Food and Agriculture Organization of the United Nations

DIGITAL EXCELLENCE IN AGRICULTURE REPORT

FAO-ITU Regional contest on good practices advancing digital agriculture in Europe and Central Asia

Advanced copy – September 2021

ACKNOWLEDGEMENTS

This report was prepared for the Food and Agriculture Organization of the United Nations (FAO) and the International Telecommunication Union (ITU) by Mihaly Csoto and László Gábor Papócsi, with the support and guidance of the FAO Regional Office for Europe and Central Asia (Sophie Treinen, Victor Lagutov, Thembani Malapela and Valentin Nagy) and in collaboration with ITU Office for Europe (Jaroslaw Ponder and Sarah Delporte) and the ITU Office for Commonwealth of Independent States (CIS) (Farid Nakhli).

FAO and ITU would like to express their sincere gratitude to all the participants of the Regional Contest "Digital Excellence in Agriculture in Europe and Central Asia" for their valuable submissions.

NOTES

Please note that for the purpose of this report, the term Europe and Central Asia refers to the following group of countries: Albania, Andorra, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Holy See, Hungary, Iceland, Ireland, Israel, Italy, Kazakhstan, Kyrgyzstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Republic of Moldova, Monaco, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Russian Federation, San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tajikistan, Turkey, Turkmenistan, Ukraine, the United Kingdom of Great Britain and Northern Ireland, and Uzbekistan.

DISCLAIMER

FAO and ITU. 2021. Digital Excellence in Agriculture Report: FAO-ITU regional contest on good practices advancing digital agriculture in Europe and Central Asia, Budapest, Hungary.

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) or of the International Telecommunication Union (ITU) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO or ITU in preference to others of a similar nature that are not mentioned.

The views expressed in this information product are those of the author(s) and do not necessarily reflect the views or policies of FAO or ITU.

Table of contents

Executive summary

This report is the outcome of the Digital Excellence in Agriculture: FAO-ITU regional contest on good practices advancing digital agriculture in Europe and Central Asia, organized by the Food and Agriculture Organization of the United Nations (FAO) Office for Europe and Central Asia and the International Telecommunication Union (ITU) Offices for Europe and Commonwealth of Independent States (CIS). Launched in November 2020, the contest sought to identify, showcase and celebrate good practices and innovative solutions that have proven successful in advancing the digital transformation of agriculture in the regions.

The contest complements the joint FAO-ITU review on the Status of Digital Agriculture in 18 countries of Europe and Central Asia (ITU-FAO, 2020) and provides evidence of how information and communication technologies (ICTs) play an emerging role in the agricultural landscapes of the regions, acting as an engine for agricultural development. However, the adoption of digital technologies in agriculture differs from country to country, and from region to region. The review of the 18 countries has highlighted that smallholder farmers have yet to experience the widespread benefits of this digital transformation; they are lagging behind when it comes to the adoption of digital agriculture solutions and innovations due to lack of trust in the potential of ICTs, limited digital skills, connectivity issues and restricted availability of ICT-based solutions to utilize and scale up. Realizing the full potential of digital agriculture transformation requires identifying, sharing and implementing best practices and proven solutions across countries, involving all actors in participatory processes.

The regional contest followed six phases:

1. Call for good practices in the field of digital agriculture in Europe and Central Asia – submission of good practices from 4 November until 11 January 2021.
2. Nomination of outstanding practices in July 2021.
3. Launch of the stocktaking report on 9 July 2021, including all good practices received.
4. Selection of the finalists and awardees in August 2021.
5. Production of a special promotional video focusing on outstanding good practices as well as the production of the Digital Excellence in Agriculture report in September 2021.
6. Celebration of the Digital Excellence in Agriculture in Europe and Central Asia virtual awards ceremony on 23 September 2021.

With nearly 200 applicants from 38 countries in the regions, the initiative revealed a diverse, dynamic and future-thinking ecosystem of innovators and problem-solvers. It empowered individuals and organizations applying innovative ICT methods to showcase solutions and best practices in response to the agricultural challenges of Europe and Central Asia.

In July 2021, ITU and FAO published the Stocktaking Report, which compiled 171 eligible good practices and transformative solutions collected through the open call, in a coherent and unified structure, with general information and short descriptions.

The diversity of the categories shows that the scope of digital tools is widening. Digital tools permeate the full range of agriculture-related activities, from agriculture-oriented research to the production process and food waste management. More and more businesses and start-ups are entering the field,

while administrations, non-governmental organizations (NGOs) and public organizations are launching digitalization programmes, and the academic sector (especially in Europe) is benefiting from comprehensive research and innovation programmes to develop this area.

This report follows the event of 9 July 2021, where the names of the 28 practices selected to compete for the final part of the contest on Digital Excellence in Agriculture were announced. These practices were identified as impactful, sustainable, up scalable, and innovative, using a combination of multiple technologies and able to enhance the digital transition of the agricultural sectors of Europe and Central Asia.

In addition to the 21 outstanding practices (three per category), members of the Evaluation Committee identified seven champion practices (one per category) coming from the 18 countries of the FAO-ITU review on the status of digital agriculture in Europe and Central Asia: Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Georgia, Kazakhstan, Kyrgyzstan, Republic of Moldova, Montenegro, North Macedonia, Russian Federation, Serbia, Tajikistan, Turkey, Turkmenistan, Ukraine, and Uzbekistan.

The winners and champions were announced on 23 September 2021 during the virtual awards ceremony.

This report presents the 28 finalists, the challenges they are addressing, the digital technologies they are using to succeed, their journeys and their plans for the near future. Furthermore, based on the information provided by all the applicants, the report summarizes the main trends in digital services and products, the most important technologies used, as well as the difficulties and challenges that arise in the development of digital agricultural applications. The latter provides useful information for developers and service providers already active in this field or planning to enter it, as well as guidance for decision-makers on possible points of intervention and areas to support or regulate.

1. Introduction

The year 2020 marked the beginning of the "Decade of Action" proclaimed by the United Nations for achieving the goals and targets set out in the 2030 Agenda for Sustainable Development. In an increasingly digital world, information and communication technologies (ICTs) play a key role as development enablers that can facilitate countries' capabilities to reach all 17 Sustainable Development Goals (SDGs).

Connectivity, mobile adoption, artificial intelligence (AI), analytics, connected sensors, and other emerging technologies are yielding new growth in the agriculture, livestock, fishery, and forestry sectors, offering the opportunity to enhance the sustainability of food systems.

While the future of agriculture is connected, agricultural and rural development in Europe and Central Asia has yet to fully realize the potential of digital technologies to overcome the new challenges facing the sector: climate change adaptation, increased food loss and waste, rural divides and urbanization, small-size farming, and the triple burden of malnutrition. The digital technology dividends are not automatic; smallholder farmers in Europe and Central Asia are lagging behind when it comes to the adoption of new technologies due to infrastructure, affordability, awareness, digital skills and regulatory issues.

The COVID-19 pandemic has brought these challenges to the forefront by disrupting supply chains and changing consumer behaviours. As the pandemic continues to ravage so many of our populations and economies, we have never faced a situation of greater urgency. Renewed global recognition of the importance of digital infrastructure, services and skills presents many unprecedented opportunities to make real and rapid progress. The new socially distant economy has been a driving force for digitalization, unlocking access to new markets for farmers and stimulating agripreneurs to bring novel digital solutions to life.

Action, coordination, and involvement of all actors are necessary to capitalize on the opportunities, to tackle the agricultural challenges in Europe and Central Asia.

1.1. Digital Excellence in Agriculture: ITU-FAO Contest in Europe and Central Asia

The Food and Agriculture Organization of the United Nations (FAO) Office for Europe and Central Asia and the International Telecommunication Union (ITU) Office for Europe have joined forces to sustainably address the digital transformation of agriculture in Europe and Central Asia.

In 2020, FAO and ITU published a joint review on the Status of Digital Agriculture in 18 countries Europe and Central Asia, which demonstrated the emerging role played by ICTs in the agriculture of Europe and Central Asia. While ICTs act as an engine for agricultural development and have spawned a consistent wave of innovation in the region, the review also highlighted the need for coordination among stakeholders.

As a follow-up action to the review, the agencies launched the Digital Excellence in Agriculture in Europe and Central Asia contest, to identify, showcase and celebrate transformative digital solutions that are contributing to building resilient food systems in the region. This initiative seeks to contribute to the achievement of the SDGs and, in particular, SDG2 Zero Hunger, to ensure a sustainable and inclusive digital transition and to contribute to bridging the digital, rural and gender disparities, known as the triple divide. The contest is also an important milestone in the implementation of FAO and ITU's regional initiatives and cooperation.

1.2. Call for good practices and innovative solutions advancing the digital transformation of agriculture in Europe and Central Asia

The call for good practices was launched in November 2020 to identify successful digital solutions advancing the transformation of agriculture in the region, as the first phase of the Digital Excellence in Agriculture in Europe and Central Asia contest. It was addressed to all actors from the region successfully applying ICTs, be they individuals or public and private organizations and institutions.
Initially the call focused on the following thematic areas:

1. *Regulatory frameworks/Enhanced market access/Financial services and insurance*: successful practices and proven solutions utilizing ICTs to implement regulatory policies and monitor progress, facilitate market access as well as increase rural communities' access to financial services and insurance mechanisms.
2. *Capacity development and empowerment:* successful practices and proven solutions widening the reach of rural communities, improving access to and knowledge of good agricultural practices, stimulating relevant digital literacy and skills, creating new business opportunities, etc.
3. *Agriculture innovations systems and sustainable farming:* successful practices and proven solutions employing various digital technologies at farm level (e.g. farm management information systems, precision agriculture, internet of farm things, sensor networks, e-extension).
4. *Disaster risk management and early warning systems:* successful practices and proven solutions aimed at providing actionable (near) real-time information to communities and governments on reducing disaster risks, including potential climate-change-related risks.
5. *Food safety and traceability, food loss and waste:* successful practices and proven solutions aimed at tackling the decrease in the quantity or quality of food waste by the different actors in the supply chain or at delivering reliable data to comply with traceability standards and food nutrition aspects.
6.

Given the success among applicants of Thematic Area 3 "Agriculture innovation systems and sustainable farming", which depicts a strong trend in Europe and Central Asia, this area was sub-divided into three categories mirroring the submissions received:

- Farm automation, robots, drones
- Specific solutions to agriculture innovation and sustainable farming
- Connected farms management systems

Therefore, the new categories are as follows:

Category 1 – *Regulatory frameworks/Enhanced market access/Financial services and insurance* **–** lists practices utilizing ICTs to implement regulatory policies and monitor progress, facilitate market access, and increase rural communities' access to financial services and insurance mechanisms.

Category 2 – *Capacity development and empowerment* **–** presents initiatives and solutions widening the reach of rural communities, improving access to and knowledge of good agricultural practices, stimulating relevant digital literacy and skills and creating new business opportunities.

Categories 3, 4 and 5 refer to the topic *Agriculture innovations systems and sustainable farming*, with the implementation of successful practices and proven solutions employing various digital technologies at the farm level, e.g. farm management information systems, precision agriculture, internet of farm things, sensor networks, and e-extensions.

Specifically, **Category 3** refers to successful practices employing *farm automation, robots and drones*.

Category 4 – showcases *specific solutions* fostering agriculture innovation systems and sustainable farming.
Category 5 reports initiatives aimed at enhancing application and use of *connected farm management systems*.

Category 6 – *Disaster risk management and early warning systems* **–** lists solutions aimed at providing actionable (near) real-time information to communities and governments on reducing disaster risks, including potential climate-change-related risks.

Category 7 – *Food loss and waste, food safety and traceability* **–** refers to practices aimed at tackling the decrease in the quantity or quality of food waste by the different actors in the supply chain and practices delivering reliable data to comply with traceability standards and food nutrition.

The call was launched on 4 November 2020 and remained open until 11 January 2021 with 192 applicants from 36 countries in the region responding to the call by filling in an online questionnaire.[1] Respondents were asked to answer a series of questions on their solution, the technology developed or adopted, and their delivery model, emphasizing elements of innovation and sustainability, eliciting the challenges innovators are facing and identifying their objectives for the future.

[1] Online Questionnaire - https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Projects/ITU-FAO/Submission%20Template%20-%20Call%20for%20good%20practices%2018.12.2020%20%281%29.docx

1.2.1. Requirements

The applications collected through the call were first analysed against the minimum requirements to enter the Digital Excellence in Agriculture contest, namely the good practice/solution must have:

- been put into practice or successfully implemented within the last three years; hence, applications that only contained a description of an idea were disqualified from the competition;
- originated or been implemented within European and Central Asian countries[2];
- centred on applying innovative methods of ICTs within the agricultural sector – which includes livestock, fisheries, and forestry, as well as the food sector as a whole – in urban or rural areas;
- been based on at least one or a combination of various digital technologies [mobile, satellite, cloud computing, machine learning (ML), sensor networks, IoT, etc.];
- been accessible and affordable to stakeholders in the agricultural sector, so that the practice is replicable and implementable across the region.

Furthermore, to be eligible for participation in the Digital Excellence in Agriculture contest, participants must have been above the age of 18 and not affiliated with ITU. Lastly, participants must have complied with the intellectual property rights of the applications and technologies described in their submission.

Chapter 4 of this report includes a compilation of the eligible submissions that met these requirements and were entered into the Digital Excellence in Agriculture contest. All applications that met the minimum requirements were also considered eligible for competing at the UN World Summit of Information Society 2021 Prizes.

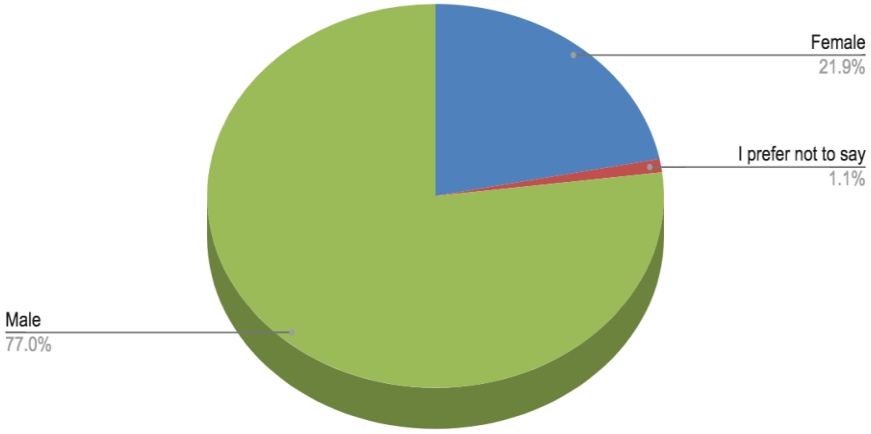
[2] https://www.itu.int/en/ITU-D/Statistics/Pages/definitions/regions.aspx

1.2.2. Insights

Out of 192 submissions received, 171 solutions met the eligibility criteria to enter the contest. Among the 171 eligible xx9 percent were female, and xx percent male (Figure 1).

The 171 solutions originated from xx European and Central Asian countries[3] (Figure 2), with implementation in xx53 countries across the region[4] and an additional xx16 countries worldwide.[5]

Figure 1 - Gender representation of the 171x respondents



[3] Albania, Austria, Azerbaijan, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czechia, Denmark, Finland, France, Georgia, Germany, Greece, Hungary, Ireland, Israel, Italy, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Republic of Moldova, Romania, Serbia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom of Great Britain and Northern Ireland

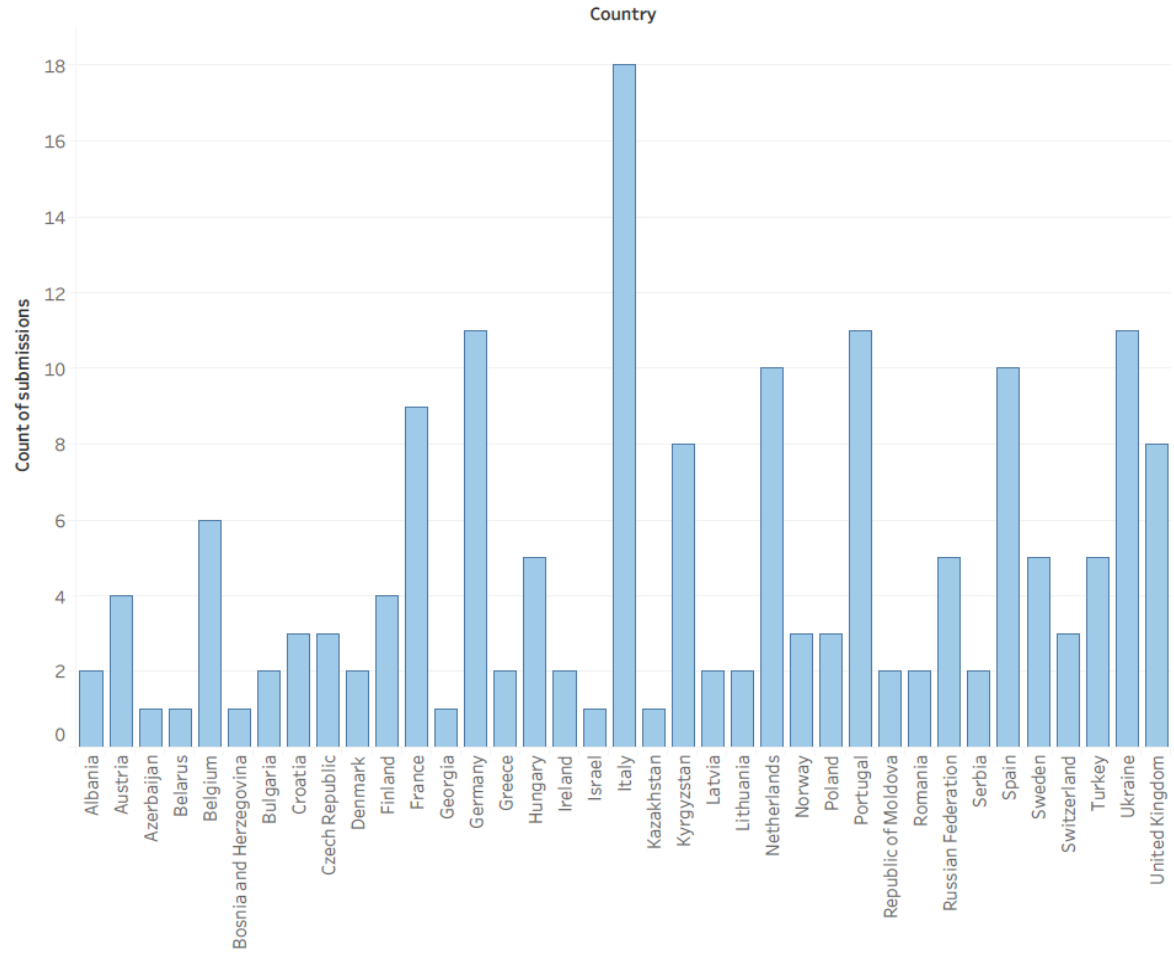
[4] Albania, Andorra, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Holy See, Hungary, Iceland, Ireland, Israel, Italy, Kazakhstan, Kyrgyzstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Republic of Moldova, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tajikistan, Turkey, Turkmenistan, Ukraine, United Kingdom of Great Britain and Northern Ireland, Uzbekistan

[5] Angola, Argentina, Australia, Brazil, Chile, Egypt, India, Iraq, Kenya, Mexico, Morocco, New Caledonia, Peru, South Africa, Saint Kitts and Nevis, United States of America

Figure 2 - Geographical coverage of the 192 applications

Figure 3 presents the number of eligible submissions received per country of Europe and Central Asia.

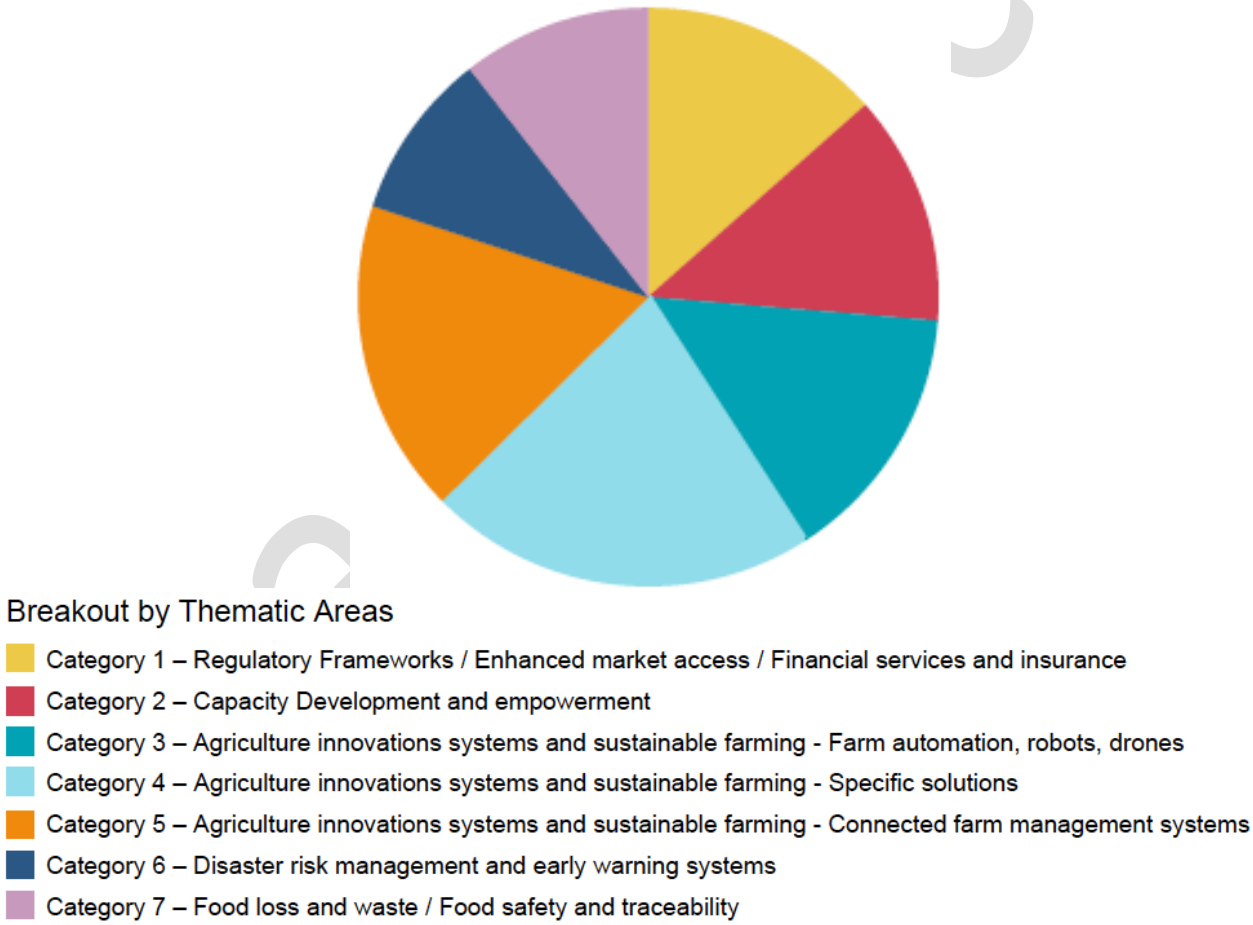
Figure 3 – Number of eligible submissions per country



The majority of the eligible practices and solutions apply digital technologies to innovate agriculture systems to achieve sustainable farming (53.8 percent), whereas 10.53 percent of eligible practices and solutions tackle food loss and waste and/or deliver reliable data to comply with traceability standards and food nutrition aspects.

Of the applications received, 12.87 percent had the objective to stimulate digital literacy and skills and improve access to agricultural knowledge (Category 2), and 13.45 percent to apply ICTs to implement regulatory policies and monitor progress, or to facilitate access to markets/financial services and insurance mechanisms, whereas only 9.36 percent focused on providing actionable (near) real-time information to communities and governments on reducing disaster risks (Figure 4).

Figure 4 - Breakdown by thematic areas – see attached



The majority of the 171 practices received (about xx percent) focused on improving the livelihoods of smallholder farmers (Figure 5), and xx percent were developed in partnership with other entities (Figure 6).

Figure 5 – Smallholders target

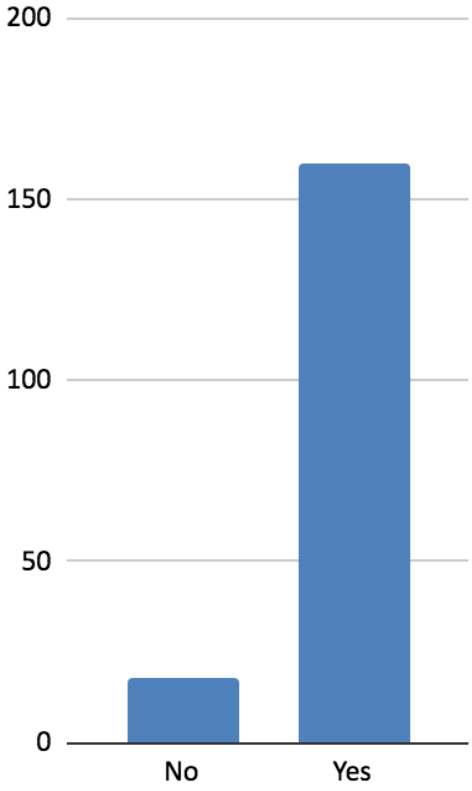
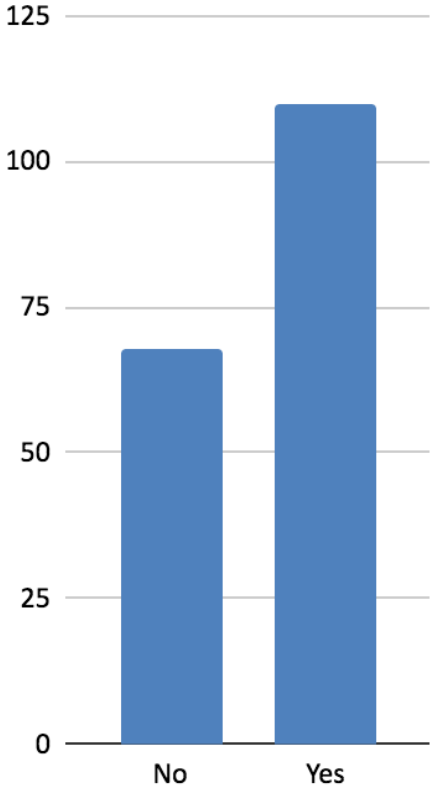


Figure 6 – Partnerships



1.2.3. Evaluation of applications, nominations and awards

The Selection Committee composed of digital agricultural experts from FAO and the ITU assessed the eligible submissions on the following criteria using a 1-to-4 grading system.

Table 1 – Evaluation criteria description

Criteria	Description
Impact and results	Have successful results and positive impact been demonstrated?
Sustainability	To what extent is the practice sustainable (socially, economically, and environmentally)?
Replicability and upscaling	To what extent can the practice be replicated in terms of appropriateness/ technology affordability?
Novelty	Are there existing analogues in other regions?
Technology	What is the complexity and combination of technologies used?

During the evaluation process, the Evaluation Committee, composed of representatives and thematic experts from FAO and the ITU, examined several aspects of the five criteria. Those aspects include the real impact (e.g. visibility and availability), different approaches of sustainability (e.g. the possible environmental and social/community effects), the business model, the use of unique/state-of-the-art technologies (e.g. number of digital technologies used, the degree they are connected to provide the service or the product) and the effort needed to implement the service on a wide or a wider scale. Special attention was paid to those solutions targeted at smallholders and family farmers.

As a result of the evaluation process, 28 practices were selected to compete for the final part of the contest on Digital Excellence in Agriculture: 21 outstanding practices (three per category) plus 7 champion practices (one per category) from the ITU-FAO review on the Status of Digital Agriculture in 18 countries of Europe and Central Asia.[6] These 28 practices are reflected in this report. On 23 September 2021, the 28 finalists showcased their innovations and outstanding achievements during virtual Digital Excellence in Agriculture in Europe and Central Asia Awards Ceremony. where the awardees were announced. In addition, the 7 champion practice awardees will benefit from a special promotional video.

[6] ITU-FAO review on the Status of Digital Agriculture in 18 countries of Europe and Central Asia (2020): https://www.itu.int/en/myitu/Publications/2020/07/09/15/27/Status-of-Digital-Agriculture-in-Europe-and-Central-Asia

2. Analysis of the status of innovation dynamics in digital agriculture in Europe and Central Asia

Based on the applications received for the call, we can draw a few conclusions on the current trends and characteristics of digitalization efforts in agriculture in the region. This chapter summarizes the main trends in digital services and products, the most important technologies used, and the difficulties and challenges that arise in the development of digital agricultural applications.

It is clear that over the last 3–5 years, an increasing number of digital tools, products and services have been targeted at farmers and, more broadly, at the whole agricultural sector. The diversity of the categories in the call shows that the scope of digital tools is widening, from research to production and food waste. The acceleration of the role of ICTs and innovation in the agricultural sector is also translated by a greater number of businesses and start-ups entering the field, and the launching of digitalization programmes by governments, NGOs and public administrations. The academic sector (mainly in Europe) benefits from comprehensive research and innovation programmes for the development of agricultural digitalization. A significant number of ICT-based tools and services have entered the market in the last two years or are currently in the validation stage and plan to do so in the near future, which also shows that digitalization will increasingly permeate all areas of agriculture.

2.1. Main trends in digital services, products and technologies

The first part of this analysis looks at the trends in digital services, products and popular technologies and highlights rare but very promising agricultural applications related to the seven categories of the call. For each category, this summary briefly reviews the main trends that can be drawn from the call and the digital technologies that are most used.

2.1.1. Regulatory frameworks/Enhanced market access/Financial services and insurance

This category gathers practices that are using ICTs to implement regulatory policies and monitoring progress (1.), facilitate market access (2.) and increase rural communities' access to financial services and insurance mechanisms (3.).

1. The good practices relating to **regulatory frameworks** are mainly applications that help farmers to lower the barrier to communicate with government agencies coordinating agricultural policies and subsidies for farmers. Governments are building a variety of tools that mainly focus on how to manage and control their agricultural policies and streamline their communication and interactions with farmers. On the one hand, these applications make the internal workings of public administration (e.g. control and administration of agricultural grants and subsidies, statistical data collection) more efficient, mostly through various spatial data management systems, by transforming the underlying back-office processes of different responsible agencies. On the other hand, they provide farmers with digital interfaces to facilitate their interaction with agencies and to gain wider access to information on grants and government programmes. NMA Agro is a representative example among the finalists.

2. There are also many examples of applications related to **enhanced market access** (see finalists Fresh.Market and Local Food Nodes in this report). They enable the expansion of market opportunities, in particular interfaces, services and platforms to shorten the supply chain, and connect producers directly to consumers. In this domain, there are various digital platforms that exploit the potential of networking, while reducing transaction costs and making the link between producers and consumers more direct. It is worth noting that, in addition to platforms linking different market players, there are also examples of the use of more traditional digital services (e.g. social media marketing, interactive websites from virtual tours), which show that the rapid introduction of the latest technology is not always the only digital solution to solve problems in a given environment or situation.

3. Financial services and insurance thematic good practices are platforms and tools that provide easier access to financial services by digital means. Half of the applicants develop applications/platforms to connect farmers with buyers, harmonizing supply and demand and providing marketing and sales opportunities. In the past year or two, a number of new businesses have started up (Ukraine is worth highlighting here as a country with a large number of companies represented among the applicants) to improve farmers' access to financial services.

The most distinctive and noteworthy technologies for the category: financial technology (fintech), digital platforms, mobile devices, and augmented reality.

Financial technology (fintech) refers to new technologies that improve and automate the delivery and use of financial services. Fintech helps companies, business owners and consumers to manage their financial processes, operations and lives with computers, smartphones, and algorithms. One of the striking trends of recent years, the rise of fintech (is becoming more and more evident in agriculture. There are also examples of combining fintech with augmented reality for a better customer experience: One practice is an augmented reality voice policy application, a structure that explains vocal the details of the policy with augmented reality technology on the real environment has been developed according to the insurance type of the producer

A **digital platform** is a place where producers and consumers can exchange information, goods and services. Platforms seek to exploit the network effect, which requires the existence of communities and a critical mass of users. Without a strong community interacting with it, the digital platform has very little inherent value.

There is also a clear trend, reflected in practices in other categories as well, for service providers to make as many applications as possible available through **mobile devices**, or to make the service as usable on mobile platforms as on PCs.

Augmented reality is the extension of the physical world with additional information (visual, audio or sensory) provided by digital technologies. In augmented reality, the real and digital worlds are connected in real time in a 3D environment.

2.1.2. Capacity development and empowerment

This category focuses on practices widening the reach of rural communities to and improving access of knowledge of good agricultural practices, stimulating relevant digital literacy and skills, and creating new business opportunities.

Good practices in this area emphasize the need to build digital knowledge bases that can be easily accessed by farmers (using innovative channels like chatbots), platforms that facilitate better knowledge transfer between growers, promoting different new ways of learning (including a gamified business simulation) or research practice and, last but not least, make advisory work more effective. Different digital technologies are enabling effective new forms of knowledge transfer and management, be they social platforms for farmers to share their experiences or thematic online knowledge bases, which are also examples of the applications received. Agricultural research and extension systems can fructify the potential of ICT in many areas. In addition to systems to support research and make it more efficient, the development and further development of services to facilitate the use of research results, especially for advisors, is often on the agenda. There are examples of pioneering services such as the gamification of knowledge acquisition through simulations (see FarmForesight in this report).

The most distinctive and noteworthy technologies for the category: data and knowledge bases, chatbots, digital platforms and gamification.

The developments in this category show how databases are increasingly becoming knowledge bases. A **database** refers to a collection of data representing facts, whereas a **knowledge base** stores information pertaining to answers to questions or solutions to problems. Knowledge bases allow for rapid search, retrieval, and reuse of information.

A **chatbot** is a software application that enables users to conduct on-line conversations using text or text-to-speech. Chatbots are used in dialogue systems for a variety of purposes, including customer service, routing requests and transferring information. Chatbot applications use different technologies ranging from AI/natural language processing to general keywords search.

Gamification is the process of enhancing a system, service, organization, or activity to create an experience comparable to a game experience and, thus motivate and engage the user. Generally, non-gaming contexts are improved by using game elements and game principles (e.g. dynamics, mechanics). One of the main popular areas of gamification is learning and training.

2.1.3. Agriculture innovation systems and sustainable farming – farm automation, robots, drones

These practices employ various digital technologies at farm level. This category contains agricultural robots (many of them providing chemical-free weeding robots, especially for orchards and viticulture), drones (biological plant protection, scouting) and other farm automation (different livestock farming tools, greenhouse and indoor farming controls, autonomous irrigation systems).

The most distinctive and noteworthy technologies for the category: robots, automation, drones, AI, big data, and mobile devices (Section 4.1.1.).

One of the most visible trends in digital agriculture is the appearance (and commercial availability) of different **robots,** the majority of which are for weed control using different methods (mechanical, microwave, or improving the accuracy and reducing the amount of spraying). There are different concepts for building these robots, ranging from small modular ones to substantial, targeted tools in defined environments and circumstances (e.g. viticulture or organic vegetables). The robots are usually electronically powered, run-on batteries and, in many cases, harness solar power. Examples in the report are the weed control robot Naiture developed by West Coast University of Applied Science and the Bakus, an electronic and autonomous vineyard robot.

Besides robot development, **automation** is gaining ground in many areas, especially automated irrigation and the partial (e.g. lighting) or full automation of greenhouse systems (including technologies for vertical farms). These automated systems mainly use different innovative sensor equipment and data processing to build new systems, but there are also tools to make conventional equipment more efficient and automatic (see BrioAgro in this report). Another field of automation concerns livestock farms, which offer practices such as 24-hour monitoring of livestock or automated cleaning.

Drones have become a hot topic in recent years. As expectations subside, the first concrete services have emerged that build on this technology or make it easier for farmers and consultants to use drones

(e.g. for scouting). The use cases include ecological/targeted crop protection, and targeted application of various pesticides and biological preparations. Most automated systems collect large amounts of data and often use techniques from the field of AI (mainly ML) to analyse it and identify problems and areas of intervention (plants, diseases, pests, unusual behavioural patterns, etc.), but autonomous devices also use it for their own operation and navigation, among other things.

Generally speaking, **AI** is the application of computer science to datasets to solve problems. The field of ML is a branch of AI and computer science that uses algorithms and data to mimic how humans learn. ML uses statistical methods to train algorithms to make classifications or predictions, so that key insights can be discovered in data mining projects. Artificial intelligence can be used in agriculture to identify weeds (i.e. differentiate between weeds and crops) or animals behaving out of the ordinary, but the technology can also support autonomous navigation of robots. Artificial intelligence is based on processing data, in some cases using **big data.** Big data refers to data sets too large for commonly used software tools to capture, curate, manage and process within a reasonable time.

Drones are unmanned aerial vehicles (an aircraft without any human pilot). In the field of agriculture, drones can be used to optimise agricultural operations, increase crop production, and monitor crop growth. Equipped with sensors and digital imaging capabilities, they can give farmers a richer picture of their fields.

2.1.4. Agriculture innovation systems and sustainable farming – specific solutions

These practices apply various digital technologies at farm level. Category 4 is for specific solutions ranging from real-time soil scanners to interoperability tools, which make it easier for farmers to connect different digital equipment, from management to monitoring systems for specific sectors, such as beekeepers and cattle farmers.

In a number of specific areas, the integration of digital tools into everyday farming practices is also visible. One such area where a number of systems are already in widespread use is beekeeping (e.g. Apiary Book, 3Bee, i-bee), where management systems, together with hive monitoring sensors, form a complete whole, often complementing several other functions (sales, monitoring). With the aforementioned **AI** techniques dealing with the processing of the data, different sensor systems relevant for a given farming sector are used to gather this data. Some stakeholders use off-the-shelf sensors, but it is also a usual practice for many service/solution providers to develop their own sensor equipment as part of a package. An important part of these systems is the radio technology to connect all the devices and the applications show a wide range of different standards (Narrowband IoT, LoRa, SigFox, etc.).

A feature of agroinformatics has been the many independent, incompatible systems available. As a solution, techniques are now being developed to enable the different systems to work together, for example using interfaces. Not everything is fully connected or comprehensive, though; several practices target a specific aim (e.g. soil measurement systems, with different tools and sensors, sustainability audits).

The most distinctive and noteworthy technologies for the category: internet of things, sensors, long-range wireless technology, digital platforms (Section 4.1.1.), and mobile devices (Section 4.1.1.).

The i**nternet of things (IoT)** refers to a network of physical objects with embedded sensors, software, and other technologies. The ITU defines IoT as "a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies".

Sensors are devices that detect occurrences or changes in the environment (e.g. weather, moisture) and send the information to computer systems. They are a key component of the IoT. With the aforementioned **AI** techniques dealing with the processing of the data, different sensor systems relevant for a given farming sector are used to gather this data. Some stakeholders use off-the-shelf sensors, but it is also a usual practice for many service/solution providers to develop their own sensor equipment as part of a package. An important part of these systems is the radio technology to connect all the devices and the applications show a wide range of different standards (Narrowband IoT, LoRa, SigFox, etc.).

One of the important elements of IoT systems is **long-range wireless radio technology** used to enable communications between different devices with the creation of Low-Power Wide-Area Networks (LPWAN). Long-range radio technologies allow devices to communicate over long distances at a low energy cost. Some examples used by the applicants are LoRaWAN, Sigfox and NB-IoT. Specific modular systems can be extended with the use of state-of-the-art technologies, for example augmented reality (Section 4.1.1.).

2.1.5. Agriculture innovation systems and sustainable farming – connected farm management systems

These practices use various digital technologies at farm level. Category 5 almost entirely consists of different connected farm management systems, which mainly amalgamate remote sensing, decision support systems, different sensors, cloud computing, farm management software tools, and many times some kind of AI.

Several existing farm management systems are evolving in this direction and incorporating more and more technologies from the IoT, taking advantage of the availability of open spatial data. Many new start-ups are providing similar connected farm management systems (mainly for arable farming), with different additional services derived from the data (e.g. calculating management zones). Connected farm management systems can often be extended with many different kinds of sensors, custom-built (by the service provider) or off-the-shelf.

Many of the systems also provide yield monitoring and forecasting. These data allow practitioners to increase production, plan efficiently, and optimize operations like logistics, packaging, warehousing and sales.

The most distinctive and noteworthy technologies for the category: digital platforms (Section 4.1.1.), AI (Section 4.1.3.), mobile devices (Section 4.1.1.), remote sensing, cloud computing, algorithms, and remote sensors.

The main technologies used in this category are **remotely sensed** (mainly satellite) imagery (a variety of satellite images/spatial data have become available for developers (e.g. Copernicus Sentinel and Landsat data), processed in a cloud (**cloud computing** is the on-demand availability of computer system resources, for example data storage and computing power) with different **algorithms** (i.e. sequences of computer-implementable instructions that specify how calculations, data processing and other computerized tasks will be performed; nowadays they are fine-tuned with the help or basic components of AI/ML systems). **Remotely sensed** (i.e. the gathering of information about an object/area without making physical contact with it) images can be used to identify nutrient deficiencies, diseases, water deficiency, insect damage and plant populations. Based on remote sensing data, variable rate fertilizer and pesticide applications can be made.

2.1.6. Disaster risk management and early warning systems

These practices focus on providing actionable (near) real-time information to communities and governments on reducing disaster risks, including potential climate-change-related risks.

Most practices in Category 6 combine environmental and meteorological information and/or facilitate the exchange of information between farmers on pests, diseases, and other risk factors to provide a more precise response to challenges related to these factors. As an increasing amount of accurate and hyperlocal data becomes available from different sources in near real time, this opens up the possibility of different types of forecasting, early warning systems, and more effective ways of managing risk. Good practices mainly support an online tool for integrated pest and/or plant management (iMETOS and VIPS are examples in the current report).

The most distinctive and noteworthy technologies for the category: IoT (Section 4.1.4.), sensors (Section 4.1.4), AI (Section 4.1.2.), algorithms (Section 4.1.5.), digital platforms (Section 4.1.1.), and databases (Section 4.1.2).

The practices in this category are mostly based on some kind of **IoT technology** (mainly using some kind of weather sensor), which are transformed into forecasts using different **algorithms and models** and displayed on some kind of web platform (also available on mobile devices).

2.1.7. Food loss and waste/Food safety and traceability

These practices allow delivery of reliable data to comply with traceability standards and food nutrition aspects. Applicants in Category 7 deal with the questions of food waste (mainly offering equipment to measure and/or exchange food surplus), helping the optimization of the food chain and logistics (e.g. accurate yield predictions), making the testing of agricultural products and foods easier and quicker, and allowing detailed or almost-real-time traceability of different products and materials.

New products and services have also emerged in the area of food waste and traceability, and while many of them have yet to prove their viability, it is clear that digitalization is also making a strong impact in this area. One of the sub-areas in traceability is the incorporation or independent application of **blockchain** technology among others, to manage the supply chain in a digital way. To avoid food waste, community solutions can help a lot. Existing, widespread examples of this connect consumers with surpluses and opportunities where food is not wasted. **AI,** in particular pattern recognition and analysis, is emerging in many areas, be it analysing food samples or assessing the amount of food waste.

The most distinctive and noteworthy technologies for the category: blockchain, digital platforms (Section 4.1.1.), mobile devices (Section 4.1.1.), AI (Section 4.1.2.), and sensors (Section 4.1.4).

Distributed ledger technology (DLT) is a decentralized recording system with mechanisms for processing, validating and authorizing transactions that are then recorded on an immutable ledger. **Blockchain** is one implementation of DLT. In relation to the traceability area, several practices are already adopting blockchain technology. It is also referred to as an “Internet of value”, i.e. a secure way to store and transact value – anything from currency, stocks, contracts, and even votes – from one entity to another.

Several applications are building on **digital platforms**, mainly for food waste prevention, but **AI** is also emerging (mainly image processing), both for value chain management (crop estimation) and for food waste and mycotoxin assessment and evaluation.

2.2. Challenges and problems related to the development of digital agricultural practices

To make the best use of the potential of digital technologies, it is worth taking a detailed look at the difficulties and problems faced by those developing such products and services. Such a review will provide useful information for all developers and service providers already active in this field or planning to enter it, as well as guidance for decision-makers on possible points of intervention and areas to support and regulate. The most typical challenges mentioned by the applicants can be clustered in four thematic groups:

1. Technological difficulties
2. Policy issues
3. Commercialization
4. Human factors

In addition, we can distinguish a fifth group of challenges, including other factors such as the impact of the pandemic. This overview is based on the answers to the relevant questions from the application form.

2.2.1. Technological difficulties – challenges related to the building and operation of digital tools, products and services

- Connectivity, lack of network coverage (rural broadband, 4G, 5G, IoT networks)
  Internet access in rural areas, network access, and the urban-rural divide in terms of infrastructure has always been a priority for the last 20 years, be it fixed or wireless, especially in remote and rural areas. This issue remains a major difficulty to this day, and it is no coincidence that a key feature of most applications used in the field is the ability to operate off-grid and synchronize data later. Another key component of the IoT, and in particular of the various data-collecting sensor technologies in agriculture, is transmission technology (preferably wireless and with adequate range) used to transmit measured data for processing. In the near future, the roll-out of next-generation 5G wireless networks (one of the main applications of which is the networking of IoT devices) could be an important milestone for rural areas and digital agricultural applications. As it is unlikely that these networks alone will be sufficient to address the shortfall in rural broadband coverage, the development of telecommunication networks in these areas will remain on the agenda.

- To adapt digital equipment to harsh conditions
  Many hardware products cannot withstand the harshness of a rural/agricultural environment. One of the main challenges in agriculture with different tools, sensors and other digital equipment is physical stress, increased wear and tear, and exposure to dust, heat and weather. In many cases, developers who incorporate off-the-shelf devices into their services are faced with the need to choose other, more robust tools, or service providers who develop sensors in-house need to invest additional resources and develop new prototypes and versions of equipment.

- Energy-related issues (battery life of sensors, solar panels)

  Closely linked to the previous two challenges (the lack of network connectivity and the need to adapt digital equipment to harsh conditions) is the power supply of the different devices. In many cases, it is not feasible to replace batteries continually and easily in remote and rural settings (e.g. sensors tracking free-range cattle), so optimizing the energy consumption of devices, many times with the installation and sizing of solar panels to recharge batteries, and maintaining their operation and efficiency, are also key development challenges and tasks.

- To develop user-friendly interfaces for farmers

  Partly related to human factors, but fundamentally a technical problem, is the development of sufficiently clear, intuitive interfaces for applications and tools. There are examples of many cases where end-users and/or farmers have been involved in the development process, or where it has been necessary to validate user interfaces during development, as many applicants agree that this is the only way to ensure uptake, proper use and exploitation of the services and their potential. This is necessary even if it means creating and resolving additional technical difficulties for the development of a practice or service.

- To integrate different technologies into one service

  As seen earlier, there are many new digital technologies available today, and the number is constantly growing. In addition, existing solutions are constantly being renewed and updated. As practices are usually characterized by a combination of these evolving technologies and a certain level of technological complexity, it is often difficult to merge the different solutions into a single service or product. Continuous technological development may also present a challenge in some cases or may require the replacement or rethinking of technologies to keep them up-to-date and operational.

- Dealing with data that is incomplete or in different formats

  As data is one of the cornerstones of digital agriculture, it is often problematic that it is not available in a complete or easily processable/reusable format, which causes difficulties for developers. Several existing initiatives aim to increase the level of interoperability in agriculture to solve this problem. One of them is the FAO Agricultural Information Management Standards Portal (AIMS). It gathers information on (and access to) standards, technology and best practices. It is also a forum connecting information management workers around the world to discuss open access and open data.

2.2.2. Policy issues – challenges affecting policy, regulation, and the functioning of the agri-innovation ecosystem

- Lack of funding programmes for agricultural start-ups

  Many providers of digital agricultural products and services feel, based on the responses, that those working in this area should receive more direct support, as the innovations they develop have significant social and environmental benefits. However, the design of appropriate programmes, their structures and their operational mechanisms to support the best developments can also be a challenge for policymakers.

- Not enough support for agricultural innovation ecosystems/limited communication between different stakeholders

  In some cases, it is not direct support that is important, but the creation of an appropriate innovation environment. In a highly functioning innovation environment, the cooperation of different actors, the existence and possibility of different forms of collaboration, and the flow of knowledge and information represented by the different stakeholders provide the right environment for the creation of high-quality services. This requires a holistic approach by R&D and innovation policymakers.

- Lack of interoperability-related regulations or comprehensive open data policies, low adoption of different standards

  The issue of interoperability has already been mentioned under technological challenges; in many cases there is a lack of regulation to help the different systems work together. A prominent aspect of this is the scope of data created and collected by the public sector, or government data. The public sector is one of the largest data-collecting entities. Much of the data collected is of particular relevance to agriculture (e.g. geographical information, weather data, different statistics, but also information collected in relation to the implementation of agricultural policies). Making this data accessible and reusable (open public data) has a significant added value (as the European Union puts it, "EU open data market is a key building block of the overall EU data economy"[7]). It is important that policies, rules and regulations on public data are drawn up, implemented and enforced.

- Quality of available public data sources

  With appropriate regulation, it is important to ensure that the data available are published in an easy-to-use format and as fully as possible. Several applicants mentioned difficulties with the quality and completeness of the data available.

- Lack of cross border/general legislation

  A particular challenge for developers and service providers, especially in terms of scalability and service expansion, is that if the same area is regulated in different countries in different ways, the resources to be spent on development can easily multiply.

2.2.3. Commercialization – challenges in scaling up digital agriculture products and services

- Finding the right business models that fit the needs of farmers and the service provider, proving return on investment

  Reaching the critical mass of users in a fragmented and/or narrow market is a challenge for many applicants. The diversity of farmers and farms in the agricultural sector presents a significant challenge for service providers, as there is no single one-size-fits-all solution and business model that can be applied to all situations. The submissions received for the call are characterized by a wide variety of approaches and an extensive range of business models to make practices available to the broadest possible range of users, including smallholder

[7] https://digital-strategy.ec.europa.eu/en/policies/open-data

farmers. In many cases, however, one of the biggest challenges for developers is to find schemes that work or find contacts and distribution channels through which users can be involved.

- Limited funding opportunities for agricultural start-ups

  The problem of limited resources also applies to commercialization, as it is more difficult for enterprises or start-ups to achieve profitability and thus stability.

- Data ownership and the monetization of data

  One of the many data-related issues is the ownership and commercialization of farmer data. There are a number of possibilities for farmers to monetize data (e.g. sharing data for R&D, being involved in experiments, selling aggregated data), but this practice raises a number of questions about data security, privacy and ownership that need to be clearly addressed upfront. Clear frameworks and rules on the commercial management of data are needed, which also play an important role in building trust.

- Applicability/scaling of a service in different countries

  It has already been partly mentioned in the context of regulation and policy that scaling up different products and services to a regional or global level is one of the biggest steps for service providers, partly because of different regulations and language barriers, but also because of organizational development necessities and logistical challenges, and possibly cultural factors.

2.2.4. Human aspects – challenges relating to the digital skills, mentality and attitude of farmers

- Wide rural digital divide - farmers' lack of digital skills and equipment

  The low level of digital skills among farmers and the lack of digital infrastructure and tools are two of the most frequently cited barriers to the uptake of digital farming tools. While the latter has been greatly alleviated by mobile devices, and a significant proportion of farmers now have at least a smartphone, there is still considerable potential in the use of the internet and applications for agricultural purposes.

- Proving clear return on investment for farmers

  Return on investment is an often-mentioned difficulty with various new technologies, because farmers expect clear evidence of the usefulness of a tool or service before they start using it. Farmers evaluate the relative advantage of a product or service, and how it fits with their existing practices.

- Low awareness of up-and-coming technologies

  In a fast-changing technological environment, newer and newer technologies and gadgets are not tracked by farmers on a daily basis, which makes it difficult to implement them in the farming context, as the specificities and benefits of a given technology are unfamiliar to the target community. This factor is usually associated with a conservative view of technology (or limited openness to new innovations) and overall results in a slow adoption process. Also,

worth mentioning, and linked to the factors mentioned here is the challenge of overcoming farmers' lack of trust (e.g. sharing data) and scepticism. Potential users evaluate a new tool or service on its relative advantage for them. The complexity and the testability of a practice also contributes to the process. Generally speaking, significant challenges digital agriculture tools face is that they can be complex, hard to measure their exact utility and difficult to test.

- High demand for training activities by the service providers/companies
  Developers of services need to invest considerable effort in user education, and in the continual organization of presentations, training and education sessions to support the use of their services and to exploit their potential.

- Language barriers
  In addition to digital skills, language is also an important factor in ensuring access to services, as in many cases farmers do not speak foreign languages, so localization of products is essential.

- Lack of human capacity (quality/quantity of staff)
  Developing digital agriculture products and services requires a broad and diverse set of skills. Service providers often face the difficulty of not finding the right specialist or specialists for certain tasks.

2.2.5. Other challenges

- A significant part of the challenges related to the COVID-19 pandemic
  Three difficulties in this area are worth noting in particular. The first is the limited possibility to organize face-to-face training. Training is a key driver for the uptake of digital farming tools, largely made impossible by social distancing rules and lockdowns. These also resulted in the loss of personal contact, and in the limited possibility of conversations with farmers, an important source of feedback. The pandemic has negatively affected production capacities and supply chains, leading to shortages of various digital products and components.

- Start-up growing pains
  Some applicants mentioned that the initial operation of a business puts a considerable burden on founders, especially in the early days, when a lot has to be sacrificed for the sake of a potentially market-leading or pioneering service. Managing a developing company may require an approach that differs from what the founders originally aimed for.

- Delivering a product/service is a long journey that requires engagement
  Not only is the beginning of the journey bumpy, in many cases it takes a lot of time and effort to get tangible results from a product or service, often with dead ends that test the developer's commitment. The journey often means dealing with complexity.

The challenges and problems, as reflected in the high number of applications, are not stopping developers from creating more and more products and services and addressing the various issues could lead to an even more evolving digital agriculture ecosystem.

3. Winners, honourable mentions, and champions

Among the 28 finalists, we selected 7 winners and 7 champions. Here is the list for each category.

Category 1: Regulatory frameworks/Enhanced market access/Financial services and insurance

- **Winner**: - Fresh.Land – Straight from the Farm, Fresh.Land, Denmark
- **Honourable mention**: Local Food Nodes, Local Food Nodes Röstånga ek Förening, Sweden
- **Honourable mention**: Mobile application "NMA agro"**,** National Paying Agency under the Ministry of Agriculture, Republic of Lithuania
- **Champion**: Agrianalytica – Integrated one-stop shop for farmers to access finance, markets, inputs, and knowledge, Agrianalytica LLC, Ukraine

Category 2: Capacity development and empowerment

- **Winner**: Organic Farm Knowledge – Online platform to promote knowledge exchange among organic farmers and advisors, IFOAM Organics Europe, Belgium
- **Honourable mention**: Genpro, Ruralbit Lda, Portugal
- **Honourable mention**: Electronic agricultural maps, Agro InformAsia, Kyrgyzstan
- **Champion**: FarmForesight, FarmForesight, Ukraine

Category 3: Agriculture innovations systems and sustainable farming – farm automation, robots, drones

- **Winner**: High-Precision Weed Control in Organic Farming, West Coast University of Applied Science, Germany
- **Honourable mention**: Intelligent watering taking advantage of the existing irrigation installation, BrioAgro Tech., Spain
- **Honourable mention**: Bakus, full electric and autonomous vineyards robot, VitiBot, France
- **Champion**: Biological protection of plants by entomophages using unmanned aerial vehicles, Fly and See Agro LLC, Russia

Category 4: Agriculture innovations systems and sustainable farming – specific solutions

- **Winner**: Nedap CowControl, Nedap Livestock Management, Netherlands
- **Honourable mention**: Apiary Book, Apiary Book Ltd, Romania
- **Honourable mention**: Hive-Tech, 3Bee Srl., Italy
- **Champion**: i-bee, IT Innovations, Ukraine

Category 5: Agriculture innovations systems and sustainable farming – connected farm management systems

- **Winner**: AGRIVI Farm Management Software, AGRIVI d.o.o., Croatia
- **Honourable mention**: Agricolus platform, Agricolus s.r.l., Italy
- **Honourable mention**: xFarm, xFarm , Italy
- **Champion**: OneSoil, OneSoil, Belarus/Switzerland

Category 6: Disaster risk management and early warning systems

- **Winner**: iMETOS: Disease and Pest Forecast with Artificial Intelligence, Pessl Instruments GmbH, Austria
- **Honourable mention**: VIPS, NIBIO, Norway
- **Honourable mention**: Sencrop: Precision ag-weather solutions, Sencrop, France
- **Champion**: agroNET – digital platform for sustainable farming, DunavNET, Serbia

Category 7: Food loss and waste/Food safety and traceability

- **Winner**: OLIO, OLIO Exchange Limited, United Kingdom of Great Britain and Northern Ireland
- **Honourable mention**: Real-time digital food supply chain auditing, powered by blockchain, ConnectingFood, France
- **Honourable mention**: Farmer Expert, Farmer Expert, Turkey
- **Champion**: BIOsens Myco, BIOsens, Ukraine

Category 1. Regulatory frameworks/Enhanced market access/Financial services and insurance

Fresh.Land – Straight from the Farm

Category winner

Fresh.Land Straight from the Farm	**Fresh.Land – Straight from the Farm**			
Applicant:	**Fresh.Land** Mathilde Jakobsen, CEO			
Country:	Denmark	Implementation in Belgium, Denmark, Italy, Portugal, Spain, Sweden		
Website:	https://fresh.land			
	Delivery model:	Sales platform; marketplace	**Stage:**	Proven/Scale-up stage

Challenge/context

The model of the food industry is in many ways broken. Moving fruit and vegetables from farm to table can take months as the food travels through a number of intermediaries before arriving with the customer. To endure a safe journey, the food is filled with chemicals. The end result is that when they reach the table, fruit and vegetables are months old, chemically laden, and tasteless with little nutritional value. Additionally, the many actors involved compress the value left for farmers; smallholder farmers are especially struggling to make ends meet, as the only way to compete is through quality, not quantity. Finally, the long journey and the many actors involved result in high pollution in terms of a high food waste, energy for refrigeration and artificial ripening, excessive use of packaging materials, and inefficient transportation between intermediaries. In short, the process is unnecessarily slow, unnatural, and polluting, and deprives farmers of value.

Description

Fresh.Land bridges food chain supply and demand in one integrated digital solution. The platform operates like an online farmers market, giving farmers access to completely new markets and customer groups. Fresh.Land was founded to give value back to the farmers and create a fairer food system. With its innovative digital platform, Fresh.Land shortens the food supply chain by cutting 3–5 intermediaries. With the Fresh.Lands model, the farmers' trees and fields become natural warehouses as they harvest fresh for every shipment. Fresh.Land allows consumers to buy directly from farmers. Instead of months, products take only days to reach consumers across Europe. Fresh.Land enables farmers to earn 20–50 percent more than the average market price, vastly increasing their livelihood. In the conventional system, low price and high volume are often the driving parameters for farmers to compete, sometimes sacrificing quality and otherwise important sustainability initiatives at the farms. The Fresh.Land platform opens the possibility for farmers to compete on other parameters. Farmers are now rewarded for quality, freshness and sustainability initiatives on the farm level. The environmental footprint is significantly reduced, as the Fresh.Land model lowers food waste by 10

percent and reduces refrigeration needs by 88 percent. The Fresh.Land solution is a digital model of the future, transforming the food supply-chain for the better. Bringing fresh produce from the farm to consumers in itself is not a new idea. The complexity arises in making the model work at scale — making it reliable, fast, and cost efficient.

Technology

This all-out digital solution consists of a software that runs a decentralized supply and creates maximum value for producers and consumers. In the end, the platform handles all operations in an integrated manner, at scale. Currently, the platform has various subsystems and core functionalities implemented:

1. Farmer portal: the interface on which farmers indicate product availability, receive allocated orders and coordinate the shipments between feeders (smaller farmers who deliver to larger farmers) and hubs (farmers with capacity to ship).
2. Order management: the backbone of this decentralized supply chain, which aggregates customer orders and allocates them to farmers, organizes the shipments in the most efficient way, and ensures complete traceability of every product.
3. Last mile delivery: the app that breaks bulk shipments into smart delivery routes for outsourced drivers, directs them in their deliveries and tracks all steps (product reception, packing of vans, GPS delivery coordinates, photo of deliveries).
4. Consumer web shop: the customer interface where they can learn and connect with farmers, discover products, place orders, manage subscriptions, trace origin and location of incoming products, and provide feedback to farmers.

History and plans

Fresh.Land was founded in 2015, starting as a business-to-business (B2B) company, selling directly to supermarkets. The company achieved profitability via B2B sales in 2016. In July 2019, they opened a B2C prototype to the market. They currently provide more than 70 different products from 6 six different countries and sell in Denmark and Sweden. In November 2020 alone, the Fresh.Land platform had over 100,000 users in Denmark and Sweden who bought products straight from farms in Portugal, Spain, Belgium, Italy, Denmark and Sweden. The aim is to complete the development of this pioneering platform and introduce four key innovations:

1. Traceability: create a digital passport for all products shipped.
2. Algorithmic optimization: develop a proprietary algorithm to replace manual processes.
3. Climate label: provide the first accurate measurement of the carbon footprint of a product, at scale.
4. Sharing economy: develop a collaborative tool for farmer-to-farmer interactions.

Local Food Nodes

Honourable mention

LOCAL FOOD NODES	**Local Food Nodes**			
Applicant:	**Local Food Nodes Röstånga ek Förening.** Albin Ponnert, Founder			
Country:	Sweden	Implementation in Australia, Belgium, Finland, Germany, Japan, Norway, Portugal, Slovakia, South Africa, Sweden, Switzerland, United Kingdom of Great Britain and Northern Ireland, United States of America,		
Website:	https://localfoodnodes.org/en			
	Delivery model:	Free to use; open source, community approach; donations free of choice	**Stage:**	Market adoption/ Validation stage

Challenge/context

Local Food Nodes has reached a point where there is a state of global consensus that many things are broken and need to be fixed in new ways, starting with food. We have to be able to feed the population. Many people are working on how to secure the food supply for the future. We need food that is produced in ways that do not overexploit the planet; food that is healthy and accessible for everyday people, distributed in ways not stuck in the same broken system we are used to. Local Food Nodes wants to direct food production to more sustainable methods, beyond environmental degradation, bee extinction, soil erosion, depletion, and dictating intermediaries. They want to strengthen local food networks, increase local resilience, and create direct relationships between producers and consumers. They are creating local food nodes to connect local food producers to local food consumers as well as strengthening existing relationships. They want to enable direct transactions, resilient communities and regain control over what we eat and how it is produced. Their desire is to make food local again.

Description

The result of this desire is an open digital tool where food producers present their food, local consumers order what they like, and payments go straight from consumer to producer. The key reason behind the project was to find ways to help existing small-scale producers get to market, and provide them with tools for better financial sustainability, as well as pave the way for more people to step into small-scale local food production. Local Food Nodes is for small-scale food producers who want to sell to end-consumers first-hand and build and own the first-hand relationship between them without third party interference. Food deliveries and pick pickups take place at a predetermined place and time called a node, i.e. the physical location where consumers and producers meet. This type of organization enables producers to deliver to multiple consumers at the same time while consumers can pick up food from many different producers. They have created an independent, donation-based, financially

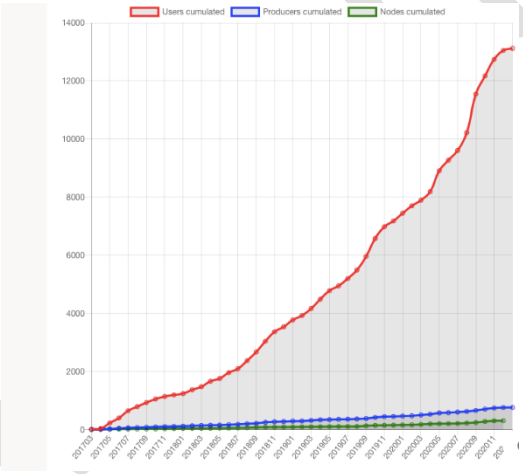
transparent and not for sale, digital open-source solution, for people-driven pre-orders and local farmers markets. This is a sales tool for small-scale farmers to build real-life first-hand relationships with their customers without revenue loss. It is a way to encourage small-scale local food production for local markets and to increase local resilience and local food sovereignty. Local Food Nodes uses a free of choice donation financial model that is 100 percent transparent, both revenue and expenditure. They currently have fewer than 3000 donors, averaging €13 each per order with 200+ drop locations globally and 750+ local food producers connected to the platform. They average 20 new users daily and have done so since the launch. The app takes a zero percent cut from the producer but is based on a gift economy model.

Technology

Local Food Nodes are creating an open-source platform with both a website and a mobile app to go with it, downloadable from the App-store and Google Play. The app is based on the application programming interface (API) from the website localfoodnodes.org.

History and plans

The project started to find ways to help existing small-scale producers get to market, and provide them with tools for better financial sustainability, as well as pave the way for more people to step into small-scale local food production. It began as a national pre-study in Sweden in 2015, followed by platform development in 2016, and the first launch in summer 2017. The first version of the mobile app was launched in summer 2018. Version 2.0 of the platform was released in March 2020. From the start, they have been in ongoing dialogues with small-scale local farmers. They aim to keep on developing the platform to include requested features and do so by having dialogues with farmers all over the globe and listening to their needs. They also aim to become better financed to increase the pace of development and engage more core functions in the team.



Mobile application “NMA agro”

Honourable mention

NMA NACIONALINĖ MOKĖJIMO AGENTŪRA	**Mobile application “NMA agro”**			
Applicant:	**National Paying Agency under the Ministry of Agriculture of the Republic of Lithuania** Aušrius Kučinskas, Head of Direct Support’ Control Unit at Control Department			
Country:	Lithuania	Implementation in Lithuania		
Website:	https://www.nma.lt			
	**Delivery model:**	Free to use	**Stage:**	Proven/Scale-up stage

Challenge/context

The Common Agricultural Policy (CAP) is one of the EU’s oldest and most important policies, launched in 1962. Designed as a policy to “support European farmers and ensure Europe’s food security”, CAP is the largest and most promising area of Copernicus and Galileo data use in the public sector, with farming being one of the main economic sectors using such data. “NMA Agro” was developed considering the proposals for the new CAP beyond 2020 and the higher ambition to completely replace on-farm checks with the use of automated checks based on Earth Observation (EO) data that enable the continuous monitoring of farmland.

Description

In 2018, the NPA (Paying Agency of Lithuania) launched a free, easy-to-use mobile application named “NMA Agro”, for both IOS and Android. Currently, there are more than 11 000 users. The app for mobile devices is designed and developed to facilitate a farmer uploading geotagged photographs as supporting evidence for CAP scheme applications. The Geotagged Photo Application will be an integral part of the Area Monitoring System, which will be a component of the Integrated Administration & Control System in the CAP post 2020. It allows sending pictures with precise coordinates and azimuth directly from the area; it can also measure distance and size. This modern solution helps farmers to report their performed activities, including cultivation of specific crops, implemented investment projects or problems related to the fulfilment of commitments not only to NPA, but also to State Veterinary and State Plant Protection services. On the other hand, it helps Paying Agencies and other related institutions to implement checks from the office and save a lot of time, human, administrative and financial resources, and thus, reduce the administrative burden on farmers. Now farmers have more options in terms of engagement with the Paying Agency. In cases where the information through EO data or aerial imagery is not sufficient or additional evidence is required by the Paying Agency, farmers are engaged to send geo-tagged evidence via the “NMA agro” geotagged photos application, proving performed activities or cultivated crop types. The mobile application has access also to all the main LPIS (Land Parcel Identification System) layers, for example, soil erosion and Natura 200 territories. It also provides access to constantly updated satellite images of the Copernicus programme "Sentinel", for example vegetation index or crop water stress index, which allow farmers to monitor

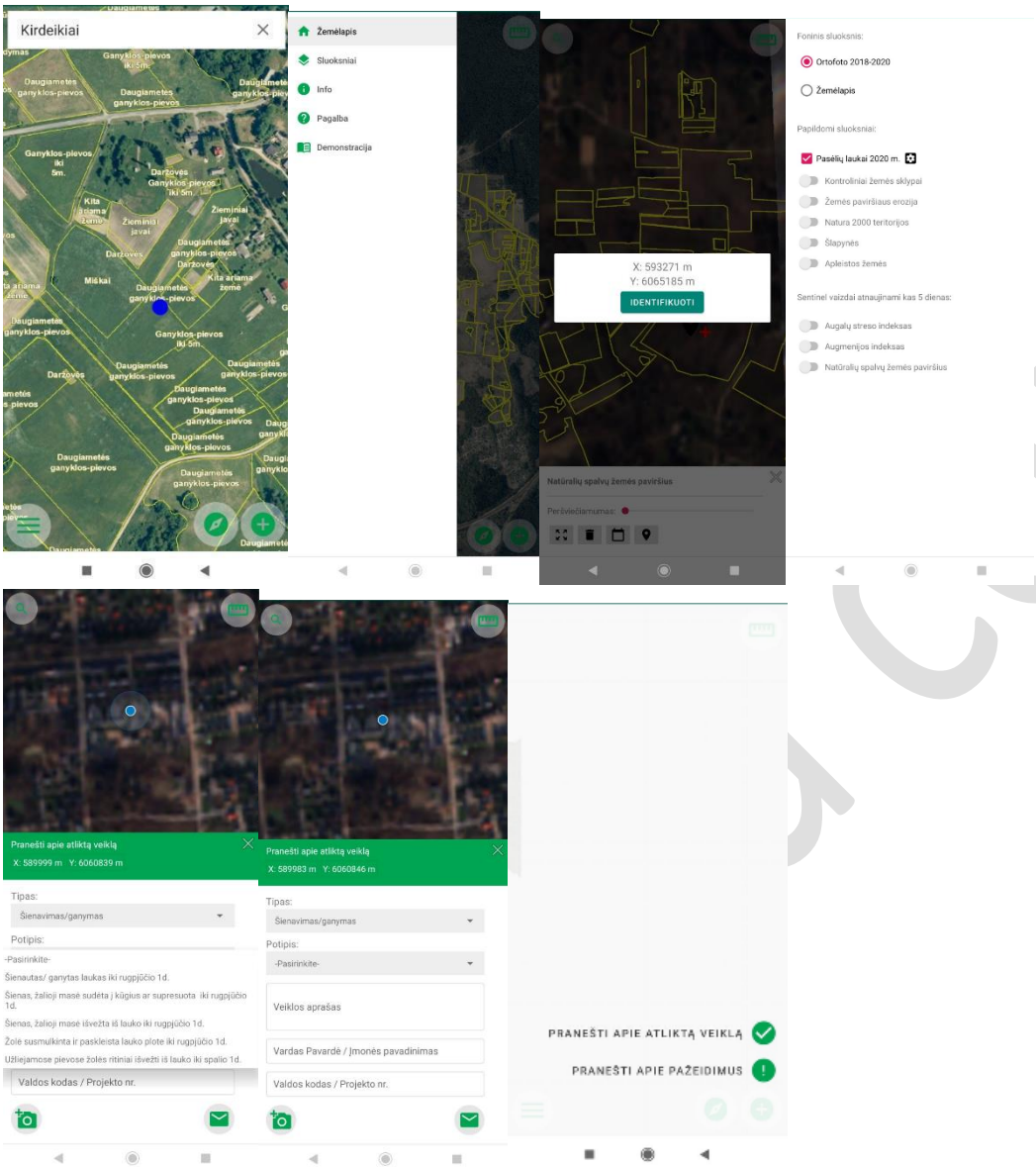
and assess the condition of the crops grown in their fields and, if necessary, to carry out the necessary farm activities. The “NMA Agro” geotagged photos framework is provided at no cost to all farmers. The importance of such a mobile application was especially visible during the COVID-19 pandemic, when during and after the quarantine period most of the checks could only be done remotely.

Technology

“NMA Agro” is a geotagging app developed with ArcGIS Runtime SDK that allows users to geotag photos taken by a mobile device camera and view the map provided with thematic layers. Coordinates and azimuth are directly captured from the area and after the user provides all necessary attribute information data are instantly transferred to the Paying Agency. It is also possible to measure distances and areas, upload them to the description of the information sent, thus completing the message. Regarding the use of constantly updated open EO-based (Sentinel) data, map layers with data vegetation index or crop water stress index are provided that allow farmers to monitor and assess the condition of the crops grown in their fields and, if necessary, to carry out the necessary farm activities. They can also draw up more accurate fertilization and irrigation plans, more accurately forecast the quantity and quality of the harvest and collect evidence of agricultural activity or force majeure circumstances. By creating and publishing a map with layers it is possible to open as much data as possible available at state institutions to the public and businesses; this tool increases the transparency of support administration and encourages businesses to create new services for farmers.

History and plans

The solution has been developed in partnership with the National Centre for Remote Sensing and Geoinformatics “GIS-Centras”. Further development of the app “NMA Agro” comprises the creation of a personalized solution, the authorization of users and the presentation of all farmer-related administered information in a single mobile app. NMA aims to be open to the public, and increase the accessibility, publicity and transparency of the provided services. It seeks to create convenient, easily accessible electronic public services for its customers, at the same time achieving greater operational efficiency by reducing the administrative burden and simplifying the administration of EU support.



The map and layout provided by NMA Agro mobile app with thematic layers.

Agrianalytica – Integrated one-stop shop for farmers to access finance, markets, inputs and knowledge

Category champion

	Agrianalytica – Integrated one-stop shop for farmers to access finance, markets, inputs and knowledge			
Applicant:	**Agrianalytica LLC** Liudmyla Tymoshenko, Director			
Country:	Ukraine	Implementation in Ukraine		
Website:	https://agrianalytica.com/en			
	Delivery model:	Free and fee	**Stage:**	Proven/Scale-up stage

Challenge/context

The main idea behind Agrianalytica is to provide one integrated place with value-added services for relevant stakeholders' groups centred on farmers and their needs. Small farmers have three main challenges:

1. Access to finance: lack of accounting or its poor quality, lack of simple tools for accounting and production planning, low financial literacy of farmers and their inability to substantiate their financial needs, lack of understanding by bank loan officers of the agribusiness specifics, lack of credit analysis tools and risk assessment for banks to lend to small farmers.
2. Access to markets and inputs: lack of tools for comparing financing proposals of banks, suppliers and buyers in one place as well as for choosing the most suitable options for material and technical resources purchases, lack of tools for finding fellow farmers to form a tradable volume of products to profitably sell the crop.
3. Access to knowledge: lack of knowledge of where to find credit at best conditions and how to compare different credit options, such as bank loan effective interest rate, input suppliers credit conditions, processors/traders' pre-finance options conditions; lack of knowledge of how to prepare a business plan and a package of documents for a lender and submit an application; lack of economic analysis knowledge to improve profitability; lack of knowledge of efficient production and crop technology; lack of knowledge of how to keep accounting in the right way.

Description

Agrianalytica developed comprehensive but simple and easy-to-use online products to help small farmers run a more efficient business and meet lenders' requirements. To help farmers prepare a business plan quickly, they have developed an online tool **Agri: Business Plan**, which plays a key role in obtaining a loan, government support, grant or private investment. It provides full substantiation to attract financial resources. To help farmers keep reliable accounting records of their production, they

have developed a simple and easy-to-use online tool **Agri: Accounting**, where all accounting entries and reports are generated automatically, including tax forms and financial statements. To help farmers be more profitable, they have developed the **Agri: Farm Management** tool, enabling farmers to organize production processes effectively, control the use of resources, and provide farmers with the necessary analytics to make informed managerial decisions. To facilitate fast and reliable credit decisions by a lender, they have developed the **Agri:Credit Analysis** tool, which includes land verification and financial, economic, ratio and benchmark analysis of the farmer-applicant. In the **Agri: Financing** module, farmers can see various state support programmes and financial products from financial institutions. They can input suppliers and buyers, choose better options and submit online applications. Using the **Agri: Trading** module farmers can find colleagues nearby (situational cooperation) to form a tradable volume for the market. Respectively, as traders/buyers are also connected to the platform, they can place their offers on what volume they want to buy so that farmers can see all traders' offers. Similarly, with **Agri: Shopping,** farmers have access to an online inputs store in their Agrarian Cabinet, where suppliers offer their inputs. **Agri:Consultant** is a digital and cost-effective agriculture extension service.

Technology

Main technologies and systems: Linux 3.10 (server operating system); Apache 2.4 (application server); PHP 7.0 and 7.2 (for backend of system); MySQL 5.6 and 5.7 (main database); JQuery 3.4 (for frontend of legacy part system); Vue.js 2 (for frontend of new part system); Bootstrap 4 (main css framework in system); RabbitMQ (message-broker system, the main usage for management request notification); Redis (data structure store, mainly used to cache the most frequent queries to database and some dictionary); Composer (package manager used to manage external php package); npn (package manager used to manage external js package); Docker (OS-level virtual machine, used to build container of different part of system).

History and plans

Agrianalytica was established in 2017 with their main office in Kyiv, Ukraine. Over the past two years, Agrianalytica have gained a strong market trust with a simple principle they follow gathering growers, financial institutions, input suppliers, buyers of agricultural produce, investors, donors, insurance companies and other businesses to ensure access to finance, markets and knowledge based on a win-win concept for all participants. Agrianalytica cooperates with USAID on financial literacy, business planning and accounting training for farmers. Currently 11 317 farmers are registered in the Agrianalytica platform. They cultivate 2 082 million hectares of land. Twenty-nine banks, 8 credit unions, 57 suppliers and 6 buyers (traders/processors) have their Partner Cabinets on the platform.

Category 2. Capacity development and empowerment

Organic Farm Knowledge – an online platform to promote knowledge exchange among organic farmers and advisors

Category winner

IFOAM ORGANICS EUROPE	**Organic Farm Knowledge – an online platform to promote knowledge exchange among organic farmers and advisors**			
Applicant:	**IFOAM Organics Europe** Maria Gernert, TP Organics Coordinator			
Country:	Belgium	Implementation in Austria, Belgium, Bulgaria, Canada, Colombia, Czechia, Denmark, Estonia, France, Germany, Greece, Hungary, Italy, Latvia, Lebanon, Netherlands, New Zealand, Pakistan, Poland, Serbia, Spain, Sweden, Switzerland, United Kingdom of Great Britain and Northern Ireland, United States of America		
Website:	https://www.organicseurope.bio			
App:	https://organic-farmknowledge.org			
	Delivery model:	Free and fee	**Stage:**	Early stages/Ideation stage

Challenge/context

Farmers within and without the organic sector are increasingly looking for more sustainable farming practices. They are often inspired by agroecological principles and organic practices. Organic and agroecological farming systems are knowledge intensive rather than input intensive. Science-based and practically applied knowledge of organic farming practices is needed to transition our food and farming systems successfully. Farmers should have access to the latest research results and be able to learn from each other. While much knowledge and many sources of information about organic farming already exist, it is difficult for farmers and advisors to use it in their daily work and find practice-oriented guidelines with concrete recommendations. Too often knowledge from research projects stays within the research community and is not always disseminated or practically applied on the farm-level. While the first source of knowledge for farmers is often their colleagues (peers) or trusted advisors, this way of exchange is costly in terms of time and travel and is not always possible, especially over longer distances. As a result, knowledge generated in a specific region or country may not be known in others.

Description

The internet provides the opportunity to make up-to-date information readily and rapidly available for a broad audience while also allowing for more interaction between actors on the ground. Online hubs can play a key role in bringing knowledge as well as actors together. Organic Farm Knowledge brings together scientifically validated and accessible agricultural knowledge at the European level, providing

access to a wide range of tools and resources for farmers and farm advisors. The platform's overall aim is to provide knowledge that is ready for use and helps improve methods applied in organic farming. The platform's tools include factsheets, guides, online calculation tools and videos that present scientific and practical knowledge designed for and by practitioners, facilitating access and implementation. They cover themes such as arable crops, soil quality and fertility, nutrient management, pest and disease control, weed management, animal husbandry, ration planning, organic seed, and plant breeding. More themes will follow soon, such as fruit production, farm economics, food chain management, and biodiversity. The Organic Farm Knowledge tools are permanently stored on the Organic Eprints database, the online archive for publications and other material related to organic farming research maintained by the International Centre for Research in Organic Food Systems (ICROFS). Currently (November 2020), there are 315 tools available on Organic Farm Knowledge. While Europe is the geographical scope of Organic Farm Knowledge, knowledge on the platform may be relevant for regions with similar climates, such as Northern Africa, the Middle East, North America, or Eurasia.

Technology

The platform was designed with the users' experience in mind. Every tool on the platform is described by metadata that helps users find the most relevant tool addressing their needs. This metadata is used to categorize the tools according to the thematic organization and the platform's core, the "toolbox". The toolbox can be searched with arbitrary text or filtered with numerous filters like themes, keywords, languages and more. The platform is available in 14 languages, making it accessible for practitioners across Europe. The platform's materials are written in English, and translations are done using Google and Deepl. As the translation technologies continue to improve rapidly, so will the platform's language quality. Disqus is used to facilitate discussions within themes and specific tools.

History and plans

The platform was established in the framework of the project OK-Net Arable (which aimed at improving productivity and quality in organic arable cropping), and further developed by OK-Net EcoFeed (which supports organic pig and poultry farmers in achieving the goal of using 100 percent organic and regional feed) as an ideal solution to minimize the time and efforts required to quickly find the right information, which is crucial for practitioners. Organic Farm Knowledge platform core partners are Research Institute of Organic Agriculture – FiBL (responsible for hosting, management, and maintenance); ICROFS (management and maintenance of Organic Eprints); and IFOAM Organics Europe, the European umbrella organisation for organic food and farming (coordination and promotion). To meet the ambition of Organic Farm Knowledge to become the European reference hub for practical knowledge on organic farming, an action plan was developed, providing an overarching framework for further developing the platform. The goal is to reach 10 000 unique visitors per month and 150 000 total visitors per year.

RuralBit Lda – Genpro

Honourable mention

	Genpro			
Applicant:	**Ruralbit Lda** Manuel Silveira			
Country:	Portugal	Implementation in Portugal, Spain		
Website:	https://www.ruralbit.pt			
App:	https://genpro.ruralbit.com			
	Delivery model:	Regular service	**Stage:**	Proven/Scale-up stage

Challenge/context

The importance of indigenous breeds has been increasingly recognized. Not only do they constitute genetic heritage whose preservation has to be guaranteed, but above all they are animals adapted to each region, able to take advantage of resources that are often scarce. They are fundamental for rural communities, allowing the maintenance of sustainable agricultural practices. These local indigenous breeds are threatened by pressure to be replaced by exotic breeds, which at the outset are more productive but compromise the sustainability of the communities, as they are not adapted to the local environment. Maintaining healthy populations of indigenous breeds is a challenge. They are mainly maintained by small farmers, in isolated areas, often in the mountains; hence, difficulties arise in marketing products and ensuring sustainability. Data recording is crucial for the monitoring of local domestic breeds.

Description

Genpro is an online platform developed for recording data related to the management of Stud Books, presently being used in the management of 67 breeds (cattle, sheep, goat, horses and pigs) representing nearly all of the Stud Books existing in Portugal. Genpro allows concentrating all information about each breed, making it possible to identify the main constraints and develop conservation plans for one. It also allows information to be processed and returned to each farmer, so that farmers can make the best use of the resources they have. Finally, it contributes to the sustainability of rural communities, by providing tools for marketing strategies for these products, being a fundamental link in their traceability. The application allows the recording of all kinds of animal data, such as ear tags, ID numbers, genealogies, weights, artificial insemination and medication, and many others. Genpro was developed for farmers' unions and associations that manage Stud Books. The development of this platform has kept us in close contact with them, giving us a deep knowledge of the livestock production sector in different regions. By using Genpro, technicians from the farmers' associations can collect the data from all several farms and obtain a full portrait of the breed they

manage. Data can also be collected by farmers directly, through the Android app R.campo, and then sent to the main database in Genpro. This data can then be used to design and implement conservation programmes, taking the information back to the farmers. By keeping the data collection and analysis through Genpro these programmes are constantly monitored, allowing them to be evaluated and reformulated if necessary. The costs are borne by farmers' associations. There is an initial admission fee and a monthly subscription fee for the service that varies between €100 and €150 per month, which includes maintenance and technical support to users and new developments of new features.

Technology

The platform **Genpro Online** can be accessed from any device connected to the internet. It has been developed with a modular structure, so it is easily adapted to different species and production systems, as well as to various languages. The information can be accessed anywhere at any time, by technicians, farmers and any participant in the production chain. A policy of access ensures that each user only gets the information they have subscribed to. R.campo is an Android app that allows data collection in the field, and later synchronization with Genpro Online. Data can be collected without an internet connection (offline). After collection, data synchronization is automatic, without file transfer. Data collection forms can be customized for different field operations and different screen sizes. R.campo is useful for all tasks, from the simple collection of live weight, to a complete check of all the animal's information. Genpro was developed using standard MySQL/PHP/HTML languages, in a scalable infrastructure, which allows the platform to grow as requirements evolve.

History and plans

Genpro has been implemented since 2006. It is currently being used in farmers' associations in Portugal and Spain, for a total of 67 livestock breeds. It has nearly 8.2 million animals registered and more than 2200 users. Growing internationalization is a key objective. In this process, Rurabit is seeking funding to bring Genpro to communities that are currently unable to support the costs of the platform, although these are low. They work closely with each farmers' association to ensure that Genpro is perfectly adapted to their requirements. They also have a partnership with the Portuguese Research Center for Agriculture (INIAV), who uses Genpro to carry out genetic evaluation of animals. This evaluation allows characterizing the animals of each breed and is fundamental for the definition of conservation strategies.

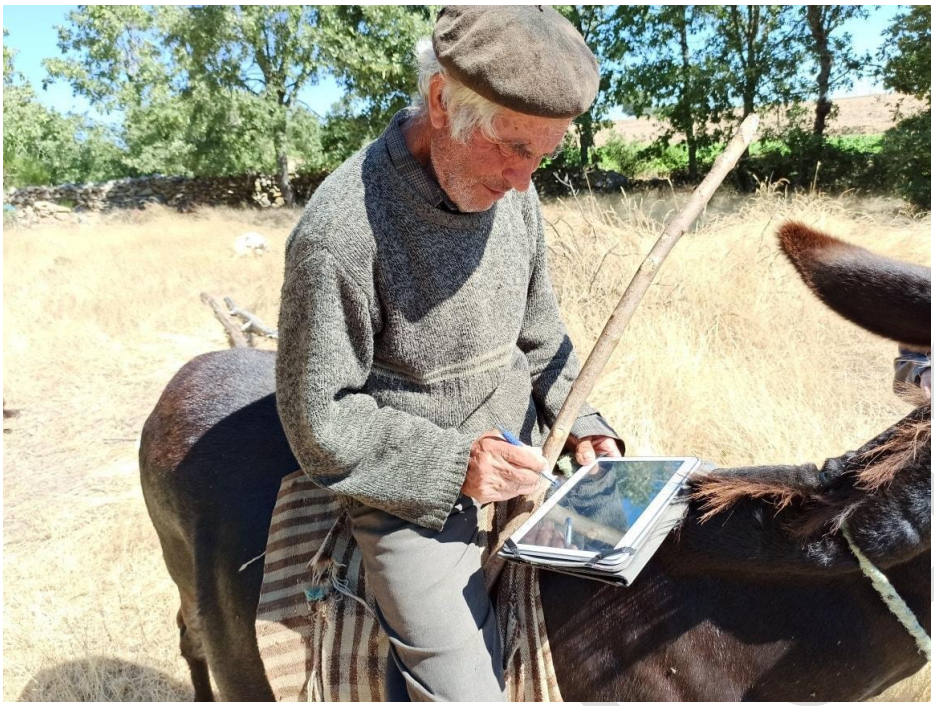


Photo taken of a local sheep breed producer (Mirandesa sheep, in NE Portugal), digitally signing documents in Genpro.

AgroInform Asia – Electronic agricultural maps

Honourable mention

АГРО TJ ИНФОРМ Информация для развития	**Electronic agricultural maps**			
Applicant:	**AgroInformAsia** Evgeny I. Ryazanov, director			
Country:	Kyrgyzstan	Implementation in Kyrgyzstan, Russian Federation, Tajikistan		
Website:	https://agro-asia.com/ru			
App:	https://maps.agroinform.asia/krg/ru			
	Delivery model:	Free and fee; regular maintenance	**Stage:**	Market adoption/Validation stage

Challenge/context

Smallholder farmers usually do not have long-term contracts to supply their grown products for processing or export. The choice of crops for cultivation is based on a review of neighbouring producers and their success in the past season. This practice leads to overproduction, a dramatic drop in retail prices and economic losses. This situation results in the need to store vegetables in storage facilities in anticipation of higher prices during the winter or spring seasons. Small farmers who do not have their own storage infrastructure can rent storage space based on information about available storage facilities and owners' contact details.

Description

The solution consists of the electronic Google-based maps at the national level with some information represented at the district level. These agricultural maps allow the following:

1. Optimization of agricultural production: producers, as well as organizations involved in planning agricultural production can analyse and determine trends in the production of a particular crop at district, region, and country level and decide on the cultivation of this crop in the current year.
2. Optimization of processing and trade of agricultural products at the domestic market and for export: identification of regions with the largest production of a certain culture, identification of opportunities, and prospects for the product's processing and sale/export.
3. Optimization of transport costs for the delivery of certain agricultural products for processing or export sites.
4. Food security assessment at the district level for a certain agricultural product. This layer also allows estimating the movement of a certain product within a country.

5. Facilitating the interaction and information exchange among various stakeholders in the agricultural value chain.

Technology

Electronic maps at the national level, provide information at the district level. The practice is based on Google maps with added district boundaries. Overlaying several layers on top of each other might be possible eventually.

History and plans

The first versions of the electronic agricultural maps were launched in 2017. These maps were contour-based, in other words they depicted national and region borders, but did not provide users with interactivity and scaling. The maps were developed by AgroInformAsia in cooperation with Nexigol Navovar and Nexigol Mushovir Public Foundation based in Khujand, Tajikistan. Later, AgroInformAsia signed a Memorandum of Cooperation with the autonomous non-profit organization, the Centre of Competence for Digitalisation in Agro-industrial Complex, Tambov, Russia, which provides information on the Tambov region. AgroInformAsia won second place in the international competition of innovative digital projects Eurasian Digital Platforms 2019, held by the Eurasian Economic Commission (EEC). This EEC's appraisal inspired partners to improve the tool, which has been translated into a Google Maps framework. Many new layers have been added, and work is underway to improve the tool and provide insights.

Implementation of analytical tools on a paid basis is planned: analysis of trends in the production of a particular crop and the relationship between changes in production and changes in market prices. The latter tool is already available in the AgroSpace platform and currently free to use (http://prices.agroinform.asia/tj/prices). Another development could be linking maps with mobile apps to represent the companies selling seeds, crop protection products and fertilizers (https://apps.agroinform.asia/)

FarmForesight

Category champion

FARM FORESIGHT	**FarmForesight**			
Applicant:	**FarmForesight** Alexander Eine, CEO			
Country:	Ukraine	Implementation in Ukraine		
Website:	https://farmforesight.com			
App:	https://app.farmforesight.com/signup			
	Delivery model:	Free and fee; accounts are completely free, but there are premium options that improve QOL of gameplay, allow better scenarios customization and provide improved analytics	**Stage:**	Market adoption/ Validation stage

Challenge/context

FarmForesight innovates the training and assessment process by turning it into a game-like experience, allows team members to refine competitive solutions, easily involves staff into the learning process, and facilitates a decrease in hiring costs and a reduced adaptation period. Smallholder farmers can use FarmForesight as the basis for building what-if scenarios and gaining relevant experience in theoretical problem-solving of market/weather conditions without risk.

Description

FarmForesight is a gamified business simulation based on statistical data and cause-effect analysis of decisions taken in agricultural companies. Decision-making processes in simulation cover management, agronomy, trading and finance areas. Modelling considers the most valuable factors that affect future yield and financial results like the influence of the weather, cost/quality of applied seeds fertilizers and crop protection sprays, the influence of crop rotation predecessors, the time for optimal technical operations in each region, price changes, etc. FarmForesight allows training in decision-making skills. It shows great results as a staff assessment and training tool, as an aid for HR in choosing proper candidates, and as a team building and event instrument. It also improves the decision-making skills of farmers and plant production companies' staff. FarmForesight is developed in partnership with Latifundistmedia, a Ukrainian media holding, which owns media resources covering different areas of the agricultural market in Ukraine, Belorussia, and Kazakhstan. Accounts are completely free, but there are premium options that improve QOL of gameplay, allow better scenarios customization and provide improved analytics.

Technology

FarmForesight is a web-application built on Java and React.js, which allows modelling of multiplayer sessions of a virtual plant production company that can be tuned to be similar to a real company (region, company size, specific weather and prices condition). Core analytic algorithms in modelling are based on big data and tuned by experts to give as realistic forecasting as possible in virtual modelling. Gamification makes the modelling process fun and involving. The model can be adapted to almost any crop type in any country if there is enough historical data to analyse and build cause-effect links.

History and plans

FarmForesight was launched in February 2020 and has already gained a few leading companies as corporate clients. There are approximately 4000 accounts already in modelling. More than 20 000 sessions have been played, with each session modelling at least one calendar year of plant production. A cyber sport tournament event between Ukrainian agricultural companies offered a $10 000 prize. The overall feedback is very positive. Modelling has been used by top companies as an event instrument, for staff training, as an assessment tool, and as a business plan proofing tool. Plans include adding more crop types and updating historical data for existing ones, enriching weather and price scenario variety, and finding partners in other countries to create localized versions of modelling with local crop types and crop-rotation specifics.

Category 3. Agriculture innovations systems and sustainable farming - farm automation, robots, drones

West Coast University of Applied Science – Naiture – High-Precision Weed Control in Organic Farming

Category winner

FH Westküste Wirtschaft und Technik	**High-Precision Weed Control in Organic Farming - Bonirob**			
Applicant:	**West Coast University of Applied Science** Prof. Dr.-Ing. Stephan Hußmann, Project Manager			
Country:	Germany	Implementation in Germany		
Website:	https://en.fh-westkueste.de/en/home			
	Delivery model:	One-time sell	**Stage:**	Market adoption/ Validation stage

Challenge/context

Increasing crop yields while protecting the environment is a major global challenge for the future as the global population is predicted to expand to 9.1 billion by 2050. Moreover, there will be an increased demand for food due to rising consumption rates. The food demand leads to the use of more and more chemical interventions, which has wide-ranging environmental consequences and threatens global biodiversity. One solution for this is the use of manual weed management that doesn't use any chemicals, but in turn is very cost-intensive due to human labour. It is also becoming increasingly difficult to find manual workers.

Description

Naiture GmbH & Co. KG develops intelligent, chemical-free robotic systems for autonomous weed control. The system achieves millimetre-accurate weed control in a row. The solution's special is that it can also distinguish randomly sown crops such as carrots or beetroot from weeds and destroy them while driving. This solution automates the cost-intensive task of manual weed management, making it a viable solution for sustainable weed management used by farmers of all sizes around the world and thus tackling the environmental challenge of providing food for an expanding population. Naiture is fuelled by recent innovations and rapid developments in the areas of image processing and AI. The first key innovation is the development of an advanced weed detection algorithm that differentiates between weeds and crops in real-time and enables a robotic system that can manage weeds with an adequate area yield performance. The second key innovation is the mechanical weeding mechanism that weeds with millimetre precision without using any chemicals, thus avoiding any negative impact on the environment. The current system is designed for 8-track operation. However, due to its modular

design, the system can be implemented on any conceivable working width. The speed is variable and can be adapted to the respective situation. For fields with a lot of weeds, a lower travel speed of 2 km/h is recommended. For fields with few weeds or a possible second pass, a speed of up to 5 km/h can be set.

Technology

Naiture is a combination of the two words Nature (nature) and AI (artificial intelligence). These two words reflect the successful integration of AI in organic farming., enabling the creating of an interface between agriculture and state-of-the-art technology. The system is based on the three technologies AI, robotics and big data. A reproduction of the human brain (deep learning) was trained to distinguish crops (e.g. carrots, beetroot, spinach) from weeds. By training the AI with large amounts of data collected over the last five years, the system achieves a high accuracy of about 98 percent under constantly changing weather and environmental conditions. Robotic systems then use this AI to destroy the weeds with pinpoint accuracy without any chemicals, specializing in products such as carrots or beetroot, to achieve millimetre-precise weed removal in the row even with randomly sown plants.

History and plans

In 2013, the project “High-precision weed detection in organic farming” was launched at the West Coast University of Applied Sciences. Over the next few years, the hardware (robot) and software (AI + control) for this 1-track functional pattern was developed and implemented. In 2018, the 8-track robot was developed. The spin-off from the university into Naiture GmbH & Co. KG took place in December 2018, which meant that the patents developed at FHW were also bought up. The company has been developing intelligent robotic systems for organic farming in cooperation. Further partners are Demeterbetrieb Rolf Hach and Ökoring e.V. In 2020, the 8-track robot was tested and evaluated. They are working with one of the biggest organic farmers in Germany. The Westhof, located near the university, asked if they could build a robotic solution for weed control in fields. Since 2014, they have been supporting this project by providing test fields for solutions. Naiture’s aims are as follows:

- Short-term: developing an alternative non-mechanical weeding unit/implementing AI on energy-saving embedded systems, so that a complete solar operation is possible.
- Mid-term: planning market entry and exploring further business ideas.
- Long-term: firmly establishing Naiture in the market as the leading company for innovative ecological agricultural technology. The goal is also to optimize systems to such an extent that even conventional agriculture uses them.

8-Track Weeding Robot during a field test / Credit: Naiture GmbH & Co. KG

BrioAgro – Intelligent watering taking advantage of the existing irrigation installation

Honourable mention

BrioAgro Technologies	**Intelligent watering taking advantage of the existing irrigation installation**			
Applicant:	**BrioAgro Tech, S.L.** José Luis Bustos Jiménez, CEO			
Country:	Spain	Implementation in Italy, Portugal, Spain		
Website:	https://brioagro.com			
	Delivery model:	Regular service; pay per use	**Stage:**	Proven/Scale-up stage

Challenge/context

Today's farmers have a double challenge – to produce food while simultaneously protecting nature and facing water scarcity. However, farmers rely on traditional techniques. In this sense, crop cycle planning has been established based on the experience of previous years and more or less previously programmed calendars, which do not admit modifications according to the actual state, based on prior studies with past meteorological data. This lack of information from the farm itself results in a deterioration in both the quantity and quality of the information since the weather stations are generally located far from the area. This causes a lack of reliability and accuracy, which today, thanks to technology, can be solved and help the sector increase its competitiveness and productivity. Among the main agricultural challenges, we need to face water scarcity due to climate change. We also need to reduce the amount of water used, as well as the use of fertilizers and other substances that pollute the water. In short, BrioAgro allows farmers to increase the environmental control of their fields, improving sustainability both by saving water and energy, a significant reduction in their carbon footprint, and by reducing the contribution of nitrates to the substrate.

Description

- This project enables European farmers to move towards responsible, cost-effective, resource-efficient water management, while ensuring their ability to cope with climate change and water scarcity. BrioAgro is an intelligent irrigation platform that uses low-cost technology based on information obtained by sensors (field and satellite). The soil moisture calibration algorithm is the most differential innovation. By connecting this data with the irrigation system, crops can be automatically irrigated when needed, by precisely calculating the amount of water. This prevents excessive use of water. Farmers are alerted about conditions that may threaten crops so they can take proper action in real time via a mobile app. As a result, BrioAgro avoids the risk of production losses, improving the yield and quality of the crops and increasing results by around 10–20 percent. This ICT-based solution collects and integrates soil and environmental data (humidity, conductivity, temperature, etc.) in real time through sensors and other sources. BrioAgro intelligently analyses the aggregated data, stratifying recommendations through a standardized process according to each crop and soil type, allowing informed, anticipatory decisions about irrigation and fertilization. This solution has been tested with many farmers from different regions of Spain, adapted to all types of irrigated crops, and

meeting the requirements of small and large agricultural enterprises. Great effort has been made to offer low-cost devices, and even rent them to be only used in the priority months of irrigation, in this way –BrioAgro supposes a minimum cost for small producers. This effort has led to systems for extrapolating information from one irrigation sector to the rest of the farm, using a single sensor combined with satellite, so that a farmer can start using BrioAgro services in Europe from only €100 per month. In addition, they have created a low-cost system that launches irrigation taking advantage of the installation the farmer has, so for only €35 a month more, a farmer can have an intelligent irrigation system for their entire farm.

Technology

The main innovative points include:

- System monitoring through sensors
- Calibration algorithm to measure soil humidity
- Use of multispectral satellite photographs
- Generation of predictions related to harvesting related to three different fields
- Use of low-cost multispectral cameras
- Monitoring the evolution of the crops

History and plans

The first prototypes started working in 2016, and by the end of 2017 they were connecting to irrigation equipment for Smart Irrigation based on information from the irrigation algorithm. In 2018, satellite images were being incorporated to make the solution more competitive in price, while the concept of guidance sensors was used to reduce the investment in sensors. The adoption/market validation stage happened in 2018 and 2019. And since the last quarter of 2020, the project has entered the proven/scalable stage, starting in new markets such as Italy and Mexico. BrioAgro has more than 250 installations, most of them in Spain, with all kinds of producers in the agro-food industry. In addition, it has accumulated experience of more than 40 different crops.

VitiBot – Bakus, full electric and autonomous vineyards robot

Honourable mention

ViTiBOT	**Bakus, full electric and autonomous vineyards robot**			
Applicant:	**VitiBot** Michael Fontanin, Chief Marketing Officer			
Country:	France	Implementation in France		
Website:	https://www.vitibot.coms			
	Delivery model:	Regular service	**Stage:**	Proven/Scale-up stage

Challenge/context

Reducing the use of phytosanitary products, preserving the environment and biodiversity, increasing the safety of operators and the shortage of skilled labour are major contemporary issues in viticulture.

Description

VitiBot is a French industrial company in the autonomous and electric vineyard robot market. The company accompanies winegrowers in the improvement of their vineyards with the latest technological solutions. VitiBot reconciles contemporary environmental and economic issues by offering a driverless solution. Vineyard robots ensure greater hygiene and safety for workers. VitiBot has created a universal platform to accommodate a large number of smart and power tools. The company's objective is to place the technological breakthrough called Bakus in the context of sustainable viticulture. its vision is: “Meeting the challenges of sustainable viticulture together.” It is designing and producing vineyards robots: VitiBot’s ambition is to evolve wine-growing practices towards a sustainable viticulture with practical and concrete answers to major contemporary challenges: increase the safety of operators, protect the vineyard and biodiversity, and reduce the environmental footprint of viticulture. Bakus, this viticultural robot, is able to meet these challenges in a sustainable way. The possibility to mount electric tools (innovations created by VitiBot) but also passive tools already owned by the operators allows supressing the use of herbicides. Autonomous movement in the vineyard allows the operator to supervise the robot using a simple smartphone and to dedicate it to more noble tasks, in complete safety. Finally, innovative technologies make it possible to plan many other applications in the vineyard (e.g. spraying with recuperator panels and adding new tools) without major transformations of the robot. VitiBot is committed, as an industrial company, to creating materials that respect the environment, biodiversity, vines and people on a global scale. More than 80 percent of its products are made with Made In France components to favour proximity with service providers, suppliers and collaborators and to reduce its carbon footprint. The product has been on the market for more than 18 months and is bringing great satisfaction to partner customers.

Technology

Bakus is a 100 percent electric, autonomous monorang vineyard straddle. It performs most of the soil working tasks in the vineyard, under the supervision of an operator, reducing or even eliminating the

use of phytosanitary products. The robot works in total autonomy on the plot. Its 100 percent electric propulsion allows it to cross vines with difficult slopes (up to 45°) and complicated inclines (>20°). It works very quietly and respects its environment. Bakus can equip itself with a range of electric and passive tools that can be fully modulated on the tool-holder pole. VitiBot has developed a range of electric tools that allow the precise adjustment of work in the vineyard and the preservation of vines and young plants in the best possible way. It is possible to combine up to two tools per side simultaneously.

History and plans

The story of VitiBot began in 2015 with the creation of the Hector project, which generated a strong interest in the viticulture community. Since then, many steps have marked the company's evolution. Bakus has been commercialized in its prototype version since 2019 and in its series version since 2020 as a model for narrow and semi-wide-growing vines. It targets most of the vineyards in France but also in Europe and the world. Bakus is already present in the largest French vineyards (Champagne, Bourgogne, Provence, Bordeaux, Pays de Loire) and VitiBot plans to further develop their robots thanks to extensive feedback from partner customers. The realization of new tools, the ever-increasing safety and the arrival of new crops are anticipated. International sales are also part of the short- and medium-term plan.

VitiBot-Both-Bakus-S-L-Wine-robot

Fly and See Agro LLC – Biological protection of plants by entomophages using unmanned aerial vehicles

Category champion

FLYSEEAGRO	**Biological protection of plants by entomophages using unmanned aerial vehicles**			
Applicant:	**Fly and See Agro LLC** Ptitsyn Vasily Nikolaevich, General Director			
Country:	Russia	Implementation in Russian Federation		
Website:	https://flyseeagro.com; https://flyseeagro.ru			
	Delivery model:	One-time sale/ regular maintenance	**Stage:**	Proven/Scale-up stage

Challenge/context

The proposed technology helps protect plants from insect pests without the use of insecticides. Pests do not develop resistance, pesticide load on land is reduced, and land degradation due to the use of pesticides is slowed down.

The use of entomophages to control insect pests contributes to:

- reducing pesticide uptake by plants and growing organic crop products;
- slowing down soil oxidation and degradation;
- conserving bees and other insect pollinators;
- reducing the use of agricultural machinery and its depreciation costs; and
- reducing soil compaction by minimizing the use of farm machinery.

Description

Fly and See Agro provides services for monitoring phytosanitary conditions of fields and entomophage treatment of fields for large and medium agricultural enterprises. The service is also available by serving several small farmers in the same area ensuring they get the service, too. In the future , the project aims to produce its own inexpensive drones for independent use by farmers.

Technology

Two special dispensers and methods of application have been developed that use entomophages to protect plants from insect pests on the bare ground. Using drones, dispensers distribute either entomophage eggs (Trichogramma, lacewing) or pupae (habrobracon hebetor). The dispensers have regulators to adjust their operation to work in different modes on different crops. They have their own GPS module, which facilitates the distribution of entomophages. One drone, with a crew of 2, can cover 20 hectares in 14 minutes. The average productivity per crew shift is 700 hectares.

Fly and See Agro is currently developing R&D directions:

1. Development of pheromone traps with remote control for pest monitoring.
2. Development of a UAV dispenser for predatory bug distribution.
3. Development of a budget-class UAV for application in open areas.

History and plans

The development of this solution was finalized in 2018. The pilot applications were carried out on various crops in the south of Russia (Krasnodar region). The demand for services is rapidly growing as can be seen from the dynamics of treated areas:

- 2018: 1 063 ha
- 2019: 5 736 ha
- 2020: 11 834 ha
- 2021: 28 000 ha (forecast)

Fly and See Agro has treated fields with various crops in regions such as Krasnodar, Stavropol, Lipetsk and Saratov.

Plans for 2021 include:

1. opening a representative office in the Volga Federal District;
2. presenting technologies in Europe (Serbia, Switzerland, France, Germany, Czechia);
3. presenting technologies in Latin America (Argentina, Brazil); and
4. constructing a bio-factory to produce entomophages.

Dispensers on drones to distribute entomophage eggs or pupae.

Category 4. Agriculture innovations systems and sustainable farming – specific solutions

Nedap Livestock Management – Nedap CowControl

Category winner

	Nedap CowControl			
Applicant:	**Nedap Livestock Management** Rudy Ebbekink, Global Marketing Manager			
Country:	Netherlands	Implementation in Austria, Belarus, Belgium, Bulgaria, Croatia, Czechia, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Israel, Italy, Kazakhstan, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom of Great Britain and Northern Ireland		
Website:	https://www.nedap-livestockmanagement.com			
	Delivery model:	One-time sell	**Stage:**	Proven/Scale-up stage

Challenge/context

The growing global demand for affordable animal protein presents an enormous opportunity, yet at the same time a scarcity in skilled labour and other resources forces more efficient production. Meanwhile, demands are rising when it comes to animal welfare, sustainability and transparency. Nedap empowers farmers using technology, so they can respond to the growing global demand for animal protein in a way that is both profitable and aligned with consumer expectations.

Description

At Nedap we believe in “Technology for life”. This means helping professional farmers run a profitable, sustainable and enjoyable business. The technology we develop enables them to automate everyday tasks and make informed decisions based on individual animal identification and data. Nedap CowControl is a wearable, wireless precision farming sensor technology. Nedap's SmartTag, which is worn around the neck or leg, identifies each cow electronically and monitors her activity, health, reproduction and location 24 hours a day. It provides precise and complete information about the health, wellbeing, fertility and nutritional status of individual cows and herds. Nedap CowControl cleverly turns SmartTag data into real-time and relevant alerts, to-do lists, reports and barn maps to help farmers manage and control their herd from their computer or mobile device. In terms of health monitoring, SmartTags measure the eating, ruminating, standing, lying, walking and inactive behaviour of each cow 24/7. If it deviates from normal behaviour, the farmer receives a warning, and the cow appears on a list of animals to be checked. Health issues are therefore detected 2 to 3 days earlier than

they are visible to the human eye and can be prevented or treated before they become severe. This ensures improved cow health, herd longevity, animal welfare and a significant reduction in antibiotic use. Monitoring group behaviour provides insights on the basis of which, for example, feed efficiency and cow comfort can be increased. In terms of reproduction, Nedap CowControl ensures that cows become pregnant in a sustainable way. The SmartTags automatically detect cows in heat and their optimal insemination moment. This allows cows to be inseminated based on their natural heat/cycle, without the need for hormone programmes. This is better for animal welfare and drastically reduces hormone use, while it vastly improves reproduction results. Automatic heat detecting, health monitoring, and cow locating drastically reduce the time and labour normally required for these tasks. This reduces lab or shortages and ensures a better work-life balance. An important effect is that it also ensures less stress for cows and, for example, shorter lock-up times. The system has proven to increase milk production, feed efficiency, and animal health and welfare, while reducing antibiotics and hormone use. It is an ultimate sustainable technology.

Technology

When it comes to innovation, Nedap is a frontrunner in the sector. Especially in the field of cow identification and monitoring. Nedap CowControl is a technologically advanced system, yet easy to use, install, integrate, and scale. The SmartTag is equipped with a state-of-the-art accelerometer. The system uses radio-frequency identification (RFID) technology and ultra-high frequency (UHF) data communication, among other things. Over time, Nedap has developed smart algorithms fully focused on cow behaviour that provide the most accurate, comprehensive, and relevant insights about individual cows and the herd. The software uses AI for various functionalities. For the cow locating functionality, Nedap has developed a unique technology. The latest and most recent addition is augmented reality. Wearing a Microsoft HoloLens, farmers can see and interact with relevant cow data and insights from Nedap CowControl presented above individual cows in their actual field of view. The technology has won multiple prestigious innovation awards, both within and without the agricultural industry.

History and plans

Nedap CowControl is a technological solution that is constantly evolving. In the mid-1990s, Nedap developed the first SmartTag that could electronically identify cows and detect heat. Over the years, hardware and software have been further developed in such a way that health monitoring, group monitoring and cow locating functionalities have been added, all in one sensor device. Since the 90s, the system is being successfully used on dairy farms across the globe. Nedap became a leading supplier of cow identification and monitoring technology. It will continuously add improvements and functionality to the CowControl solution, based on user and industry needs and (new) technological capabilities.

Apiary Book Ltd – Apiary Book

Honourable mention

	**Apiary Book**			
Applicant:	**Apiary Book Ltd** Iordache Bogdan-Stelian			
Country:	Romania	Implementation: It is already used by 22 000 monthly active users from around the world		
Website:	http://www.apiarybook.com			
App:	https://web.apiarybook.com			
	Delivery model:	Free and fee	**Stage:**	Proven/Scale-up stage

Challenge/context

Apiary Book Ltd sees beekeepers as the first line of defence in the mission to protect the planet's bees. Their mission is to help beekeepers from around the world to overcome the challenges of modern beekeeping by providing a complete platform that allows data collection and analysis against best practices, defined by all stakeholders involved in the apiculture industry: beekeepers, associations, farmers, veterinarians, researchers and authorities. To overcome the current challenges of modern beekeeping, we need to:

- increase general knowledge about bees;
- improve awareness of the threats affecting honeybee health;
- promote a set of good management practices; and
- facilitate communication between beekeepers.

Description/Technology

Apiary Book's objective is to help all beekeepers around the world to make better-informed decisions based on historical data, current conditions, and best practices, to minimize bee colony losses and increase productivity. They provide a complete solution for apiary management (applications developed for different devices: smartphone, tablet, computer), monitoring of beehives (remote IoT sensors) and data analysis (decision system, big data).

1. *Apiary management:* **Apiary Book** allows recording of information on the number, health and maintenance of each bee's colony, activities, inspections, treatments carried out, and other operations in the field of beekeeping. Based on the recorded information a beekeeper gets immediate useful insights and analysis that allow them to check the history of each beehive and decide to ease current apiary activities or plan future work. Using innovative technologies, like quick response (QR) codes/near field communication (NFC) tags, voice assistant/hands-free or offline storage, Apiary Book for Android allows beekeepers to identify beehives, analyse their history and record information about bee families directly on a smartphone even when they are working in the apiary. Apiary Book for Web enables easy access to management, reporting, data analysis and recommendations based on best practices on a desktop/laptop.

2. *Hive monitoring:* **Apiary Sense** is a remote hive monitoring hardware system that provides information on bee colony status automatically. The system has the following characteristics:
    - Integrates hive scale and sensors – internal/external humidity, temperature
    - Uses autonomous energy – battery and solar panel
    - Transmits data wirelessly – general packet radio service (GPRS)
3. *Analytics, decision system*: To enable beekeepers to make better-informed decisions, all collected data is analysed in relation to a knowledge base of beekeeping best practices. The results of the analysis can be presented to an individual beekeeper or a group of beekeepers from a geographical area. Useful information, trends and reports can be extracted and used in environmental or food safety assessment projects.
4. *Collaboration platform:* **Apiary Inform** is a management and communication solution for beekeeping associations. Beekeepers receive beekeeping news, best practices, disease/pest alerts, event details, and other information directly on their email or mobile phone (in-app notifications, SMS).
5. *Reporting tools:* **Apiary Report** is a platform designed to record and help the early detection of problems/incidents affecting the health of bee families and a valuable tool connecting beekeepers with farmers and local authorities.
6. *Academy:* **Apiary Academy** is an eLearning platform that helps beekeepers around the world to overcome the challenges of modern beekeeping. The objectives are to increase general knowledge about bees, improve awareness of the threats affecting the health of honeybees, promote a set of good management practices and facilitate communication between beekeepers.
7. *Community:* **Community Support** is an initiative that supports and promotes beekeepers by providing useful programmes such as mentoring; access to know-how and best practices from around the world; communication tools to talk with other beekeepers, get valuable advice and share information; education programmes for teachers and students; adopt a hive and others.
8. *Marketplace B2B, B2C:* **Apiary Marketplace** is a platform that facilitates the commercialization of apiary products to end-consumers or wholesale buyers and the sale of beekeeping equipment and supplies to beekeepers.

History and plans

Apiary Book is the most complex/complete solution for apiaries appreciated worldwide by beekeepers (160,000+ downloads, 22,000+ monthly active users). The actual success of Apiary Book was achieved mostly organically (word of mouth). The growth potential is very high. There are a lot of beekeepers around the world who have not yet discovered the solution; in France, for example, only 5 percent of beekeepers have downloaded the app.

Hive-Tech - 3Bee

Honourable mention

	Hive-Tech			
Applicant:	**3Bee Srl** Niccolò Calandri, CEO and Co-Founder			
Country:	Italy	Implementation in Italy		
Website:	https://3bee.com			
	Delivery model:	One-time sell	**Stage:**	Proven/Scale-up stage

Challenge/context

Bees represent an essential source of value and are crucial for human life. In terms of global agricultural production volumes, bees pollinate 75 percent of the crop categories that provide 90 percent of food worldwide. However, they are slowing dying off. The mortality rate has reached 265 in European countries since 2006. In particular, it has reached a peak of 40–50 percent in Italy. The cause of this decline is connected to several factors:

1. Pesticides (largely diffused and really harmful for the colonies).
2. Pathogens (lack of adequate veterinary medicines and incorrect use of medicines by beekeepers)
3. Beekeeping practices (beekeepers lack training and make errors such as wrong positioning or inappropriate treatments)

The survival of bees is strictly dependent on the precious job of beekeepers, who are now facing major difficulties regarding their economic sustainability.

Description

3Bee develops customized IoT monitoring systems powered by AI algorithms. The core business is represented by the Bee Project, supporting bees, beekeepers' role and jobs, and more generally, sustainability. 3Bee has built a beekeeper-centric business model and provides several solutions:

1. B2B: **Hive-Tech** is an innovative data-driven decision support system (DSS) based on proprietary AI algorithms for optimized beekeeping management. This technology is placed below hives and assesses the colony's activity status, and parameters such as weight variation, temperature, humidity, and air quality. It represents a virtual assistant for beekeepers, ensuring them comfort, control, and a productivity boost.
2. B2C: **Adopt a BeeHive** provides a link between beekeepers in the 3Bee network, who have installed Hive-Tech, and end-consumers willing to support biodiversity. Consumers can select a beekeeper, the specific variety of honey and the adoption plan they want to subscribe to. They can adopt a controlled beehive, receiving the possibility to monitor its status through an app and, consequently, a variable quantity of honey.

3. Corporations: **Pollinate the Planet** is a corporate social responsibility (CSR) project through which 3Bee supports small, medium, and large enterprises in developing projects with a positive social and environmental impact. They generate real benefits for the ecosystem by protecting bees, empowering beekeepers, and providing tangible outcomes to customers.

The product is commercialized through a freemium business model. Customers purchase the device, and then between a basic service (rough data transmission) or a premium one (advanced set of services). The use of this technology has proven to reduce the mortality of bees by 20 percent and to increase productivity by 30 percent.

Technology

3Bee technology for beekeepers, Hive-Tech hardware, is an innovative data-driven DSS based on proprietary AI algorithms. In detail, it is composed of two aluminium profiles that are placed below the hive and a small biomimetic sensor that is placed inside. In addition, it can be sold with or without other accessories such as a solar panel or a GPS sensor, which can enable the implementation of other additional services. The parameters collected by the sensors are transmitted in the cloud through the global system for mobile communications (GSM) network. They are processed through AI algorithms so that the virtual assistant can suggest to beekeepers how to implement prompt and focused intervention, overcoming a calendar-based, standardized approach. The offer is easy to use through a high UI/UX mobile app, compatible with both IOS and Android systems.

History and plans

3Bee was born in December 2016 when the two founders, Niccolò Calandri and Riccardo Balzaretti, merged their backgrounds in Electronics and Biology to find a solution to beekeepers' problems. After a year of full-time work on product development, the very first Hive-Tech was launched on the Italian market at the end of 2017. In particular, 2019 was a tipping point for the start-up when the number of devices sold reached 500 and the B2C project Adopt a Beehive was launched at the end of August. Overall, the customer base of the project includes 14 000 users, and it is quickly expanding. 3Bee launched a mobile app compatible with either IOS or Android to improve customer's UI/UX. Currently, 3Bee has sold 2000 devices to nearly 1300 beekeepers, most of whom are located in Italy, but the start-up is now starting its internationalization process.

3Bee Hive-Tech device

IT Innovations - i-bee

Category champion

i-bee	**i-bee**			
Applicant:	**IT Innovations** Elizabeth Kochevykh, Product manager			
Country:	Ukraine	Implementation in Belarus, Poland, Republic of Moldova, Ukraine		
Website:	http://www.i-bee.net/en			
App:	iOS: https://apps.apple.com/ua/app/i-bee/id1442548233?l=ru Android: https://play.google.com/store/apps/details?id=www.i_bee.net&hl=uk			
	Delivery model:	Fee and free; one-time sell; regular service	**Stage:**	Proven/Scale-up stage

Challenge/context

The main problem in recent years in beekeeping is the massive death of bees as a result of chemical poisoning during field spraying, as well as a result of sudden changes in weather conditions and microclimates inside the hives. The bee is recognized as the most important creature on the planet, therefore, constant control and monitoring of the state of their vital activity is a very important task. With the help of the i-bee system, beekeepers get full control over their apiary using special devices and smartphones with the app.

Description

The system solves all the problems that beekeepers have, including the need for a regular physical examination of apiaries, which are often located far from the beekeeper's location; tracking sudden changes in humidity and temperature, which lead to diseases or death of bees; and timely responses to changes in sound and the rescue of bee colonies in case of poisoning and during brood and swarming. A constant change in the weight of the hive signals the need to pump out honey, change the frame or change the location of the apiary in the absence of weight growth. In the winter season, weight measurement provides information about the need for timely feeding, which also saves bees from death or premature departure. i-bee helps to follow the basic rule of beekeeping: to disturb the bees and their vital activity as minimally as possible. i-bee comes with a free beekeeper’s diary and helps receive push notifications in the app in the shortest possible time in the case of an emergency. i-bee is aimed at a different target audience. Clients are private beekeepers with at least five hives, nomadic apiaries, industrial apiaries with at least 200 hives, and agricultural holdings with their own apiaries, which pollinate their fields and bring honey. Private beekeepers use the system more to provide security functions and analyse data online to make timely decisions.

Technology

The solution consists of special sensors and software. A **base station i-bee HUB** is installed on the apiary, which transmits data about the state of the apiary to the server via GSM or a Wi-Fi channel. The base station is powered by 220V or solar panels. Weather sensors can be connected to the base station showing precipitation, air temperature and humidity. **i-bee HIVE sensors** are installed on the hives that fix the temperature, humidity, and sound inside the hive, monitor the weight of the hive, and perform a guard function in the case of a fall, tilt or theft. Optionally, external sensors at the entrance which count bees can be connected to the HIVE sensors. All data collected on the server is displayed on a mobile app installed on iOS and Android smartphones. The beekeeper can continuously remotely monitor the status of their apiary and hives in real time. Data from the hives is received every 30 minutes. By obtaining data on the weight of the hive, beekeepers can control the honey harvest. Temperature and humidity data in the hive gives the beekeeper information all year round about the need for insulation or ventilation. Sound information informs the beekeeper about the brood of the queen and the swarming process. The **i-bee COUNTER sensor** is an indispensable tool for beekeepers who provide pollination services.

History and plans

IT Innovations has been developing i-bee since 2018. Before the development began, they held a series of consultations with experienced beekeepers and conducted a series of experiments to validate their idea. They tested the first samples of devices in several hives on real apiaries and worked out the technology and logics for displaying data on a mobile appl. In 2019, they registered their first sales and received a lot of feedback from real users about the necessary expansion of the functionality and confirming the importance of the system. In 2020, they registered regular sales to private beekeepers and carried out a number of pilot projects aimed at controlling pollination in research institutes in Poland, with large agricultural holdings (Kernel and Continental Farmers) in Ukraine. They have since improved mobile apps and data logic. For 2021, they have a number of pre-orders from industrial and nomadic apiaries. In November 2020, IT Innovation became the best agro start-up in Ukraine according to the Aggeek portal. In 2021, they plan to launch automatic algorithms for sound analysis and forecasting the state of bees and mass serial production of the bee counter sensor. In the near future they plan to strengthen their presence in the EU through the Polish market and start sales in North America and Australia.

Category 5. Agriculture innovations systems and sustainable farming – connected farm management systems

AGRIVI Farm Management Software

Category winner

AGRIVI	**AGRIVI Farm Management Software**			
Applicant:	**AGRIVI d.o.o.** Anita Flajslik, Senior Marketing Lead			
Country:	Croatia	Implementation in Bosnia and Herzegovina, Bulgaria, Croatia, Hungary, North Macedonia, Poland, Portugal, Romania, Serbia, Slovenia, Spain, United Kingdom of Great Britain and Northern Ireland		
Website:	https://www.agrivi.com			
App:	https://app.agrivi.com			
	Delivery model:	Regular service	**Stage:**	Proven/Scale-up stage

Challenge/context

AGRIVI Farm Management Software (FMS) digital solution brings great benefits to farmers by helping to avoid the triple loss experienced during the year. The first loss farmers experience is while planning production. Without precise data on soil quality and actual crop needs, it is impossible to optimally calculate the necessary inputs for the season. The second loss happens during the growing season, mostly caused by the wrong judgment of when to apply agricultural practices. Late crop protection against pests and diseases is accountable for 20 to 40 percent yield losses every year and this is just one factor that impacts the yields. The third loss farmers experience is while selling the product when the price for their crops depends on quality and their ability to guarantee food safety. The demand to prove the traceability of food is growing, both from consumers and retailers that buy directly from farmers. Farmers need to showcase each product when and where it was planted, how it was treated and what its nutritive value is. Without the digitization of each stage of production, it is impossible to show this information transparently

Description

AGRIVI FMS digitizes farming production and gives farmers the ability to remove triple losses in farming production, get measurable results, make more profit, and secure a better life. By providing farmers with knowledge about farming best practices with real-time insights into farm performance, AGRIVI helps farmers to make smart timely decisions, take preventive actions that eliminate the risk of low yield and take actions that boost high yields. The platform has full localization capabilities that are very complex when it comes to serving a global market. The AGRIVI platform supports different languages, measurement units and currencies, but also provides algorithms that are fine-tuned with local databases for pests and diseases, crop protection products, and fertilizers with details about

ingredients they are made of to enable intelligence and insights. The uniqueness of the AGRIVI farm management platform comes from a combination of the following capabilities:

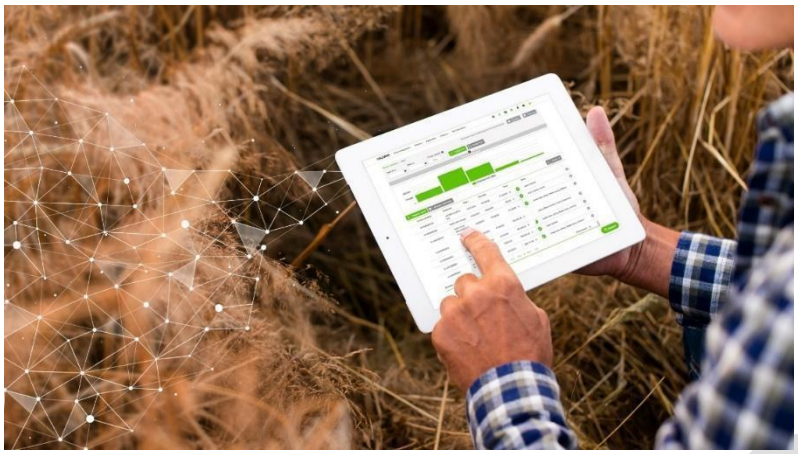
- Fully featured FMS platform covering both the agronomic and the business side of farming to support growers to be economically and environmentally sustainable.
- Collaboration features for value chain stakeholders and growers.
- Agronomic knowledge base pushed to growers and the ability to continuously update the knowledge base is based on big data analytics by analysing grower data, identifying productivity drivers of best performers, and making these insights available to all growers.
- Powerful insights on agricultural production (yield analysis, profit analysis, cost analysis) per crop, variety, and field.
- Predictive analytics like pest alerts to support growers in timely crop protection, weather alerts to mitigate bad weather, and a regular activity plan like when it is suitable to fertilize, spray, etc.
- User-friendly and localized user interface available as a web or mobile application with offline mode to support growers in remote areas.

Technology

AGRIVI's product is a farm management software delivered as a cloud-based solution to customers on a software-as-a-service (SaaS) business model. Customers access the solution via www.agrivi.com; there is also the possibility to deploy the solution on-premises to a customer's infrastructure to meet specific corporate security policies. Powerful analytics help farmers to make decisions based on data. The platform also helps value chain stakeholders like input manufacturers, food processing companies, banks, insurances, development organizations, and others to collaborate with growers, provide agronomic advice to help growers be more efficient, ensure traceability is sourcing produce from growers and secure sustainability of their agricultural ecosystem.

History and plans

AGRIVI solution has been available on the market for eight years since the founding and first versions of solutions in 2013. As a company, AGRIVI works directly primarily with large growers and reaches small and medium sized growers through the value chain. They support great customers in the agriculture value chain like Driscoll's, Nestle, Kimberly Clark, the World Bank, BNP Paribas, Helvetas, the Ministry of Agriculture Croatia and many others. Their farm management platform is now at the level of maturity where it serves the requirements of leading organizations in the agri-food industry globally. Now is the time to bring it to as many customers as possible, so expansion is the primary goal of the future period. Customers come from over 100 countries, with Europe and the United States of America representing most of their customer base. On the product innovation side, their focus is on predictions based on AI-driven insights, data collection automation, and compliance with food safety, quality, and sustainability standards.



AGRIVI Farm Management Software Application

AGRIVI Farm Management Software - Traceability Report

AGRIVI Farm Management Software

Agricolus platform

Honourable mention

	**Agricolus platform**			
Applicant:	**Agricolus s.r.l.** Andrea Cruciani, CEO			
Country:	Italy	Implementation in Albania, Austria, France, Germany, Greece, Hungary, Israel, Italy, Netherlands, Poland, Portugal, Republic of Moldova, Romania, Serbia, Spain, Turkey, United Kingdom of Great Britain and Northern Ireland		
Website:	https://www.agricolus.com			
	Delivery model:	Free and fee	**Stage:**	Proven/Scale-up stage

Challenge/context

Agricolus wants to push for an ecological transition of the economy favoured by the implementation of precision technologies in the agricultural sector, that today, sees only 10 percent of European farmers adopt mechanized methods to achieve efficient, sustainable, and quality agricultural production. The increase in technology rate adoption will improve the market stability of agriculture, giving a tool to the farmers for adapting to climate change.

Description

Agricolus is a cloud platform accessible directly from the web by creating an account. It is composed of the main applications of precision agriculture:

- geolocated field mapping (GIS technology);
- vegetation indices (vigour, water stress, chlorophyll) elaborated by the Agricolus team from satellite imagery (satellites used: Landsat 8, Sentinel 2, coming soon Airbus Spot 6 and Pleiades);
- forecast models developed with proprietary algorithms for phenology, irrigation, pests and diseases;
- crop scouting with a mobile app;
- task management; and
- prescription maps for fertilization.

What's new is having all these tools available on a single, easy-to-use platform, able to integrate data from different sources and provide farmers with a complete DSS. Agricolus supports farmers who must increase productivity and profitability, also given a greater demand for food, and the need for agriculture to have less impact on the environment to avoid desertification and loss of biodiversity and maintain the balance of ecosystems. Agricolus prevents and monitors the climatic adversities and pests and crop diseases allowing a healthy development of the territory and reducing the environmental

impact of agriculture, thanks to continuous and systematic monitoring by the combination of satellite imagery, forecast models and smart scouting. The platform detects information about pests and diseases that can attack crops, suggesting timely indications and solutions to minimize environmental damage. Agricolus not only helps agricultural producers to be environmentally friendly and to reduce the use of water sources and pollutants (reduction of fertilization up to 40 percent) but also allows them to be sustainable in the long term. Agricolus Free is the version of the Agricolus platform forever free for up to 10 hectares. Its basic features allow smallholder farmers to take the first steps towards the digitization of their farm. For example, they can use satellite images from Landsat 8, every 15 days at a spatial resolution of 30 metres, consult vigour and water indices, such as NDVI and NDMI, map their field, consult weather forecasts, and register all the operations carried out and consult data by using the mobile app.

Technology

Agricolus is a cloud platform accessible directly from the web by creating a simple account. It is composed of the best innovative technologies for agriculture: field mapping using GIS (service provider: Esri) to allow farmers to geolocate their fields and register information about them; vegetation indices elaborated internally by the Agricolus team from satellite imagery (service providers: Copernicus and Airbus) to allow farmers to remotely assess crop development and health and efficiently plan interventions in the fields; forecast models (developed with proprietary algorithms based on ML) for phenology, irrigation, pests and diseases to allow farmers to act promptly against harmful insects and/or diseases and to reduce the use of water, fertilizers, plant protection products; smart scouting with mobile app **Agricolus Farmer** to allow farmers to geolocate crop operations carried out directly in the fields; and prescription maps for fertilizations obtained using vegetation indices to allow farmers to reduce the use of fertilizers to the right amount needed.

History and plans

The Agricolus platform was launched as a solution in 2018. Since then, the platform has been improved and the offer has changed: **Agricolus Free** is still free for up to 10 hectares and the number of packages that farmers and organizations can choose from according to their needs has increased. There are more than 4000 users in 56 countries, with 33 partners on 4 continents; the platform is available in 6 languages so far. **Agricolus Academy** trains professionals and farmers in innovative technologies for agriculture with 1065 professionals already certified. Because of the COVID-19 pandemic, Agricolus organized a free webinar on Smart Farming and offered farmers one of the Agricolus packages for free for 3 months. They want to improve the platform by adding new features according to farmers' needs, increase the numbers attending the free webinar for the Agricolus Academy, and enter the European market.

xFarm - xFarm

Honourable mention

	xFarm			
Applicant:	**xFarm** Riccardo De Nadai, Content Marketing manager			
Country:	Italy	Implementation in Albania, Austria, Belgium, Bulgaria, Chile, Colombia, Costa Rica, Croatia, Czechia, France, Germany, Greece, Hungary, Italy, Morocco, Netherlands, Poland, Portugal, Republic of Moldova, Romania, San Marino, Slovenia, Spain, Switzerland, Turkey, Ukraine, United Kingdom of Great Britain and Northern Ireland, United States of America		
Website:	https://xfarm.ag			
App:	https://cdn.xfarm.ag/install-app/index.html			
	Delivery model:	Free and fee	**Stage:**	Proven/Scale-up stage

Challenge/Context

Today's farmers face numerous challenges. On top of traditional agricultural activity, there are more and more regulations and certifications. Consumers are increasingly attentive to the origin of the food they eat. At the heart of all these challenges, there is one main issue: the farmer's data.

Description

xFarm is a platform created by a farmer to take farms into the digital age, by simplifying data collection and analysis, thus reducing paperwork and improving efficiency and sustainability. xFarm is based on free farm management software in the cloud, IoT field sensors, and premium services. Aggregating data from sensors, machinery, and observations, xFarm supports farmers in their work allowing them to base their decisions on data. The application has been translated into six different languages and is available for everyone in the free version, so it is suitable for farms with different needs, dimensions, and possibilities. In fact, the xFarm platform supports 400 different crops and offers a multi-device experience. Due to its nature, the software is easily scalable, and it is possible to spread it in different countries of the world. Indeed, it is enough to have an internet connection to download the application. The premium version with paid modules, is very competitive in price and affordable for different farmers' pockets. Even the hardware, i.e. the sensors, are scalable and still suitable for the needs of small farmers. xFarm’s commitment is not to create the best solution for each functionality; it is to create a digital platform that fits all farms, both large and small that very often cannot afford certain tools. xFarm believes that democratizing technology is necessary to scale the digitalization process and that this is the most relevant innovation it brings to the agri-food sector. With xFarm, it is possible to:

- manage water in a sustainable way using a soil moisture sensor that sends data to the app that gives an alert when it is the right moment to irrigate with a reduction of water consumption by 30 percent;
- prevent the occurrence of disease and reduce the use of pesticide by 10 percent using the forecasting model; and
- save 15 percent on fertilizer, thanks to remote sensing and prescription maps.

Technology

xFarm is a wide-view working deck:

- a comprehensive management software helps farmers run their farms by improving data management and creating all the documents that are now essential, in a simple and intuitive way.
- An IoT sensor (xSense) captures local data and uses it for several functions for informing and alerting the user in real-time and for the xFarm internal database. This is crucial to anticipate possible plant pathologies, save on water consumption for irrigation and reduce the use of pesticides. All this is realized with software that is simple and appealing and minimizes the number of clicks to input data.
- Blockchain increases transparency and traceability of all the operations in the field.
- Cloud computing allows users to have access to the data and increases agility and flexibility.
- Remote sensing allows the farmer to receive a lot of precious data from the field on their smartphone, such as vegetation index. It offers them the possibility to compare the same or different fields at different moments and with different indices. There is also a tool that provides prescription maps to carry out variable-rate fertilization.

History and plans

The beta version of the platform was developed between January and December 2018, followed by a focus on the development of the IoT sensors and, during 2020, the premium part. In that year, xFarm made several paid modules available, such as **Satellite** to monitor fields from above, **Telemeters** to monitor telemetry data of tractors, **Finance** to check the expenses incurred, and many others. Regarding accomplishments, in 2020 xFarm grew from 4 000 to 30 000 users. Today, some 32 000 farmers use xFarm to digitalize their farms. This is certainly the most significant result. xFarm's social network reach includes 5 000 followers on Facebook, 3 000 on Instagram, and 3 000 on LinkedIn. In the medium-term, they plan to improve their service, develop new products, grow their user base, and to expand to other countries, both in Europe and outside, especially in the Mediterranean region. xFarm's long-term goal is to become a worldwide leading farm management platform, and at the same time be the main driver of traceability in the agri-food system.

Category champion

OneSoil	**OneSoil**			
Applicant:	**OneSoil** Rada Klimenko, Head of Business Development			
Country:	Belarus / Switzerland	Implementation in Albania, Andorra, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Kazakhstan, Latvia, Lithuania, Montenegro, Netherlands, Norway, Poland, Portugal, Republic of Moldova, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Switzerland, Turkey, Ukraine, United Kingdom of Great Britain and Northern Ireland		
Website:	https://onesoil.ai			
App:	https://app.onesoil.ai			
	Delivery model:	Free to use	**Stage:**	Proven/Scale-up stage

Challenge/context

According to a World Economic Forum report, if 15–25 percent of farms adopted precision agriculture by 2030, the production and environmental effects could be significant. Global yield could increase by 10–15 percent, and greenhouse gas (GHG) emissions could be reduced by 10 percent. OneSoil aims to build a global platform for farmers and hopes to become a significant contributor to achieving the SDGs.

Description

The OneSoil team of 44 people develops free OneSoil web and mobile apps. The latter run on satellite images, ML algorithms, and big data analysis. They offer field monitoring and crop scouting features, as well as weather forecasts to every farmer. For advanced and more experienced users, OneSoil offers data visualization from agricultural equipment and variable-rate application (VRA) of seeds and fertilizers on their web app. The **OneSoil web app** ensures interoperability for various brands of agricultural equipment. A farmer can upload files of different types to the system and download files with tasks for onboard computers of various brands. OneSoil's VRA technology and productivity zones help farmers refine their use of inputs and unsustainable practices that lead to soil exhaustion and erosion and pollute ground waters with fertilizers. Remote crop scouting available in the **OneSoil Scouting app** allows them to precisely identify field problem areas and apply pesticides or other chemicals by zones without polluting the rest of the soil. Main features include the following:

1. Automatic field boundary detection using AI and satellite images simplifies user onboarding.
2. NDVI is calculated in seconds, saving time and effort on crop scouting and field monitoring.

3. Data on crops, sowing and harvest dates, yield, and growth stages can be easily recorded for all fields.
4. Productivity zones are calculated in seconds. This helps understand the best- and worst-performing field zones.
5. Variable-rate seed and fertilizer application maps are created automatically in a couple of clicks.
6. Notes for field problem areas ease the crop scouting routine.
7. A 5-day weather forecast helps plan fieldwork.
8. The spraying time feature helps select the best time to spray crops.
9. Growing-degree days and accumulated precipitation charts help predict growth stages and plan fieldwork.
10. Onboard computer data visualization helps check the accuracy of field operations.

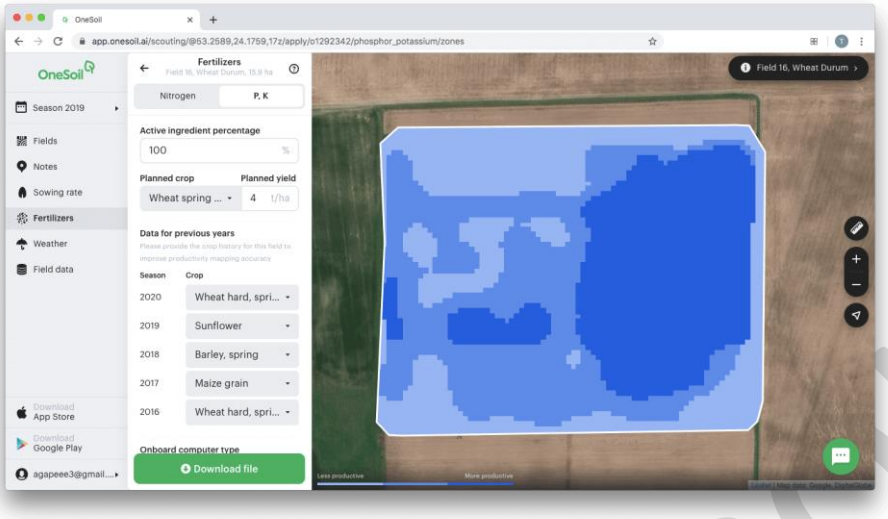
OneSoil makes farming technologies simple, fast, and free to use. The solution targets farmers across the globe who have 2 ha and larger fields. The automatic field boundary recognition is available for the fields larger than 0.5 ha.

Technology

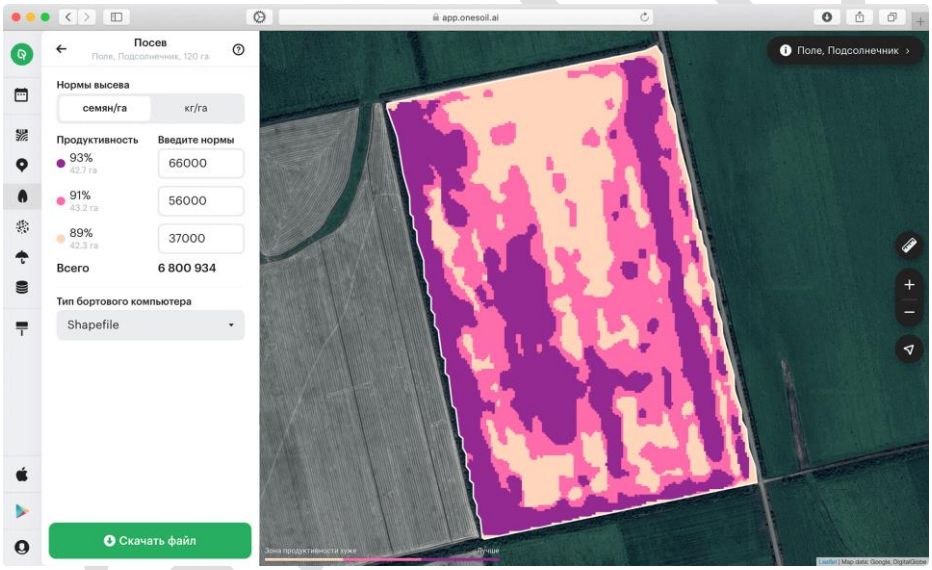
OneSoil detects field boundaries using AI and satellite images simplifying the onboarding process significantly. A farmer no longer needs to travel around the farm on a GPS-equipped ATV or hire a third-party company to do this work. OneSoil calculates the NDVI vegetation index in seconds. Using satellite images, it understands how plants are developing. When a farmer knows the NDVI, their field scouting routine becomes easier. OneSoil creates maps for variable-rate fertilizer application by defining field productivity zones, and helps farmers calculate nitrogen, phosphorus, and potassium rates for variable-rate application. It also creates a prescription file for an onboard computer in one click.

History and plans

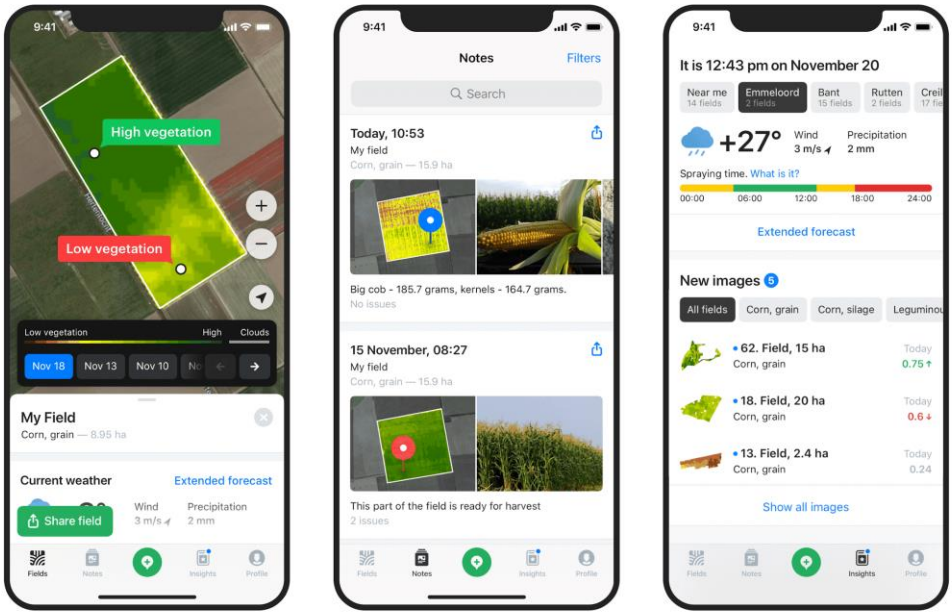
OneSoil began as an initiative between two friends. Co-founders Usevalad Henin and Slava Mazai met in Minsk in 2014. In the beginning, they did custom orders for farmers. Slava took pictures from a drone, and Usevalad made maps for the VRA of fertilizers based on their analysis. In 2016, Sasha Yakovlev joined them. The team began using ML algorithms to process field data, and the company expanded to six people. At the end of 2017, the company received its first investment. This allowed the team to work faster to create the free OneSoil apps that launched in the summer of 2018. According to a World Economic Forum report, if 15−25 percent of farms adopted precision agriculture by 2030, the production and environmental effects could be significant. Global yield could increase by 10−15 percent, and greenhouse gas emissions could be reduced by 10 percent. OneSoil aims at building a global platform for farmers, so we hope to become a significant contributor to achieving SDGs.



Productivity zones for variable-rate fertilizers in the OneSoil web app



Zones for variable-rate seeding in the OneSoil web app



OneSoil Scouting EN

Category 6. Disaster risk management and early warning systems

Disease and Pest Forecast with Artificial Intelligence – iMETOS

Category winner

METOS®	**Disease and Pest Forecast with Artificial Intelligence**			
Applicant:	**Pessl Instruments GmbH** Gottfried Pessl, CEO			
Country:	Austria	Implementation in Albania, Andorra, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Ireland, Israel, Italy, Kazakhstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Republic of Moldova, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tajikistan, Turkey, Turkmenistan, Ukraine, United Kingdom of Great Britain and Northern Ireland, Uzbekistan		
Website:	https://metos.at			
	Delivery model:	Regular service; part of advisory service	**Stage:**	Proven/Scale-up stage

Challenge/context

We cannot control the weather, but we can control how we respond to it. Agriculture is without a doubt one of the most weather-dependent industry sectors. Therefore, having real-time accurate, precise and reliable weather data is crucial for successful crop management and production. Planting, harvesting, spraying, irrigation? With METOS solutions, farmers always know which step to take next. Agriculture has changed drastically in the last two decades. Fast-developing technology will continue to have a tremendous effect on farming in the coming years. IoT in agriculture is gaining importance since it helps monitor multiple assets at once.

Description

FieldClimate is a plant disease model and global pest forecast with real-time weather data and cloud-based disease and pest forecast models. “Spray and irrigate when it is needed – do not spray and irrigate when is not.” With this technology, farmers spray less due to better weather information from the fields, saving money and protecting the environment. Some diseases are difficult to control; timing of fungicide application is crucial in keeping diseases under control for over 80 different crops. METOS helps growers worldwide comply with legislation and have a healthy crop with less pesticide usage. Use METOS to protect the environment and grow a better crop. Data can be shared from multiple

farmers and costs are minimal. This business model is termed Data-as-a-Service (DaaS) and its proliferation is hugely beneficial for smallholder farmers who can effort stations. This new approach will also ensure that Pessl Instruments will be able to leverage their technology to generate revenue for longer periods via the DaaS contracts for the local communities.

Technology

A complete solution for environmental monitoring, disease models, soil moisture, insect flights and more, iMETOS is a durable and flexible data logger for all climatic conditions, powered by rechargeable battery and a solar panel. The data logger has a built-in modem for direct communication with the **FieldClimate** platform and can handle up to 600 sensors through the intelligent sensor bus system. The system is extremely reliable due to a non-volatile internal memory and can store up to 8 MB of logged data (ca. 1 month). iMETOS can also send SMS alarms (user-defined via the internet) to alert users in cases of frost, heavy rain, high temperatures and more. Data is regularly uploaded to the FieldClimate platform where users can access it from any place at any time in real-time. Along with accessing historical data and daily evapotranspiration values, users can also take advantage of DSS like localized weather forecast, disease models and irrigation management.

History and plans

Thirty-six years since the start, 70,000 stations have been installed globally and are working with permanent improvements. For more than 35 years, Pessl Instruments has been offering tools for informed decision-making. A complete range of wireless, solar-powered monitoring systems under the iMETOS brand, and the online platform FieldClimate are applicable in all climate zones and can be used in various industries and for various purposes from agriculture to golf, landscaping, Smart Cities, animal welfare, research, hydrology, meteorology, flood warning and more. Over the years, iMETOS has become a global brand with local support, reaching out to almost every corner of the world. Durable, highly precise technology and support from trained partners worldwide are the recipe for success. Pessl Instruments is global with 200,000 farmers using iMETOS on a daily basis; they want 200 million farmers using it by 2025.

NIBIO – VIPS

Honourable mention

	**VIPS**			
Applicant:	**NIBIO** Berit Nordskog, Research Scientist/Project leader of VIPS			
Country:	Norway	Implementation in Bosnia and Herzegovina, Norway, Sweden. Part of FAO's mobile app for Fall armyworm (FAMEWS)		
Website:	https://www.nibio.no			
App:	https://www.vips-landbruk.no/			
	Delivery model:	Free and fee; open source, community approach	**Stage:**	Proven/Scale-up stage

Challenge/context

Pest and disease models of relevance to local needs can easily be implemented into the VIPS system. The open-source licence allows VIPS users to make adaptations and changes to accommodate local needs; implement, test, and validate models locally or as part of an international network; and eventually provide the models directly to end-users through the same systems. The sustainability of the system is based on the combined outreach for scientific development through research projects, while adapting the product to meet the preferences of local users.

Description

VIPS is an open-source technology platform for prognosis, monitoring and decision support for integrated pest management (IPM) in agricultural crops. The Norwegian VIPSweb (www.vips-landbruk.no) is developed and managed by researchers at NIBIO in collaboration with the Norwegian Agricultural Extension Service and is designed to meet the needs of Norwegian agricultural advisors and farmers. **VIPSweb** is an online tool for IPM, particularly addressing two IPM principles: tools for monitoring and threshold values as a basis for decision-making. The service includes pest risk models and early warnings of relevance for the most important pests and diseases in Norwegian agriculture, targeting crops such as cereals, apples, and field vegetables. Observations of pests and diseases are reported to the system by agricultural advisors, addressing both inputs to models and reports on pest and disease observations. The website presents a map where model outputs are linked to geographical locations, showing risk alerts in traffic light colours (i.e. red, amber, green) to indicate whether there is a need for further action. More details on risk levels related to each pest or disease risk model is available in the system. Pest and disease warnings have been open and freely available for Norwegian farmers and advisors through the web since 2001, providing data from a network of more than 80 weather stations. Additional locations can be added by linking private weather stations to the system.

The VIPS system is designed with flexibility in mind, aiming to create new and improved tools for better implementation of IPM at an international scale. VIPSweb allows for local adaptations, including multi-language support, the incorporation of models and other services. This opens the way for easy customization for international use. Alternatively, model output views can be incorporated on existing websites or distributed on smartphones or tablets. Data from most online weather stations, public weather data networks and weather forecasts can be used, allowing pest and disease models to be tested and validated under local conditions, with multiple sources of input data. Observations of pests and diseases can be easily reported and visualized in online maps.

Technology

The VIPS platform is designed as an application platform suited for international use and collaboration. The open-source code of VIPS (https://gitlab.nibio.no/VIPS) allows users to make adaptations and changes to accommodate local needs. Any model of relevance or amendments to the system can be implemented and shared with VIPS users worldwide. All models should be open for sharing with other users of the system. However, depending on the ownership of the models, models can be exempt from open source, and royalties may apply to users of such models.

History and plans

The Norwegian VIPSweb has been available online since 2001. The development of a new and flexible technology platform for VIPS was initiated as part of a project between Norway and Bosnia and Herzegovina in 2013–2015. In 2014, the new VIPS platform was established and tested for use in Bosnia and Herzegovina. Since 2016, the Swedish Board of Agriculture has provided VIPS-based risk warnings for potato blight in Sweden. The same year, the updated VIPSweb was relaunched for Norwegian users. The international integration of VIPS as part of systems in the EU and Africa is part of ongoing project developments. NIBIO aims to initiate international research collaboration to create new and improved tools for better implementation of IPM. As part of the combat against Fall Armyworm (FAW) in Africa, elements from VIPS have been implemented in the FAW Monitoring and Early Warning System (FAMEWS) mobile app. Current outputs include facilitation of access to weather data through the FAMEWS app. VIPS is currently being adapted for use in Mali, Niger and India, and integrated with advisory application tools being developed or in place. NIBIO's medium-term objective with VIPS is to integrate it with tools of the other pillars of IPM (diagnosis, identification, monitoring and advice) into a Swiss army knife that can serve as a general model. VIPS is a nominee to the UNs Alliance of Digital Public Goods (https://digitalpublicgoods.net).

Sencrop – Precision ag-weather solutions

Honourable mention

Sencrop	**Sencrop: Precision ag-weather solutions**			
Applicant:	**Sencrop** Jeanne Longueville, Marketing Coordinator			
Country:	France	Implementation in Austria, Belgium, Czechia, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Luxembourg, Mauritius, Netherlands, Portugal, Romania, South Africa, Spain, Sweden, Switzerland, Ukraine, United Kingdom of Great Britain and Northern Ireland		
Website:	https://sencrop.com			
	Delivery model:	Regular service	**Stage:**	Proven/Scale-up stage

Challenge/context

Sencrop takes part in two fundamental trends, which will impact agriculture in the medium term. On the one hand, the digitization of agriculture, thanks to more local data, accessible in real-time and easy to decode will help the farmer to make a remote field tour, in the visualization and mapping of their territory with no need for time-consuming field trips. A stronger interconnection between the apps will make it easy to create alerts and perform analyses. There is also an increasing digitalization in the relationship between the technician of the coop, the agro-consultant, and each farmer resulting in a better exchange around the data collected in the fields, to advise the farmers on incoming diseases or pests, and on plant protection. On the other hand, the agro-environmental transition, with one of its vectors, precision agriculture means that farmers are ready to respond to this development. They are the first ones to love their land and look for its preservation. They are waiting for tools to help them join this agro-ecological revolution, as long as it allows them to be profitable.

Description

Sencrop develops and implements connected, accessible, and collaborative solutions based on agro-weather data collection to make precision agricultural monitoring technology available to everyone. It strives to develop more accurate, efficient, and environmentally responsible agricultural techniques and practices for widespread implementation. Easy to install and connected to a friendly application designed for farmers and winegrowers, Sencrop's rain gauges, anemometers and wetness sensors allow professionals to instantly access their plots' ultra-local weather data, anywhere, anytime, 24 hours a day. Users can access their data in real time, personalize alerts to position an intervention at the best time, and intervene in the event of diseases or frost. The accumulations can be calculated to position a treatment after rain, or to predict phenological states thanks to the accumulation of degree days and cold hours. Climate data can be exported in different formats for permanent storage. A

Sencrop station costs about €500 (all included). The solution is also a collaborative tool: Farmers can help each other. Thanks to its large network in Europe, Sencrop offers annual subscriptions from €79 to access local weather data from nearby farms for example. The system helps farmers save time, allowing them to manage their farm in other ways, or just to enjoy more comfort in their daily lives.

Technology

Sencrop takes advantage of the benefits that IoT and 0G offer in terms of connectivity for agricultural success. In this sense, when developing their ag-weather sensors, Sencrop required a reliable, steady and expansive data collection and transmission system that would have a low energy consumption and broad coverage, especially in rural areas, but which would be cost effective for the volume of data transmission of real-time weather measurements.

- **Raincrop** comes equipped with a dual-trough swivel system to measure cumulative rainfall accurately. Three temperature and humidity sensors are combined to deliver more reliable weather data and prevent measurements from drifting over time.
- **Windcrop** is an independent sensor to ensure stable free readings, providing wind average speed and gusts.
- **Leafcrop** simulates a real leaf placed at the heart of the foliage to measure leaf humidity, temperature, and air. Three other temperature and air humidity sensors are placed nearby for local weather conditions measures.

The rain and leaf sensors transmit data every 15 minutes and the wind sensor, every 20 minutes. Sigfox's 0G network provides the capacity to sustain an autonomous product for many years, thanks to the low electrical consumption of the technology.

History and plans

Sencrop started in 2016 and established its first cooperative partnership with UNEAL (North of France). The following year, Sencrop won a SIMA Innovation Award for their connected pluviometer and anemometer. In 2018, dedicated sales settled in the UK and in Spain. At this point, 3 422 stations had been sold. In 2019, Sencrop won another prize for its third station (Leafcrop) at SIVAL. In the same year, Sencrop started setting up private networks for larger organizations. Finally, in 2020, the start-up asserted itself as the European leader in connected weather stations and acquired its competitor, Visio-Green. It now has15,000+ agricultural data points and 75 employees. In the medium term, Sencrop wants to continue scaling up the market in other European countries. This year, Sencrop will therefore present a brand-new sensor (its fourth), as well as an improved version of one of its existing stations thanks to technological advances.

Category Champion

	agroNET – digital platform for sustainable farming			
Applicant:	**DunavNET** Senka Gajinov, Product manager - Digital farming solutions			
Country:	Serbia	Implementation in Georgia, Montenegro, Serbia, Slovenia		
Website:	https://dunavnet.eu			
App:	https://digitalfarming.eu			
	Delivery model:	Regular service	**Stage:**	Proven/Scale-up stage

Challenge/context

With the continuous increase of global population and the changing priorities of the consumers, the crucial challenges the food industry is facing are feeding the people without destroying the land/natural resources and ensuring animal welfare regardless of their life duration expectancy. These challenges can only be met by relying on modern technologies, combining advances in the IoT and AI sectors with domain expertise. Providing holistic management of farm activities leading to the introduction of sustainable agricultural practices by automatically optimizing inputs and resource utilization, resulting in high-quality crops and reduced negative environmental impact.

Description

A strong ecosystem and enthusiasm led to the final product agroNET, a modular and open smart agriculture platform providing holistic support to farmers, acting as a farm data interoperability hub with built-in powerful data analytics modules. The first step of introducing agroNET is choosing and installing different devices depending on the client's requirements and communication available at the site. DunavNET combines hardware components from multiple vendors to get the best cost/performance ratio. Gathered data are sent to the cloud and visualized at the agroNET web and mobile applications where different expert modules are available. Instructions on activities to be undertaken are created automatically by combining embedded expert modules and gathered infield measurements. For decision support in pest and disease management, weather stations for monitoring environmental parameters (air temperature and humidity, precipitation, wind speed and wind direction, solar radiation, etc.) are installed in vineyards, orchards and fields where arable crops are produced. Some environmental parameters (air temperature and humidity, precipitation) as well as leaf wetness are used as inputs in pest and disease prediction models providing information about when and what type of pesticide to use in order to avoid disease spreading and insect overpopulation. agroNET comes with different configurations, tailored to the needs of vineyards, orchards, vegetable production and arable crop production.

Having established such an integrated view of farm operations with a rich set of data readily available, thus overcoming the fragmentation of data generated by equipment from different vendors, the platform provides a range of expert data analytics services designed to provide just-in-time guidance and support to farmers and to enable advanced automation of activities and labour savings.

Technology

agroNET includes a comprehensive range of sensors, data loggers with multiple communication options, data analytics modules, an integrated farm dashboard, and a secure, scalable and reliable cloud environment. The practice relies on a combination of new technologies (sensors, IoT/ML) and domain expertise to provide recommendations and guidance tailored to a specific crop, its vegetation state, and the weather conditions. The practice goes beyond simple visualization of sensor data and acts as an agronomy consultant providing adequate recommendations, notifications, and alerts whenever an important event is detected, or a new phase started. The IoT/ML platform acts as a farm data interoperability hub, using specific data analytics algorithms. Data collected and actions taken are logged and made available to other actors in the supply chain, contributing to the increased transparency of the complete agri-food supply chain.

History and plans

The partnership behind agroNET includes DunavNET – designing and developing the solution; experts from the University of Novi Sad Faculty of Agriculture – providing domain expertise; and Agroprotekt – a crop protection advisory company, providing domain expertise and acting as a sales channel.

Modern agriculture production implies using the smart, ICT-based technology, but it is necessary to teach the producers about all the benefits that such technologies could bring. Additionally, constant support is necessary, at least during the first couple of years. Simplifying the solution, i.e. starting with just the basic, easy-to-understand solution is a better approach than going for a fully-fledged solution from the outset.

Category 7. Food loss and waste/Food safety and traceability

OLIO

Category winner

	OLIO			
Applicant:	**OLIO Exchange Limited** Tessa Clarke, Co-founder & CEO			
Country:	United Kingdom of Great Britain and Northern Island	Implementation in Ireland, Netherlands, Sweden, United Kingdom of Great Britain and Northern Ireland		
Website:	https://olioex.com			
	Delivery model:	Free to use	**Stage:**	Proven/Scale-up stage

Challenge/context

OLIO exists to tackle the problem of food waste in the home and local community. Globally, one-third of all the food produced each year gets thrown away; this is worth over $1 trillion annually. Meanwhile, 800 million people go hungry (who could be fed on a quarter of the food wasted in the West). If food waste were to be a country, it would be the third largest source of GHGs, after the United States of America and China. As we look to the future, we have another 2.2 billion people joining the planet by 2050. To feed us all we need to increase global food production by 60 percent according to FAO. To date, the approach to solving food waste in the home has focused on awareness and educational programmes. However, these have met with only limited success. With half of all food waste in developed countries taking place in the home, and with no innovation since the rubbish bin/trash can, the OLIO app is a pioneering solution to this most pressing of problems.

Description

OLIO is a peer-2-peer app tackling the problem of food waste in the home and local community. Globally, we estimate that households throw away well over $100 billion of food, with a devastating environmental effect due to the incredible number of resources that go into the production of that food, and the GHG-intensive supply chain it travels through. OLIO solves the problem by connecting users with each other, and volunteers with local businesses, so that surplus food can be given away, rather than thrown away. Users simply snap a photo of their spare food to add it to the app; neighbours then receive customized alerts letting them know something new has been added. They can request what they want and arrange a pickup via private messaging within the app. The handover of the food takes place on the doorstep or in a public location, generally the same day. OLIO is a for-profit company that generates revenue by charging businesses for the service provided to enable them to have zero

food waste stores. They are a remote-first team of 40 employees, funded by a combination of venture capital, impact investment, revenue, and grants. While OLIO's mission is to reduce food waste in the home through leveraging the power of digital technology, it also has several powerful secondary benefits that include tackling the problem of food poverty and increasing social cohesion at a local community level. The beauty of OLIO's model is that it is not only extremely effective at tackling the problem of food waste, but that it does so in a way that is highly scalable.

Technology

There are several components to OLIO's technology. They have two mobile apps (iOS and Android) built using React Native and Ruby on Rails, which are the main interface for users to give away and pick up surplus food. This can be surplus food from the home (regular users) or from local businesses (via Food Waste Heroes – volunteers). OLIO also have a web app that ensures it is available via desktop for those who don't have a smartphone. The product not only harnesses cutting-edge technology, but also utilizes the latest in behavioural science to ensure that users are motivated to share food with a neighbour, and just as importantly, continue to do so over time. OLIO have also built a separate system to support its Food Waste Heroes Programme (volunteers who collect unsold food from local businesses and redistribute it via the app). This marries their proprietary and highly innovative food safety management system with a user interface for volunteers to claim and manage their collection slots, plus reporting and compliance requirements that are needed on the backend to support paying clients and food safety regulations. Finally, OLIO have a working proof of concept of the world's first real-time longitudinal food poverty database, which shows food insecurity down to street level, and over time, thereby enabling local governments to measure the scale and location of food poverty, and to assess the effectiveness of their food poverty interventions over time.

History and plans

Launched in 2016 in the United Kingdom of Great Britain and Northern Ireland, OLIO now has over 2.7 million members, who have together saved 11 million portions of food. This has had the environmental impact equivalent of taking 33 million car miles off the road. Half of all the food added to the app is requested within 30 minutes, demonstrating what an effective hyper-local redistribution platform OLIO is. While OLIO originated in the United Kingdom of Great Britain and Northern Ireland, 25 percent of all activity takes place outside of the country, and food has been successfully shared in 54 countries so far. OLIO's growth both within the United Kingdom of Great Britain and Northern Ireland and beyond has been powered by over 60 000 people who have reached out to offer to help spread the word about OLIO (Ambassadors), and by 10 000 trained volunteers (Food Waste Heroes) who collect and redistribute unsold food from local businesses such as Tesco, Pret a Manger and Compass Catering.

Connecting Food – Real-time digital food supply chain auditing, powered by blockchain

Honourable mention

CONNECTING FOOD	**Real-time digital food supply chain auditing, powered by blockchain**			
Applicant:	**Connecting Food** Samantha Gadenne, Global Sales Director			
Country:	France	Implementation in several countries across Europe and Southeast Asia		
Website:	https://connecting-food.com			
	Delivery model:	Regular service	**Stage:**	Proven/Scale-up stage

Challenge/context

From sowing to harvesting, from processing to packaging, and from palletization to shelf-stocking, a food product often goes from hand to hand, and from machine to machine. Each and every transaction in the process is recorded by this platform, in real-time.

Description

Connecting Food offers digital transparency solutions that create value for agri-food players and restore consumer confidence in food. It improves food chain traceability, food safety and consumer transparency, while reducing food wastage. The objective is three-fold. First, to provide end-to-end supply chain traceability to all food chain actors. Second, to leverage new technologies to help food chain actors identify issues and make decisions in real-time. Third, to allow food chain actors to respond to the growing consumer demand for transparency in where their food comes from and how it is made. In the short-term, clients achieve end-to-end supply chain traceability, aggregating and standardizing their data into one centralized and secure platform. They are very quickly able to respond to the new consumer trends asking for proof of product origin and quality. Longer-term, they achieve supply chain efficiencies by being able to digitize their supply chains, as well as make decisions with real-time data, and thanks to **LiveAudit®,** which alerts them to product non-compliance as it occurs during production, instead of once a product is in store. Connecting Food founders are also firm believers in male-female parity and have hired accordingly within the organization. They believe their solution touches on the following SDGs: 1, 2, 3, 9, 10, 11 and 12.

Technology

The platform is powered by blockchain, a technology that enabled Connecting Food to build LiveAudit®, a fully digitalized auditing module. The blockchain allows authentication of each transaction and recording in a tamper-proof manner. Connecting Food has chosen to base their blockchain on Hyperledger Fabric, which is the most used infrastructure in enterprise blockchain applications. Hyperledger Fabric is a private, permission-based blockchain: Connecting Food and other players of the blockchain share the nodes. The advantage of this type of blockchain is that each player

in the network gives their consent to share certain pieces of information, while still allowing other data points to remain confidential (customers, price…). Hyperledger Fabric is supported by the Linux Foundation. LiveAudit® provides real-time traceability of products and audits their quality, ensuring that every promise made to the consumer is kept. The major area of work includes supply chains for all food verticals. LiveAudit® can be used to verify all the specifications of a raw, semi-finished or finished product. This means that instead of physically checking the quality of batches on an ad-hoc basis, or a small sample of the production, LiveAudit® is able to leverage data to perform these quality controls 24/7, in real-time.

History and plans

In 2016/2017 the first employees joined the Connecting Food adventure, with the goal of internalizing development and deploying the platform among the first customers. It joined La Ferme Digitale, the largest AgTech association in France. This same year, Connection Food won an innovation bid launched by Coop Italia – the largest Italian retailer – to trace their organic eggs. 2019 saw the pace quickly accelerating with 15 new customers choosing them to ensure the end-to-end traceability of their products. The technology was rolled out across multiple food chains. The recruitment of additional developers, sales teams and agricultural engineers supported their growth. One of their first big announcements of 2020 was the Connecting Food Community, bringing together the pioneers of the agri-food industry who are committed to transparency. 2020 also saw a new round of funding, even in the midst of the COVID-19 pandemic, bringing the funds raised to over €5 million. This was an important step that allowed the company to accelerate its technological and commercial development and to continue asserting itself as a leader in the food transparency market both in Europe and abroad.

Farmer Expert

Honourable mention

	Farmer Expert			
Applicant:	**Farmer Expert** Abdula Davudov, COO			
Country:	Turkey	Implementation in Turkey		
Website:	https://www.farmerexpert.com/en			
	**Delivery model:**	Free to use; regular service; part of advisory service	**Stage:**	Proven/Scale-up stage

Challenge/context

Farmer Expert decided to provide an access point for farmers, customers and third parties together, where everyone sees everything, including prices, farmer location and other multiple features. In addition, they are currently integrating SMS companies for farmer messaging, opening up a chat section for all farmers to communicate together, adding a brokerage section where customers will purchase from farmers in advance, and additionally requesting price matching if this service is desired. Therefore, their goal was to enable all technologies for farmers for free, where this system would be global.

Description

Farmer Expert provides the technological infrastructure that facilitates traceability and full control at all stages of the supply chain by making it possible for any business to complement the IT it lacks at any stage of the chain. It is, therefore, much more than a platform provider. Consumers care about the traceability of the food they consume and want information about the product's history in a transparent way. Traceability in the FarmerExpert infrastructure using blockchain technology provides very valuable PR potential against competitors and consumers in the market. By seeing where and how much time the products are spending in their supply chain, users can evaluate the best alternatives to manage the procurement process in an optimal way. FarmerExpert makes it possible to see the whole process from the field where the crop is produced to the consumer in just a few seconds. This journey can be examined in detail, so that retailers can only reorder from the suppliers they need, and in the fastest way possible. The platform links all parties in the agricultural business, combining all companies in one place and all of it is free for users. The platform has different sections:

1. Registration of farmers, agronomists, customers, logistics companies (additional modules are being added). All of this is free. Anyone can add as much information as they like for everyone to see. Customers and farmers can buy and sell from each other without intermediaries. The intention is to make this global.
2. The platform is blockchain based, therefore integrations are possible. The API integrates with companies who provide satellite imagery, logistics, door-to-door delivery and others.

3. It integrates the use of fertilizers and companies providing seeds, sprouts and other farming necessities.
4. Farmer Expert has manufactured drones that are being tested for farmers to use.
5. Companies producing juices, organic fertilizers, canned produce and other relevant parties who get ugly fruits and extra produce from farmers are being integrated. The end goal is to make an all-in-one platform for farmers where they receive all benefits of the technology out there for free.

The platform allows all farmers to register for free (there is absolutely no fee for farmers for using the platform, too). It includes agronomists, customers, payment systems, logistics and additional features to integrate within the process of seed to customer and provides farmers with access to everything they need to grow the best produce providing traceability for customers, and currently adding an ugly fruit section, and factories to collect waste from farmers. This platform is blockchain based and has multiple API connections including satellite imagery company.

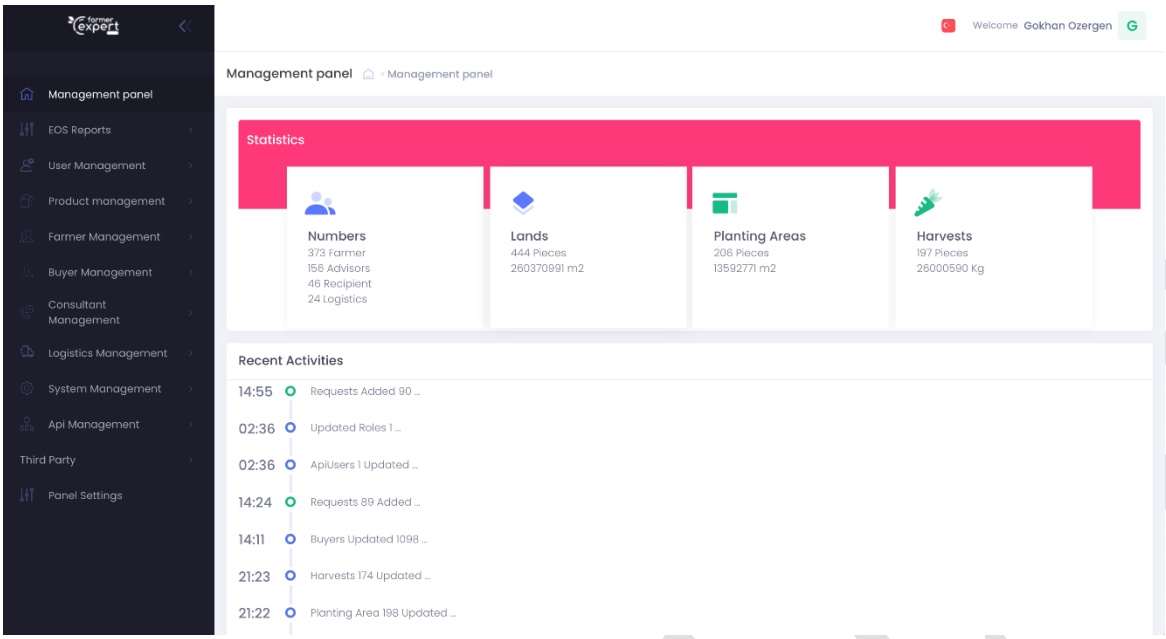
Technology

Farmer Expert has integrated banking software, satellite imagery, delivery companies, accounting software providers and blockchain data.

History and plans

The company opened in 2018, but the work had started in 2014. The platform's latest features will be updated in the coming months with all additional features which are not yet visible on the website, including QR code payment and a lot more. Farmer Expert is adding different features all the time to improve the user experience. Further plans include adding lawyers' help for farmers, testing drones and adding more payment options for farmers. It is the only company in Turkey who has signed an agreement with the UN Technology Bank for least developed countries (LDCs) to implement this technology (Uganda was the first country for implementation).

GrapeTag – A farmer grew the grapes, a customer purchased them. They were delivered to an e-commerce platform in Turkey. Customers get the full traceability of the process in the product.



Admin panel of Farmer Expert

BIOsens Myco

Category champion

BIOSENS	**BIOsens Myco**			
Applicant:	**BIOsens** Andrii Karpiuk, CEO			
Country:	Ukraine	Implementation in Poland, Ukraine		
Website:	https://sens.bio			
	Delivery model:	Regular service; part of advisory service	**Stage:**	Market adoption/Validation stage

Challenge/context

Mycotoxins are toxic compounds naturally produced by certain types of moulds. They are a significant food safety concern in agriculture affecting 25 percent of the global food supply with annual losses of food reaching 1 billion tons. Contaminated food and feed products represent a major threat to human health. While mycotoxins can occur at any point of the value chain, market players do not have an ability to check mycotoxins containment rapidly on-site and get accurate reliable quantitative results to prevent future losses. BIOsens rapid mycotoxins testing, and prediction tool addresses important global food safety issues, namely human health losses and economic costs.

Description

To help industry players to maintain the required consistently high level of quality and safety of food and feed, BIOsens developed a precise, portable, rapid mycotoxins detection device – the **Mycotoxin Prediction Tool**. From the farm to the fork, BIOsens helps clients to reduce the risk of mycotoxins contamination and avoid associated losses. Its unique proprietary solution is the first to provide an automated way to prepare samples of plants (e.g. corn, wheat) and analyse the content of mycotoxins within 21 minutes. A breakthrough in device architecture allows automated sample preparation. Tests are conducted onsite with laboratory accuracy and the time required for analysis is reduced by dozens of times in comparison to laboratory tests. As testing using BIOsens can be conducted by non-professionals, it allows market players to easily perform the test themselves and avoid using costly laboratory services. Moreover, the BIOsens AI-based software solution can predict mycotoxin contamination areas, so agriculture market players (e.g. farmers) can prevent crop contamination.

Technology

Technically, the BIOsens solution consists of two components:

1. a unique hardware solution – a portable electromechanical device 40x25x15cm in size with disposable cartridges with reagents and a developed software solution; and
2. a mobile app and web platform to securely store data, analyse it and make predictions powered by AI algorithms.

The unique structure of the device allows it to run the whole mycotoxins testing process within only 21 minutes, reducing the time required for food analysis by dozens of times compared to existing solutions. The device provides both qualitative (whether the product contains mycotoxins) and quantitative (how much mycotoxin is in the product) analysis. The BIOsens testing device automatically conducts the process of crops analyses:

1. Sampling and milling.
2. Sample preparation.
3. Analysis – an integrated fluorimeter is turned on and measurements are conducted. A sensor detects fluorescence signals from the analyte in a specific spectral range.
4. Results delivery – qualitative and quantitative results appear on the BIOsens screen and are delivered to the customer's web platform or mobile app.

The software part of the BIOsens mycotoxin testing solution consists of mobile and web applications. The mobile app was designed for storage of analysis results and other details of tests conducted. To bring more value to the clients, the BIOsens team included a unique mycotoxin occurrence forecasting function together with an alert system for users to prevent massive contamination of crops based on advanced ML methods. All the data transferred to the mobile app, or the web platform is analysed by ML methods to increase the accuracy of prediction.

History and plans

BIOsens started to work on the device in 2016 with different approaches and device` prototypes. Finally, to validate the current device technology and unique value proposition (UVP), as well as identify target users, the BIOsens team conducted numerous in-depth interviews and meetings with market players involved in the different stages of the agricultural value chain in all key markets. The team identified pain points for each type of potential customer and ranked all market players according to the intensity of their needs, which could be efficiently addressed by BIOsens. At the end of 2020, BIOsens had finalized a device testing Ochratoxin (OTA) and the team had conducted in-house validation of the device. The team also tested the device with agricultural companies Agroprosperis and Agro Smart Lab and received successful results which validated the device's accuracy. A mycotoxin testing market analysis was conducted by type, technology, sample and region which allows us to identify the attractive opportunities in the market by determining the largest and fastest-growing segments across the key regions. After solution finalization, the company plans to validate it inhouse as well as by independent globally respected organizations such as AOAC International or the Federal Grain Inspection Service (FGIS). In the first half of 2021 BIOsens continued piloting a market-ready device with several crop producers and sold the first batch for beta testers.

Biosens portable electromechanical device

4. Conclusions and recommendations

Farmers, and more broadly, the entire agricultural sector, have evolved increasingly towards the use of digital tools, products, and services over the last 3–5 years. This trend is reflected in the large number of proposals submitted for the Digital Excellence in Agriculture in Europe and Central Asia – Call for Good practices and the number of topics and technologies covered by the applicants. The scope of digital tools is widening and covers the whole supply chain, be it skills development, precision agriculture, market access or food waste reduction.

State-of-the-art technologies are being implemented and used to create and develop services and applications. It is worth noting that there are also examples of the use of more traditional digital solutions (e.g. social media marketing and interactive websites from virtual tours), which show that the rapid introduction of the latest technology is not always the only innovative way to solve problems in a given environment or situation. More and more businesses and start-ups are entering the field, while many of them have been around for decades, continually improving their products and services by incorporating the latest technologies. NGOs and public organizations are also launching digitalization programmes and the academic sector (especially in Europe) benefits from comprehensive research and innovation projects for the development of agricultural digitalization.

The most commonly used emerging technologies embrace AI, big data/databases, IoT, agricultural robots and financial technologies. Generally speaking, AI is the application of computer science to datasets to solve problems; the technology can be used in agriculture in many aspects, for example to identify weeds (differentiate between weeds and crops) or animals behaving out of the ordinary. But the technology can also support the autonomous navigation of robots. Artificial intelligence is based on processing data, in some cases using big data. In general, big data refers to data sets with sizes that are too large for commonly used software tools to capture, curate, manage and process within a reasonable time. This also shows that the collection of data (mainly with the use of different sensor equipment) and the exploitation of available data sets (including open public sector data and remotely sensed satellite images) is one of the key factors for digital agriculture. Closely related to this trend, the IoT (interconnected physical and virtual things based on existing and evolving interoperable ICTs mainly with embedded sensors) is proliferating, together with long-range wireless radio technologies, which are enabling communications and data transfer between different devices and systems. Another visible trend in digital agriculture is the appearance (and commercial availability) of different robots.

Many of the autonomous farm machinery devices developed by the applicants are for weed-control purposes. They are usually electronically powered and, in many cases, also try to harness the energy of the sun. Automation is another area targeted by many applicants, especially irrigation automation and the partial (e.g. lighting) or full automation of greenhouse systems (including technologies for vertical farms). Drones have become a hot topic in recent years, and as expectations have subsided, the first concrete services have already emerged that build on this technology. A recent trend of digitalization is the spread of financial technologies, which can also be seen in agriculture. Fintech refers to new methods that improve and automate the delivery and use of financial services. There is also a clear general trend, reflected by the good practices, for service providers to make as many applications as possible available through mobile devices.

In addition to the technologies used by many of the applicants, the potential of digital agriculture is demonstrated by the fact that technologies and concepts such as blockchain (to manage the supply chain transparently in a digital way), gamification (e.g. to make learning and training comparable to a game experience thus, motivate and engage the user), chatbots (mainly for customer service, routing requests, and transferring information) and augmented reality (enhancing the real-world environment and existing services with virtual information) are also starting to take root.

To make the best use of the potential of digital technologies, it is worth taking a detailed look at the difficulties and problems faced by those developing such products and services, as it can provide helpful information and guidance for decision-makers on possible points of intervention. The most typical challenges mentioned by the applicants can be grouped in four thematic groups and recommendations can be made in all four areas that can help digital agriculture to reach its potential:

1. **Technological difficulties** – challenges related to the building and operation of digital tools, products and services. These challenges include connectivity issues and the lack of sufficient network coverage in rural areas; preparing digital equipment for harsh conditions that characterize agriculture (e.g. physical stress, increased wear and tear, and exposure to dust, heat and weather); ensuring the power supply of the different devices, as it is often not feasible to continuously and easily replace batteries; the development of sufficiently clear, intuitive user-friendly interfaces to applications and tools; the difficulty to merge the different solutions into a single service or product, as practices are usually characterized by a combination of many new technologies available, and a certain level of technological complexity.
   Recommendations:
   - Regulators and policymakers should pursue the deployment of rural broadband infrastructure by finding incentives and forms of support tailored to the specifics of a given country/region and its telecoms market. Possible interventions include the easing of the regulatory requirements for community network operators, promoting tax and customs duty breaks to enable more investment, enhancing transparency and ease of doing business, and also focusing on complimentary access networks that service underserved markets.
   - Supporting the adoption of different technological standards can facilitate the development of complex services and the interconnectivity of devices. Governments as technology users themselves can also influence the direction of technological development and user requirements.

2. **Policy issues** – problems and difficulties, which affect policy, regulation, and the functioning of the agri-innovation ecosystem. Developers and providers of digital agricultural products and services often state that there is a lack of funding programmes for agricultural start-ups. Digital agriculture innovations should receive more direct support, as they have significant social and environmental benefits. Limited communication between different stakeholders in the agricultural innovation ecosystem can also hinder the development of services. As is clear from most practices, data is one of the most important components of digital agriculture, and its use can be hampered by a number of factors (lack of interoperability-related regulations or comprehensive open data policies, low adoption of different information management standards, data ownership, etc.), also affecting the quality of available public data sources.

Recommendations:

- Governments can benefit from the development, realization and continuous monitoring of an e-agriculture strategy to review and coordinate the various disciplines needed to develop digital agriculture and implement a coherent policy. The realization of a clear and comprehensive strategy can create a predictable regulatory environment with rules and regulations fitting everyday practices.
- Policymakers can initiate digital agriculture start-up/entrepreneurship support programmes, giving them the opportunity by the usage of the right conditions to push developments in the direction that best suits society and the needs of the country. The design of the most appropriate measures, their structures and their operational mechanisms can be a challenge, but an essential part of the process. Other, softer form of support actions (e.g. easy creation of businesses, supporting tax policies, subsidized finance/loans, coaching/mentoring programmes) can also be considered.
- The creation and the continuous review of the relevant legal environment should take into account global challenges and frameworks and other countries' responses to those challenges, to make cross-country service provision easier and also facilitate joint activities.
- Comprehensive data governance is essential for a properly working digital agriculture ecosystem, including interoperability regulation, the implementation and reinforcement of data management standards, while clearly outlined policies should be formulated by governments on access and (re)use of public administration data and regulations have to cover data ownership and data protection.
- Innovation and R&D policy should include initiatives encouraging knowledge transfer and cooperation, making the communication flawless among different actors (e.g. improve researcher-developer or farmer-developer dialogues) enabling co-design and co-creation.

3. **Commercialization** – challenges in scaling up a digital agriculture products and services. One of the main obstacles for service providers is to find the right business models that fit the needs of the farmers and service providers. The diversity of farmers and farms in the agricultural sector presents a significant challenge for service providers, as there is no single one-size-fits-all solution and business model that can be applied to all situations. One of the many data-related issues is the ownership and commercialization of farmer data, where the lack of rules and regulations can influence the take-up of digital agricultural services in a negative way. Scaling up different products and services to a regional or global level is one of the biggest steps for service providers, partly because of different regulations, language barriers, but also because of organizational development necessities and logistical challenges, and possibly cultural factors.

   Recommendations:

   - The issues of data privacy and ownership are relevant in this respect. Rules and regulations need to ensure the protection of farmers' data, as it can also build trust in digital agriculture applications.
   - Agricultural extension and advisory service providers can play a significant role in mediating between farmers (especially smallholder farmers) and service providers to realize relationships that are mutually beneficial.

- Governments can support agricultural start-ups to enter regional/international markets (e.g. by a harmonized legal environment, providing opportunities to take part in different promotional and marketing programmes abroad).

4. **Human aspects** – challenges relating to the digital skills, mentality and attitude of farmers and the shortage of workers. The low level of digital skills among farmers and the lack of digital infrastructure and tools is one of the most frequently cited barriers to the uptake of digital farming tools. The difficulty of proving a clear return on investment is to be addressed, as farmers expect clear evidence of the usefulness of a tool or service before they start using it. Low awareness of up-and-coming technologies is to be dealt with, as the specificities and benefits of the rapidly changing technological environment are unfamiliar to many farmers. Digital agriculture tools also face a significant challenge of complexity, being hard to measure their exact utility and difficult to test them; language is also an important factor in ensuring access to services, therefore localization of products is essential. Developing digital agriculture products and services requires a broad and diverse set of skills. Service providers often face the problem of not finding the right specialist for a certain task.
   Recommendations:
   - Ensure that different groups of farmers have access to existing programmes for the development of digital skills, and that the farmers' needs and the factors keeping them away from training opportunities (seasonality, limited travel capabilities in rural areas, etc.) are not overlooked during the design of such initiatives.
   - Review and make sure that knowledge of agricultural digitalization is sufficiently reflected in curricula at all levels of agricultural education and other related disciplines (including the development of digital skills and digital agriculture related knowledge of public servants).
   - Facilitate and promote the diffusion of digital technology in agriculture. Preference should be given to formats (e.g. demonstration facilities) that give farmers the opportunity to gain direct, hands-on experience and the possibility to build relationships with service providers.

Beyond the difficulties and challenges mentioned, a significant number of issues related to the COVID-19 pandemic. Three difficulties in this area are worth noting in particular. The first is the limited possibility to organize face-to-face training. Capacity building is a key driver for the uptake of digital farming tools, largely made impossible by distance rules and lockouts. They also resulted in the loss of personal contact, and in the limited possibility of conversations with farmers, an important source of feedback for developers and service providers. The pandemic has also negatively affected production capacities and supply chains, leading to shortages of various digital products and components. Nevertheless, COVID-19 has highlighted the benefits and potential of digital technologies as well. The task at hand for the near future is to maintain this momentum and to develop flexible, expanding digital agriculture ecosystems that best respond to the challenges identified and meet the needs of farmers and society as a whole.

To achieve the widespread use of technologies across the agricultural sector, many challenges remain to be addressed. While the main connectivity indicators have been on a rise in the regions over recent years, rural areas remain underserved. More needs to be done in terms of accessibility and

affordability. In addition, the growing complexity of technologies in use requires up-to-date and continuous information and digital skills, which can be even more critical for farmers in specific locations and conditions.

The ITU is committed to addressing such challenges, which are embedded in its core priorities, specifically the ITU Regional Initiatives for Europe and CIS on:

- Broadband infrastructure, broadcasting and spectrum management.
- Accessibility, affordability and skills development for all to ensure digital inclusion and sustainable development.
- Development and regulation of infocommunication infrastructure to make cities and human settlements inclusive, safe and resilient.
- Citizen-centric approach to building services for national administrations.
- Information and communication technology-centric innovation ecosystems.
- Fostering innovative solutions and partnership for the implementation of Internet of things technologies and their interaction in telecommunication networks, including 4G, IMT-2020 and next-generation networks, in the interests of sustainable development.

These challenges require the concerted effort of all players in digital agriculture. The ITU and FAO are committed to intensify collaboration and implement actions at the regional and national levels to enhance the role of ICTs in agriculture.