state orders could be behind these initiatives. Some of the mentioned planned tools can potentially be used for future CAP implementation, compliance (e.g. in line with the requirements of the Farm Sustainability Tool, FAST) and in particular regarding international strategic frameworks (e.g. AMR, land management, GHG mitigation and water management). Regarding EIP-AGRI platforms, we can generally conclude from the results that there are currently few digital tools/possibilities for interaction and exchange between end-user and other actors. The results did not show any significant plans to develop this in the (near) future either. Regarding other planned future tools and platforms, it was mentioned often that these will include tools/possibilities for interaction.

The study also focused in particular on digital tools available for CAP compliance. In many EU MSs and regions digital tools are available for CAP compliance (for reporting, planning, assessment, nutrient management, etc.). Especially regarding nutrient management, most respondents indicated that there are digital tools available. The end-users are mostly farmers and advisors who use Nutrient Management Plan (NMP) tools for fulfilment of obligations related to among others, the Nitrate Directive, the Water Framework Directive, NEC Directive and CAP requirements. These tools are often managed by national authorities, NGOs or private companies. There is a need for advisory services to support farmers in using the tools and applications. The NMP tools are based on results of (mostly national) research and are often oriented on local conditions and methods, which makes cross-regional interoperability difficult. This implies that a standard EU NMP tool is likely not applicable, although there are several EU level tools (e.g. EUNEP's nutrient use efficiency tool) which aim at EU wide farm level utilisation. Finally, most nutrient management tools address the whole nitrogen cycle, from feed to applying manure to provide comparable and transparent data.

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1. INTRODUCTION

Digital technologies support European farmers in providing safe, sustainable and quality food. Existing and new technologies such as the internet of things (IoT), artificial intelligence, robotics and big data can contribute to making processes more efficient and can lead to the creation of new products and services. Digitalisation can also play a role in creating a better life in Europe's rural areas, as is highlighted in the Cork 2.0 Declaration¹. The European Commission (EC) aims to make the agricultural sector and rural areas in Europe digitised and data-empowered under the Digital Single Market strategy. In the Communication 'Building a European Data Economy' the EC explores how data can potentially bring many opportunities for the European industry, including the agri-food sector². Similarly, the emphasis placed on digitalisation in agriculture allows linking up to the EU Digital Agenda³. Digital technologies in agriculture figure high on the European Union's research and innovation (R&I) agenda, with around €100 million euro available under the Horizon 2020 work programme 2018-2020 to advance the development and uptake of digital technologies in agriculture and rural areas, to anticipate the impacts of the digital revolution.

Technological developments and digitalisation are also important elements in the CAP Strategic Plans, making big leaps possible in resource efficiency and climate smart agriculture, increasing resilience and soil health while decreasing costs for farmers. However, digitalisation and new technologies for enhancing knowledge flows in farming through communication, dissemination and digital tools, remain below expectations and unevenly spread throughout the EU. There is also a particular need to find solutions for small and medium-sized (SME) farms with a view to better integrate them into national/regional agricultural knowledge and innovation systems (AKIS)⁴. Due to increasing EU requirements for knowledge sharing, digital tool utilisation and networking several Member States (MSs), supported by IT companies, have developed tools and monitoring systems to achieve the related EU and international ambitions. However, these tools are heterogeneous at both national and regional level and interoperability often lacks. This heterogeneity is embodied in their function and also in their users. Consequently the systems are existing but fragmented and need to be better connected at regional, national and EU level, to contribute to successful implementation of digital platforms in the framework of the new CAP, according to its current AKIS related proposal. Moreover, strengthening linkages between digital infrastructures and exchanging experiences and good practices are necessary for developments and improvements in implementing digital infrastructures to enhance knowledge flows in AKIS.

The EU Strategic Working Group AKIS of the Standing Committee for Agricultural Research (SWG SCAR AKIS) acknowledged digitalisation as a core issue in the development of future AKISs in the EU countries. Therefore SWG SCAR AKIS commissioned a study entitled 'Exploring Digitalisation for AKIS' in which the key question is how various digital platforms and digital tools can be used by and developed with and for various AKIS actors in Europe. Specific attention was asked for the already existing good Member State level solutions on AKIS actors using digital tools and their possibilities to extend or adapt in other countries. The study focuses on mapping digital infrastructures and digitalisation strategies, which enable the uptake of existing or new knowledge by practitioners (end-users such as farmers and advisors) and strengthen interconnections between different actors in AKIS to enhance CAP compliance. The aim is to collect best practices, support and inspire EU MSs on how to put in place practical measures/interventions supporting the cross-cutting modernization objective of the new CAP.

The study was conducted by a core group of partners (see authors) in the Netherlands (Wageningen University and Research), Belgium (AgriLink) and Hungary (the Ministry of Agriculture and NAK) and supported by an expert group, consisting of partners from Ireland (Mark Gibson, Teagasc), Italy (Simona Cristiano, CREA), Spain (Andres Montero Aparicio, University Carlos III de Madrid), Estonia (Hanna Tamsalu, Agricultural Research Centre),

¹ https://ec.europa.eu/agriculture/sites/agriculture/files/events/2016/rural-development/cork-declaration-2-0_en.pdf

² https://ec.europa.eu/eip/agriculture/sites/agri-eip/files/eip-agri_brochure_digital_revolution_2017_en_web.pdf;
https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/DTM_Agriculture%204.0%20IoT%20v1.pdf

³ https://eige.europa.eu/resources/digital_agenda_en.pdf

⁴ https://ec.europa.eu/agriculture/sites/agriculture/files/future-of-cap/future_of_food_and_farming_communication_en.pdf

Austria (Martin Hirt and Florian Herzog, LKO), Romania (Mark Redman) and Bulgaria (Yanka Kazakova-Mateva, University of National and World Economy).

2. POLICY FRAME

Digitalisation of knowledge and best practices in agriculture and forestry can play a major role in contributing to wide dissemination and the uptake of research and development results by the end-user, farmer, forester, advisors and other key actors and hence increase impact. As such, digitized knowledge which can be easily found in open access and a user friendly system is receiving increased impact in stimulating innovation in several agricultural and forestry sectors. Interoperability with other systems is a prerequisite to be able to connect with other existing databases at European and/or national level.⁵

The Cork 2.0 Declaration⁶ states that the use of digital technologies will be increasingly vital for farmers and other rural businesses to enable them to deliver sustainable solutions to current and future challenges. According to Point 7 for Boosting Knowledge and Innovation: 'rural communities must participate in the knowledge economy in order to fully utilise the advances in research and development. Rural businesses, including farmers and foresters, of all types and sizes must have access to appropriate technology, state-of-the-art connectivity, as well as new management tools to deliver economic, social and environmental benefits. Stronger policy focus on social innovation, learning, education, advice and vocational training (in AKIS) is essential for developing needed skills. This should be accompanied by the strengthening of peer-to-peer exchange, networking and cooperation amongst farmers and rural entrepreneurs. The needs and contributions of rural areas should be clearly reflected on the research agenda in the European Union. Industry, researchers, practitioners, knowledge providers, civil society and public authorities must work closer together to better exploit and share opportunities arising from scientific and technological progress.'

In the Communication 'Building a European Data Economy'⁷ the EC explores how data can potentially bring many opportunities for European industry, including the agri-food sector⁸. 'Improving information flows up and downstream in agri-food chains could result in a wide range of benefits for those involved, including farmers and stakeholders in distribution and retail. Also consumers, researchers, governments and NGOs see benefits from improvements in transparency.' For example, the SMART AKIS project developed a platform to improve knowledge flows to enhance the uptake of smart farming technologies. The Smart Farming Platform of the thematic network Smart AKIS allows farmers to identify and assess smart farming technologies through a quick assessment tool. The tool assists farmers in choosing the technologies that are best suited for their small and medium-sized farms (www.smart-akis.com).

The CAP legislation proposal⁹ addresses the regulation of the European Parliament and of the Council, establishing rules on support for strategic plans to be drawn up by the Member States under the CAP, financed by the EAGF and the EAFRD and repealing regulation. 'The proposal reinforces the links to research policy by putting the organisation of knowledge exchange prominently in the policy delivery model. Similarly, the emphasis placed on digitalisation allows linking up to the EU Digital Agenda' (p.3). 'A smarter, modernised and more sustainable CAP needs to embrace research and innovation, in order to serve the multi-functionality of Union agriculture, forestry and food systems, investing in technological development and digitalisation, as well as improving the access to impartial, sound, relevant and new knowledge' (p.18, text section 12). The following articles described in the CAP legislation proposal form the main guiding policy principles for this study:

- *Article 72: Knowledge exchange and information:*
(6) 'Member States shall ensure that actions supported under this type of interventions be based on and be consistent with the description of the AKIS provided in the CAP Strategic Plan in accordance with point (i) of Article 102(a)' (p.83).
- *Article 102: Modernisation (of the agricultural sector and the CAP):*

5 http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-data-mgt_en.pdf

6 https://ec.europa.eu/agriculture/sites/agriculture/files/events/2016/rural-development/cork-declaration-2-0_en.pdf

7 https://ec.europa.eu/eip/agriculture/sites/agri-eip/files/eip-agri_brochure_digital_revolution_2017_en_web.pdf

8 https://ec.europa.eu/eip/agriculture/sites/agri-eip/files/eip-agri_brochure_digital_revolution_2017_en_web.pdf

9 [http://www.europarl.europa.eu/RegistreWeb/search/simple.htm?reference=COM_COM\(2018\)0392](http://www.europarl.europa.eu/RegistreWeb/search/simple.htm?reference=COM_COM(2018)0392)

'To provide 'an overview of how the CAP Strategic Plan will contribute to the cross-cutting general objective related to fostering and sharing of knowledge, innovation and digitalisation and encouraging their uptake' (p.101).

3. ANALYTICAL FRAMEWORK

The study's key challenge is how various digital infrastructures (platforms and tools) can be used by and for the various AKIS actors for enhancing knowledge flows within the AKIS. The main objectives are to:

- give an overview of existing good practices of tools and approaches supporting digital knowledge flows in the different EU Member States (EU 27+ UK), which enable farmers and authorities to learn and exchange knowledge and to better integrate outcomes of agricultural research and best practices in AKIS;
- identify success factors and main barriers for unlocking the generation, adoption and utilisation of open and free access digital platforms and tools for knowledge exchange by practitioners;
- describe good examples based on experiences of MSs, including both the description of the digital infrastructure and the way it came about;
- develop recommendations for digitalisation strategies and potential indicators for digital platforms and tools in line with the Strategic Modernisation plans for the future CAP and guidance for capitalising knowledge, including specific recommendations on how to include digital aspects in AKIS for the 5th mandate of SWG SCAR AKIS.

We consider digital infrastructures as repositories for storing and exchanging practical knowledge respecting the principles of open source data, ideally also using open IT systems and open management of these systems so that constant improvement by a variety of AKIS actors is possible (such as in Wikipedia) and monopolies can be avoided. Digital infrastructures are for example:

- digital interactive platforms, wherever possible managed by non-profit organisations or administrations which provide open source knowledge, easy understandable and freely available to all and with the possibility for Q&A and/or exchanging knowledge and experience;
- digital exchange tools which are publicly accessible and free of charge such as applications, simulations or other digitalised techniques to enhance knowledge exchange and innovation.

AKIS actors are actors using and producing knowledge for agriculture and interrelated fields (value chains, rural actors, consumers, etc.). The main AKIS actors (related to this study) will be researchers, advisors, extension workers, farmers, other businesses, teachers, policy makers, administrations, etc. AKIS is a useful concept to describe a system of innovation, with emphasis on the organisations involved, the links and interactions between them, the institutional infrastructure with its incentives and budget mechanisms (SCAR AKIS, 2012, 2106). AKIS is the combined organisation and knowledge flows between persons, organisations and institutions who use and produce knowledge for agriculture and interrelated fields¹⁰. Although different components of AKIS, extension/advise, education and research, are often stressed, it is important to realise that there are many more actors in the food chain which directly influence the decision making of farmers and their innovations (see Figure 1).

¹⁰ <https://www.eesc.europa.eu/en/our-work/opinions-information-reports/opinions/cap-legislative-proposals>

Figure 1: Relations and interaction between AKIS actors. Source: PowerPoint slides European Commission DG AGRI (2018, 2019).¹¹



The study approach consisted of a survey which was sent out to nearly all EU member states, an expert meeting to discuss the preliminary results (June 13th 2019) and supportive desk research. The questionnaire was developed in close collaboration with the SCAR AKIS management team as delegated commissioner of the study. In total 26 surveys were returned by 24 Member States (AT, BE, BG, CZ, DE, DK, EE, ES, FI, GB, GR, HR, HU, IE, IT, LT, LUX, LV, NL, PT, RO, SE, SK, SL) and additionally 2 Italian regions (Emilia-Romagna and Tuscany), which were used for our study analysis. The plan of the study and draft questionnaire were presented during the SWG SCAR AKIS meeting in Dublin, Ireland (April 2019) and the preliminary results were presented during the SWG SCAR AKIS meeting in Acireale, Italy (June 2019).

The survey contained three sections with open and closed questions. Section 1 contained questions on national/regional strategies (existing or planned) on digital infrastructures to enhance knowledge flows between AKIS actors, included the following questions:

- How do digital infrastructures in your AKIS system affect the uptake of R&I results and best practices in your country/region?
- Which existing digital dissemination channels for knowledge exchange are mostly used by practitioners (end-users) in your region/country?
- Does your country/region have digital tools used for CAP compliance in particular?
- E.g. is there a digital tool for nutrient management?
- What are the main bottlenecks hindering the utilisation of digital platforms and tools at farm level?
- What are success factors?
- Which measures/interventions could help to enhance digital knowledge flows?
- Does your country/region have a digitalisation strategy or is a strategy being developed?
- Actors involved, main end-users, stimuli, monitoring system and indicators, coherence with strategic AKIS plans.

Section 2 contained questions on existing digital infrastructures and section 3 contained questions on planned digital infrastructures, enhancing knowledge flows in the member states, included the following questions:

¹¹ https://ec.europa.eu/eip/agriculture/sites/agri-eip/files/field_event_attachments/eip-agri_sem-spoletto-2018_inge_van_oost_eip_and_akis_post-2020-cap.pdf

- Which good practices/examples of digital infrastructures exist / are planned in your country/region which enable the uptake of knowledge by practitioners and enhance interconnections between different AKIS actors?
 - o Which actor(s)/organisation(s) are involved and interconnected
 - o Do the practitioners utilise the knowledge as expected?
 - o How is that monitored?
 - o Is the infrastructure funded by or connected to one or several projects or other initiatives on regional, national, EU or global level?
 - o Who will sustain and maintain (update) it on the longer term when the project does not support it anymore (e.g. beyond 10 years)?
- Are the digital infrastructures merely repositories without digital interactive possibilities or are there infrastructures with (some form of) interactivity?
- How is this form of interactivity managed (person or organisation tasked for this)?
- In particular regarding nutrient management (in general), which digital tools are publicly available and are they successful?

It is important to note that the results of this study are mainly based on the results required from the questionnaires and therefore depend on the answers from the respondents (working at/as Ministries, regional authorities, NRNs, chambers of agriculture, advisors/consultants and researchers). Often multiple actors from MSs/regions filled in the respective questionnaire jointly. **The results do not represent formal statements from EU Member States or regions.**

4. DIGITALISATION ENHANCING KNOWLEDGE FLOWS IN AKIS

In this chapter the survey results are described regarding digital dissemination channels, materials, their influence to enhance knowledge flows between AKIS actors, success factors and bottle necks, concerning the utilisation of digital platforms and tools related to knowledge flows in AKIS (Section 1).

4.1 Digital dissemination channels and their influence

To understand digitalisation in agriculture enhancing knowledge flows, it is first of all important to have insight in the types of dissemination channels which are used most often by agricultural practitioners (end-users). Table 1 indicates the media channels which were mentioned by the respondents of the different MSs and regions. Annex 1 contains a list of all mentioned channels and references.

Table 1: Media channels used most often by agricultural practitioners

Media	Mentioned by no. of MSs/regions
(Organisational) websites and databases	25
Digital Platforms/forums	14
Social Media	14
Applications (PC and mobile)	12
Digital newspapers/journals	10

Table 1: Media mentioned most often for exchanging agricultural knowledge and information.

Next, the respondents indicated how digital infrastructures in the AKIS system affect the uptake of R&I and learnings from best practices in their country or region.

1. AT: in Austria certain R&I results are very well covered by the existing digital infrastructures. For example, specialised articles on current research results are regularly published, as well as training events on such results. Company reports and reports on different experiences are also shared regularly via digital channels.
2. BE: in Belgium websites are used by end-users to look for best practices, to look for online advice and online services. Knowledge is accessible to a broader audience so more and dispersed uptake of R&I uptake is expected. An example of a mobile app frequently used, is the EVA-app, a tool for simplifying administration. You tube (social media) is a dissemination channel which is used among others by the government, to provide information on regulatory issues and by ILVO and the research stations for demonstrations and exchanges of latest knowledge. Another example is WatchITgrow, an online platform to support growers to monitor arable crops and vegetables in view of increasing yields, both qualitatively and quantitatively.
3. BG: in Bulgaria the main use of digital agricultural infrastructures is on exchanging information about CAP schemes and measures for related requirements, controls and solutions. The information about R&I relates mostly to events and announcements. The use of digital infrastructures to exchange R&I information is usually general and limited.
4. CZ: in the Czech Republic digital infrastructures affect the uptake of R&I results and best practices by: 1) sharing information from different professional websites, 2) exchanging knowledge between farmers, 3) obtaining information from research institutes and 4) by using weather and drought applications by farmers. The first three affect the uptake on long term decisions, the latter includes tools which help farmers to decide about their daily agriculture work (on the short term).
5. DE: in Germany¹² digital infrastructures lead to a faster transfer and uptake of knowledge, especially related to short-term decision making by farmers (for example,

¹² The responses from Germany were gathered from *Bundesländer* Baden-Württemberg, Nordrhein-Westfalen and a nation-wide view on the digitalisation strategy.

- the Plant Protection Warning Service). The number of users of the Chamber of Agriculture website is high. However, the actual uptake of R&I results cannot be verified with certainty.
6. DK: in Denmark the digital infrastructure is very important in ensuring a fast and efficient implementation of R&I results and best practices. It forms an important part of the Danish AKIS. The Danish AKIS and advisory system are responsive towards the needs of the farmers and the demands and wishes from the political system and the public.
 7. EE: in Estonia newsletters and social media postings provide mostly information with news-value. Some news contains information about R&I results and best practices. The National Rural Network (NRN) has a task to disseminate examples about best practices, including R&I project outcomes. An ongoing study on knowledge transfer (April 2019¹³) preliminary indicates that 36% of Estonian farmers and 60% of food processors have gained new ideas or direction of actions from trainings, materials or advisory services. Furthermore, 48% of farmers have difficulties to adapt to new technologies; 12% has experience on cooperation with R&I institutions, while 32% acknowledges the need for cooperation with R&I institutions¹⁴.
 8. ES: in Spain access to technical information is more and more digitalised. E.g., the initiative APORTA was introduced in 2009 to promote open access of public information and the development of advanced services based on data from public (national and regional) administrations and research. However, farmers are not the main users of digital information sources (yet) and face-to-face communication between peers or other (technical) professionals is still more intense.
 9. FI: best practices are disseminated among the Finnish rural network through websites. Farmers use the digital services provided by ProAgria and LUKE.
 10. GB: digital infrastructures enable farmers and growers in the United Kingdom to access the latest agricultural research free of charge and this then allows them to begin the process of adapting and implementing changes to their businesses, in accordance with the latest knowledge in agricultural R&I.
 11. GR : in Greece the existence of digital tools for agriculture was not well known to farmers until 3 years ago but this has taken a leap forward. However, it is still too early to assess the effective uptake of R&I results and best practices, as induced by the digital infrastructures.
 12. HR: digital infrastructures influence the uptake of R&I results also in Croatia. For example, there are several successful examples of farmers innovating their facilities and production technologies by learning from YouTube.
 13. HU: in Hungary, information from R&I results and best practices usually reaches farmers through marketing by input providers and (other) private companies. Digital channels are mostly used for annunciations and information on events but not to communicate about results.
 14. IE: R&I uptake is affected positively through digital infrastructures because of better information sharing and more direct and more regular flows of information to users and intermediaries. Through digital infrastructures more two way flows of information and data are stimulated.
 15. IT (national level): capturing, systematizing and dissemination of R&I results and best practices at national level are considered essential in regionalised Italy. Digital portals provide a common source of information for all relevant actors who implement CAP measures at different levels. This includes the provision of systematized information on the laws and incentives applicable for investments in R&I results and up-take.
 - IT – Emilia Romagna: an example of a successful tool which affects the uptake of R&I results is IRRINET – IRRIFRAME (from regional to national level). The tool has been used to support decisions and strategies at farm level on water management. The data are used by researchers, experts and policy makers for scenario building,

¹³ <https://www.maainfo.ee/index.php?page=3840>

¹⁴ <https://www.maainfo.ee/index.php?page=3839>

- policy analysis and evaluation. The irrigation model has been developed by CER and has been validated locally for over 30 years.
- IT – Tuscany: digital infrastructures lead to the reduction of farmers’ and other target groups’ costs and time for searching and selecting information. The digital platforms provide a wider collection and timely updating of data and information on R&I results, which are easier selected and put to practice. Digital infrastructures provide a wider evidence of best practices and increase the skills of farmers, advisors and innovation brokers.
16. LT: newsletters, social media postings and project websites provide mostly information with news-value, also about R&I results and best practices. An important public actor in the dissemination of relevant information, is the Lithuanian Agricultural Advisory Service (LAAS).
 17. LUX: the available websites and digital newsletters form the main digital dissemination channels currently used by public bodies, advisors and the national public research centre to reach farmers (including winegrowers) directly. The channels ensure good connections within the whole sector.
 18. LV: newsletters, social media postings and project websites provide information to AKIS actors about R&I results and best practices. An important public actor in the dissemination of relevant information, is the Latvian Rural Advisory and Training Centre (LLKC).
 19. NL: all mentioned channels in Table 1 are available and used to enhance uptake of R&I results and learnings from best practices. They are very influential and are considered as important supportive means to enhance knowledge flows in the Dutch AKIS. The advantage is that farmers have better access to the latest knowledge and new technologies. However, there is the risk of information and digital infrastructure overload.
 20. PT: the most important digital infrastructures in Portugal are specialized online media (Agroportal, Agricultura e Mar, Agronegocios). They provide information on innovation projects and project results on a regular basis. They reach a vast audience of different actors.
 21. RO: relatively little information is exchanged relating to the dissemination of the results of research and innovation (R&I), but this is perceived as a growing opportunity and several new platforms have recently emerged on the market with a particular focus upon precision farming targeted at the larger-scale farmers who have the capacity to implement. Existing digital infrastructures are dominated by the websites of the two Paying Agencies which are the primary tools used to disseminate / exchange information about CAP schemes and measures, including related requirements, application procedures, controls, sanctions etc. However, beneficiaries of CAP support lack access to the internet and/or do not have the necessary skills to download and interpret the relevant information available to them.
 22. SE: to some extent advisers and researchers participate in the main Swedish communication channels for agricultural information exchange, which affects and facilitates the uptake of R&I results by end-users in a positive way.
 23. SK: the website www.agroporadenstvo.sk in Slovakia disseminates the latest R&I results. The tool EkonMOD Milk was mentioned as an example to transform latest knowledge for practical usage via a user friendly interface.
 24. SL: digital infrastructures are considered to function positively in connecting researchers with end-users and stimulating peer-to-peer knowledge exchange among farmers at both national and international level. They increase the search for solutions.

4.2 Bottlenecks and success factors

The main bottlenecks hindering and the main success factors supporting the utilisation of digital platforms and tools at farm level related to knowledge flows in AKIS, are described in Table 2

below. Similar to a comparable analysis in Spain¹⁵, these can be grouped in 4 categories, related to:

- technical aspects: such as lack of connectivity, interoperability, lack of data quality, maturity of services and products and homogeneity of data;
- legal aspects: such as conflicts about data ownership, dispersed regulation (at EU, national and regional level), re-utilization of data and regulation about the use and utilisation of the results of (new) technologies;
- economic/financial aspects: such as insecurity about returns on investments, viability of investments (in particular by SMEs) and a dispersed structure of the sector;
- human capital and social aspects: such as lack of skills/competences, lack of a culture in digitally exchanging information, lack of trainings and integration in education, lack of good examples to replicate.

Table 2: Bottlenecks and success factors regarding the utilisation of digital platforms and tools

Bottlenecks	Success factors
<i>Technical aspects</i>	
Sustainability of tools which need regularly updating	Centralised overall information channels/systems such as 'knowledge counters' (e.g. in BE, DK) which combine and connect different types of information, knowledge services and AKIS actors
Interoperability: end-users cannot simply combine technologies of their choice or several digital solutions are not connected so the basic farm data have to be entered repeatedly	There are good examples of interoperable systems for multiple usage in one effort
Using the application and getting an output usually requires data to be entered first. Entering input is often cumbersome and a bottleneck for farmers	The 'once only'-principle in which the government requests the data as little as possible from the farmer and extracts it as much as possible from already available data sources. This does not only reduce administrative burdens on the farmer, but also increases the quality of the data.
Insufficient broadband connections in certain regions	Increased broadband connections
Insufficient search engines to find the right information	Availability of e.g. registers through mobile devices and information which are available on both the web and through mobile apps
A significant proportion of the agricultural community does not have smart phones/PC's	Personalised information and topic related information deliverance makes it easy and quick for the user to access relevant information
	Development of user-friendly solutions and directly applicable information which benefits the farmer
<i>Legal aspects</i>	
Regulations are so complicated that a representation via digital infrastructures reaches its limits	Data transmission into documentation systems which are necessary for the control of the technical legislation and security during checks, e.g. controls (example GQS Hofcheck in Germany)
Legal issues regarding interoperability of infrastructures and tools	Development of international norms and standard for data formatting enabling utilisation across platforms/tools
<i>Economic/financial aspects</i>	
Availability of added value applications, including	Digital platforms and tools which motivate farmers

¹⁵ http://www.redruralnacional.es/documents/10182/417111/Maquetacion_Interior-VERSION_LARGA-web.pdf/e7662acd-2811-42f1-8fff-c409b76f90d2

the cost-benefit ratio of digital infrastructures, in particular for SMEs	to develop their business further e.g. by indicating cost reductions etc.
Specific private tools are considered expensive to use	Many digital platforms and tools are publicly available or easy to join for the farmer's community and free of charge
Relationship between public and private digital platforms can be contentious	Good examples in ppp between private software providers and public organisations
Reluctance and lack of recognition of the value of sharing data and information among farmers and other actors	Implementation of feedback systems (examples) to collect and share information on the economic profitability of new technologies
	Reduction of administrative burdens
	The availability of simple tools which require low user effort and in which immediate value is apparent
	Tools for CAP compliance support and motivate farmers to look for solutions and avoid CAP payment penalties
<i>Human capital and social aspects</i>	
Lack of willingness and incapacity of farmers to use and adopt digital infrastructures (a.o. because of age)	Young farmers realising the benefits
Use of trusted and traditional channels (hindering the utilisation of modern media)	Possibility to quickly and easily compare and choose best options
Fear of using IT e.g. in terms of privacy, changes in business models and lack of courage or readiness to use new/unfamiliar platforms	Increased usage of internet and smart phones
Lack of digital skills and competences to search for and 'translate' existing R&I information for the farmer's needs, among farmers and advisors/consultants	Digital infrastructures and tools increase the educational level of farmers
A lack of understandable, clear R&I information being shared to farmers (e.g. language, form, visualization, lack of practical recommendations)	Integration of / linkages between digital platforms and social media channels
Lack of trust in the source from which the information is derived and lack of trust in participating in interactive digital platforms	Confidence by the end-users in the quality of R&I results
A lack of tools/platforms which allow a quick translation of information into the farmer's needs	Ability to use output in peer group discussions
Lack of promotion of digital infrastructures and tools and lack of awareness of the existence of tools	Commonly recognized and impartial platforms for interaction between AKIS actors
Information overload, including the supply of too much general agricultural knowledge instead of specific sector knowledge	Platforms/tools which share results peer-to-peer providing inspiration and possibilities
Administration and 'paper' management in farming are still considered unpopular in general	Co-creation and interactive processes which support shared ownership of infrastructures
Digital platforms do not fully cover all farmers' needs	Tailored solutions for a variety of target groups
End-users lack (professional) support in using digital possibilities by advisors/extension workers	Qualified and impartial advisors and innovation brokers who act as navigators and support farmers' in using digital infrastructures
Information and infrastructure overload	Easy and quick access to knowledge and advisors as intermediaries and knowledge brokers

	(practicality)
Digital tools are easier used by highly educated farmers who speak English, indicating a gap	The technological developments in the farming sector have increased through digital infrastructures

5. CASES OF DIGITALISATION STRATEGIES IN THE EU

In this chapter different developments in national or regional strategies to enhance digitalisation and digital knowledge flows in agriculture, are described as 20 cases (including the answers from two regions) and additional (short) information from 3 countries. One country did not provide information in the survey on the development of a digitalisation strategy. From the descriptions, we learned that some countries/regions have already implemented a strategy for agriculture in particular or can be considered advanced in the progress of developing a digitalisation strategy. Other countries/regions are less advanced in developing their strategy which is yet to follow. The aim of these case descriptions is to provide a state of the art and inspire EU Member States and regions to (further) develop their digitalisation strategies in agriculture. Not all respondents provided sufficient information for a full case description and in many MSs the digitalisation strategy is still under development.

5.1 AT: Austria

Austria does not yet have a dedicated digitalisation strategy in place. However, the 'Platform on Digitalisation in Agriculture' and its report provide good preparatory work to develop a national digitalisation strategy. The main objective of the platform is to present the topic of digitalisation according to subject areas. Its activities consist of regular exchanges by the most important national associations, institutions, authorities, educational and consulting organisations and cooperatives (beside the industry) in order to inform each other about current activities and to jointly develop the state of knowledge.

The Platform (which has an informal character) has met regularly since the beginning of 2017 and meets twice a year. The Platform's report addresses the needs of farmers and tries to identify new needs and demands.¹⁶ The main AKIS actors who should benefit from an increased flow of knowledge through the digitalisation strategy are:

- the chambers of agriculture (including advisory services), as leading advisory organisations and actors who cooperate with agricultural and forestry enterprises on a daily basis;
- rural training institutes, as leading training organisations in rural areas who cooperate on a daily basis with agricultural and forestry enterprises in the field of knowledge transfer;
- research institutions (public as well as private research partners) who should obtain better access to digital platforms and better connect with other AKIS actors through digitalisation, above all with agricultural practitioners; another benefit is the fact that digital technologies provide better data which can be used for research purposes;
- administration and authorities, through improved communication between AKIS actors and simplified administration, e.g. 1) simplified accounting of subsidies by advisory and educational organisations and the administration and 2) simplified reporting of data subject to mandatory reporting from the agricultural holding to the administration.

The most important end-users are farmers or agricultural holdings. The main financial beneficiaries are also the agricultural holdings and/or operations, as they are the main target groups. Eventually the strategy should be beneficiary for other actors as well. Digital knowledge flows will be stimulated in the AKIS through improved knowledge management and better methodologies e.g. in online meetings. It is not yet clear if the digitalisation strategy will be fully implemented under the AKIS strategic plans for the future CAP.

¹⁶ <https://www.bmnt.gv.at/service/publikationen/land/digitalisierung-in-der-landwirtschaft.html>).

5.2 BE: Belgium

Flanders

Flanders does not have a digitalisation strategy yet but 2018 was the 'year of data' in which an action plan was drawn¹⁷. Furthermore, a regional S3 Smart Specialisation Strategy is in place: the IBN Network 'Smart Digital Farming' (2017-2020) which belongs to the main registered innovation hubs in RIS3. The main aim of the Flanders' Smart Digital Farming network is to:

- enhance knowledge and expertise in applied agri-smart businesses;
- stimulate capacity building in precision farming;
- build and validate concrete and innovative business cases for SMEs;
- implement new business models within an AgriFood 4.0 environment;
- stimulate market- and product differentiation in this domain;
- streamline public/private funding opportunities for new ideas;
- deploy local and international exposure of the SDF initiative.

The plan is to integrate new technologies into the current counter 'E-loket' (see chapter 6 for more information). This does not only aim at following up on the CAP-measures at farm level and controlling aspects but also aims at advising and data generating facets. Where the E-loket is currently focusing on up-to-date data provision, data collection and active support from the Flemish farmers when filling out the requests, the E-loket will increasingly play a more pronounced role in more proactive support for the farmer. Based on progressive data management where data collection but also data generation are the central aspects, the E-loket fed by the various applications will become a source of accessible information for the farmers. Activities are to: 1) to organise thematic workshops, events, demo's, 2) to participate in the High Tech Farming Smart Specialisation Platform RIS3 and European projects, related to digitalisation strategies and 3) to operationalise projects within the digitalisation strategy of 'Smart Farming'.

The knowledge needs of end-users have not yet been investigated in Flanders except for precision farming through a survey about the use of precision farming at farms¹⁸. The main actors in Flanders who would need to profit from increased knowledge flows by the digitalisation strategy are:

- farmers (easy access to digital tools and knowledge, attractive to a younger generation);
- advisors (easy access to a broad range of knowledge and information);
- SMEs and start-ups;
- research community (knowledge base, cross fertilisation);
- policy makers and funding agencies, to be able to know the gaps, strengths and needs.

The main end-users of the digitalisation strategy would be:

- farmers for the uptake of new technologies;
- advisors for dissemination of knowledge and to act as intermediary;
- researchers for state of the art knowledge supply;
- policy-makers, to enhance policy choices and legislation implementable in practice, etc.

The main financial beneficiaries would be:

- farmers, for economic benefits through the uptake of new knowledge and innovation;
- SMEs and start-ups in new digital technologies and digital tools;
- society at large for sustainable innovative solutions and to contribute to a better environment and healthy food.

How the regional digitalisation strategy will be taken up within the strategic AKIS plans for the future CAP, is still under discussion. A digitalisation strategy will be a major tool for knowledge exchange and the sharing of innovation in Flanders. It will become a tool to advice and support the farmer (e.g. the integration of the Soil Passport, see chapter 6 for more info).

¹⁷ <https://lv.vlaanderen.be/nl/voorlichting-info/publicaties-cijfers/landbouwcijfers/data-de-landbouw>

¹⁸ https://lv.vlaanderen.be/sites/default/files/attachments/summary_adoption_of_precision_farming_by_flemish_farmers.pdf

Wallonia

Wallonia has a digitalisation strategy (Digital Wallonia, 2019-2024¹⁹) in place, including the Digital Wallonia's Smart Farming Project. Its aims are to:

- drive economic growth through pioneering research and a strong digital sector;
- support innovation and technology development;
- develop a digital economy for the industry;
- enhance digital skills for all;
- provide a new generation of open and agile public services;
- introduce high-speed broadband and new technologies for new services to citizens and businesses.

The Digital Wallonia's Smart Farming project acts as a support or coordination platform to develop projects and partnerships focused on the digital transformation of the agricultural sector, including in particular awareness-raising and support initiatives. A number of operational partnerships are in place with public and private stakeholders: the Digital Boostcamp Agriculture²⁰, Ecosystem of service and product²¹ offering two data driven projects for building a platform for culture and breeding, the Agricultural digital maturity barometer²², demonstration days on precision agriculture and a network of Digital Wallonia Champions in agriculture²³.

5.3 BG: Bulgaria

Bulgaria has a digitalisation strategy: 'Strategy for the digitalisation of agriculture and rural areas in Bulgaria'. It was drafted by the 'Institute of Agro-strategies and Innovation', a private organisation. The draft has been published on the website of the Ministry of Agriculture for public consultation in February 2019. It was officially adopted by a Council of Ministers and decided on 2 May 2019. The strategy has four main sections:

- analysis of the current situation, including a SWOT analysis;
- a strategic section, including the vision, strategic objectives, specific objectives, specific results of digitalisation and expected impacts from digitalisation;
- an action plan;
- recommendations for the 2021-2027 CAP Strategic plans.

The timeframe of the strategy is not explicitly defined in the strategic section or action plan. However, the descriptions of the activities include a timeline. Some activities will be undertaken in 2020, while others will be undertaken in the period 2021-2027. For the digitalisation strategy, the following strengths and weaknesses were analysed.

Identified strengths include:

- the existing infrastructure for broad-band internet at national level;
- available support from the EAFRD for the promotion of investments in digitalisation;
- the availability of qualified IT-programmers;
- the availability of qualified lecturers;
- the availability of a well-developed scientific base in the agricultural sector with potential for experiments;
- existing national registers and information systems.

Identified weaknesses include:

- partial coverage of rural areas with fixed broadband infrastructure and low utilisation of ICT from people and businesses;
- the digitalisation investments which are private and depend on the farm's capability;
- most of the software companies which develop digital solutions do not work in the agricultural sector;
- insufficient information about digitalisation among farmers;

¹⁹ <https://www.digitalwallonia.be/en/digital-strategy>

²⁰ <http://www.digitalboostcamp.be/agriculture>

²¹ <https://www.digitalwallonia.be/fr/tags/ecosysteme-smart-farming>,

²² <https://www.digitalwallonia.be/fr/publications/entreprises2018-secteur-agricole>

²³ <https://vimeo.com/210593742>

- a lack of farmers' digital skills;
- a lack of forms for innovation and knowledge transfer for farmers;
- many and unconnected state registers and systems.

The strategic objectives of digitalisation include:

- increasing the productivity and sustainability of agricultural production;
- improving human health by the production of quality food;
- protecting the environment and adaptation to climate change challenges;
- increasing/widening the presence of Bulgarian products on the European and world markets;
- encouraging the interest of and attracting young people to the agriculture sector.

Specific aims in the agricultural sector related to the digitalisation strategy are: 1) to increase farmers' income, 2) to reduce production costs, 3) to improve the traceability and quality of production in order to meet the demand and markets/consumers requirements and 4) new opportunities for financing.

Activities and timing of the digitalisation strategy are:

- A1: the set-up and development of an appropriate digital infrastructure for communication and connectivity, focused on broadband internet and meteorological stations on agricultural land, up to 2020.
- A2: investments for modernisation and technologies for precision farming (2021-2027).
- A3: the development of digital networks and utilisation of software applications in the operations' management and decision-making (decision support systems), 2021-2027.
- A4: the training and consultation for the development of digital skills and qualification (2021-2027).
- A5: the R&D and innovation partnership for the exchange and transfer of innovations, development of and access to infrastructure for experimenting (2021-2027);
- A6: the development of digitalisation of the public administration and administrative services (up to 2020);
- A7: the introduction of Block-chain technologies in the agriculture sector (up to 2023);
- A8: the development of Smart villages (2021-2027);
- A9: the processing, sharing and protection of data (up to 2022).

The knowledge needs of end-users will not specifically be inventoried and made explicit. The description of the current situation seems to be rather detailed in the field of precision farming, in particular with regards to the farming needs in the cereal sector. However, this is not made explicit in the strategy.

The main AKIS actors who would need to profit from increased knowledge flows by the digitalisation strategy are:

- farmers: with focus on precision farming, training and consultation (activity 4). However, it is not clear how targeted these trainings will be;
- meteorological station managers: the strategy envisions the installation of 200 up to 260 stations across the country.

The main end-users of the digitalisation strategy are expected to be farmers (due to the investment opportunities and potentially the digital exchange of new knowledge, although this is not very clear) and private agri-hubs. These two groups should also be the main financial beneficiaries of the digitalisation strategy. It should be noted that the public agricultural research institutes, universities and extension services are not mentioned in the digital action plan.

- Monitoring and evaluation

The strategy contains a monitoring description indicating that monitoring is the responsibility of the Ministry of Agriculture and will be based on 'detailed annual/multiannual plans with specific actions, financial plans, timelines and indicators'. The indicators are listed per activity:

- A1: the share of arable land with internet coverage;
- A2 (main indicator): number of agriculture holdings with investments in digitalisation;
- A2 (additional indicators): limitation of GHG (%), increased productivity in holdings with digitalisation investments (%), reduced CO₂ emissions (%), share of soils with improved

quality due to implementation of digital technologies, share of water saved on the farm, increase of Bulgarian agriculture products and food on the market due to the introduction of digital technologies (%);

- A3: number of farmers using the developed software applications;
- A4: number of organised trainings, number of trained farmers, number of information campaigns;
- A5: number of operational groups set-up.²⁴

The other activities have no indicators (yet). It is not yet clear how or if the digitalisation strategy will enhance or incentivise digital knowledge flows in AKIS. The focus is rather on setting up the infrastructure and less information is available on what type of data, for which actors, and in which way flows of knowledge will be stimulated. The Strategy does not refer to key AKIS actors such as the public research institutes and universities, the national agricultural advisory system, private advisory systems, teachers, etc. It is assumed that the Strategic AKIS plan to comply with the future CAP, may consider other or additional activities regarding digitalisation of the agricultural sector.

5.4 CZ: Czech Republic

The digitalisation strategy in Czech Republic is called 'Digital Czech Republic' which is divided into three documents and strategies. Formally, these three are referred to as the 'Strategy for the Coordinated and Comprehensive Digitalisation of the Czech Republic 2018+'. The government will be negotiating with the EU, approving, releasing resources and financing this strategic plan. Several ministries and authorities will also play an important role as they 'must release adequate human and financial resources'.

The main AKIS actors that need to profit from increased knowledge flows by the digitalisation strategy are:

- farmers, through to less administration burden and through precision agriculture which should make farm management more effective and profitable;
- consumers, because of improved food security;
- citizens, through a better environment;
- research centres, through improved data availability.

The main end-users are the people living in rural areas and mainly farm managers for more effective entrepreneurship. Solutions such as precision agriculture, ICT and satellites and DSS for pest protection ought to increase resource efficiency (soil, water, energy, fertilisers and pesticides) and reduce environmental problems such as greenhouse gas emissions. The main financial beneficiaries of the digitalisation strategy are:

- private IT companies;
- private training companies providing advice to end-users of the technology;
- research centres and universities, in relation to funding for demos and implementation;
- farmers, because of the reduction of entry costs and increase of farm profitability.

Digital knowledge flows in AKIS will be stimulated or incentivised through the RDPs which provide support for cooperation and the setting-up of OGs (by e.g. farmers, consultants, businesses, researchers and administrations) to carry out projects, test and implement innovative processes, products and technologies. A dedicated innovation network will be created to promote the dissemination of innovate experiences and best practices and to improve communication between agricultural practices and science.

Monitoring and evaluation of the strategy will be performed by the accessibility of IT technologies, the location of end users, the level of input costs of acquiring technology, the frequency of usage and data accuracy. The main aim of connecting the digitalisation strategy within the CAP Strategic Plan is to ensure a fair income for farmers, increase competitiveness, balance power in the food supply chain, fight climate change, to provide for better environmental care, preserve landscapes and biodiversity, support generational renewal in rural areas and to protect the quality of food and health in the food chain. Further details are not yet available.

²⁴ There are no operational groups set-up in Bulgaria (dated: end of May 2019). The measure is not opened yet.

5.5 DE: Germany

A new digitalisation strategy is currently being developed for Germany. The Federal Ministry of Food and Agriculture (BMEL) has set itself the task of helping to shape the framework conditions for digitalisation in agriculture and rural areas. The aim is to exploit the opportunities of digitalisation, especially for SMEs, as well as for the environment, animal welfare and resource efficiency and to minimise risks (e.g. in the areas of data sovereignty, data security, know-how development and structural changes). The strategy does not only focus on facilitating and promoting the exchange of knowledge between regional or national actors but also focuses on the promotion of networking in the European area, possibly also with third countries.

The BMEL 'Future Programme Digital Policy for Agriculture' contains the fields of action for political implementation. For example, experimental fields are to be set up on farms to test various digital techniques and interfaces. A competence centre for the digitalisation of agriculture is also being set up. With a view to future technologies such as 5G and international competition, the future programme is to be implemented rapidly. The German Engineering Federation (VDMA), the German Farmers' Association (DBV) and the German Agricultural Society (DLG) are closely involved in the development of this strategy.

In June 2019, BMEL intends to present a 10-12 page digitalisation strategy which does not only address agriculture and forestry but also agricultural administration, food and rural areas. It is not clear if the knowledge needs of end-users will be inventoried and made explicit. The following group of actors will directly benefit from the digitalisation strategy:

- farmers, since they are directly linked to the objectives envisaged, e.g. resilience to climate change;
- advisors, since they directly support the farmer in examining existing results with regard to the specific conditions of the farm;
- researchers, since they have direct access to practical applications;
- other actors outside of the AKIS.

Main beneficiaries are researchers because of their high digital literacy and internet access and politicians, as they can benefit greatly from this form of knowledge management. Main end-users are farmers and foresters. Digitalisation is considered to be a great opportunity to promote a competitive, resource/climate friendly agriculture which includes animal welfare. Digitalisation also supports making agriculture more sustainable in its use of soil, water air and biodiversity. Finally, digitalisation is ought to lead to administrative simplifications.

N.B. Baden-Württemberg provides an example of a regional digitalisation strategy²⁵ in which all policy areas are involved.

5.6 DK: Denmark

The Danish Agriculture & Food Council published a report in 2017 called 'Digital Growth in the Danish Food Cluster' based on input from a panel of experts from the food cluster. Its vision correlates to the ability and the will of the food cluster to jointly exploit the many opportunities of digitalization which will give Denmark a next key competitive advantage. The ambition is that Denmark will be the world's most profitable, sustainable, innovative and trust-building food cluster by 2025.

The mission of the Digital Growth Strategy is to create the most significant digitalisation gains of the food cluster in relation to:

- responsiveness to consumer requirements for products, traceability and accountability, which creates increased consumer trust and willingness to pay;
- resource efficiency and optimisation which makes a better financial as well as an environmental bottom line;
- innovation and research through analyses of big data and the use of new technological opportunities, contributing to new value-creating concepts.

²⁵ <https://www.digital-bw.de/>

There are 10 recommendations supported by 34 actions: 1) to make trust and transparency the strongest competitive parameters of the Danish food cluster; 2) to create an Internet of Food and Farm Powerhouse; 3) to harvest the value of data through closer collaboration on data; 4) to boost digital growth in SMEs and Internet of Food scale-ups; 5) to strengthen digital expertise and attract digital talents to the food cluster; 6) to strengthen ICT research and technology transfer in the food sector; 7) to create 'smart regulation' jointly between the authorities and industry; 8) to create good conditions to support digital growth in the food cluster; 9) to make cyber security a higher priority; 10) to ensure continued and common progress for digital growth in the food cluster.

It is expected that an inventory will be made of the knowledge needs of the end-users and to make these explicit. How this will be done, will depend on which type of knowledge is needed. In the report it is stated that the food cluster must work together to use the digital transformation as a means to a new competitive advantage in the 21st century. Therefore, all actors in the food cluster need to profit from increased knowledge flows, in particular farmers and companies. Advisory services, researchers, policy makers, administrators etc. will also profit from increased knowledge flows. The main actors who will benefit from the digitalisation strategy are expected to be the farmers and companies in the food cluster. Advisory services, researchers, policy makers, administrations, consumers, etc. will also be important beneficiaries.

Finally, the report recommends to establish a standing digitalisation group which will meet regularly. A digitalisation panel will come together once a year to take stock, adjust course and ensure progress. It has not been decided yet if the digitalisation strategy related to agriculture will be taken up in the AKIS plans for the future CAP. Digitalisation will have a broad perspective in the food cluster, including knowledge exchange and sharing of innovation.

5.7 EE: Estonia

Estonia has a nation-wide digitalisation strategy 'Plan 2020: Creation and development of general conditions for the development of the information society and the use of ICT' coordinated by the Ministry of Economic Affairs and Communications. In the smart specialisation development document the closest growth area to agriculture is 'bio-technologies' (as functional food). There is also an 'Agenda for Agriculture and Fisheries' until 2030, which contains some sentences about AKIS digitalisation. This Agenda should be approved in the fall of 2019.

The aim of the Estonian Information Society Development Plan 2020 is to:

- increase the internet availability;
- develop a single public and private service area (for electronic identification security, transnationally);
- develop digital literacy to enhance personal well-being and to promote higher ICT skills;
- a smarter state government.

The plan was approved in 2013, amended in 2018 and actions are running until 2022. A survey about farmers' and food processors' knowledge transfer will be executed by the end of December 2019. A survey about rural advisory services has been published in January 2018. The satisfaction level is also assessed through monitoring of the Rural Development Plan.

The main beneficiaries who need to take advantage from the digitalisation strategy are:

- farmers, because of faster and systematic decisions for farm management ;
- researchers, through less needs to collect basic data repeatedly;
- government officials, for regulatory frameworks
- advisors, as a reference base for services
- trainers/teachers because easier access to an up-to-date wide range of knowledge and training material.

The main end-users are governmental officials and decision-makers when setting policy objectives and strategic priorities. The main financial beneficiaries are:

- governmental officials and decision-makers to develop European wide strategies;
- farmers' organisations;
- researchers and IT developers for gaining funding;

- farmers using tools for easier access to data.

Digital knowledge flows should be stimulated as people are using digital solutions more and more. Quantitative and qualitative indicators of the digitalisation strategy could include:

- the number of digital solutions according to target groups or sectors (optimal number of different platforms);
- the number of users (people and enterprises);
- covered hectares or number of animals related to farm-based solutions;
- satisfaction level of digitalisation (in general);
- satisfaction level of specific tools.

Different platforms have different objectives. There should be several possibilities kept open for tools free of charge.

5.8 ES: Spain

Spain has recently adopted (presented by the minister of Agriculture on April 3rd 2019) the National Digital Strategy (AGENDA)²⁶ for the agri-food and forest sector and the rural areas, with the following main objectives:

- reduce the digital divide: connectivity technology and skills training;
- support data use: interoperability, open data, value chain and environmental data;
- boost enterprise development and new business models.

In addition, a horizontal governance strategy is developed, which aims to not only guarantee the execution of the Agenda itself, but also the promotion of interactions, the transfer of knowledge and cooperation among the actors involved. Actions and monitoring and evaluation also accompany these three objectives. Currently a Strategic Plan for digital transformation is being developed, which will include actions related to the agri-food sector. The main AKIS actors who will benefit are SME farmers, cooperatives, farm advisory services, technology and services providers oriented to the agri-food sector. The main end-users of the digitalisation strategy will be all the interested actors in the system: farmers, advisors, cooperatives, food industries, retailers, consumers, public administrations, researchers, universities, agricultural school teachers, technological companies, start-ups and the financial sector. These actors will also be the financial beneficiaries. In view of the strategy, the Spanish Ministry of agriculture is concerned about the needs of the end-users and takes this into account through a public open data²⁷. The future Strategic Plan for digital transformation will certainly take into account the end-users' needs.

It is considered necessary to define knowledge thematic databases. For example, an Integrated Pest Management (IPM) database should allow access to practical innovation in this area from the moment it is created by researchers, technicians or even the farmers themselves. INTIA is running project on this topic. Digital flows are expected to be incentivised: the Spanish Digitalisation AGENDA will work in this direction. A number of EIP-AGRI OG's funded under the national RDP, are linked to digital knowledge flows. As of the last call, 30% of the OG's funded were related to this area.

The AKIS culture in relation to knowledge flows should be further stimulated. In that respect collaboration should prevail over competition and transparency is key to the benefit of all. The creation of incentives or financial mechanisms is necessary to break down barriers and move forward. For example, prioritizing participation in collaborative public pest monitoring networks (e.g. AGRO-integra coordinated by INTIA from Navarra). Furthermore, Spain has identified different types of evaluation indicators associated with the different phases of program implementation of the AGENDA for the Digitalisation of the Agri-food sector.

Context or strategic indicators are:

1. Connectivity indicators: % households rural fixed Broad Band (BB) coverage; % households rural mobile BB coverage; % coverage of New Generation rural networks (NGA);

²⁶ <https://www.plantl.gob.es/digital-agenda/Documents/digital-agenda-for-spain.pdf>

²⁷ datos.gob.es

2. Connectivity, digitalisation and environment indicators: % households in rural areas with internet connection; % primary sector companies (CNAE 01 and 02) and agri-food industry (CNAE 10 and 11) with internet connection; % primary sector companies (CNAE 01 and 02) and agri-food industry (CNAE 10 and 11); who make sales / purchases e-commerce; if they use some kind of robot; if they invest in the Internet of Things; if they invest in block chain initiatives / smart contracts; total expenditure on ICT; index of masculinization in municipalities with population $\leq 30,000$ inhabitants and density less than 100 inhabitants / km²; population aging index in municipalities with population $\leq 30,000$ inhabitants and density less than 100 inhabitants / km²; index of over-aging of the population in municipalities with population $\leq 30,000$ inhabitants and density less than 100 inhabitants / km²;
3. Productivity, R&D and training: productivity of the primary and agri-food sector (per hour worked); business expenditure in R & D primary and agrifood sectors / VAB primary and agrifood sectors; number of Digital Innovation Hubs (DIHs) with capacities in agriculture (and percentage on total); number of Technology Centers and Innovation Support Centers with agrocapacities (and total percentage); percentage of graduates in rural areas; percentage of early abandonment of education in rural areas; percentage of survival of companies created after three years in predominantly rural regions.

Operational indicators are:

1. Product indicators: connectivity: number of dissemination actions on connectivity and number of people impacted; training: number of coordination actions for training, number of training actions and people impacted; interoperability: number of dissemination actions on interoperability and number of people impacted; open data: number of promotional initiatives for the creation of open datasets in rural areas; data of the agri-food chain: number of dissemination actions on agri-food chain data and people impacted, number of cooperatives benefited by aid; strengthening the digital innovation ecosystem: number of coordination actions among ecosystem agents; advice for digital adoption in agro-food, forest and rural knowledge and innovation systems: number of actions linked to the offices of digital transformation, number of days and demonstration activities and people impacted; promotion of new business models: number of dissemination actions on rural entrepreneurship and impacted population;
2. Product indicators of funds invested in the National Rural Development Plan (RDP) related to different lines of the Agenda: number of final beneficiaries benefited; number of cooperatives benefited;
3. Financial indicators: connectivity: financial execution dissemination actions on connectivity (annual total and percentage of execution); training: financial execution actions coordination training (annual total and percentage of execution); financial execution training actions (annual total and percentage of execution); interoperability: financial execution of dissemination actions on interoperability (annual total and percentage of execution); open data: financial execution open data promotion actions (annual total and percentage of execution); data of the agri-food chain: financial execution dissemination actions on agri-food chain data and impacted people (annual total and percentage of execution), financial execution aid to cooperatives (annual total and percentage of execution); strengthening the digital innovation ecosystem: financial execution coordination actions among ecosystem agents (annual total and percentage of execution); advice for digital adoption in agro-food, forestry and rural knowledge and innovation systems: financial execution actions linked to the Digital Transformation Offices (total and percentage of execution), financial execution number of days and demonstration activities (total and percentage of execution); promotion of new business models: financial execution dissemination actions rural entrepreneurship / smart rural entrepreneurship (total and percentage of execution);
4. Financial indicators channelled through other programs (connected to the Agenda): financial execution awareness-raising / revitalization actions (annual total and percentage of execution), financial execution of direct aid PNDR (annual total and percentage of execution).

There are also result and impact indicators. The fundamental difference between both, is the time span and its more or less general character. The result indicators are linked to shorter term

effects and linked to more concrete actions that appear in the Agenda, while the impact indicators allow to measure the effects on longer term consequences of the actions contemplated from a more holistic or generalist perspective. In these indicators it is especially important to take into account the clarity in its delimitation, the simplicity in its application and the representativeness in terms of the objectives contemplated in the Agenda and the challenges of the focal group. Through these indicators, it is intended to collect the degree of transparency required to achieve the selection of the best possible actions to be funded.

A) Result indicators: relate to the number of actions contemplated in the Digital Agenda, number of user complaints telecommunications rural areas, number of datasets open in conditions to be exploited in rural areas, initiatives of exploitation and reuse of open data in rural areas, number of datasets collected by cooperatives, number of new digital agro entrepreneurs / primary sector / rural environment, number of followers of the platform and number of interactions between them, other programs related to the Digital Agenda, creation of networks and participation in proposals, the Framework Program H2020 primary sectors, agriculture and rural development, success rate / returns in digitalisation calls H2020 primary sectors, agricultural and rural development, number of digitalisation and expenditure measures contemplated in Rural Development Programs.

B) Impact indicators: relate to self-diagnosis results for the primary and agri-food sector in HADA (Advanced Self-Diagnosis Tool for the evaluation of digital maturity), level of digitalisation companies and users of actions in Digital Transformation Offices.

The Spanish Agri-food sector Digitalisation AGENDA is consistent with the different initiatives developed at the level of the European Union. It is aligned with the transversal objective of the CAP post-2020 modernisation, in which innovation and digitalisation are configured as key elements for its achievement. It also fits into the conception of AKIS that this policy addresses, and contributes to its specific objectives and initiatives underway in the current programming period, both through the instruments of EIP-AGRI, as through the action for the development of smart villages driven by the European Rural Network (Smart Villages).

The AGENDA considers a measure oriented to promote the collaboration for the Improvement of the Integrated System of Administration and Control of the CAP. This measure is intended to encourage the exploitation of the system's digitalisation potential. In this sense, the MAPA participates, through the Spanish Agrarian Guarantee Fund (FEGA), as the Paying Agency of the CAP aids, in the H2020 NIVA project, in collaboration with Paying Agencies or Coordination of 9 Member States, as well as like other partners from different public administrations, private companies and universities.

Catalonia

Following the Ministry's initiative at national level, other regions like Andalucia and Catalonia are developing their strategies. For instance in Catalonia, the government adopted the SmartCAT²⁸ strategy in 2014, in line with the EU Europa 2020 strategy, aiming at spreading the use of smart technologies to innovate in public services, promote economic growth and promote a more intelligent, sustainable and inclusive society. Besides the initiative to ensure connectivity and digital infrastructures throughout the territory, 'Smart Rural' is one of the areas of action outlined in the SmartCAT strategy, and is currently under development. RuralCat also offers communication channels allowing the collection of data on the end-users' needs. In the Catalonia region at present both Digitalisation strategy and Strategic AKIS plans are currently being drafted²⁹. Although the Strategic Plan for digital transformation is still under development, the already proven effective methodology used for monitoring the implementation of other strategic action plans, such as PRITAC (the Strategic plan for research, innovation and knowledge transfer in the Catalan agri-food sector) will be used. A complete set of impact and monitoring indicators was agreed within PRITAC. Monitoring indicators were collected yearly,

²⁸ <http://observatori.smartcatalonia.gencat.cat/about>

²⁹ <https://www.eesc.europa.eu/en/our-work/opinions-information-reports/opinions/cap-legislative-proposals>

while impact indicators were collected at mid-term review and at the end of the programming period.

In Catalonia one of the tools used at present to stimulate digital knowledge flows is RuralApps³⁰, by an award distinguishing company who has developed mobile applications contributing to the improvement of the agri-food, forestry and fisheries sector. The Rural Development measure to support the development of innovative pilot projects is another tool than may prove useful to incentivising digital knowledge flows. Another example is Xarxa i-Cat, an innovation network within RuralCat (the virtual community of the Catalan agricultural, food-industry and rural world) which also contributes to digitalisation of knowledge exchange). More tools are needed to facilitate interconnections between AKIS actors but also more and new tools are needed to achieve knowledge capitalisation, visualization and innovation take-up.

5.9 FI: Finland

In 2017 a governmental decision was taken in Finland to enhance the digitalisation in rural areas by ensuring digital infrastructures and possibilities to use these. This includes among others developing e-services, enhancing e-studies, developing and subsidising digitalisation of entrepreneurship and e-working in rural areas. The main aim of the digitalisation strategy (2017-2019) is to create new and better possibilities for residents and entrepreneurs in rural areas. The activities consist of research and experimental projects, among others related to enhancing the use of big data, networking analyses etc., at both regional and national level.

A study on the needs in Finland preceded the strategy³¹. This study was based on a literature review (including final reports of projects and research projects and web pages of digital services), interviews, an assessment of digitalisation strategies in Canada and Scotland and surveys of rural residents, businesses and municipal decision-makers in three regions. Also, several workshops mapping out future digital services, were organised in three cities. However, there is a need to further analyse the needs of specific groups of end-users such as farmers. An example of an experimental project is FARMIDATA³². This project concerns the collection of new data from 6 farms for their own use instead of being shared and transferred to other parties. In doing so, farmers benefit directly from the collected data. Another example is an EIP-AGRI operational group called MIKA DATA³³ focusing on field data and their use in farming practices.

In 2017 a set of research policies and recommendations were formulated on digitalisation in the food chain³⁴ and digitalisation in the bio-economy, both including the primary production sector. The main AKIS actors who need to profit from increased knowledge flows by the digitalisation strategy are:

- farmers through better connectivity and easier ways to obtain best knowledge, better usage of resources, better performance, better market information, etc.
- advisors, by getting the latest research results, big data, data about the farms etc.
- researchers, by getting better, faster and updated data and connections;
- other actors in the food system through better connectivity and big data analyses;
- other actors in bio- and circular economy systems, by better connectivity and big data analyses;
- consumers by better transparency and traceability;
- society at large through better care for the natural environment and better knowledge effects on agriculture, less and more precise use of natural resources, nutrients, chemicals, etc.

The main end-users and financial beneficiaries are expected to be all main actors in rural areas. Digitalisation can increase agricultural productivity and the profitability of farms. The use of information technology makes it possible to better anticipate risks and sudden changes in

³⁰ <https://ruralcat.gencat.cat/premis-ruralapps>

³¹ https://enrd.ec.europa.eu/sites/enrd/files/tg_smart-villages_case-study_fi.pdf

³² <https://www.sitra.fi/en/projects/farmidata/#what-is-it-about>

³³ <https://ec.europa.eu/eip/agriculture/en/find-connect/projects/maatalousen-liiketoiminnan-kehittaminen-alykkäällä>

³⁴

https://tietokayttoon.fi/documents/10616/3866814/60_Digitalisaatio+ruokaketjun+kehitt%C3%A4misess%C3%A4pdf.pdf/681da803-2060-4362-9f5b-c8f8856a1cb0/60_Digitalisaatio+ruokaketjun+kehitt%C3%A4misess%C3%A4pdf.pdf.pdf?version=1.0

agriculture and in food production in a broader sense. Ideally, this will lead to higher productivity and a lower environmental impact. In this respect digital knowledge flows need to be further stimulated and incentivised.

There are several kinds of projects which are evaluated according to their substance, e.g. broadband coverage, 2-5 G coverage, the bio-resource atlas, nutrient circulation, etc. The digitalisation strategy will not be fully taken up within the Strategic AKIS Plan of the future CAP. As digitalisation and digital information flows are the basis of the modernisation of agriculture, bio- and circular economy as well as sustainable food systems, it cannot be limited to one specific objective. Also public services, including simplified procedures under the future CAP plan, should be developed for the benefit and efficiency for all partners.

5.10 GR: Greece

Greece has planned to develop a digitalisation strategy for agriculture. Its main aim will be to enable farmers, advisors, SMEs and scientists to utilize open data gathered by the digital infrastructure to boost the utilisation and adoption of digital agriculture in the country. Its activities are focused on the deployment of 6,500 meteorological stations, the development of a centralized platform and training for digital agriculture through webinars. The infrastructure is planned to start in late 2019 and it should be ready by the end of 2021.

The needs of the end-users are addressed through an inventory by the Farm Advisory System (FAS) through which producers/producer organisations, advisors, researchers, administration, labs, training organizations and controllers may benefit from the data collected. The main AKIS actors who need to profit from increased knowledge flows by the digitalisation strategy are: farmers (for farm developments and family welfare) and young farmers in particular (for generation renewal and actions against the depopulation of rural areas), rural societies and researchers (for easy access to multiple data, more space to experiment and enhanced knowledge flows). The main end-users of the digitalisation strategy will be advisors, farmers, processors and researchers. The main financial beneficiaries of the digitalisation strategy will be processors, due to economies of scale and farmers, due to cost reductions.

Digitalisation is supposed to support a major convergence of information to producers and smoothing the communication among the different types of actors in Greece, through enhancing knowledge flows among the producers and between the producers and the advisors. The following non-exhaustive list of indicators will be used to monitor the digitalisation strategy:

- end-user usability (friendliness) and frequency of usage;
- number of digital platforms set up;
- number of accesses to digital platforms;
- number of downloads from digital platforms.

The digitalisation strategy will serve other societal objectives too such as transport reductions.

5.11 HR: Croatia

Croatia has set up the 'E Croatia – strategy of digitalisation of public services'. Its main objectives are to improve connections between state and citizens, productivity of public services, competitiveness of business entities, innovation processes and inclusion in the EU digital administrative space. There is no information available on (planned) activities (yet). The need for innovation was underlined but no specific needs were inventoried. The timeframe is 2018-2023.

The main AKIS actors who need to profit from increased knowledge flows by the digitalisation strategy are young farmers who tend to learn and solve technical problems and the agri-food industry for improved processes and relations with cooperants. The main end-users of the digitalisation strategy are the farmers and the consumers, aiming at a better variety and availability of food and easier purchases. The main financial beneficiaries are the farmers because of free or cheaper advice and more information and the IT industry because of new infrastructures and investments. The infrastructure and preconditions must be enabled but 'digital knowledge flows' or activities as such, should be voluntary or commercially based. Regarding monitoring and evaluation, each entity involved (ministries and others) will have their role in achieving certain milestones, which will be monitored. The Croatian digitalisation strategy

will be taken into consideration within the Strategic AKIS plans of the future CAP and will serve the purpose of knowledge exchanges.

5.12 HU: Hungary

In the framework of this study, an AKIS stakeholder workshop was held in Hungary in June 2019, which also included discussions on a digitalisation strategy for agriculture to enhance knowledge flows and implementation of CAP and AKIS plans. The preparation, coordination and management of the digital changes in agricultural sector, are seen as a common task. Digitalisation has revolutionised different aspects of daily life and it has a huge impact on technological processes, communication and data management. The objective of the Hungarian government is to foster space specific farming systems, which protect the environment (soil, air and water). One of the highlighted aims of the Ministry of Agriculture is to enhance agricultural modernisation and to improve profitability and competitiveness of the sectors by tools in digitalisation. In the frame of the national Digital Agricultural Strategy (DAS), the first step is to make all public data systems accessible as part of the agricultural overhead reduction program. The main aim is to provide free national databases and to facilitate national and European obligatory reporting and administration. The objectives are the application of precision farming systems, utilisation of management coordination tools in decision making and the development of traceability. Its main activities are oriented on digital competence development among agricultural stakeholders and the development of an agri-innovation ecosystem, access to public data and services and easier and faster data gathering (foreseen for 2019-2022). The project 'Digital Agricultural Academy' (managed by NAK) has already examined the needs of agricultural students and farmers. Specific needs of advisors were also mapped by NAK (this information will be fed into the project 'Digital Advisors').

The main AKIS actors who would need to profit from increased knowledge flows by the digitalisation strategy are:

- researchers (regarding the smart Farm Accountancy Data Network system, the smart soil system, etc., provision of direct access to representative databases and primary data to prepare for studies;
- precision technology providers (regarding new markets);
- advisors (for decision making and to facilitate administration);
- agricultural administration (for data gathering, traceability, to reduce the number of on-spot controls and cost-effective processes);
- NGOs (easier access to data for decision making and services).

The main end-user groups are farmers, advisors, the public sector and service and input providers. The main financial beneficiaries are farmers, the Hungarian Chamber of Agriculture (NAK), background institutes, research institutes, the public sector and service and input providers. Development of digital competencies will be a separate measure. Several projects will be financed in the frame of the Strategy, which may result in more intensive knowledge flows or at least information flows (e.g. the development of an integrated data system).

The digitalisation strategy will be monitored through the following indicators:

- number of farmers involved in competency development;
- number of territories covered by digital tools;
- quantity of used data;
- number of prepared curricula.

The readily set directions and recommendations shall be incorporated in the Strategic AKIS plan. DAS will be part of the CAP AKIS Strategic Plan. The primary objective is information provision. First, digitalisation will be used for the strengthening of state data, systems and services. Since there are many data collected in a fragmented way, this is essential to be solved and to connect all data in an integrated system. The aim of this integration process is to support the controls, the monitoring and decision making in addition to providing aggregated information and benchmarks, also for farmers. This is also a way to motivate them to be more conscious and efficient. Finally, due to easier access to digital data and infrastructures, researchers will be able to make better use of up-to-date data and cost-effective analyses will be better achievable for farmers and advisors.

5.13 IE: Ireland

The Irish government is in the process of preparing a national digital strategy. The consultation was launched in October 2018. There are a large number of digital actions embedded in the current national strategy for food and agriculture 'FoodWise 2025' but there is not a separate digital strategy for agriculture. The Department for Agriculture, Food and the Marine (DAFM) has a digital strategy which looks at their own internal strategies and many of these reach out and impact on the whole AKIS. As there is no specific digital strategy for agriculture in Ireland an inventory of the knowledge needs of end-users has not been made yet. However, it is expected that this will take place during the development of the national strategy. User needs are gathered when developing specific systems.

The main AKIS actors who would need to profit from increased knowledge flows by the digitalisation strategy are:

- farmers, through facilitation of complex decision making in modern farming and to better connect farmers and consumers;
- advisors/Innovation Support Providers, to provide targeted advice;
- researchers and teachers, to have easy access to the latest knowledge training material;
- consumers, for better traceability and connections with primary producers;
- policy makers, for access to accurate information;
- input suppliers to provide targeted and appropriate advice and products;
- services, e.g. accountants, to provide more strategic farm management advice;
- media.

The main end-users of the digitalisation strategy should be:

- farmers, while farming has become a knowledge intensive job which requires decision support and quick access to relevant information;
- advisors, while providing a bespoke service requires access to local information and also to improve knowledge flows to multiple clients;
- the media which depend on access to latest knowledge;
- agricultural students who require access to the latest learning platforms.

As there is no strategy in place, it is difficult to say who will be the main financial beneficiaries. On the basis of existing systems, it is foreseen that farmers (in a general, sense because not all farmers will benefit equally) will benefit from improved access to knowledge and labour efficiency. Advisors are ought to obtain access to more efficient and accurate decision support tools. e.g. mapping. The Ministry of Agriculture is likely to profit from reduced administration costs. The media should profit from low cost access to latest information, while social media are ought to for good sources of sharing examples and best practices. Researchers are likely to profit from a low cost capture of data from national systems e.g. ICBF. The wider industry and consumers should benefit from e.g. improved genetics, increased quality of products and improved traceability processes. Finally, students are ought to profit from lower cost access to education programmes via online training modules.

The digitalisation strategy will be monitored through the tracking of interactions and engagements with digital tools and services. It is likely that both regional and national digitalisation strategies will be fully integrated into a new Strategic plan for Food and Agriculture 'ClimateWise 2030' which will supersede FoodWise 2025. Digitalisation shall further support knowledge and data exchange through investment in existing and new digital tools and platforms. There is increased interest in agri-tech from the private sector, so this will also have an impact on the types of solutions. Stakeholders will need to be involved from the start of any digitalisation of knowledge flows.

5.14 IT: Italy

National level

The 'Plan for Agriculture 2.0: Digital administration to simplify innovation' was launched in November 2014, to support interventions concerning technological innovation and

administrative simplification. It was part of the bigger National Plan for Digital Growth 'Industria 4.0' (cross-sectorial) which focuses on actions aimed at administrative and process simplifications to drastically reduce the bureaucratic burdens of entrepreneurs and the use of non-computerised processes. The Plan for Agriculture 2.0 was articulated around 6 main projects:

1. the National Register of Farms (a common and up-to-date, open access data base of farmers at national level, based on the in real-time synchronization of the regional databases);
2. an integrated Single Farm File, which includes structural data, single application for assistance, an assurance plan, RDP applications submitted, payments received and geo-referencing of the farm;
3. pre-filled CAP applications;
4. advance payments;
5. unified databases of the certificates needed to apply for public funds;
6. unified forms for the application of various CAP measures.

The Plan also includes the provision of several additional innovation services to farmers which are:

- the release of the AgriPay card, which contains the digital identification and electronic signature of farmers (1,500,000 in 2014);
- free added value services for farmers (e.g. the Farmer's Tool Managing Support System and Business Plan);
- the DOP-IGP web portal with detailed information on producers', controlling and certification activities;
- e-commerce platform for farmers;
- informative actions and digital platforms: InformAzienda, Apps and Open Data.

In 2016, the focus of the second turn of the 'Plan for Agriculture 4.0' was shifted on agricultural productions and agri-food industry, through introducing incentives and funds for agricultural investments on technologies 4.0, in particular precision farming technologies, and on innovation. The first turn of planning (Agriculture 2.0 in 2014) was aimed at simplifying the life of over 1,5 millions of farmers through reducing administrative burdens in provision of public funds and investments. The second turn (Agriculture 4.0 in 2016) was aimed at boosting the digital transformation in agriculture to increase the competitiveness and the sustainability of the primary sector. More in particular the objective is to achieve the 10% of utilized agricultural area through precision farming systems by the end of the 2021 (compared to the 1% registered in 2016). The Plan for Agriculture 4.0 set a budget of 13 Billiards of euros of Public Funds to be spent in incentives within 5 years (until 2020) for investments on digitalisation at farm level. In 2017 the Ministry of Agriculture delivered guidelines for precision farming to inform on the benefits and to guide the farmers and other actors through the opportunities for investments in technologies 4.0. Apart from the above-mentioned projects and services, the Plans set a mix of measures and incentives:

1. over-depreciation at 250% for the investment in technologies 4.0 for farmers, contractors and the agro-industry;
2. support for the investments on infrastructures and access to the ultra-wide band;
3. zeroing of the cost of primary guarantee for farmers;
4. relaunch and extension of development contracts for farmers and the agri-food chain;
5. strengthening of agricultural and agri-food research.

The two Plans for Agriculture are based on studies conducted under the responsibility of the Ministry of Agriculture. The needs of end-users and the state of digital agriculture in Italy is documented in specific background studies conducted by two teams of researchers and experts.

The main AKIS actors who would need to profit from increased knowledge flows by the digitalisation strategy are:

- farmers, because of the improvement of farming practices, in terms of productivity, sustainability and global management, modernization, reinforcement of positions across the supply chains, timely reimbursement of the financial contributions by the paying

- agencies, and simplified and less documented procedures to access to public funds and payments
- advisory services because of modernization and strengthening of advisory approaches, methods and tools, extension to a plurality of new advisory services, and simplification;
- public funders because of the increase of controllability and timely monitoring of the outputs and results of the investments supported, and the provision of a plenty of data to sue for policy scenario design;
- researchers and academics because of new frontiers, paradigms and a multitude of useful data to analyse
- paying agencies because of an increased, timely and greater detailed controllability of interventions realized.

The main end-users of the digitalisation are the same as mentioned above in addition with civil society and consumers because of an increased evidence of the effects of the funded interventions; greater transparency and information on the origins, nutritional properties and values of agri-food products and of the multitude of actors contributing along the supply chains.

The main financial beneficiaries are:

- contractors and specialized advisory services providers, because their business would be based on the selling of technologies 4.0.;
- farmers and the agro-food sector as they as a whole face an increased added value of the productions and all along the supply.

Digitalisation in AKIS will certainly help a better circulation and co-creation of knowledge. Digitalisation is also enlarging the multitude of relevant actors in AKIS at trans-sectorial, trans-regional and trans-national levels. For example, some digital platforms in Italy already take advantage of trans-national contributors.

The digitalisation strategy will be monitored through several indicators:

1. percentage of utilised agricultural area through precision farming systems (target is 10% by 2020);
2. total investments on digital farming (by typologies);
3. number of farmers beneficiaries of incentives/funds for digitalization;
4. increased agricultural added value;
5. total accesses to fiber optic in rural areas;
6. Increased connectivity in rural areas;
6. number of digital platforms and correlated indicators (number of participants and accesses; number of downloads).

The national digitalisation strategy will use the CAP strategic plans to support investments in infrastructures and in services, training and advisory included, to increase smart farming practices. The national and regional digitalisation strategies will be fully taken up by the CAP strategic plan to ensure continuity and integrate the actual set of incentives and funds. In Italy, a multitude of digital platforms already serve the knowledge exchange and sharing of innovation. The Plans for Agriculture already set several communication activities.

Emilia Romagna

In Emilia Romagna the regional Smart Specialization Strategy (2014-2020)³⁵ was designed according to the framework of the National Plan for Industry 4.0 and the National Plan for Agriculture 2.0 and Agriculture 4.0 (2016). The S3 aims to strengthen the dynamics of technological innovation, with particular reference to the organisation and development of those services that generate added value, profitability and loyalty, and are based on competitiveness and capacity of logistics services, technologies, and the information; other high-intensity services and on knowledge and professionalization.

The main drivers are:

- sustainable agriculture on investments for, among others, precision farming, sensors in-situ, industrial biotechnology, green chemistry, bioenergy;
- healthy and active living based on Functional foods and nanotechnology;
- IoT to increase transparency, traceability and integration along the supply chains and to achieve smart and green supply chains.

³⁵ <http://www.regione.emilia-romagna.it/s3-monitoraggio/about.html>

Also, for geomorphological reasons, a main objective of the region of Emilia Romagna is to improve water use efficiency by the use of innovative techniques and smarter drive support systems which enable farmers to improve overall economic and sustainable production.

The activities are:

- incentives for investments on precision farming;
- drive support systems
- technological infrastructures and tools; .
- services for knowledge exchange.

The S3 is based on studies on the knowledge needs of end users conducted under the responsibility of the regional administrations.

The main AKIS actors who will profit from increased knowledge flows by the digitalisation strategy are and main end-users are:

- farmers for the improvement of farming practices and for the use of more simplified and less documental procedures;
- agronomists and other technicians to better tailor their approaches and tools to farmers needs and features and to enlarge the offer of services;
- digital infrastructures providers due to the enlargement of target markets;
- paying agencies due to the multitude of data they access to.

The main financial beneficiaries of the digitalisation strategy are:

- farmers due to the increased added value of agricultural products;
- more innovative agronomists and other technicians due to the competitive advantage they gain in dealing with innovative and digital tools to support farmers.

The systemic approach of the AKIS would certainly help digital knowledge flows.

The digitalisation strategy is monitored by the following indicators:

1. ameliorated water management indicators;
2. energetic intensity of farms;
3. increased number of certifications (EMAS/ ISO 14001)
4. indicators in use for monitoring and evaluation of RDP (relevant measures contributing to the digital strategy).

The regional digitalisation strategy will be fully taken up within the Strategic AKIS plans of the future CAP in continuity with main objectives and the types of interventions already promoted by the actual strategy. Early stage of CAP strategic planning to detail how will be done. Currently the need to understand how the transition to the National CAP strategic plan will influence an effective take-up of the regional strategies is being addressed.

As the S3 strategy is region-specific , digitalisation serves objectives such as sustainability, competitiveness, transparency, traceability, productiveness.

Tuscany

In line with the national strategy 'Industria 4.0' and the regional smart specialization strategy, the 'Tuscan strategy towards transformation 4.0' is based on roadmaps that identify and produce projects sustainable on the ground. One of the key elements is the identification of criteria for the evaluation of efficiency, i.e. to define whether or not public resources are spent in a better way. The regional public entity should take action to allow enterprises to use the most convenient 4.0 innovations, which initially are mainly processes, that later on become products and business models in a second stage. The strategy is implemented by biannual plans which help the adaptation to the merging needs of farmers who approach digitalisation and utilize digital technologies, with the consequent transformations of production processes and business models.

In 2016, the 'Guidelines for consolidation and valorisation of the regional technology transfer system' which were aimed at supporting the implementation of the regional digitalisation strategy, set 4 operational objectives:

1. consolidating the reticular form on a cooperative basis, as a way of connecting the components of the transfer system;

2. promoting technology transfer infrastructures;
3. coordinating the action of actual technological districts, as a moment of operational synthesis, and of connection between production system and technology transfer system;
4. promoting the systemic dimension by concentrating on a few technological lines and platforms aimed at increasing the competitiveness of the production system.

The activities consist of:

- digital platforms Funds for investments in technologies 4.0;
- microcredits and loans;
- vouchers for the use of audit services to assess the level of digital maturity of farms on technologies 4.0: a range of 40%-60% of contribution on a range of 5.000-20.000 of eligible costs;
- vouchers for the use of training 4.0 by the managers of farms;
- communication and dissemination of the strategy: events, brochures, platform, leaflet, territorial labs etc.

The technical and scientific branch of the regional administration, conducted a preliminary study on the supply and demand for technology in Tuscany. This study was used to ground the Regional Platform Industry 4.0³⁶.

The main AKIS actors who would profit from increased knowledge flows by the digitalisation strategy are:

- farmers: improvement of farming practices, in terms of productivity, sustainability and global management; modernization; reinforcement of positions across the supply chains;
- advisory services due to the renovated, reinforce and renewed skills and capabilities;
- researchers/academics because of new frontiers, paradigms and a multitude of useful data to analyse.

The main end-users of the digitalisation strategy the AKIS as a whole and the production systems which will take advantage of the new models of business and meliorated knowledge flows.

The main financial beneficiaries of the digitalisation strategy are:

- contractors and specialized advisory services providers, because their businesses would be based on the selling of technologies 4.0;
- the farmers and the agro-food sector as a whole face an increased added value of the new processes and production schemes

The regional strategy is specifically aimed at stimulating knowledge flows. Indicators have been specifically defined for the variety of activities and platforms carried out to implement the strategy. Monitoring and evaluation activities feed the biannual reports of the strategy implementation plans.

The main objectives and the types of interventions already promoted by the actual regional digitalisation strategy will be fully taken up within the Strategic AKIS plans of the future CAP. The early stage of CAP strategic planning will detail how this will be done. There is a need to understand how the transition to the National CAP strategic plan will influence an effective take-up of the regional strategies.

In line with the regional strategy for digitalisation, this serves the knowledge exchanges and sharing of innovation, through the creation of an innovation ecosystem.

5.15 LT: Lithuania

Lithuania's 'Next Generation Internet Access (NGA) Development Plan'³⁷ focuses on direct state contribution to long-term infrastructure development, and specifically supports measures

³⁶ https://ec.europa.eu/futurium/en/system/files/ged/the_regional_industry_4.0_tuscany.pdf

³⁷ <https://www.e-tar.lt/portal/en/legalAct/7e1fdab0600411e4bad5c03f56793630>

promoting the private sector. The Lithuanian Information Society Development Programme 2014-2020, 'Digital Agenda of the Republic of Lithuania'³⁸, focuses on 3 major areas:

1. skills and motivation of the Lithuanian citizens to use ICT;
2. development of electronic content;
3. evolvement of ICT infrastructure, including access, investments to foster an increase in demand for fast broadband access.

The concept of the establishment and development of integrated science, studies and business centres³⁹ (valleys), aims to proceed by implementing the process of smart specialization. The 'Lithuanian Innovation Development Programme 2014-2020'⁴⁰ is linked to Smart Specialisation as measures covered by the action plan of the programme will facilitate in promoting the established specific priorities of the smart specialisation area stimulating the competitiveness of the economy of Lithuania.

The Programme refers to the Implementation of the Priority Areas of Research and (Socio-Cultural) Development and Innovation (Smart Specialisation):

- to create innovative technologies, products, processes and/or methods and, using the outputs of these activities, respond to global trends and long-term national challenges;
- increase competitiveness of Lithuanian legal entities and their opportunities for establishing in global markets – commercialization of knowledge created in the implementation of the R&D and innovation priorities as well as knowledge created in developing the R&D and innovation priority areas otherwise and using the unique synergy arising from the collaboration of science and businesses, economic entities and other public and private sector entities.

Six Smart specialisation RDI Priority Areas have been identified:

1. energy and sustainable environment;
2. health technologies and biotechnologies;
3. agricultural innovation and food technologies;
4. new production processes, materials and technologies;
5. transport, logistics and information and communication technologies;
6. inclusive and creative society.

The task of 'Agricultural innovation and food technologies' includes those R&I activities that enable the creation of a sustainable food chain, use of biological resources in agriculture and food industry in a sustainable manner, production of safe and quality food, and effective development and use raw food. More specifically, the activities are oriented to:

- sustainable agri-biological resources and safer food;
- functional food;
- innovative development, improvement and processing of biological raw materials (biorefinery);
- advanced pest control and plant nutrition systems;
- precision crop and livestock farming technologies.

Surveys at national level are not being carried out at a regular basis. Every year, a survey of the users' level of satisfaction of provided service is carried out by the Lithuanian Agriculture Advisory Service (LAAS). Results of this survey are taken into account in the process development of new services. The main AKIS actors who would need to profit from increased knowledge flows by the digitalisation strategy are:

- farmers, by having access to knowledge in a quicker and easier way, and apply this knowledge in practice;
- advisors, probably will use and share knowledge with a farmer his way an advisor will have influence on a farmer to use precision agriculture;
- authorities responsible for implementation of CAP as the objectives of the programme will be achieved.

³⁸ <https://www.e-tar.lt/portal/lt/legalActEditions/dbd546f0b04011e39a619f61bf81ad0a?faces-redirect=true>

³⁹ https://www.smm.lt/uploads/documents/en_smm/Concept%20of%20Valleys.dov

⁴⁰ https://mita.lrv.lt/uploads/mita/documents/files/_en/national-programmes/innovation-in-lithuania/lithuanian_innovation_programme.pdf

The main end-users of the digitalisation strategy would be:

- farmers: have to have the possibility to use digital tools and get new knowledge to produce food;
- advisors: whose main function it is to assist farmers to interpret data and advise how to apply data in practice.

Digital knowledge flows in AKIS could be stimulated through developing different structures and systems, in particular databases of open access, systems for training and knowledge transfer. The Strategic AKIS plans for the future CAP still have to be developed as national documents are usually prepared after regulations have been approved. In Lithuania, there is no standard for the dissemination of information. Also, electronic services based on intelligent transport systems (ITS) and applied solutions for residents and businesses are not sufficiently developed.

5.16 LV: Latvia

Latvia's national broadband strategy (Nākamās paaudzes platjoslas elektronisko sakaru tīklu attīstības koncepcija 2013.-2020.gadam) remains valid until 2020. Three components of the electronic communications network are discussed in the strategy – backbone network, transport network and subscriber lines ('last mile'). The main aims and priorities of Latvian Smart Specialisation Strategy are:

1. knowledge intensive bio-economy;
2. biomedicine, medical technologies and biotechnology;
3. smart materials, technology and engineering;
4. advanced ICT;
5. smart energy.

The activities associated to the strategy are not specifically related to agriculture. There are no data available on the knowledge needs of end-users, LLKC organises surveys about their services.

5.17 LUX: Luxemburg

The Ministry of Agriculture is currently developing a new digital system for agricultural advisory services, including nutrient management, in collaboration with advisory organizations (2020-2021). In addition, a mobile application for these advisory services will be linked to the new system. Three thematic digital interactive platforms are currently being developed in the frame of EIP-AGRI innovation projects:

1. integrated pest management in agriculture;
2. high resolution monitoring of pests in vineyards;
3. improved grassland management based on grass growth predictions;
4. sub-questions regarding the national/regional digitalisation strategy.

An inventory on the needs of the end-users will be done by the Ministry of Agriculture. The main AKIS actors who would need to profit from increased knowledge flows by the digitalisation strategy are:

- farmers and winegrowers because they can benefit from an improved advisory service;
- advisors because it should save them time;
- scientists because of faster access to data and improved feedback from the farmers and advisors.

The main end-users of the digitalisation strategy are mainly advisors and farmers/winegrowers because they can benefit from an improved advisory system. The main financial beneficiaries of the digitalisation strategy are farmers because they save resources and advisors because it should save them time. Digitalisation should serve knowledge exchanges and improve monitoring according to the following guidelines. Private data from farmers will remain their property. Only public data will be used for monitoring purposes. Indicators are being developed and should be used from 2021 and on.

5.18 NL: The Netherlands

The Netherlands have a general digitalisation strategy 'The Dutch digitalisation strategy: the Netherlands digital'⁴¹ in place, but not yet specifically for agriculture. This is still in progress. The main AKIS actors who would need to profit from increased knowledge flows by the digitalisation strategy are:

- farmers, because of better uptake of knowledge;
- researchers because of better impact of their results;
- advisors through developing skills and a 'digital culture' of the utilisation of digital platforms and tools;
- education, e.g. 'Groen Kennisnet'⁴², as both distributors and end-users of knowledge;
- policy makers because of better reach and impact of R&I results, fulfilling societal aims;
- other AKIS actors such as sector organisation ZLTO, the NRN, Paying Agency RVO and the triple helix top consortium for knowledge and innovation (the topsector policy for agri-food and horticulture and starting materials⁴³).

The main end-users of the digitalisation strategy are expected to be: farmers, educational institutions and initiatives, research institutes, advisors and other agri-food entrepreneurs than farmers. In general all actors mentioned above would also be financial beneficiaries through saving time and effort. The main financial beneficiaries of the digitalisation strategy would be policy makers, through more efficient and effective knowledge uptake and increased public return on investment and for IT companies and digital service suppliers. The ambition by the Ministry of Agriculture and other actors at national level, is to enhance knowledge flows between AKIS actors to better bridge the gap between knowledge and practice.

The digitalisation strategy could be monitored through inventorying:

1. the number of platforms per sector, including the number of actors involved;
2. the number of tools per sector, including the number of actors involved;
3. the number of visitors per website;
4. the amount of interaction, visible on online chat functions and including twitter surveys per platform.

The digitalisation strategy for agriculture is under development and will be aligned with the CAP Strategic AKIS Plan.

5.19 RO: Romania

Romania adopted the 'National Strategy for the Romanian Digital Agenda 2014-2020'⁴⁴ in February 2015. The Strategy defined four main areas of action:

1. e-governance, interoperability, cyber security, cloud computing and social media;
2. ICT in education, health, culture and e-Inclusion;
3. e-commerce, R&D and innovation in ICT;
4. broadband and digital infrastructure services.

The full implementation of the Strategy was estimated to require total investments of approximately 2.4 billion euros leading to a direct and indirect impact on the economy equivalent to a 13% GDP growth, 11% increase in employment and a 12% reduction in administration costs over 2014-2020. Concrete measures outlined in the Strategy were intended to lead to:

- ensuring citizens 'and organizations' access to e-Government services (eGovernment services);
- improving access to the internet by increasing the coverage of high-speed broadband electronic communications networks;

⁴¹ <https://www.rijksoverheid.nl/documenten/rapporten/2018/06/01/nederlandse-digitaliseringsstrategie>

⁴² <https://www.groenkennisnet.nl/nl/groenkennisnet.htm>

⁴³ <https://www.topsectoren.nl/>

⁴⁴ <https://www.comunicatii.gov.ro/agenda-digitala-pentru-romania-2020/>

- increasing the use of the internet;
- promoting e-commerce;
- increasing the number of cross-border electronic public services;
- enhancing digital content and developing ICT infrastructures in the fields of education, health and culture;
- supporting the increase in added value generated by the ICT sector by supporting research, development and innovation in the field.

In 2016 the Prime Minister also launched the Manifesto for Digital Romania which sets out principles and vision for a digital future, but this has not yet been transformed into a clear national strategy for digitalisation. Progress with implementing the National Strategy and Manifesto is reported to have been limited. According to the 2019 Digital Economy and Society Index (DESI) Country Report for Romania⁴⁵, Romania ranks 27th out of the 28 EU Member States in the European Commission Digital Economy and Society Index (DESI) 2019. Although Romania shows slight improvements in performance in almost all of the DESI dimensions measures, digitalisation of the economy is still lagging behind. More than one fifth of Romanians have never used the internet, and fewer than a third have basic digital skills.

In Romania there is little mapping of end-user needs which is of relevance to the AKIS. In the Strategy document there is only one reference to the needs of agricultural sector and farmers: 'Internet access to public libraries supports agriculture, the main employment sector in Romania. Public libraries actively help 70% of the rural population of Romania working in agriculture, which represents 12% of GDP. In 2012, more than 41,000 farmers registered online applications for grants in public libraries in Romania, with direct result of more than \$63 million in subsidies received from the Ministry of Agriculture by individuals.'

The main AKIS actors who would need to profit from increased knowledge flows by the digitalisation strategy are in particular SME farmers because they are under-served by the public agricultural advisory services. Since they cannot afford to use private advisory services they are an obvious end-user group for increased knowledge flows via enhanced digitalisation. The main end-users and financial beneficiaries of the digitalisation strategy are large-scale farms, private advisory services, agrochemical companies and machinery suppliers with a major focus on services relating to precision agriculture.

Many new companies have emerged in recent years which are working in partnerships with foreign suppliers from Germany, Netherlands, Denmark and the USA etc. to provide integrated packages of machinery and IT hardware and/or software for precision farming (e.g. NHR Agropartners⁴⁶). There is no evidence from the National Digital Strategy that the digitalisation of agriculture is a priority for public intervention. Instead it appears to be left entirely to the private sector. The Strategy included the following targets (which could be translated into indicators) for Romania in 2020:

- at least 35% of citizens use e-Government systems;
- at least 60% of citizens regularly use the internet;
- at least 30% of citizens makes on-line purchases;
- coverage of broadband communication networks (over 30 Mbps) of at least 80%.

A monitoring and evaluation manual for the National Strategy was prepared with the support of the World Bank and published in January 2016⁴⁷. It is not yet clear to what extent digitalisation will form part of the CAP Strategic Plan for Romania.

5.20 SE: Sweden

The digitalisation strategy in Sweden has been put in place since 2017. The strategy does not address AKIS explicitly. Its activities are divided in 5 parts: competence, security, innovation,

⁴⁵ <https://ec.europa.eu/digital-single-market/en/scoreboard/romania>

⁴⁶ <https://nhr.ro/precizia-conteaza-in-agricultura/>

⁴⁷ https://www.comunicatii.gov.ro/wp-content/uploads/2016/02/Manual_Monitorizare_Evaluare_v2.0-BM.pdf

infrastructure and governance. Different actions have different time lines, e.g. the whole country will be fully covered by broadband in 2025. One of the major goal is to provide all people with internet access and to make them sufficiently competent to use digital solution in every-day life. There are also state initiatives to increase the digital tools for businesses to simplify when coping with regulatory requirements, including farms. CAP application is digital to almost 100%. If so, how?

The main AKIS actors who would, need to profit from increased knowledge flows by the digitalisation strategy are:

- businesses in many rural fields;
- farmers
- advisors, researchers and innovators;
- companies buying and selling farmers goods and products;
- authorities controlling the businesses and constructing CAP payments.

The digitalisation strategy addresses several sectors at several levels, the main end-users of the digitalisation strategy can also be the farmers. The main financial beneficiaries of the digitalisation strategy are the authorities controlling the businesses and constructing CAP payments. Today, Sweden has also broadband as an intervention measure. Currently is being analysed it is suitable to continue this measure within the CAP. There is potential to broaden digital knowledge exchange in AKIS, but this has not yet been considered in depth.

5.21 Additional information from Member States

Additional information from Member States who have not developed a digitalisation strategy for agriculture yet, is described below:

- **PT:** in Portugal there are different OGs with a strong focus on digitalisation. Most communication and dissemination strategies of R&I projects now have a digitised and social media component. In this sense, the digital knowledge flows are in fact being 'naturally' built through existing platforms;
- **SK:** there is no digitalisation strategy in agriculture for Slovakia yet;
- **SL:** according to the Slovenian respondents, a digitalisation strategy for agriculture should be dynamic as the agricultural sector is now in a transition period with fast moving technologies. So the digitalisation strategy needs to be prepared/written in this way also. The main AKIS actors who would need to profit from increased knowledge flows by the digitalisation strategy is the Agriculture Institute of Slovenia, because it is the main leader in agricultural research.

6. EXISTING DIGITAL TOOLS AND PLATFORMS ENHANCING KNOWLEDGE FLOWS IN AKIS

This chapter includes the analysis on already existing digital infrastructures which are available in EU MSs and regions to enhance knowledge flows in AKIS. Most infrastructures were initiated by EU legislation, primarily for environmental compliance. However, access to up-to-date market information, legal amendments and open calls can also motivate stakeholders to launch digital platforms. One of these are the Nutrient Management Plan tools which are used for the fulfilment of the Nitrate Directive, CAP cross-compliance and RDP agri-environmental measures rules. It was highlighted by respondents that future developments of digitalisation should be based on the already existing good examples (tools, infrastructures and strategies) and experiences shall be taken into account before taking further steps at national level.

6.1 Analysis of existing digital tools and platforms in EU AKIS

Most mentioned existing digital infrastructures in the EU countries are initiated, set-up and owned by the national governments (ministries), national chambers of agriculture or research institutes. Some presented digital infrastructure with special focus on a particular field (e.g. breeding, grazing grass seeds, market analysis, etc.) were launched by private companies, cooperatives or breeding organisations. Most of them are used at national level. However, there are also public infrastructures which operate at regional level.

The knowledge and data supplied to the digital infrastructures, are mainly derived from researchers from universities and applied research institutes or from private advisors, advisory and training centres. In some particular cases meteorological and paying agencies provide accessible information when meteorological data or spatial data, phenological and phytosanitary data, through forecasting and warning systems are requested. Involvement of different stakeholders ensures a continuous updating of information in diverse mentioned tools and platforms. Nonetheless, as described in chapter 4, interoperability between tools and platforms lead to scattered information or important data (e.g. weather data, spatial data, soil data etc.) are not freely accessible for end-users. We observed from the inventoried digital strategies that quite a few MSs are (still) working on the public availability of free data flows, which is an important barrier in knowledge transfer.

Mentioned digital tools such as forecasting systems, manure calculation applications, fertilizer applications, plant protection systems and data gathering processes, are provided mainly by IT companies, advisory or research institutes. Most initiatives tend to be working on data integration from different sources, in order to minimize management costs and administrative burdens. To achieve this aim, Ministries and background institutes are working on synthesising agricultural data based on IT solutions. However, mainly private IT companies supply the infrastructure which makes the process less flexible since government bodies do not have own HR sources and competencies. To facilitate knowledge flows, the interlinking of data should also provide for better transparency which is crucial for compliances and productivity. Most of the digital infrastructures are also managed by IT companies, which develop and maintain the architecture.

Most mentioned existing digital infrastructures can be defined as repositories providing variable possibilities for interaction such as Q&A functions or linked social media groups/apps. Capacity to support interaction is often (still) lacking. Except for examples in Belgium, Denmark, Finland, Italy and the Netherlands (see Table 3), most mentioned platforms and tools do not function as 'living tools' referring to open source tools in which other actors than the IT provider can adapt the content. Most infrastructures mentioned do not have an interactivity function, which could mean that the end-users do not demand for a certain function and mostly look for new information or a tool which they can use them self. On the other hand, this could indicate a lack of interconnectivity possibilities to exchange between different AKIS actors.

Table 3: Good practices of interactive and open source, living tools.

MS	Title and responsible organisations	Description
BE	EVA-app: research station PC Fruit, producers	The EVA-app is an interactive tool to reduce administrative burdens which has evolved in a knowledge exchange tool and inventory of best practices related to comply with regulatory requirements. As a flexible tool the EVA-app frequently adapts content and structure.
DK	Landmand.dk: SEGES	SEGES is responsible for the IT development of Landmand.dk. It is a living digital platform where each user can set up their own personalised page with selected knowledge and information channels.
FI	Biomass Atlas: LUKE	Biomass Atlas is built on an Oskari open source platform for displaying and analysing geospatial data. Some technological functionalities developed for the Biomass Atlas are shared for open use within the Oskari community. However, the comprehensive development of Biomass Atlas only takes place at LUKE.
IT	IMAGE LINE: Image line SRL (private)	IL includes a community of producers and professionals which actively participates to receive advice, find the best products and services from companies and other rural actors and learn from experiences of technicians or other farmers and breeders. The adaptation of the IT tool is ensured by the community of professionals, farmers and other agricultural practitioners who animate the network of IL. One of the most used services is the farmer logbook software (under payment) which allows the farmer to fill out the register of treatments in accordance with the requirements of current legislation.
	Oenosmart: Copernico SRL (private)	Oenosmart is a digital platform which provides a system of digital maps a.o. on vegetation that together with meteorological maps, structure the cultural status of farms. It's a living tool open for content adaptation by the end-users, external to the IT provider.
NL	Green Knowledge Net: WUR	Green Knowledge Net is a repository and interactive platform for sharing and exchanging knowledge targeted specifically at academic, applied scientific and vocational education. GKN makes use of wiki's for example which students, teachers and researchers can develop and adapt in interaction. It is planned to broaden the platform for more AKIS end-users.

In general, monitoring of current digital platforms/tools is not well elaborated apart from some examples. Statistical information is made available by integrated IT applications. Some long-standing platforms use surveys to monitor the usage by end-users. The Austrian Arbeitskreise (Working Groups⁴⁸) measures the improvement of farm managers who take part in regular working group meetings. Main indicators to monitor the use of digital platforms/tools are:

- number of registered users;
- number of visitors;
- number of users of linked applications, calculations or other services;
- number of followers/users of linked social media channels;
- number of downloaders;
- number of shared content.

The respondents indicated three types of financial support for the presented digital platforms/tools: publicly, public-privately and privately funded. Many infrastructures which were developed from 2015, were supported by the RDP but mostly national or regional funds were used for their implementation. In some examples the NRN supported the digital network building and IT developments as well. Only some mentioned examples were purely based on private investments, which was the case in Bulgaria (Agri Gate Media and NAAS), in Italy (ImageLine) and Luxemburg (Convis). Most mentioned projects on developing tools/platforms are either co-financed or totally financed by user fees which assures the sustainability and continuity of these tools. The fact that most examples mentioned were developed with public (co)financing is likely due to the study focusing on in AKIS because there are many private digital tools/platforms available supporting knowledge flows.

⁴⁸ www.arbeitskreisberatung.at

The examples generally aim at linking AKIS actors, facilitating knowledge exchange, transferring research results and reducing administrative burden. However, some of the examples specifically focus on regional-based knowledge demands. In Austria, the *Arbeitskreise* platform provides a benchmark system (partly digital) for farm managers who take part in regular working group meetings. In Ireland the *Pasture Based Ireland* tool provides a benchmarking system to improve the kg. grass utilised per ha. (including usage of statistics e.g. the number of farmers entering data on a weekly basis). In the Netherlands the *Biodiversity Monitor for dairy farming* is a new performance tool which quantifies biodiversity enhancing efforts on dairy farms' based on Key Performance Indicators (KPI). The KPI results can be linked to develop new business models which stimulate ecosystem-based dairy farming. In Italy the *IRRINET* tool in Emilia Romagna is a free service which provides irrigation advice to the farmer on the time of intervention and the volumes to be used to optimise production while saving water resources.

Overall, the provided existing digital platforms and tools propose a wide range of opportunities for AKIS services, according to local climatic, economic, environmental or social needs. The main drivers are environmental legislative requirements, mitigation (a.o. regarding pests, climate change, demands for new varieties, irrigation, etc.) and market volatilisation. The operators can be both public and private actors and public-private cooperation is important to fully cover all available knowledge and know-how in well-functioning tools and platforms. In most examples cooperation is conspicuous by research institutes, advisors, chambers, ministries and IT companies.

Finally, MSs launched their national or regional EIP-AGRI Platform but most platforms are not applied for interactive knowledge exchange (yet). Many EIP-AGRI national platforms and knowledge reservoirs are used for publishing EIP-AGRI and international R&I project calls and introductions of innovative best practices and projects. For example, In Italy the National Rural Development Network manages the web portal (www.innovarurale.it) which is devoted to knowledge exchange on R&I. This includes a database of the operational groups, a database of research projects, a database of best practices in rural innovation, a tool to search partners for collaborative innovation, guidelines, news on the focus groups set up in Italy and other knowledge.

6.2 Digital tools and platforms used for CAP compliance in particular

Digital tools and platforms for CAP compliance are available in many EU countries and regions. In particular, most respondents indicated that digital tools are used for Nutrient Management Plans (NMP). Most NMP tools mentioned address the whole nitrogen cycle, from feed to manure application, including the ability for handling economic data. These tools are mostly coordinated by national authorities, NGOs and/or private companies. The end-users are mostly farmers and advisors who use NMP tools for fulfilling obligations related to the Nitrate Directive, Water Framework Directive, NEC Directive and CAP requirements. In general, NMP tools are based on national research results and a long history of knowledge and experience thus adapted to local soil, climate and other environmental conditions, taking into account nutrient application restrictions such as Good Agricultural Practice, in line with the Nitrate Directive. This means that the methods and results are very specific and depending on local conditions, for example locally developed soil tests which effect discrepancies between soil test results⁴⁹. This induces that one general NMP tool will not be applicable in all EU member states.

Most tools are able to handle complementary tasks, including manure storage calculations, irrigation planning, reporting to authorities, nutrient use efficiency, etc. Application of the Nutrient Management Plan is an interesting market while many SMEs and international companies provide tools according to local needs and official procedures of soil analysis. The user-friendliness of these services depend among others on the interfaces and digital competencies of farmers, the penetration of precision farming techniques, the accessibility of information and (big) data, size of farms, certification requirements by food chains partners, control procedures of national authorities and national laws. E.g. in the Netherlands there are special traceability requirements for manure transport. Many of these bottlenecks correspond with the general barriers of using digital tools/platforms described in chapter 4. Many mentioned tools for CAP compliance and nutrient management in particular, are not publically accessible

⁴⁹ Results vary if extracting materials are different as calcium-chloride or Kalium-chloride.

because of intellectual property and data ownership reasons. Farmers and advisors often pay a contribution fee for utilisation and data flows. Finally, many respondents indicated that tools and platforms shall be developed to be compatible with FAST suggestions in relation to new CAP requirements⁵⁰ and in particular more NMP tools shall be digitalised for further application.

Annex 2 contains the table (A2.1) with mentioned tools and platforms which are in line with the CAP objectives. We describe some examples in this chapter (5):

- AT, Austria: the publicly accessible LK fertilizer calculator is provided and updated by the Chambers of Agriculture. The high number of downloads makes the LK fertilizer calculator very successful. However, it is excel-based which may limit the possibilities for further high-end developments.
- DK, Denmark: the Landbrugsinfo transfers knowledge about nutrient management related to the growing of crops. The Mark Online Farm Tracking and Farm Manager tool offers digital solutions supporting nutritional management. Both tools are developed by SEGES.
- FI, Finland: Agrinuevos is a programme provided by a private company for cultivation planning and 'field book keeping', including estimations of required fertilisation.
- GB, United Kingdom: Tried & Tested is an initiative of the agricultural industry, aiming to help farmers to improve nutrient management planning through a toolkit of resources and guidance. In 2018, 60% of farm holdings (76% of the farmed area) in England reported the possession of a nutrient management plan and 18% of those with a plan used Tried & Tested.
- IE, Ireland: NMP Online is managed by Teagasc and is available to all advisors. Training and support is provided for all users e.g. Teagasc advisors, private advisors and teachers. Output is available to farmers online. As this service is based on professional interpretation of crop fertiliser recommendations, it is only available for use as a planning tool for professionally qualified and trained advisors. A small fee is applied for the use of the system.
- NL: The Netherlands: Kringloopwijzer is a dairy farm management tool based on nutrient efficiency, which dairy farmers are obliged to use. Data streams are, where possible, linked to other databases in order to minimise administration efforts of farmers.

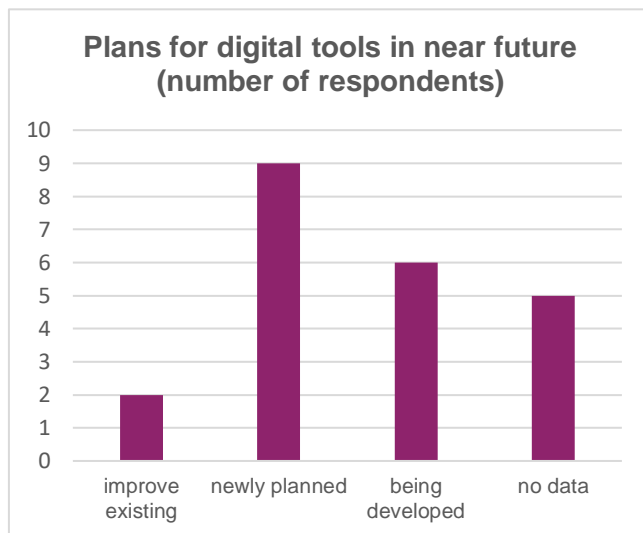
⁵⁰ CAP proposal after 2020 Annex 4., GEAC 5.

7. PLANNED DIGITAL TOOLS AND PLATFORMS ENHANCING KNOWLEDGE FLOWS IN AKIS

This chapter includes the analysis on planned digital infrastructures in EU MSs and regions to enhance knowledge flows in AKIS.

7.1 Analysis of planned digital tools and platforms in EU AKIS

Figure 2: Plans for digital tools in the near future



Most respondents indicated that there are plans in their countries/regions to (further) develop digital tools and platforms enhancing knowledge flows in AKIS. In some countries the aim is to improve already existing infrastructures, but mostly it is about constructing new initiatives. Six MSs (BG, BE, HU, LV, LT, NL) have already started with the development of new digital tools/platforms. See Figure 2.

The main driving actors behind new tools/platforms are mostly the countries' most prominent research institutes (see Figure 3). However, we could not derive from our analysis how many of these initiatives are coming from state

orders or are driven by EU policies or instruments. Other actors who initiate new plans for tools/platforms are national governments, advisory services, universities, farmer organisations, private companies and other actors.

Figure 3: Main drivers of the developments in AKIS digital tools and platforms

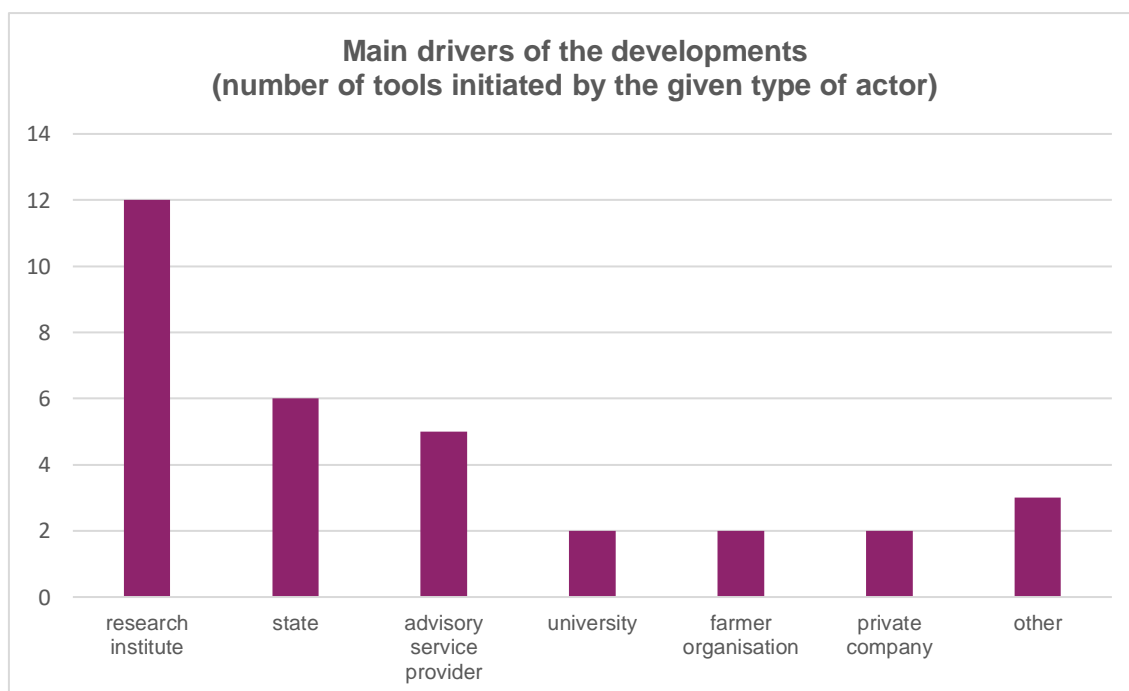
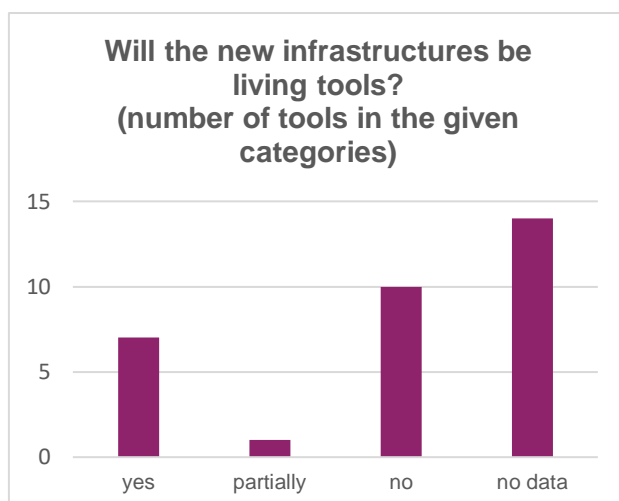


Figure 4: Planned living tools in AKIS



Approximately half of the mentioned examples in this analysis will not be merely repositories. Functions for interaction will make it possible for all users to get in contact, give feedback, upload content, etc. Compared to the existing tools, it can be concluded that more interaction possibilities within the tools/platforms will be developed, including living open source tools. More specifically, this would be the case in Belgium, Italy, Denmark (the latter will rather improve its existing tool), the Netherlands, the Czech Republic, Finland and Lithuania. See Figure 4. More interaction possibilities also means the need for more back office capacity to

coordinate and manage these functionalities.

Almost all planned tools will directly target farmers and more than half of the mentioned planned tools will target advisors and researchers. Policy makers, authorities, IT and machinery companies and training organisations were also mentioned relatively often as target groups. While POs, cooperatives, processors, traders, laboratories, consumers, bookkeepers, teachers, students, NGOs and farmer organisations were mentioned less frequently.

7.2 Planned digital tools and platforms used for CAP compliance in particular

Among the planned tools there are some which can potentially be used in future CAP implementation (BE - Soil passport, EE - Big Data Platform etc.). There is also an example of a tool which will be further developed and already declared to support CAP compliance as its main aim (HU - Smart FADN). The Hungarian Farm Accountancy Data Network (FADN) is planned to be developed further by the Research Institute for Agricultural Economics (AKI), to serve better CAP performance. The platform will interconnect farmers, advisors, bookkeepers, researchers and national authorities, providing information to all of them. The main challenge of the smart FADN development is to gather agro-environmental data according to CAP Annex III Indicators, in order to reduce administrative burdens of farmers and to assess the environmental performance of farmers. The basis of the planned development was provided by the European FLINT project and the national Sow R&D projects enabled a pilot test to select a representative basis and to collect all technical data. The next step will be the development of big data flows. The development of the tool will be financed from national budget in the framework of the Hungarian Digital Agriculture Strategy. Annex 3 contains Table A3.1 in which all digital tools/platforms being developed in EU MSs and regions are represented for which respondents provided more detailed information.

In chapter 6 it was made clear that there are already many tools and platforms for nutrient management. Ten countries (AT, DK, EE, DE, IE, IT, NL, SK, UK, ES) indicated that they already have tools/platforms in place for (future) CAP compliance. In addition, there are also many privately initiated tools and platforms available, which leads to discussions if more effort from the public side is needed to stimulate digital tools/platforms for CAP compliance regarding nutrient management in particular. As for future plans, five countries (BE, EE, DE, HU, LU) provided more detailed information about new digital initiatives to improve nutrient management which mainly target farmers and advisors (see Table 4). Luxembourg focuses specifically on developing a digital tool for nutrient management for advisory services.

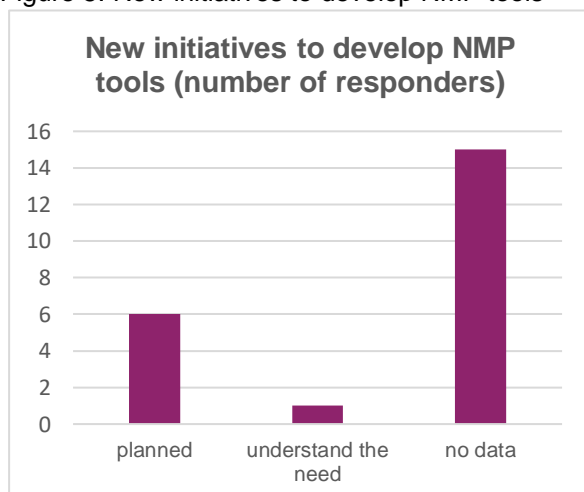
Table 4: New digital initiatives to improve nutrient management

Member state	Name of the planned tool	Developing organisation
Belgium*	Soil passport Watch-It-Grow**	ILVO
Estonia	Nutrient calculator	Estonian University of Life Sciences
Germany*	"fertiliser portal"	Chamber of Agriculture NRW
Hungary	SoilWeb	Research Institute for Agricultural Economics (AKI)
Luxembourg	digital system (including nutrient management), also in a mobile application version	Ministry of Agriculture in collaboration with advisory organizations

*responders believe already that it will be successful.

**for potato growers will be extended to all other arable crops.

Figure 5: New initiatives to develop NMP tools



In Bulgaria, there is no tool planned at the moment but they are aware of the CAP framework post 2020, indicating the demand for IT developments to address enhanced conditionalities (Farm Sustainability Tools).

Figure 5 shows a summary of the responses regarding new initiatives on NMP tools. Fifteen countries could/did not provide information on any planned improvements on NMP tools.

8. CONCLUSIONS

Digitalisation enhancing knowledge flows in AKIS

The main digital channels for knowledge exchange and dissemination, which are used in the different MSs and regions are (organisational) websites and databases, followed by digital platforms/forums, social media, applications (on PC and mobile) and digital newspapers/journals. In general digital channels influence the uptake of R&I results positively although some MSs indicate that digital dissemination of R&I results to end-users is not common (yet). Bottlenecks and success factors which either hinder or stimulate the usage of digital platforms and tools by end-users, can be categorised in: 1) technical aspects, 2) legal aspects, 3) economic aspects and 4) human capital/social aspects. Most mentioned bottlenecks and success factors have to do with human capital aspects, indicating a need for both educating and training of (future) farmers in digital skills and competences as well as enhancing professional support e.g. by advisors and innovation brokers, for farmers to use and adopt digital infrastructures for enhancing their farming practices. Well-informed, educated and experienced impartial experts who could help in shaping the attitudes and in the utilisation of digital tools/platforms by end-users, are (still) lacking. Digital tools must prove to be useful, add value to end-users/farmers and save them time. They should be able to deal with a large amount of data but in a way that it looks very simple and easily accessible to the end-user. Hence, interfaces must be kept simple and user-friendly. There is also a need for a legal background or at least for guidance on legal issues concerning sharing data and information. Furthermore, the specific needs of farmers are not sufficiently covered by the information that is being digitalised and is available in open access. User friendliness and interoperability between adjacent tools/applications should be also taken into better account when implementing digital platforms, tools or databases. Digital infrastructures developed by managing authorities and/or research (related) institutions are often not the result of a co-creation process with end-users. Some member states have 'knowledge counters' in place which guide the end-user to the requested information, connecting different AKIS actors and which act as an interactive forum with a Q&A and/or innovation brokering functionality. Finally, it is important to note that the inclination and passion for gadgets / apps or willingness for knowledge acquisition and utilisation, depends on the individual farmer.

National and regional digitalisation strategies in the EU

In several Member States a digitalisation strategy has been recently put in place at national and/or regional level. Often these digitalisation strategies affect different policy areas and in some cases a part of the digitalisation strategy at national or regional level, is specifically oriented at farming (e.g. in Wallonia, Bulgaria, Italy, Emilia-Romagna, Spain). These strategies mainly focus at economic profitability (e.g. increasing farmers income and production) and in some cases traceability, in order to meet market and consumers' demands. Activities cover a wide range of fields, for example ecosystem services, data driven projects, introduction of new technologies and precision farming techniques, digital infrastructures such as digital platforms and broadband connectivity, demonstration days on precision farming, and initiatives linked to education and training. In some countries such as Spain there is specific attention for enhancing knowledge flows in AKIS, including indicators for monitoring and evaluation. In most member states and EU regions a particular digitisation strategy/plan for agriculture is still being or yet to be developed. There is a difference in member states who already have a plan available to develop their strategy on, such as in Austria and Denmark, or countries which are in the early stages of developing a strategy specifically for agriculture.

Digitalisation strategies have often been introduced through a top down approach rather than being based on the end-users' needs in particular from farmers and advisors. Introducing e.g. thematic digital platforms for farmers, can help to overcome this and be more oriented to specific problems and demands from the end-user. Some countries which are still in the process of developing digitalisation strategies, have planned to make a survey on the end-users' needs. The most important groups of end-users that are perceived as financial beneficiaries are farmers and advisors but also researchers, authorities, companies, and educational institutions and/or initiatives should benefit from an agricultural digitalisation strategy. Some EU regions (Flanders, Tuscany, Emilia-Romagna, Catalonia) have implemented a smart specialisation strategy linked to digitalisation and precision farming with activities

strongly linked to the creation of digital innovation hubs and public/private partnerships. Most cases which have implemented a digitalisation strategy linked to agriculture, have developed a set of quantitative and qualitative, operational and impact indicators for monitoring and evaluation.

Existing digital tools and platforms enhancing knowledge flows in AKIS

The inventoried EU existing digital infrastructures offer a wide range of opportunities for AKIS services addressing local conditions, economic, environmental and/or social needs. The responses on the survey mostly concerned existing digital infrastructures initiated and owned by ministries, chambers or research institutes and some private initiatives. Operators can be both public and private actors and their cooperation is essential for well-functioning and complete knowledge transfer. Main drivers of the examples are environmental legislative requirements, mitigation effects and market volatilisation. Most mentioned tools/platforms were initiated based on EU legislation and primarily for environmental compliance. However, access to the latest market information, legal amendments and open calls, also motivate the launch of digital platforms. Only few examples of open source infrastructures were mentioned, in which end-users can upload or adjust own information.

Planned digital tools and platforms enhancing knowledge flows in AKIS

Many MSs and regions are taking initiative for the (further) development of digital infrastructures. Many of them originate from the need for data integration and sharing, both from the public side and from the private side, based on the needs of end-users (mostly farmers). These tools can have a broader scope (such as country-wide big data platforms), or can be related to rather specific areas (such as winter wheat production, dairy farming). New plans and solutions for NMP are also being discussed and developed. In addition, more and more digital innovation hub ideas to stimulate exchanges between different actors are being raised and implemented. However, dedicated tools and platforms planned to improve CAP implementation and compliance in particular, were not mentioned often in the surveys. This could be due to limited information provided by respondents, or it could also be assumed that countries/regions who have already existing and well-working data systems, did not indicate how they would improve their tools. It could also be that the countries/regions which will need to establish a better functioning (monitoring) system according to the approach of the new CAP, still do not have a specific idea on how to do that.

Compared to the existing tools (described in chapter 6), it can be concluded that more interaction possibilities within the tools/platforms will be developed, including living open source tools. Almost all the mentioned tools are directly targeting farmers, followed by targeting advisors and researchers. Among both the existing and planned tools there are some which can be potentially used in future CAP implementation and there are also examples of tools who already have declared to comply with the CAP. According to the mentioned examples, in almost all of the MSs involved in the survey one or more digital NMP tools already exist. At least from private initiatives but at least 10 MSs indicated that the available tool(s) can provide a good basis for future CAP compliance.

9. GENERAL RECOMMENDATIONS

The study provided examples of digital infrastructures which are merely used as repositories. Therefore, possibilities for interactions and exchange should be stimulated in the digitalisation strategies for agriculture to enhance knowledge flows in AKIS. Interoperability and connections between digital tools and platforms are still lagging. Hence, based on the results of this study, a further mapping of the status quo, gaps and blind spots of existing and developing platforms, tools and how they affect knowledge flows and knowledge uptake by end-users in the national/regional AKIS, should be provided. There are many tools and platforms in line with CAP objectives already and most of them are based on national or local knowledge and experience. However, to improve tools for CAP compliance or nutrient management in particular, learn from lessons, barriers and success factors from other instruments. More cross-regional exchange on digital tools and platforms enhancing knowledge flows in AKIS, should be organised. Entities such as respective H2020 projects, EIP-AGRI and SWG SCAR AKIS could create awareness among the MSs to stimulate opportunities for interregional exchanges.

Specific targeted recommendations are formulated below, along the following four categories, to further develop and improve digital tools and platforms enhancing knowledge flows in AKIS.

Organisational and technical aspects

- Develop centralised systems, hubs (or linked to hubs) in which all digital tools, apps, and useful information are available as well as single national or regional nutrient management systems. 'Knowledge counters' which guide the end-user to the requested information, connects different AKIS actors, have an interactive forum functionality and the possibility for Q&A, can support these systems.
- The initial development and investment in digital infrastructures and tools should be supported by the public domain.
- As well as promoting the targeted (sector-/region-/farm-size) development of digital consulting tools and solutions (e.g. apps), design them in a way that is as farm-specific as possible with less general information, more focused and solution-oriented. This would require various data which are currently not collected or processed in several countries. Some data-bases in EU member states are out-dated.
- Build better internet infrastructures or upgrade them, in particular in rural areas. A priority to develop digital infrastructures including tools, is the availability of high-speed internet.
- Support the (further) development of digital knowledge hubs, interlinking digital databases and 'remote' advisory services.
- Develop a personalised calendar and information system, which informs the farmer with relevant information at the right timing;

Legal aspects

- Regarding interoperability, there is an urgent need for defining a broad adoption of standards (for data formats), so that adjacent systems can communicate and be better linked.
- Digital tools and platforms should be used more for decision making in farming practices (e.g. livestock performance recording data) which should be supported by obligating data collection and facilitated by automatic transmissions.
- Protection of farmer's data is a very important topic. However, field data and digital tools should in general be able to be used openly and freely available to any AKIS actor for legal requirements and beneficiary developments in farming practices. Hence, we need rules and regulations on data ownership and management. The Code of Conduct by Copa Cogeca could offer perspective.
- Ensure continuous professional development (after graduation) by making it obligatory in every second year for all types of agricultural engineers to broaden their digital skills.

Economic aspects

- The public and private sector need to cooperate tightly since the private sector is capable in creating customer friendly solutions, including a better integration/coordination of public funds to support private investments on digitalisation.

- Platforms and tools which focus on real-time data and business intelligence information at individual farm level, provide the farmer a quick overview of the status of selected focus areas.
- A digital platform should make it easy to combine individual farm data stored in a central data hub with data and information from dairy, slaughterhouse etc. as well as official data, in order to support the farmer with intelligent, personalized information.
- Support the development of pilot projects/developments and experimenting, aiming at reaching viable business plans with advisory support.
- Stimulate more synergies at cross-sectorial and programming level to support the setting up of digital infrastructures along with the enhancement of capabilities, skills and competences.

Human capital and social aspects

- The benefits of digital platforms must be clearly recognisable for farmers and easy to use for all ages and educational levels.
- Communication between advisors leading to the improvement of digital platforms and tools, should be improved.
- The enhancement of multi-actor regional networks should be promoted by stimulating digital interactive platforms, including EU- wide networking of AKIS actors for exchanging knowledge and experiences.
- Farmers should be trained and educated (also the future generation of farmers) how to use different tools and applications which can help both their daily activities and provide them with better insight for decision making on the longer term.
- Examples of successful results from knowledge uptake via digital platforms, should be demonstrated and promoted to farmers.
- Organise workshops and seminars to support farmers in the possibilities and opportunities of digital platforms and tools at regional, national and EU level.
- Develop topic-specific applications, which are not too complex to use, including an introduction and basic information e.g. handling animals as a video tutorial.
- Develop formal qualifications in education systems and professional development points for farmers in applying digital tools to improve farming practices.
- Peer-to-peer mechanisms for farmers and consultants associated to digital platforms should support the development of trust and confidentiality in using digital infrastructures.
- Provide relevant trainings on skills and competence development to both farmers and farm advisors. Digital teaching materials are to be made available on dedicated online platforms which could include both a public, free access availability as well as paid for content.
- Focus on stimulating and enhancing possibilities for feedback and interaction in both platforms and tools, including rating processes on the use of digital infrastructures and good practices of R&I uptake. This helps to reduce the reluctance by some end-users.

Sustainable AKISs ought to support the enhancement of digital knowledge flows. However, in some countries the AKIS are very dynamic in which changes often occur. The CAP can support enhancing knowledge flows in AKISs, in particular by:

- setting up trainings (in the Farm Advisory System), organising field-days and study-visits about the possibilities of digital solutions in agriculture to provide digital impartial/institutional information to end-users;
- promoting the setting up of networks among farmers and advisors to exchange knowledge and experiences;
- introducing topics in EIP-AGRI on stimulating and development of digital infrastructures to enhance knowledge flows in AKIS in particular, linked to national and regional digitalisation strategies for agriculture e.g. new technical solutions for disseminating knowledge and information;
- setting up operational groups for the development of new business models across the supply chains based on digital platforms, tools and technologies to enhance knowledge flows;
- inclusion of a set of digital based tools/possibilities to enhance engagement with compulsory actions in relevant measures;

- better coordination and synergies between structural and cohesion funds to support the setting up of the digital infrastructures, the enhancement of capabilities and knowledge and investments in digitalisation.

Specific recommendations concerning digitalisation strategies, are to:

- make a detailed inventory of the end-user needs, in particular farmers' needs as a basis for the development of a digitalisation strategy for farming;
- develop evaluation assessment methodologies, including digitalisation indicators and end-user satisfaction levels, which have to be in place to monitor the efficacy of digitalisation strategies at national and regional level, and to adopt accordingly;
- develop digitalisation strategies for farming in a co-design approach with farmers, farmer and advisory organisations strongly involved.

Digitalisation strategies at national and/or regional level should not only cover digital tools and field data but should also cover digital infrastructures to stimulate knowledge flows (e.g. innovative information and project results) between all actors of the AKIS. Digital connections between EIP-AGRI (H2020 multi-actor, OGS) and other projects, are to be enhanced through a.o. national rural networks. Finally, MSs should take advantage of the results of European H2020 projects such as FAIRshare, EURAKNOS, EUREKA and NEFERETITI and the NIVA42 project.

10. RECOMMENDATIONS FOR THE SWG SCAR AKIS 5TH MANDATE

The study has brought forward very rich information on the status quo and plans for digital tools and platforms to enhance knowledge flows in AKIS. Considering the uniqueness and respecting the contexts in the different MSs and regions, we recommend first of all to invite EU MSs and regions to present the survey results in a SWG SCAR AKIS plenary meeting or by organising a separate meeting, dedicated to digitalisation to enhance knowledge flows. The aim would be to exchange experiences and plans among the MSs, to inspire each other and to co-design solutions together. This will not in the least place, lead to more understanding in current and future digital infrastructures to enhance knowledge flows in the different regions and MSs in the EU.

More specifically we recommend the SWG SCAR AKIS to focus in its 5th Mandate on:

1. THE WHY: by understanding and gaining insight why there is still a considerable gap between available digital tools/infrastructures, the uptake of (R&I) knowledge and exchanging knowledge, information and data (regarding willingness and capacity). Tools and platforms are just means to achieve the aim of enhancing knowledge flows. So start with this principal, basic question;
2. THE HOW: the second question which should be addressed by SWG SCAR AKIS, is how digital platforms and tools are developed in the different MSs and regions and how they will be (further) developed in the future. From the study results we learned that there are many tools and platforms already. Interoperability and interconnectivity are still lagging. There should be a further analysis and mapping in the countries and regions, which tools address which specific topics and provide which kind of information and how adjacent tools and platforms could be better connected. User-friendliness and facilitation should be the central aim. Like Google, the end-user should not have to be aware of the app, tool or platform he/she is using. E.g. it is required to enhance connections so that farmers only have to enter data once and data can serve more multiple purposes than they do now, respecting the ownership and legal requirements of the data. SWG SCAR AKIS can organise discussions with partners such as COPA COGECA, (H2020, EIP-AGRI and other) projects and end-users (representatives) on data ownership, focusing on creating win-win situations for the end-user, including user-friendly and targeted tools/platforms, within the value chain. We mention the farmer as a logical end-user, but the 'how' question naturally addresses all AKIS end-users, hence, this ought to be a layered discussion for all target groups.
3. THE WHO: the farmer is the pivot in knowledge flows, yet the study shows a lack of inventoried needs resulting in top-down driven tools and platforms to enhance knowledge flows. Monitoring of digital infrastructures and evaluating their effects, are also meagrely applied in many of the mentioned examples. There is a need for public-private cooperation in developing digital tools, platforms and strategies for enhancing knowledge flows, since it is the business model of companies to develop end-user/customer relations, to create awareness of tools/platforms and user-friendly interfaces and applications. However, public partners are required to ensure the independency, completeness of shared information and inclusiveness of all actors within AKIS knowledge flows. The who-question also addresses the need to develop skills and competencies among end-users. Train-the-trainer principals should focus on developing 'digitally wise' advisors and innovation brokers who facilitate and innovate farming by transforming the farmer's business in more digitally oriented farming. On the other hand, farmers and future farmers, need to develop skills and competencies on their own to become more acquainted with the possibilities digital tools and platforms have to offer. It is about facilitating the job, innovating the farm and transforming farming

as a way of life in which the digital revolution is an ongoing fact. Again, also the 'who' question should address not only the farmer but all AKIS actors involved in the further development of digital infrastructures for enhancing knowledge flows in agriculture. In particular the crucial role of *education* in the integration of ICT in agriculture and farming should be tackled in the discussions and the work of SWG SCAR AKIS V.

Finally, we recommend to form a subgroup within the SWG SCAR AKIS group to further build on the results of this study and surveys, to develop a policy brief on the role of digital tools and platforms, enhancing knowledge flows in AKIS.

ANNEX 1. Examples of existing digital dissemination channels

This annex presents examples of existing digital dissemination channels (such as public or private websites, social media, mobile apps, etc.) for knowledge exchange, mainly used by agricultural practitioners (end-users) in EU countries.

Country	Website / other	Social media	Mobile apps
Austria	www.lko.at	www.facebook.com/landwirtschaftskammern	
	www.lfi.at	www.facebook.com/landwirtcom	
	oekl.at		
	www.baeuerinnen.at		
	meinhof-meinweg.at		
	www.meinbetrieb-meinezukunft.at		
Belgium	Watch it grow	Facebook	EVA
		YouTube	REDUNG
		Blogs	
Bulgaria	fermer.bg ¹		
	www.dfz.bg ²		
	www.naas.government.bg ³		
	agrozona.bg ⁴		
Croatia		YouTube, Facebook	
Czech Republic		Facebook, Twitter	
Denmark	www.landbrugsinfo.dk ⁵	Facebook groups ⁸	
	www.landmand.dk ⁶		
	svineproduktion.dk ⁷		
Estonia	www.pollumajandus.ee ⁹		
	maaleht.delfi.ee ¹⁰		
	www.pikk.ee ¹¹		
	pollumeheteataja.ee ¹²		
	maainfo.ee ¹³		
	edukad.etag.ee ¹⁴		
	www.agri.ee ¹⁵		
	www.toiduteave.ee ¹⁶		
Finland	www.maaseutu.fi/maaseutuverkosto		
	www.farmit.net		
	www.rural.fi		
	kartta.paikkatietoikkuna.fi		
	www.fmi.fi		
	www.foreca.fi		
Germany	www.landwirtschaft-bw.de ¹⁷		Agrar ¹⁹
	www.landwirtschaftskammer.de ¹⁸		
	Hortigate ²⁰		
	Pro-Plant ²¹		

	ISIP ²²		
Greece	National Rural network ²³		
	SmartAgriHubs ²⁴		
	GaiaSense DIH		
Hungary	agroinform.hu		
	agrarszektor.hu		
	agrarszektor.hu		
	www.met.hu		
	www.nak.hu		
	portal.nebih.gov.hu		
Ireland	www.teagasc.ie	WhatsApp	AgriLand
	www.agriLand.ie	www.youtube.ie/teagasc	
	www.agriculture.gov.ie		
	www.farmersforum.ie		
Italy	www.reterurale.it		
	www.innovarurale.it		
	www.rural4learning.it		
	www.imaginenetwork.com		
	www.agriturismoitalia.gov.it		
	gaia.crea.gov.it		
Latvia	new.llkc.lv		
	www.laukutikls.lv		
	www.lad.gov.lv/en/news		
	esatbalsti.llkc.lv/		
	ks.llkc.lv/demofarm/investanalize		
	laukutikls.lv/nozares		
	rpl.llkc.lv/		
	laukutikls.lv/riki/tehnikas_aprekins		
	www.llka.lv		
	www.ldc.gov.lv/lv		
Lithuania	www.agroakademija.lt		
	www.manoukis.lt		
	www.lzukt.lt		
Luxembourg	agriculture.public.lu/de.html		
	www.convis.lu/home.html		
	www.lwk.lu		
	lbla.lu		
	www.agrimeteo.lu/Internet		
	www.list.lu/en/research/project/sentinel3		
	www.list.lu		
The Netherlands	www.boerderij.nl	You Tube, Facebook, Twitter, LinkedIn	
	www.kennisonline.nl		
	www.groenkennisnetwerk.nl		

	www.netwerkplatteland.nl		
Portugal	www.agroportal.pt		
	www.agriculturaemar.pt		
	www.agronegocios.pt		
Romania	http://www.apia.org.ro/ https://www.afir.info/ https://agrintel.ro/		
Slovakia	www.agroporadenstvo.sk		
Slovenia		You Tube	
Spain	ruralcat.gencat.cat	WhatsApp, Instagram, Facebook, Twitter	
Sweden	Växa Sverige		
	www.cropsat.se		
	www.markdata.se		
	Vallprognos		
UK	Innovation for Agriculture		
	AHDB		
	Agricology		
	Innovative Farmers		
	The Farmers Forum		

Notes:

- 1) A private website of a farming media.
- 2) Website of State Fund Agriculture /Paying Agency.
- 3) Website of the National Agriculture Advisory System.
- 4) A private website and on-line platform of a farming media.
- 5) Main website for knowledge exchange to advisors, farmers and other stakeholders.
- 6) Website is a personalised website mainly for farmers.
- 7) Website that focuses on knowledge exchange related to pig production.
- 8) Run by SEGES, advisory centres, individual advisors, farmers etc.
- 9) Weekly electronic newsletter Agriculture of private media corporation (also active in Facebook). Other private corporations provide their weekly information – situation of crop-fields, need for plant protection activities etc.
- 10) Private newspaper which also provides news in social media.
- 11) Website of Agricultural Advisory System which contains information about principles of agriculture and calendar for agricultural events.
- 12) Monthly newsletter provided in cooperation with private farmers organisations (Estonian Chamber of Agriculture and Commerce, Estonian Farmers Union, and central cooperative for private forest owners).
- 13) Website of Estonian National Rural network with info about innovation projects.
- 14) Website of Estonian Research Council which provides research-related news and successful project descriptions.
- 15) Website of Ministry of Agriculture of Estonia about different legislations and development strategies.
- 16) Websites of knowledge transfer programmes and information about events, published materials etc.
- 17) Extensive portal with more than 20,000 documents and neutrally provided by public authorities.
- 18) The country's most frequently used website for information on educational programmes, application procedures, advisory services, promotion measures and nutrient management.
- 19) App developed by the Landwirtschaftskammer NRW (North Rhine-Westphalia Chamber of Agriculture) which announces dates, e.g. via lectures, field inspections, etc. to an interested circle of users. A plant protection module is connected, which can be used for a fee within the scope of the consultation.
- 20) A knowledge platform for horticulture.
- 21) An expert system as a decision-making aid in plant protection.
- 22) Expert system and knowledge platform with focus on crop protection.
- 23) National Rural network from the Ministry of Agriculture and Rural development.
- 24) Digital Innovation Hub for Smart Farming at Agricultural University of Athens
- 25) RO: http://www.apia.org.ro/ - website of Payment and Intervention Agency for Agriculture (the Paying Agency for area-based support), https://www.afir.info/ - website of Agency for Rural Investment Finance (the Paying Agency for investment support), https://agrintel.ro/ - popular private website offering comprehensive on-line news and information for farmers. Facebook is very popular with farmers and there are several dedicated groups (e.g. *Fermierul roman* with over 150,000 followers) where information is shared, services are exchanged and products are traded.

ANNEX 2: Table of EU existing digital tools and platforms in line with CAP objectives

In the following Table A2.1 examples of digital tools and platforms are described per EU country/region which are in line with CAP objectives. They can be either public, public-private or private initiatives.

Table A2.1 Digital tools and platforms in line with CAP objectives

C/R	Digital tools in line with CAP objectives	Who manages it?	Who uses it?
AT	LK fertilizer calculator	Chambers of agriculture	Farmers
	ÖDüPlan	Soil and water protection consultants	Farmers
	LBG ground detector	LBG	Farmers
	AgrarCommander	AgrarCommander GmbH	Farmers, Contractors
	Farmdok	Farmdok GmbH	Farmers, Contractors
BE	E-loket ⁵¹ : e-portal for communication and information exchange. The E-loket also provides access to Geoloket Agriculture to retrieve information of agricultural plots	Gvt. Dpt. Agriculture and Fisheries	Farmers and advisors
BG	Green payments calculator ⁵²	State Fund Agriculture /Paying Agency	Farmers
<i>NB. No digital nutrient management tools are being used so far for CAP compliance.</i>			
CZ	eAGRI websites registers (mainly registry of land, animals, fertilizers, plant protection, portal for subsidies)	Ministry of Agriculture	Farmers, professionals, public
DE	Nutrient balance	The State Institute	Consultants, farmers and administration
	GQS Court Check	Chamber of Agriculture NRW LEL Baden Württemberg	Counsellors, agricultural office staff, farmers,
<i>NB. There are many more digital tools, which are at the disposal of the administration, associations and farmers. Furthermore, there are EDP applications and forms for a.o. determining fertiliser demand and nutrient comparison. A nutrient management digital tool is in planning.</i>			
DK	Landbrugsinfo ⁵³	SEGES	Farmers, advisors and stakeholders
	Farmers can get access to a personalised website Landmand ⁵⁴	SEGES	Mainly farmers
	Different digital solutions supporting the CAP compliance e.g. plants, cows and economy ⁵⁵	SEGES	Mainly farmers

⁵¹ <https://www.landbouwvlaanderen.be/eLoket/Domain.Eloket.Portaal.Wui/>

⁵² <https://seu.dfz.bg/seu/f?p=727:8130:::NO:::>

⁵³ www.landbrugsinfo.dk

⁵⁴ www.landmand.dk At this website farmers get general information, production related information and specific information for their farm e.g. the fertilizer norm for the actual year.

⁵⁵ <https://www.seges.dk>

EE	Several calculators for nutrient management (humus balance, grazing, volume of manure storage). Farmers must provide a calculation that the planned harvest and the amount of fertilizer are in balance. The use of calculator is not required.	Humus balance calculator (Estonian University of Life Sciences), Grazing calculator (NPK left to field, Estonian Chamber of Agriculture and Commerce), Manure storage volume – Ministry of Agriculture and balance of plant nutrients (project BalticDeal, ended).	Farmers, advisors and scientists
	Map-application for register of agricultural parcels (including farm buildings, landscape elements etc.). The electronic map is linked to the area-based support.	Paying Agency	Farmers, advisors, officials
FI	Nutrient management programs, databases and other ProAgria tools	ProAgria advisory center and private companies Suonentieto Ltd, Datek Finland Ltd, Softsalo Ltd and some other private companies	Farmers, advisors and researchers
	Agrineuvos	Suonentieto Ltd.	Farmers
	Aktiivi Pelto	Datatech Ltd.	Farmers
	Peltotuki Pro	Softsalo Ltd.	Farmers
GR	Field locator, cotton crop management (e-cotton), olive sector producer organisations, programmes and other online apps.	OPEKEPE (paying agency)	OPEKEPE, administration, farmers, POs
GB	Tried and Tested	National Farmers Union (NFU), Country Land and business Association (CLA), Linking Environment And Farming (LEAF), Catchment sensitive farming (CSF), British Grassland Society (BGS), The Agricultural Industries Confederation (AIC)	Farmers for nutrient management
HR	Nutrient balance software	Farm advisory service	Farmers
ES	<i>There are no prescriptions for the use of digital tools for CAP compliance but there are some tools already in place used by farmers, such as sigAGROasesor on nitrogen, phosphorus and potassium nutrients. In Catalonia RuralCat includes a virtual office exclusively dedicated to fertilisation.</i>		
HU	Land Parcel Identification System (MePAR)	Lechner Knowledge Center	Farmers, advisors, rural consultants, accountants
	Farm Accountancy Data Network (FADN)	National Agricultural Research and Innovation Center (NAIK)	Farmers, policy makers, private companies, researchers
	Integrated Administration and Control System (IIR)	State Treasury (Paying Agency, MÁK)	Farmers, policy makers, national authorities, rural consultants, accountants
	Information system on market prices (PÁIR)	National Agricultural Research and	Farmers, input providers, chain

		Innovation Center (NAIK)	partners, policy makers, researchers, advisors, rural consultants
	Farm data reporting tool (WebGN)*	National Food Chain Safety Office	Farmers, advisors, rural consultants, national authorities
	Nitrate reporting tool*	National Food Chain Safety Office	Farmers, advisors, rural consultants, national authorities
	E-cellar book	National Food Chain Safety Office	Wine farmers, bookkeepers, custom officers, advisors
	e-AKG	Ecologic consulting Ltd.	Farmers, advisors
	<i>Nutrient management tools</i>		
	Proplanta	Hungarian Academy of Sciences (MTA)	Farmers, advisors, rural consultants, researchers
	3RP Systems	Hungarian private company	Farmers, advisors, rural consultants, researchers
	Agrovir	Hungarian private company	Farmers, advisors, rural consultants, researchers
IE	Agfood.ie – BPS, Animal Records, Dept. Scheme Application	Dept. Agriculture Food and the Marine	Farmers, advisers/consultants
	Nutrient Management Planning (NMP) Online	Teagasc	Advisers/consultants
	Herdplus	ICBF (farmer led organisation)	Farmers
	Farmflo (assists compliance)	Farmflo (private)	Farmers
	Herdwatch	Farm Relief Service	Farmers
	APHA Veterinary Compendium	Animal and Plant Health Association	Farmers/veterinaries
	Kingswood Computing	Private Company	Farmers
	Agrinet Computing	Private Company	Farmers/advisers
IT	La Baseline: an informative campaign which uses a variety of communication channels to inform farmers and advisors on CAP compliance requirements	ISMEA (under the framework of the National Rural Development Network)	Farmers
IT	IRRINET-IRRIFRAME TOOL	Canale Emiliano Romagnolo CER – Emilia-Romagna Region	Farmers, technicians, agronomists, regional stakeholders
LT	IKMIS system (Information System for Plant Protection) ⁵⁶	LAAS	Farmers, advisors, researchers, policy makers
	Farm Management Programme e-GEBA ⁵⁷	LAAS	Farmers, advisors, researchers, policy

⁵⁶ Publishes catalogues of plant protection products, diseases, pests and weeds that help identify a disease or pest more quickly and make it easier to choose plant protection products registered in Lithuania. Includes map-application of monitored agricultural parcels.

⁵⁷ The farm management programme accumulates farm data, plans farm activities, manages available stocks, performs comparative analysis, evaluates farm activity results and prepares reports for controlling institutions. Farm data is automatically generated from external data controllers.

			makers
	Farm assessment service ⁵⁸	LAAS	Advisors
	Mobile precision farming training stand ⁵⁹	LAAS	Advisors, farmers, researches, policy makers
LUX	Tools for nutrient management currently exist of 3 different systems used by advisory organisations	Convis, Chambre d'agriculture and Naturpark Oewersauer	Advisors and farmers Convis: 371 farmers Chamber: 388 farmers Naturpark: 66 farmers
LV	Latvian Paying Agency (Rural Support Service) Electronic Application System ⁶⁰	Rural Support Service, in cooperation with developers from AUTENTICA Ltd.,	Beneficiaries of supports
	Latvian Paying Agency-s (Rural Support Service) greening Calculator: to calculate farm's greening requirements ⁶¹	Rural Support Service	Farmers, advisors
	Cross-compliance review (service by EL Rural Development Plan) ⁶²	Latvian Rural Advisory and Training Centre (LLKC)	Farmers, advisors
NL	Kringloopwijzer	Zuivel NL, LTO, NZO, Nevedi, VLB (private)	Dairy farmers, advisors
	Biodiversity Monitor for Dairy Farming	WWF-NL, FrieslandCampina, Rabobank, Duurzame Zuivelketen (DZK, a wider sector initiative for sustainable dairy), Foundation Biodiversiteitsmonitor for the sustainability.	Dairy farmers, dairy companies, financial institutes, local/regional governments, water boards, drinking water companies.
PT	<i>There are a few platforms developed by farmers associations or technology centres on e.g. irrigation management and pest control. However, they are only used by a minority of farmers.</i>		
RO	Annually-updated on-line guide (PDF format) to cross compliance: http://www.apia.org.ro/files/pages_files/Ghid_econoconditionalitate_2019_Ed_V.PDF Together with list of current modifications to the cross compliance rules: http://www.apia.org.ro/files/pages_files/Instruțiuni_modificare_Ghid_2018.pdf	Payment and Intervention Agency for Agriculture (APIA)	Farmers and advisers
	Numerous variants (very confusing!) in PDF format of the Code for Good Agricultural Practice for the Protection of Water (the basis of SMR1) A downloadable nutrient management planning tool in Excel spreadsheet format: https://www.icpa.ro/documente/calculator_cod_bune_practici_agricole.xls	National R&D Institute for Soil Science, ICPA Bucharest	Farmers and advisers
	INPCP website with news, events, presentations, documents relating to the control of nitrate pollution: https://apanoastra.ro/ . This includes an on-line platform intended specifically to support compliance with the Code for Good Agricultural Practice for the Protection of Water (the basis of SMR1) with FAQs, a Forum for technical advice / peer-to-peer exchange and a link to a telephone Help Line: https://infonitrati.apanoastra.ro/	Project Management Unit of the Integrated Nutrient Pollution Control Project (INPCP), Ministry of Waters and Forests	Farmers and advisers
SL	Monitoring nutrients and pH in soil. The owner and the administrator is The Central Control and Testing Institute in Agriculture, but the user of the tested soil receives detailed information about the nutrient content of the soil and pH. Publicly available are only data and datasets on pH and nutrient status in soils on average for individual territorial units.		
SE	Digital applications for CAP support	Board of Agriculture	All farmers
	Nutrient balance	Board of Agriculture	Local farmers

⁵⁸ (In a form of a questionnaire) provided to farms receiving European Union support when they are subject to management, good agricultural and environmental condition and other requirements.

⁵⁹ Used for demonstration of smart equipment for agricultural machinery in order to promote sustainable agriculture complying with requirements for the CAP.

⁶⁰ <http://www.lad.gov.lv/en/eas/electronic-application-system/>

⁶¹ https://eps.lad.gov.lv/greenery_calculator

⁶² <http://laukutikls.lv/savstarpejas-atbilstibas-atbalsta-nodrosinasana>

	Vallprognos	SLU and several organisations/ companies	Farmers, advisors, sales managers
	Dataväxt	Datavaxt.se	Farmers, advisors

ANNEX 3: Digital tools/platforms being developed in EU MSs and regions

Table A3.1: Digital tools/platforms being developed in EU MSs and regions

MS	Title	Description
Bulgaria	Agrinizer	An online platform for electronic trade of cereals targeting and interconnecting both producers, traders and processor. The creator of the platform is a producer of cereals. The platform won the Innovations' competition at the International Agricultural Exhibition 'Agra 2019'. However, it is a private initiative, so even if for one year it has been available for free, it will probably only be accessible for a certain fee in the future.
	AgroHub.BG	The Digital Innovation Hub for agriculture will make it possible for all kind of stakeholders in the agribusiness sector to interact, aiming at bringing together knowledge and resources, to combine expertise in order to generate solutions for raised problems/ needs. The platform is being developed as part of the SmartAgriHubs H2020 project.
Belgium	Soil passport	The Soil passport will create a 'medical record' of field plots in which all soil data (crop rotation, treatments, analyses, yeals, environmental conditions) are compiled. The development of the tool has been initiated by ILVO, who set up a multi-disciplinary team (soil specialists, data managers, image analysts etc.) to work on a platform which, integrating the relevant data and supporting farming decisions, could serve a more sustainable and climate-friendly soil management in the future, also potentially become a policy instrument of the new CAP.
	Agrofood Datahub	A hub is being developed between 2018 and 2020 by ILVO in cooperation with the Innovative Company Network, six companies (AVEVE, Boerenbond, CRV, DGZ, Innovatiesteunpunt, Milcobel) and agricultural organizations for data sharing with a focus on transparency, data privacy and data ownership. The concept is trialed first with the involvement of dairy farms.
Croatia	State Agricultural Information Center	Initiated by the state, to serve as a source of information for farmers, advisors, public officials and other interested stakeholders in the farming sector. The need for its development, along with the creation of a <i>Knowledge HUB</i> , will probably be integrated in the CAP Strategic Plan.
Estonia	Big Data Platform for Agriculture	Initiated by the Agricultural Research Center, to increase the availability, attractiveness and operability of agricultural data by linking the relevant state-owned databases (appr. more than 40) and providing related data-analytics functionality. A number of third parties (state bodies, IT companies) would be able to profit from that, and develop applications needed by their customers (farmers, policy analysts etc) to serve a broader public. At the moment a feasibility study (Sep 2018 - Sep 2019) is taking place describing also the concept and the roadmap for implementation.
Finland	SmartAgriHub	Plan of a digital innovation hub to connect all relevant actors in the Finnish AKIS. It will be implemented in the framework of SmartAgriHubs H2020 project.
Hungary	Online knowledge reservoir	Currently being developed by the Hungarian Chamber of Agriculture (NAK) to gather relevant practical knowledge (from TN projects, and also directly from researchers and other AKIS actors) and introduce it in an attractive way for the use of practitioners in the agri-food sector (for advisors at the first place), in a publically available form with interactive functions as well.
	Smart FADN	The Hungarian FADN is planned to be developed further especially with the aim to support CAP compliance, e.g. to reduce administrative burden for farmers. <i>More info is in Box 4.1 below</i>
Greece	Open meteo data platform	Through a currently launched call for tenders the aim is to build up (2019-2021) a country-wide digital infrastructure deploying and interconnecting 6,500 meteo stations with the development of a centralized data platform. The gathered data with remote sensing data would be integrated and provided to agricultural stakeholders as open data.
Ireland	Agricultural E-learning platform	Initiated by Teagasc to interconnect learners (farmers, indutry professionals), teachers, advisors, tutors, course administrators, external verifications, awarding bodies, college management for interactive education purposes.

	Online Nutrient Management Planner Upgrade	Improvement of the existing nutrient management planning system used by advisors to prepare nutrient management plans for farmers. The development will be made by Teagasc who is the owner of the system as well.
Italy	Agri Digital Innovation HUB	The aim is to connect farmers, farmers Organizations, high tech companies, RTOs for new technological solutions in the framework of the regional strategy Industry 4.0. Additionally, through the S3 HTF Partnership, also an interregional platform/interface is planned to be set up. Long-term operation will be ensured by PPP.
Latvia	Decision Making System	EIP project led by the Latvian Rural Advisory and Training Center (LLKC) with the goal to create an Internet-based winter wheat leaf and ear disease control system to support farmers in their decisions on phytosanitary issues.
	Decision making in winter rape	Also project financed by RDP (measure 16.2), implemented in the cooperation of more companies with the aim to provide a decision making tool on the use of plant growth regulator in winter rape, targeting farmers.
	Digitalisation of beekeeping	EIP project to develop an autonomous technological solution that meets the environmental conditions of Latvia with multi-parameter sensory analysis of bee colonies and beekeeper notification.
Lithuania	Gates of Innovations (TITRIS)	EIP project led by LAAS (Lithuanian Agricultural Advisory Service) to create an information system of innovation results (database), and in cooperation with research and academic institutions to set up a demonstration farm network.
	IKMIS2	It is planned by LAAS to develop further its existing platform (IKMIS: information, consulting and training system in the field of integrated plant protection). The aim is to broaden it for other sectors, such as horticulture and gardening.
Netherlands	Green Knowledge Net 2.0	The plan is to redesign the existing Green Knowledge Net to a digital interactive data infrastructure and knowledge platform (a living tool) for all AKIS actors.
	Biodiversity Monitor	The existing system provides data on farm performance regarding biodiversity both to the farmers and consumers. Now it is planned to improve its 5 KPIs with 2 more KPIs for herb-rich grassland (% of total farm acreage), and nature & landscape (% of land managed for nature conservation). For this purpose, next to the database of the existing obligatory Kringloopwijzer for dairy farmers, a national registration system for agricultural nature management is currently in the pilot phase (executed by Duurzame Zuivelketen and BoerenNatuur) to deliver relevant data per farm. Also the development of a foundation is planned to be responsible for gathering all needed (farmer-owned) data from the other systems, data analysis and scoring, and providing legal access to the KPI scores per farm to end-users. Ensuring the long-term sustainability of the infrastructure.
Spain	datos.gob.es along with Aporta Initiative	Aporta initiative was launched in 2009 to promote the opening of public information and the development of advanced data-based services. With datos.gob.es as the infrastructure behind it. The aim is to make possible the direct reuse of information generated by the public sector in order to improve also the agricultural sector, encouraging the talent, technical capacity and creativity of the participants The platform of datos.gob.es is in continuous change/renewal..

